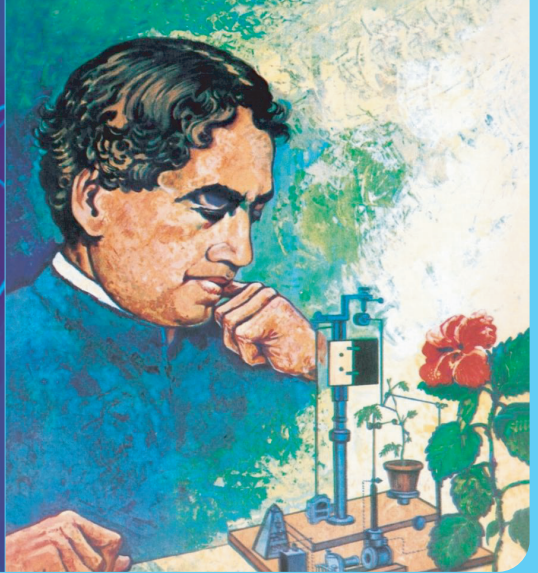
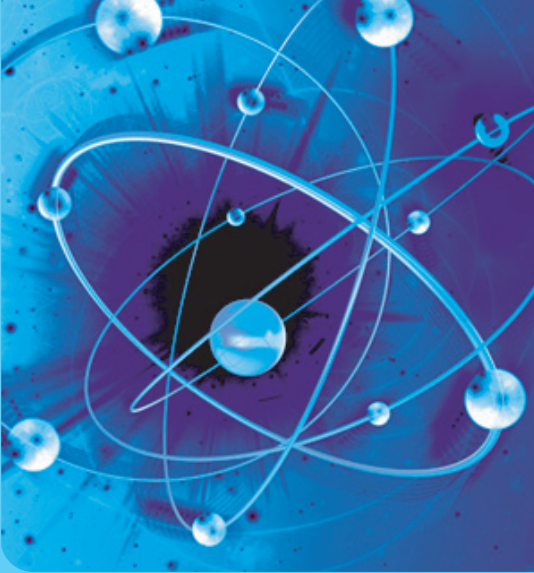
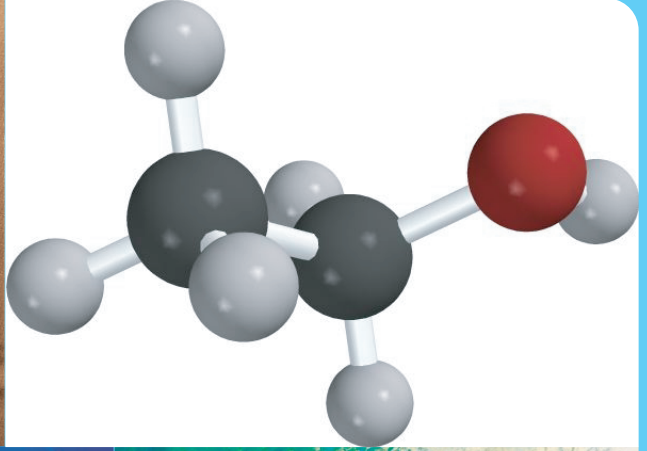
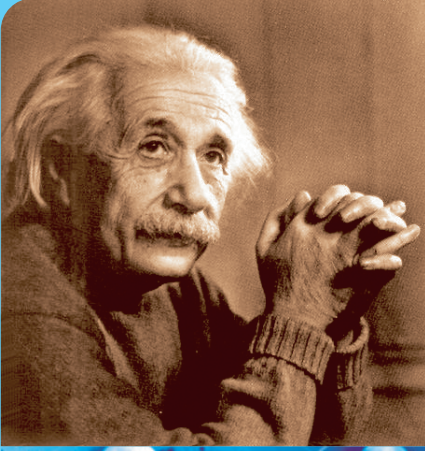


# পদার্থবিজ্ঞান

নবম-দশম শ্রেণি



জাতীয় শিক্ষাক্রম ও পাঠ্যপুস্তক বোর্ড, ঢাকা

জাতীয় শিক্ষাক্রম ও পাঠ্যপুস্তক বোর্ড কর্তৃক ২০১৩ শিক্ষাবর্ষ  
থেকে নবম-দশম শ্রেণির পাঠ্যপুস্তকরূপে নির্ধারিত

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# পদার্থবিজ্ঞান

নবম-দশম শ্রেণি

## রচনা

ড. শাহজাহান তপন

ড. রানা চৌধুরী

ড. ইকরাম আলী শেখ

ড. রমা বিজয় সরকার

## সম্পাদনা

ড. আলী আসগর



# জাতীয় শিক্ষাক্রম ও পাঠ্যপুস্তক বোর্ড

৬৯-৭০, মতিঝিল বাণিজ্যিক এলাকা, ঢাকা

কর্তৃক প্রকাশিত

[ প্রকাশক কর্তৃক সর্বস্বত্ত্ব সংরক্ষিত ]

পরীক্ষামূলক সংস্করণ

প্রথম প্রকাশ : অক্টোবর- ২০১২

পাঠ্যপুস্তক প্রণয়নে সমন্বয়ক

মোঃ মোখলেস উর রহমান

কম্পিউটার কম্পোজ

লেজার স্ক্যান লিমিটেড

প্রচ্ছদ

সুদর্শন বাহার

সুজাউল আবেদীন

চিত্রাঙ্কন

মোঃ হাসানুল কবীর সোহাগ

ডিজাইন

জাতীয় শিক্ষাক্রম ও পাঠ্যপুস্তক বোর্ড

সরকার কর্তৃক বিনামূল্যে বিতরণের জন্য

## প্রসঙ্গ-কথা

শিক্ষা জাতীয় জীবনের সর্বতোমুখী উন্নয়নের পূর্বশর্ত। আর দ্রুত পরিবর্তনশীল বিশ্বের চ্যালেঞ্জ মোকাবেলা করে বাংলাদেশকে উন্নয়ন ও সমৃদ্ধির দিকে নিয়ে যাওয়ার জন্য প্রয়োজন সুশিক্ষিত জনশক্তি। ভাষা আন্দোলন ও মুক্তিযুদ্ধের চেতনায় দেশ গড়ার জন্য শিক্ষার্থীর অন্তর্নিহিত মেধা ও সম্ভাবনার পরিপূর্ণ বিকাশে সাহায্য করা মাধ্যমিক শিক্ষার অন্যতম লক্ষ্য। এছাড়া প্রাথমিক স্তরে অর্জিত শিক্ষার মৌলিক জ্ঞান ও দক্ষতা সম্প্রসারিত ও সুসংহত করার মাধ্যমে উচ্চতর শিক্ষার যোগ্য করে তোলাও এ স্তরের শিক্ষার উদ্দেশ্য। জ্ঞানার্জনের এই প্রক্রিয়ার ভিতর দিয়ে শিক্ষার্থীকে দেশের অর্থনৈতিক, সামাজিক, সাংস্কৃতিক ও পরিবেশগত পটভূমির প্রেক্ষিতে দক্ষ ও যোগ্য নাগরিক করে তোলাও মাধ্যমিক শিক্ষার অন্যতম বিবেচ্য বিষয়।

জাতীয় শিক্ষানীতি-২০১০ এর লক্ষ্য ও উদ্দেশ্যকে সামনে রেখে পরিমার্জিত হয়েছে মাধ্যমিক স্তরের শিক্ষাক্রম। পরিমার্জিত এই শিক্ষাক্রমে জাতীয় আদর্শ, লক্ষ্য, উদ্দেশ্য ও সমকালীন চাহিদার প্রতিফলন ঘটানো হয়েছে, সেই সাথে শিক্ষার্থীদের বয়স, মেধা ও গ্রহণক্ষমতা অনুযায়ী শিখনফল নির্ধারণ করা হয়েছে। এছাড়া শিক্ষার্থীর নৈতিক ও মানবিক মূল্যবোধ থেকে শুরু করে ইতিহাস ও ঐতিহ্য চেতনা, মহান মুক্তিযুদ্ধের চেতনা, শিল্প-সাহিত্য-সংস্কৃতিবোধ, দেশপ্রেমবোধ, প্রকৃতি-চেতনা এবং ধর্ম-বর্ণ-গোত্র ও নারী-পুরুষ নির্বিশেষে সবার প্রতি সমমর্যাদাবোধ জাগ্রত করার চেষ্টা করা হয়েছে। একটি বিজ্ঞানমনস্ক জাতি গঠনের জন্য জীবনের প্রতিটি ক্ষেত্রে বিজ্ঞানের স্বতঃস্ফূর্ত প্রয়োগ ও ডিজিটাল বাংলাদেশের রূপকল্প-২০২১ এর লক্ষ্য বাস্তবায়নে শিক্ষার্থীদের সক্ষম করে তোলার চেষ্টা করা হয়েছে।

নতুন এই শিক্ষাক্রমের আলোকে প্রণীত হয়েছে মাধ্যমিক স্তরের প্রায় সকল পাঠ্যপুস্তক। উক্ত পাঠ্যপুস্তক প্রণয়নে শিক্ষার্থীদের সামর্থ্য, প্রবণতা ও পূর্ব অভিজ্ঞতা গুরুত্বের সঙ্গে বিবেচনা করা হয়েছে। পাঠ্যপুস্তকগুলোর বিষয় নির্বাচন ও উপস্থাপনের ক্ষেত্রে শিক্ষার্থীর সৃজনশীল প্রতিভার বিকাশ সাধনের দিকে বিশেষভাবে গুরুত্ব দেওয়া হয়েছে। প্রতিটি অধ্যায়ের শুরুতে শিখনফল যুক্ত করে শিক্ষার্থীর অর্জিতব্য জ্ঞানের ইজ্জাত প্রদান করা হয়েছে এবং বিচিত্র কাজ, সৃজনশীল প্রশ্ন ও অন্যান্য প্রশ্ন সংযোজন করে মূল্যায়নকে সৃজনশীল করা হয়েছে।

সভ্যতার শুরু থেকেই প্রযুক্তি বিকাশের যে অধ্যায় শুরু হয়েছে তার সাথে পদার্থবিজ্ঞান ওতপ্রোতভাবে জড়িত। প্রকৌশলশাস্ত্র, চিকিৎসা-বিজ্ঞান, জ্যোতির্বিজ্ঞান, সমুদ্রবিজ্ঞান, জীববিজ্ঞান, মনোবিজ্ঞান সর্বত্র পদার্থবিজ্ঞানের পন্থিতি ও যন্ত্রপাতির প্রভূত ব্যবহার রয়েছে। মূলত এ বিষয়গুলোকে সামনে রেখেই পদার্থবিজ্ঞান পাঠ্যপুস্তকটি প্রণয়ন করা হয়েছে। এছাড়া পাঠ্যপুস্তকটি রচনায় আমাদের চারপাশে সংঘটিত বিভিন্ন ঘটনার আলোকে পদার্থবিজ্ঞানের তাত্ত্বিক দিকগুলো ব্যাখ্যা করা হয়েছে। পাশাপাশি বিভিন্ন অনুসন্ধানমূলক কার্যক্রমের মাধ্যমে বিষয়টির ব্যবহারিক গুরুত্ব তুলে ধরা হয়েছে। এই পাঠপরিকল্পনা শিক্ষার্থীকে ভবিষ্যতে এ বিষয় সম্পর্কে আরও বেশি আগ্রহী হতে অনুপ্রাণিত করবে।

একবিংশ শতকের অঙ্গীকার ও প্রত্যয়ে সামনে রেখে পরিমার্জিত শিক্ষাক্রমের আলোকে পাঠ্যপুস্তকটি রচিত হয়েছে। কাজেই পাঠ্যপুস্তকটির আরও সমৃদ্ধিসাধনের জন্য যে কোনো গঠনমূলক ও যুক্তিসঙ্গত পরামর্শ গুরুত্বের সঙ্গে বিবেচিত হবে। পাঠ্যপুস্তক প্রণয়নের বিপুল কর্মযজ্ঞে অতি স্বল্প সময়ের মধ্যে পুস্তকটি রচিত হয়েছে। ফলে কিছু ভুলত্রুটি থেকে যেতে পারে। পরবর্তী সংস্করণগুলোতে পাঠ্যপুস্তকটিকে আরও সুন্দর, শোভন ও ত্রুটিমুক্ত করার চেষ্টা অব্যাহত থাকবে। বানানের ক্ষেত্রে অনুসৃত হয়েছে বাংলা একাডেমী কর্তৃক প্রণীত বানানরীতি।

পাঠ্যপুস্তকটি রচনা, সম্পাদনা, চিত্রাঙ্কন, নমুনা প্রশ্নাদি প্রণয়ন ও প্রকাশনার কাজে যারা আন্তরিকভাবে মেধা ও শ্রম দিয়েছেন তাঁদের ধন্যবাদজ্ঞাপন করছি। পাঠ্যপুস্তকটি শিক্ষার্থীদের আনন্দিত পাঠ ও প্রত্যাশিত দক্ষতা অর্জন নিশ্চিত করবে বলে আশা করি।

প্রফেসর মোঃ মোস্তফা কামালউদ্দিন

চেয়ারম্যান

জাতীয় শিক্ষাক্রম ও পাঠ্যপুস্তক বোর্ড, ঢাকা

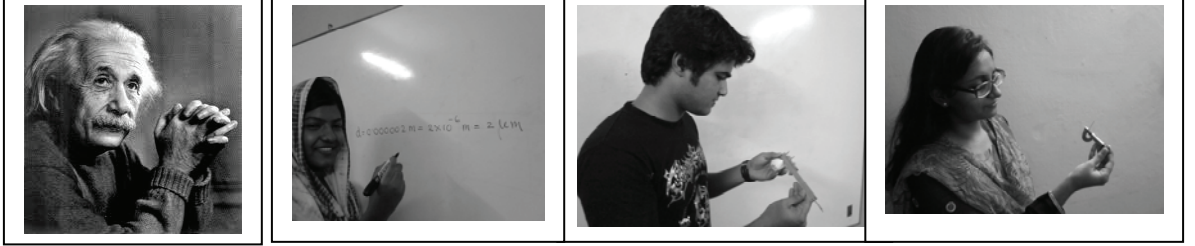
# সূচিপত্র

অধ্যায়	বিষয়বস্তু	পৃষ্ঠা
প্রথম	ভৌত রাশি ও পরিমাপ	১
দ্বিতীয়	গতি	২৬
তৃতীয়	বল	৪৮
চতুর্থ	কাজ, ক্ষমতা ও শক্তি	৬৮
পঞ্চম	পদার্থের অবস্থা ও চাপ	৮৭
ষষ্ঠ	বস্তুর উপর তাপের প্রভাব	১০০
সপ্তম	তরঙ্গ ও শব্দ	১১৪
অষ্টম	আলোর প্রতিফলন	১২৬
নবম	আলোর প্রতিসরণ	১৪২
দশম	স্থিরতড়িৎ	১৬০
একাদশ	চল তড়িৎ	১৭৫
দ্বাদশ	তড়িৎের চৌম্বক ক্রিয়া	১৯৮
ত্রয়োদশ	আধুনিক পদার্থবিজ্ঞান ও ইলেকট্রনিক্স	২০৯
চতুর্দশ	জীবন বাঁচাতে পদার্থবিজ্ঞান	২২৭

## প্রথম অধ্যায়

# ভৌত রাশি ও পরিমাপ

## PHYSICAL QUANTITIES AND MEASUREMENT



[বিজ্ঞান আমাদের নিত্যসঙ্গী। আমাদের দৈনন্দিন জীবনের প্রতিটি কাজে বিজ্ঞান ওতপ্রোতভাবে জড়িত। ভোরের টুথপেস্ট থেকে শুরু করে সারা দিনের ইন্টারনেট, মোবাইলসহ রাতের টেলিভিশন সবই বৈজ্ঞানিক আবিষ্কারের ফসল। বিজ্ঞান মানব জীবনকে করেছে সুন্দর ও সমৃদ্ধ, বাড়িয়ে দিয়েছে আরাম-আয়েশ এবং সুখ স্বাচ্ছন্দ্য। কিন্তু বিজ্ঞানের এই সমৃদ্ধি একদিনে সম্ভব হয়নি। প্রাচীনকাল থেকে অগণিত বিজ্ঞানীর নিরলস সাধনার ফলে বিজ্ঞান আজকের এই অবস্থানে এসে দাঁড়িয়েছে। এই অধ্যায়ে আমরা সেই প্রাচীনকাল থেকে শুরু করে ভৌতবিজ্ঞানের বিশেষ করে পদার্থবিজ্ঞানের বিকাশের একটি সর্থক্ষিপ্ত অথচ ধারাবাহিক ইতিহাস বর্ণনার মাধ্যমে সেই সব নিবেদিতপ্রাণ বিজ্ঞানীদের কাজের সাথে পরিচয় ঘটানোর চেষ্টা করব।

আমাদের দৈনন্দিন জীবনে প্রায় প্রতিটি কাজের সাথে মাপ-জোখের ব্যাপারটি জড়িত। এই মাপ-জোখের বিষয়টাকে বলা হয় পরিমাপ। পদার্থবিজ্ঞানের প্রায় সকল পরীক্ষণেই বিভিন্ন রাশি পরিমাপ করতে হয়। এই অধ্যায়ে আমরা পরিমাপ, পরিমাপের একক, এককের আন্তর্জাতিক পদ্ধতি, পরিমাপের বিভিন্ন যন্ত্র ও এদের ব্যবহার আলোচনা করব।]

### এই অধ্যায় পাঠ শেষে আমরা—

১. পদার্থবিজ্ঞানের পরিসর ও ক্রমবিকাশ ব্যাখ্যা করতে পারব।
২. পদার্থবিজ্ঞান পাঠের উদ্দেশ্য বর্ণনা করতে পারব।
৩. স্থান ও কালের ধারণা ব্যাখ্যা করতে পারব।
৪. ভৌত রাশি [মান এবং এককসহ] পদার্থবিজ্ঞানের মূল ভিত্তি ব্যাখ্যা করতে পারব।
৫. পরিমাপ ও এককের প্রয়োজনীয়তা ব্যাখ্যা করতে পারব।
৬. মৌলিক রাশি ও লব্ধ রাশির পার্থক্য ব্যাখ্যা করতে পারব।
৭. পরিমাপের আন্তর্জাতিক একক ব্যাখ্যা করতে পারব।
৮. রাশির মাত্রা হিসাব করতে পারব।
৯. এককের উপসর্গের গুণিতক ও উপগুণিতকের রূপান্তরের হিসাব করতে পারব।
১০. বৈজ্ঞানিক পরিভাষা, প্রতীক এবং চিহ্ন ব্যবহার করে পদার্থবিজ্ঞানের ধারণা এবং তত্ত্বকে প্রকাশ করতে পারব।
১১. যন্ত্রপাতি ব্যবহার করে ভৌতরাশি পরিমাপ করতে পারব।
১২. পরিমাপে যথার্থতা, নির্ভুলতা ও সূক্ষ্মমান বজায় রাখার কৌশল ব্যাখ্যা করতে পারব।
১৩. সরল যন্ত্রপাতি ব্যবহার করে বস্তু র ক্ষেত্রফল ও আয়তন নির্ণয় করতে পারব।
১৪. দৈনন্দিন জীবনে ব্যবহৃত বস্তুসামগ্রীর দৈর্ঘ্য, ভর, ক্ষেত্রফল ও আয়তন নির্ণয় করতে পারব।

## 1.1 c`v\_ŕĖÁvb

### Physics

ŕĖÁvĕbi th kvLvq c`v\_ŕĖÁvb kŕ³ ŵbĕq AvĕjvPbv Kiv nq ĩmB kvLvĕK ejv nq c`v\_ŕĖÁvb | c`v\_ŕĖÁvĕbi gj j Ȧ nĕ"Q chĕȦY, cixȦY I ŵĕkĭȦYi AvĕjvĕK e` I kŕ³ i ĩcŕšĭ I mᄁúK©D`NvUb Ges cŵi gŕYmZfĕte Zv cĕKĭk Kiv |

c`v\_ŕĖÁvĕbi cŵi mi

ŕĖÁvĕbi PŵĕKŵV ntĭjv c`v\_ŕĖÁvb | c`v\_ŕĖÁvb nĕ"Q ŕĖÁvĕbi GKŵU tgšĭj K kvLv ĩKbbv Gi bŵmZ, ĩjvB ŕĖÁvĕbi Ab`vb` kvLvmgĕni ŵfŵĖ ĤZŵi KĭĭĕQ | D`vniY Ĥĕc, kŕ³ i msi ȦYkxj Zv bŵmZ nĕ"Q c`v\_ŕĖÁvĕbi GKŵU gj bŵmZ hv nĕ"Q cigŕYȦ MVb ĩĕK ĭi" Kĭi Avenĭl qŕi cĕffŕm `vb chš-ŕĖÁvĕbi ŕĖĭZ GjvKvi gj ŵfŵĖ | cĕšKj kvĕ ĩĕK ĭi" Kĭi ŵPŵKŕmŕ ŕĖÁvb, ĩR`ŵmZŕĖÁvb ĩĕK ĭi" Kĭi mgȦŕĖÁvb, RxŕĖĖÁvb ĩĕK ĭi" Kĭi gtĕŵĖÁvb mĕŦ c`v\_ŕĖÁvĕbi cŕŵmZ I hšĕcŵmZi cĕfZ e`envi ĩĕqĕQ | cVb cŵĕbi mȦeavi Rb` c`v\_ŕĖÁvbĕK Avgiv cĕvbZ ŵbĕŵĕ³ kvLv, ĩjvĕZ fŵM KĭĕZ cŵi : (1) ejŕĖÁvb (2) Zŕc I ZŕcMŵmZŕĖÁvb (3) kĕŕĖÁvb (4) AvĕjvKŕĖÁvb (5) ZŵoZ ĩPšĕ^KŕĖÁvb (6) KŵVb Ae`vi c`v\_ŕĖÁvb (7) cŕi gŕYŵĕK c`v\_ŕĖÁvb (8) ŵbDKxq c`v\_ŕĖÁvb (9) ĩKŕqŵUvg c`v\_ŕĖÁvb (10) Bĕj KUŵb. BZ`ŵ |

c`v\_ŕĖÁvĕbi ŵgŵĕKĭk

AvĕjbK mF`Zv ŕĖÁvĕbi dmj | ŕĖÁvĕbi GB AMŵmZi ĩcQĕb ĩĕqĕQ ŕĖÁvbĕĕ i AKŕš-cŵi kĕĭ, bŕbv Aŵĕ<vi I D`ŵĕb | ŕĖÁvĕbi ĩKŕĕbv RvZxq ev ĩvR%bŵmZ Kxgv ĩbB | ŕĖÁvĕbi DbŵZ, mgŕŕ I Kĭ`Y mKj RŵmZi mKj gŕbĕĭi Rb` | cĕPŕbKj ĩĕKB ŕĖÁvbĕiv ŕĖÁvĕbi Dbĕĕb Ae`vb ĩĕL AvĕĕQb | Avgiv GB Abĕ"Qĕ` c`v\_ŕĖÁvbĕĕ i Ae`vb Zĕj aiĕZ ĩPóv Kie | ĩŵj m (ŵL÷ce©624-569) mĕŵŵY mᄁúŵKZ fŵĖl ŐŕYxi Rb` ŵĖL`vZ | ŵZŵb ĩjŵĕ÷ĕbi ĩPšĕ^K ag©mᄁúĕKŦ RvbĕZb | ŕĖÁvĕbi BŵZŕŕĕm ŵc\_ŕĕMŕm (ŵL÷ce©527Ũ497) GKŵU Ĥŕi Yxq bvg | ŵĕŕfĕĕR`ŵgŵZK Dccŕ` Qŕovl Kᄁúgvb Zŕĭi Dci Zŵi KvR AŵaK `vqx Ae`vb ĩvLĕZ mȦg nĕqŵQj | eZĕĕb ev Ĥšĕ I msMxZ ŵĕl qK th ĩ`<j ĩĕqĕQ Zv Zŕĭi Kᄁúb ŵĕl qK Zŵi AbȦŵĕbi AvŵĕK Ae`vb |

ŵŵK `vkĕbK ĩŵĕgŵŵUŵm (ŵL÷ce©460-370) avi Yv ĩ`b th c`ŕĕ\_P Aŵĕŕŕ` GKK ĩĕqĕQ | ŵZŵb GĕK bvg ĩ`b GUg ev cigŕYȦ | cŕi gŕYmᄁúĕK©Zŵi GB avi Yv eZĕĕb avi Yvi ĩPĕq mᄁúY©Avĕv`v ntĭj I tek ZŕrchĕYŦ ŵŵK ŕĖÁvbŕ AŵKĕgŵŵm (ŵL÷ce©287-212) ŵj fŕĕi bŵmZ I Ziĕj ŵbgrᄁ4Z e` i Dci ŵŵqŕkxj EaȦȦLx etĭi mĕ Aŵĕ<vi Kĭi avZi ĩfRvj ŵbYŦq mȦg nb | ŵZŵb ĩMj xq `cŦYi mŕŕŕĕh` mĕhŦ ĩŵĕĕĕK`ĕfZ Kĭi Av, b aiĕbvi ĩšKj I RvbĕZb |

AŵKĕgŵŵĕmi ci KĕqK kZŕĕxKvj ĕĖÁvbK Aŵĕ<vi gš`i MŵZĕZ Pĕj | cĕKZĕȦĦ ĩĕqĕ`k kZŕĕxi cĕĕ BDĕĕĕĕ ĕĖÁvbK AbȦŵĕŕmŕi cĕRĕĕb Nĕŵb | GB mgq cŵĕg BDĕĕĕxq mF`Zv ŵĕkĭ fĕte MĕY KĭiŵQj evBRvbUvB I gȦmj g mF`Zvi Áĕbi avĭ | Avĕiv ŕĖÁvb, MŵYZ, ĩR`ŵmZŕĖÁvb, ĩmŕqb I ŵPŵKŕmŕ ŕĖÁvbĕ



weþkl cvi`kPŕŕQþjb| GB mgq c`v\_ŕeÁvþbi GKŕŕ kvLv AvþjvK ZþĖji tŕŕŕĤ Beþb Avj nvB\_vg (965-1039) Ges Avj nvþRb (965-1038) Gi Ae`vb weþkl Dþj þþhMŕ| Utþwg (127-151) I Ab`vb` cŕPxb weÁvbxiv weþjm KiþZb th tKvþv e` t`Lvi Rb` tPvL vbþR AvþjvK iŕkŕ cvWvq| Avj nvþRb GB gþZi weþiwaZv Kþib Ges eþjb th e` tþK Avgvþ`i tPvL Avþjv Avþm eþjB Avgiv e` þK t`LþZ cvB| AvZŕk KvP vbþq cixŕŕv ZvþK DĖj tþŕŕi AvaybKZþĖji KvQvKwQ vbþq Avþm| Avj Œgvmŕx (896-956) cŕKŕZi BŕZnm mþúþKŕGKŕŕ GbmþBþKŕcwWqv tþþLb| GB eþþq evqKþji Dþj Œ cvlqv hvq| eZŕþb cw\_exi AþbK tþþK GB evqKþji mŕvþh` Zworkw<sup>3</sup> Drcv`b Kiv nt`Q|

iRvi teKb (1214-1294) ŕŕþjb cixŕŕvgjK `eÁwbK cŕŕŕZi cĖ<sup>3</sup>v| Zvi gþZ chŕŕŕŕŕ I cixŕŕvi gŕa`tgB weÁvþbi me mZ` hvPvB Kiv DŕPZ| vj Dvþ`P`v vŕŕŕ (1452Œ1519) cþþiv kZþKi tklw`þK cŕŕLi I ov chŕŕŕŕŕ Kþi DþovRŕvþRi GKŕŕ gþWj `Zvi Kþiŕŕþjb| ŕZvb gjZ GKRb ŕPŕŕŕŕŕ ntþj I ejwe`v mþúþKŕZvi Dþj þþhMŕ Ávb ŕQj| dþj ŕZvb ŕKQzmŕviY hšĖ`ŕŕZvi mþ` Dŕŕŕeb KiþZ mŕŕg nb|

Mŕwj ŕj I -ŕbDUBxq hþM Ges Zvi I Avþm msL`vq Kg ntþj I KþqKRb c`v\_ŕeÁvbx RbMþY Kþib| weÁvþbi AMþvŕvq Zviv Acŕi mxg Ae`vbI iþLb| Wv. Mŕjeŕŕ(1540Œ1603) Pŕ`KZi vbþq we`ŕŕi Z MþeŕYv I ZĖj cŕþþbi Rb` ŕPi`ŕiYxq ntþq AvþQb| Avþjvi cŕZmiþŕi mŕ Awe`<vi Kþib Rvgŕŕbi tmþ (1591-1626)| nvþþMb (1626-1695) t`vj Kxq MŕZ chþjvþv Kþib, Nŕoi hŕšĖK tKšKþji weKvk NUvb Ges Avþjvi Zi½ ZþĖji Dŕŕŕeb Kþib| ierŕŕĖK (1635-1703) c`vþ`ŕ ŕ`ŕZ`ŕcK atþŕ Abŕŕŕŕb Kþib| weŕŕŕŕe Pŕþc Mŕþmi agþei Kivi Rb` cixŕŕv-bŕŕŕŕŕ Pjvþ ierŕŕŕŕŕ (1627-1691)| fb`ŕqŕi K (1602-1686) evqcvþú Awe`<vi Kþib| tivgvi (1644-1710) en`ŕŕZi GKŕŕ DcMþni MþY chŕŕŕŕŕ Kþi Avþjvi teM cŕi gŕc Kþib, ŕKš` Zvi mgmvgŕqK weÁvbxþ`i tKDB weþjm Kþibŕb th Avþjvi teM GZ teŕk ntþZ cvþi|

tKvcŕbŕŕm th tmšþþKŕ`K ZþĖji aviYv Dcw`Z Kþib tKcjvi (1571-1630) tmB aviYvi mŕviY MŕYŕZK eYŕv t`b ŕZbŕŕ mþŕi mŕvþh`| tKcjvþi mvdþþi gj ŕŕŕĖ ntþv, ŕZvb cþwj Z eĖŕKvi Kŕŕcþ\_i cŕieþZŕDceĖŕKvi Kŕŕc\_ Kŕbŕ Kþib| Mþþ`i MŕZc\_ mþúþKŕZvi MŕYŕZK mþ` ŕþjvi mZ`Zv ŕZvb hvPvB Kiþjb Zvi`i` ŕvBþKvettþi (1546-1601) chŕŕŕŕŕ jþ Zþ`i ŕviv|

AvaybK `eÁwbK cŕŕŕZi mPbv NþU BZwj i ŕeL`vZ weÁvbx Mŕwj ŕj i (1564-1642) nvþZ| ŕZvbB cŕg t`Lvþ th chŕŕŕŕŕ, cixŕŕŕ Ges mþ;Lj fŕþe tŕšZ iŕki msÁv cŕvb I Gþ`i gþa` mþúKŕŕŕŕŕŕŕ `eÁwbK Kþŕŕ gj ŕŕŕĖ| MŕYŕZK ZĖjŕbgŕŕ I cixŕŕvi gŕa`tg tm ZþĖji mZ`Zv hvPvþqi `eÁwbK avivi mPbv Kþib Mŕwj ŕj I | Avi Gi cYŕv`vb Kþib ŕbDUB (1642Œ1727)| Mŕwj ŕj I miY, MŕZ, ZþY, mgq BZ`ŕi msÁv cŕvb I Gþ`i gþa` mþúKŕŕŕŕŕŕŕ Kþib| dþj ŕZvb e` i cZþbi vbqg Awe`<vi I mþZŕe`vi ŕŕŕĖ`ŕcb Kþib| ŕbDUB Zvi we`ŕqKi cŕZŕvi ŕviv Awe`<vi Kþib ejwe`v I ejwe`vi ŕeL`vZ ŕZbŕŕ mþ Ges weþRbŕb gŕvKŕŕŕŕ| AvþjvK, Zvc I kþeÁvþbi Zvi Ae`vb AvþQ| MŕYþZi bZb kvLv Kþj vmI Zvi Awe`<vi|

Aóv`k I Ebwesk kZvāxi Awe®<vi I D<sup>m</sup>eb BDtīvc†K wki wec†ei w`†K wbtq hvq| tRgm I qv†Ui (1736–1819) Awe®<Z ev<sup>u</sup>xq BwĀb wki wec†ei t††Ī „i“ZcY<sup>o</sup>fīgKv cjb K†i| n<sup>v</sup>Y w<sup>u</sup>uōqv I†q†÷W (1777–1851) t`Lvb th, Zwor cēvni tPš<sup>α</sup>K w<sup>u</sup>qv Av†Q| GB Awe®<vi gvB†Kj d<sup>v</sup>iv†W (1791–1867), tnbix (1797–1879) I tĴÄ (1804–1865) tK cwi Pwĵ Z K†i tPš<sup>α</sup>K w<sup>u</sup>qv Zwor cēv Drcv`b K†i GB NUbv Awe®<v†i i w`†K| Av†ĵ GwU ntjv hwšZK kw<sup>3</sup>†K Zwor kw<sup>3</sup>†Z šcvš†i cōwqv Awe®<vi |

1864 mv†ĵ tRgm KwK<sup>o</sup>g<sup>v</sup>. I†qj (1831–1879) t`Lvb th Av†jv GK cKvi ZwōZ tPš<sup>α</sup>K Zi½| wZwb Zwor t††Ī I tPš<sup>α</sup>K t††Ī†K GKxfZ K†i ZwōZ tPš<sup>α</sup>K Z†Ēj weKvk NUvb| 1888 mv†ĵ tnbwi L nvR<sup>o</sup> (1857–1894) GKB iKg wewKiY Drcv`b I D<sup>n</sup>Uv K†ib| 1896 mv†ĵ gvK<sup>o</sup>x (1874–1937) G iKg Zi½ e<sup>v</sup>envi K†i Awak `††Z†gvm†Kv†W m†KZ cV†bvi e<sup>v</sup> v K†ib| Zvi I Av†M evOwĵ weÁvbx RM`xk P<sup>o</sup>emy(1858 ņ 1937) ZwōZ tPš<sup>α</sup>K Zi†½i gva`tg GK `v†b t††K Ab` `v†b kw<sup>3</sup> tčŶY Ki†Z m†Ĵg nb| Gf†e teZvi thw†hwm Rbĵv† K†i| Ebwesk kZvāxi t††i i w`†K ib†Rb (1845–1923) G-†i Ges te†K†ij (1852ņ1908) BD†iwbqv†gi tZRw†EqZv Awe®<vi K†ib|

wesk kZvāx†Z c`v\_ŕeÁv†bi we`sqKi AMMwZ N†U| g<sup>v</sup>. cĵv¼ (1858–1947) Awe®<vi K†ib wewKiY mspvš-†KvqvUvg ZĒj| Avj evU<sup>o</sup>AvBb÷vBb (1879–1955) cōvb K†ib Av†cw†K ZĒj| GB `ß ZĒj Av†Mkvi cix†Ĵj ä djvdj†KB iaye`vL<sup>v</sup> K†ib, Ggb fwe†ŶYxl cōvb K†i†Q hv c†i Av†iv cix†Ĵv wbx†Ĵv ņiv cōwYZ nt†Q| Av†b<sup>o</sup> iv`vi†d†W<sup>o</sup> (1871–1937) cigvYw†qK wDKxq ZĒj I bxjm te†i i (1885 ņ 1962) nvB†W†Rb cigvYj B†j KUb `††i i aviYv cigvYweK c`v\_ŕeÁv†bi AZ`š-„i“ZcY<sup>o</sup>avc wQj |

cieZ<sup>o</sup> „i“ZcY<sup>o</sup>Awe®<vi N†U 1938 mv†ĵ | GB mgq I†Uv nvb (1879–1968) I t÷mg<sup>v</sup>vb (1902–1980) tei K†ib th wDKxqvm wdkb†hwm| wdk†bi d†ĵ GKwU eo fi mSL<sup>v</sup> wekō wDKxqvm cōq mgvb fi mSL<sup>v</sup> wekō `wU wDKxqvm šcvšw†Z nq Ges wDKxqvm†i f†i i GKwU Ask kw<sup>3</sup>†Z šcvšw†Z nq- Rb† tbq wDKxq tevgv I wDKxq Pwĵ | eZg†b Avgiv wDKxqvm t††K th kw<sup>3</sup> cw<sup>o</sup>Q Zv AZx†Zi mKj Drm t††K cōß kw<sup>3</sup> i Zj bvq wecj | w`b w`b wDKxq kw<sup>3</sup> kw<sup>3</sup> i GKwU cēvb Drm w†m†e cwi MwYZ nt<sup>o</sup>Q| GB kZvāx†ZB ZwĒK c`v\_ŕeÁv†b weKvk jv† K†i†Q tKvqvUvg ZĒj, Av†cw†K ZĒj c†wZ| XvKv wekpe`v††q c`v\_ŕeÁv†bi cōdmi m†Z`<sup>o</sup> b<sup>v</sup> emy (1894–1974) ZwĒK c`v\_ŕeÁv†b „i“ZcY<sup>o</sup>Ae`vb iv†Lb| wZwb c††¼i tKvqvUvg Z†Ēj GKwU i`wZi cōvY Dc`vcb K†ib| Zvi ZĒj tevm- AvBb÷vBb mSL<sup>v</sup>qv b††g cwi wPZ| Zvi Ae`v†bi `xKwZ `šc GK†kŶY t††ĴK K Yv†K Zvi bvgvbm†i ņtevmō ejv nq| wZbRb t†††ej cĵ`<vi weRqx c`v\_ŕeÁvbx cwk`†v†bi cōdmi Ave`yn mv†vg (1926–1996), gwK<sup>o</sup> h†i v†ō† t††Wb M††kv (1932-) Ges w÷††b IqvBew<sup>o</sup>(1933-) GKxfZ t††Ī Z†Ēj te†vq t††ĴK ej t†††K GK†xKi†Yi t††Ī ZwōZ `†† ej Awe®<vi K†i Amvgv` Ae`vb iv†Lb| Zvi I Av†M fvi Zxq t†††ej cĵ`<vi weRqx c`v\_ŕeÁvbx P<sup>o</sup>†kLi igb (1888–1970) igbc†we Awe®<vi K†ib| wesk kZvāx†Z

WpKrmv weÁvtbi AM0mZtZ c`v\_@Ávb ivLtQ „i"ZpY©Ave`vb| WpKrmweÁvtbi wewfbae hš¿cmZ  
Ame®<vtii ckvcmk tZRw(Eq AvBtmvUc wewfbaeWpKrmvq e`eüZ ntq tivM wbovgti t¶¶t¶I Amvgvb`  
Ae`vb ivLtQ| wek kZvãtZ c`v\_@Ávtbi AvtiKuU „iZpY©AM0mZ grvkb` Airfhvb| Put` gvb¶li c`vc¶  
t\_tK`ii" Kti g½j M0n Awfhvbmn grvkb` t÷kib grvmi ci gym gvb¶li emevm Ávtbi t¶¶t¶I Amvgvb`  
AM0mZ| Kuſg DcM0h Avenl qvi ceſſvm`vib wKsev thvMvthvMtK mnR KitiZ PgrKvi Ae`vb ivLtQ|  
Avi Btj Ku0b` tZv Avgvt`i`bwb Rxeib wbtq GtmQ wec¶, cvtè w`tQ Rxeb hvcb c¶wvj |  
tiwvI, tUvj wFkb, wWwRUvj K`vtgiv, tgrvBj tdrv, AvB c`wW Avi KwúDUvtii K\_v GLb Nti Nti | wewfbae  
Btj Ku0bK miÁvg I KwúDUvi gvb¶li ¶gZvtK AtbKLwb ewotq w`tqQ|

1.2 c`v\_Átbi Dti k"

## Objectives of Physics

c`v\_ŋeÁvb cKwZi inm` D`NvUb Kti : c`v\_ŋeÁvb nt`Q weÁvtbi GKwJ tgšij K kvLv tKbbv Gi bmxZ,tjvB  
weÁvtbi Ab`vb` kvLvmgñi wfŋĚ`Zwi Kti tQ| D`vniY`~c, kw³i msi ŋYKxj Zv bmxZ nt`Q c`v\_ŋeÁvtbi  
GKwJ gj bmxZ hv nt`Q cigŋYj Af`šñi Ae`v t\_tK`ii` Kti Avenl qvi ceŋŋm`vb chš`weÁvtbi  
we`fZ GjvKvi tgšj wfŋĚ|

hw̃ l c̃\_v\_©l kw̃³i Aa"qbB c̃\_v\_©Áṽbi gj KvR etj eYBv Kiv hvq, w̃Kš' c̃\_v\_©Áṽbi Avmj D̃t̃i'k"  
ñt̃"Q c̃Kw̃zi inm̃ D̃NvUb Z\_v c̃Kw̃zi w̃bqg,tjv Ab̃ṽeb Kiv| wesk kZṽāxi ĩi't̃Z c̃\_v\_©Áṽxiv  
Ame®<vi Kit̃jb th, cigvYy abvZ̃Kf̃r̃e Am̃nZ w̃bDKxqm Øviv M̃w̃Z hvi Pvi cr̃tk B̃t̃j KUb t̃Ñt̃i| cieZP̃  
cix¶v w̃bix¶v t̃\_t̃K cvlqv hvq th w̃bDKxqm t̃c̃Ub l w̃bDUB Øviv M̃w̃Z| GLb c̃\_v\_©Áṽxiv Ame®<vi  
Kit̃Qb th t̃c̃Ub l w̃bDUB Aṽt̃iv ¶̃i³KYv Øviv M̃w̃Z|

c`v\_ŒÁvbi MteIYv cŒKwZK NUbv,tjvK fvtjvfvte eŒtZ Ges e`vL`v KiŒZ thgb mnvh` Kti tZgwb  
ŒÁvbi Avrbv` kvLvq Zvi cŒqM „i`ZcYŒAe`vb ivtL| ŒÁvbi Ab`vb` kvLvq c`v\_ŒÁvbi e`enviB  
mœeZ c`v\_ŒÁvbtK eZgwb ŒÁvbi hŒM Gi tKt`ª cwiYZ KtiŒtQ| Dwbk kZŒKi tklvtaŒBtj KuŒbi  
Ame®`viB Btj Kub gvBtvtv`vŒci DTMeb NwtŒtŒQ hv e`- ŒÁvb I tKvl -Rxeœ`vq Œeœ GtbtQ|

GKw`tk c`v\_@Avtb thgb ZĖj mġo I MwYzi cġqm AvtQ Aci w`tk GtZ e`enwi K Dbq b ev weKvk  
thgb cġKskj kr`ġ i tqŧQ| imq b weAvb, fNĖZĖ; weAvb, tR`wZ weAvb, Avenl qweAvb BZ`w` m`uŧK®  
tgSij K e`vL`v I aviYv MVtb c`v\_@Avb AZ`š-cġqRbxq| Gŧrov RxweAvb, mġi ĩeAvb, gŧbweAvb I  
wPukrmweAvtb c`v\_@Avtbi c`wZ I hš;cwZi cġFZ e`envi i tqŧQ|

c\_v\_Ávb cĳkZi wbgg,tjv eYBv Kti : Avgiv th cĳkZK RMtZ evm Kwi, Zv KZ,tjv wlv 8 wbgg thgb wvDUtbi gnrKl<sup>9</sup>mĳ, k<sup>3</sup>i msi 1YKkj Zv bxmZ BZ'w' tgĳb Ptj | Avgiv Avgvĳ' i e'w<sup>3</sup>MZ AwFÁZv jvtfi qva'tg wĳi Kvj t\_tK GBme wbggbxwZ wĳtL AvmO | GB Ávb Avgvĳ' i Rxeĳbi Rb' AZ'vek'K | cĳkZi



wbDUBxq ev wPivqZ c`v\_ŕĖÁvb `vb nŕ"Q wġ gwġ K GK we`ŕwZ | `vŕbi tKvŕbv`i" ev tkl tbB | Amxg Gi we`ŕwZ | `vbŕK AwZŕŕi` Astk fŕM Kiv hvq A\_ŕ `vb wbiwŕQbŕ `vb mgmĖj A\_ŕ `vŕbi th tKvŕbv GjvKv Ab" GjvKv t\_ŕK Awfŕbŕ `vb wbiŕŕŕ | `vŕbi gŕa" me NUbv NŕU Ges `vŕbi we`ŕwZi gŕa" B mg`ŕ e` i Ae`vb wKŠ` `vb tKvŕbv e` ev NUbv Øviv cŕŕweZ nq bv | `vb thgb e` I NUbv wbiŕŕŕ tZgbB mgq wbiŕŕŕ, dtj Kvŕj i cŕvn `vbŕK e`jvŕZ cŕŕi bv |

wbDUŕbi aviYv Abjŕŕi mgq ev Kvj wBŕ^ aviŕq cŕvnZ nŕe | tKvŕbv e` ev NUbvi Øviv GB Kwj K cŕvn cŕvnZ nq bv | mgŕŕi tKvŕbv`i" ev tkl tbB | mgŕŕK AwZŕŕi` Astk fŕM Kiv hvq | A\_ŕ Gi cŕvn wbiwŕQbŕ mgŕŕi th tKvŕbv Ask Ab" Astki mgŕŕ | Gi dtj tKvŕbv cixŕŕv hLbB mŕŕv`b Kiv tŕvK Zv mgq wbeŕŕŕbi Dci wŕfŕ Kŕi bv | mgq `vb wbiŕŕŕ |

wbDUBxq `vb Kvŕj i aviYŕq Avgŕŕ`i GB gnwekŕwġ gwġ K `vb I GKgwġ K mgq wŕŕq MwZ | thLvŕb mg`ŕ NUbv NUŕQ I mg`ŕ e` aviY Kiv AvŕQ |

AvaybK c`v\_ŕĖÁvb wbDUBxq `vb Kvŕj i aviYvi cwieZŕ GŕmŕQ | Gi gŕŕ iŕŕŕQ AvBb÷vŕŕbi AvŕcŕŕŕK ZĖj Ges cŕŕŕŕi tKvŕwUvg ZĖj |

## 1.4 ŕŕŕZ iwk

### Physical quantities

G ŕŕŕZ RMŕZ hv wKQz cwi gvc Kiv hvq ZŕŕK Avgiv iwk ewj | thgb ŕZvgvi mvgŕbi ŕWŕ`<i` Nŕ cwi gvc Kiv hvq, Nŕ GKwU iwk | ŕZvgvi ŕŕni fi cwi gvc Kiv hvq, fi GKwU iwk | Zŕg KZŕŕY aŕi ŕ`ŕŕ AvQ ŕmB mgq gvcv hvq, mgq GKwU iwk | Zŕg hw GKwU eBŕK Dcŕi DVŕl, Zŕnŕj KZUKz KvR Kiŕj Zv cwi gvc Kiv hvq, mZŕis KvR GKwU iwk | G ŕŕŕZ RMŕZ Gŕŕ eĖ iwk AvŕQ | GB mKj iwiki gŕa" gvġ KŕŕKwU iwk AvŕQ thŕŕjv cwi gvc KiŕZ Ab" tKvŕbv iwiki mŕvŕh" cŕŕvRb nq bv | G iwkŕŕjv tgŕŕj K iwk | thgb ŕWŕ`<i` Nŕ gvcŕZ ŕMŕj ŕKej Nŕ gvcŕj B Pŕj | G Nŕ gvcŕi Rb" Ab" tKvŕbv iwk gvcŕZ nq bv ev Ab" tKvŕbv iwiki mŕvŕh" `iKvi nq bv | mZŕis Nŕ GKwU tgŕŕj K iwk | AciŕŕK KŕŕKwU iwk Qŕov Aci th mKj iwk AvŕQ ŕmŕŕjv gvcŕZ nŕj Ab" iwiki `iKvi nq | thgb Zvgvi NbZj cwi gvc KiŕZ nŕj GK LĖ Zvgvi fi Ges AvqZb cwi gvc KiŕZ nŕe Ges fiŕK AvqZb wŕŕq fŕM Kŕi NbZjŕei KiŕZ nŕe | Aveŕi AvqZb gvcŕZ nŕj Nŕ, cŕŕ` I DŕPZv gvcŕZ nŕe A\_ŕ wZŕevi ev wZŕwŕŕK Nŕ gvcŕZ nŕe | mZŕis, ŕLv hvŕŕ"Q wKQz wKQz iwk AvŕQ, thŕŕjv gj iwk; Gŕŕjv Ab" iwiki Dci wŕfŕ Kŕi bv | GB iwkŕŕjvŕK tgŕŕj K iwk ejv nq |

mZŕis th mKj iwk ŕvaxb ev wbiŕŕŕ thŕŕjv Ab" iwiki Dci wŕfŕ Kŕi bv eis Ab"vb" iwk Gŕi Dci wŕfŕ Kŕi ZŕŕiŕK tgŕŕj K iwk etj | Ávb weÁŕŕbi mKj kvLv cŕvLvq gvcŕŕŕŕŕLi ŕŕŕŕŕ weÁŕŕŕiv Gŕŕ



mVZU iwkK tgšj K iwk ȳtc wPwZ KtiQb| G,tjv ntjv (1) ^N°(2) fi (3) mgq (4) Zvcgŷv (5) Zvor cēv (6) `xcb ZxeZv (7) c`v\_@ cwi gvY|

Avi Ab` mKj iwk tgšj K iwk ,tjv t\_+K jvf Kiv hvq A\_@ GK ev GKwaK tgšj K iwiki ,Ydj ev fMdj t\_+K cŷZc` b Kiv hvq| Gt` i+K ejv nq j ä iwk ev thšMK iwk|

mZivs th mKj iwk tgšj K iwiki Dci wbfP Kti ev tgšj K iwk t\_+K jvf Kiv hvq Zt` i+K j ä iwk etj|

teM, ZiY, ej, KivR, Zvc, Zvor wefe BZ`w` iwk ,tjv tgšj K iwmgn t\_+K jvf Kiv hvq etj G,tjv j ä iwk|

thgb :

$$\begin{aligned} ej &= fi \times ZiY \\ &= fi \times \frac{teM}{mgq} \\ &= fi \times \frac{\sim i Zi}{mgq^2} \end{aligned}$$

mZivs, ej GKwU j ä iwk|

## 1.5 cwi gvȳci GKK

### Units of measurements

Avgt` i ^bw` b Rxeȳ cŷ cŷZU KvȳRi mvt\_ gvc-tRvLi e`vciw RwoZ| G Qovl wvfbŷMteYvi KvȳR cŷqvRb nq m<sup>2</sup> gvc-tRvLi| Avgt` i ^bw` b Rxeȳbi GB gvc-tRvLi wvqUvK ejv nq cwigvc| maviYfȳte cwigvc ejtZ ešvq tKvȳv wKQi cwi gvY wbyŷ Kiv| thgb wiRj ewo t\_+K ^<tj i ^+Zi 700 wguvi| tmvtnj t`vkvb t\_+K 5 wKtjwŷg Pij wKtb Avbj| wibvi Kvm t\_+K Awdm i`tg thtZ 50 tmKÊ mgq jvM| GLvȳ 700 wguvi ntjv ewo t\_+K ^+Zi cwi gvY| 5 wKtjwŷg ntjv wKtb Avbv Pȳji fȳi cwi gvY Ges 50 tmKÊ ntjv mgȳqi cwi gvY| tKvȳv wKQi cwi gvY wbyŷ KiȳZ ntj Avgt` i `yU wRwbtmi cŷqvRb nq| GKwU msL`v Avi GKwU GKK|

th tKvȳv cwigȳci Rb` cŷqvRb GKwU ÷`vEW`ev Av` k`cwigȳYi hvi mvt\_ Zj bv Kti cwigvc Kiv hvq| cwigȳci GB Av` k`cwigȳY+K ejv nq cwigȳci GKK| gtb Kiv hvK, tKvȳv jwVi ^N°4 wguvi| GLvȳ wguvi ntjv ^N° GKK Ges 1 wguvi ejtZ wKQ GKUv ^N° AvtQ| Avi jwVi ^N°4 wguvi ejtZ ešvq jwVi ^N°1 wguvi i 4 ,Y| mgq, AvqZb, teM, fi, ej, kv<sup>3</sup>, Zvcgŷv, Zvor cēv BZ`w` gvcvi Rb` wfbwfbwGKK itqQ| G GKK ,tjv Ggbfȳte wK Kiv ntqQ hvZ G,tjv nq mearRbK AvKti i Ges mnȳR I mwKfȳte Zv cpi`rcv` b Kiv hvq| GB GKȳKi KtqKwU Qov ewK ,tjv Avei ci`ui mȳuKŷ|

GmAvB (SI)–Gi tğšvj K GKKmgn :

tğšvj K i wki GKKmgn thtnZtAb` GKK,tjvi Dci wbfP Kti bv, ZvB tğšvj K GKK Bt`OgtZv wbePb Kiv hvq| wKš` tmB wbePbtbi AvšRmZK `xKwZ \_vKtZ nte| Gi KtqKwU `ewkó`I \_vKtZ nte| thgb GwU ntZ nte AcwieZmN `vb, Kvj, cvl tKvbtv wKQi Dci wbfP Kite bv| Kvji weeZfb ev Ab` tKvbtv cKwZK cwieZfb dtj Gi tKvbtv cwieZfb nte bv| mntR GKKwU cpi`rcv`b Kiv hvte| 1960 mtj GKtKi AvšRmZK c`wZ Pvj mgq tğšvj K GKK,tjvi th Av`k`ev ÷`vEwMhY Kiv ntqUj cieZKvtj Dctiv<sup>3</sup> `ewkó`,tjv ARfb j t`I Gt`i AtbK,tjvi Av`k`ej Kiv ntqtQ, wKš` ZvtZ GKK,tjvi gvtbi tKvbtv cwieZfb nqwb| thgb GLb Avtjvi AwZmvs-`tZi w`tq wglvttK msÁwqZ Kiv nq, Zvi AvtM GK cKvi Avtjvi Zi ½% tNq mrvnth` wglvti msÁv t`lqv ntZv| Zvi l AvtM c`witmi wKtU m`vtatZ ivLv GKwU `tEi `NqK wglvti Av`k`aiv ntZv| wbtP AvšRmZK c`wZtZ tğšvj K GKK,tjvi Rb` mefkI MpxZ Av`k`eybv Kiv ntjv|

`tNq GKK : wglvi : kb` `vfb Avtjv  $\frac{1}{299\,792\,458}$  tmktÊ th `tZi AwZmug Kti ZvtK 1 wglvi (m) etj |

fii GKK : wKtjwMg : dxtYi m`vtatZ Bvbi b`vkbvj l tqUm GE tgrvitm G i w`lZ c`wUvbg Bwi wWqvq msKi avZi `Zwi GKwU wmwj Êvti fi tK 1 wKtjwMg (kg) etj | GB wmwj Êvi wU e`vm 3.9 cm Ges D`PZv 3.9 cm |

mgvti GKK : tmktÊ : GKwU wmwRqvq N 133 cigvYj 9 192 631 770wU `w`b m`ubekitZ th mgq jvtM ZvtK 1 tmktÊ (s) etj |

ZvcgvIvi GKK : tKjwfb : cwb i `Ta we`j ZvcgvIvi  $\frac{1}{273.16}$  fvMtk 1 tKjwfb (K) etj |

Zwor c`vni GKK : A`w`uqvi : kb` `vfb 1 wglvi `tZi Aew`Z Amxg `tNq Ges Dct`Yxq eÊvKvi c0`t`Q`i `wU mgvstvj mij cwievtKi c0Z`KwUtz th cwigvY Zwor c`vn Pjtj ci`úti gta` c0Z wglvi `tN<sup>2</sup> × 10<sup>-7</sup> wDUB ej Drcbmq ZvtK 1 A`w`uqvi (A) etj |

`xcb ZxeZvi GKK : K`vtÊjv : K`vtÊjv nt`Q tmB cwigvY `xcb ZxeZv hv tKvbtv AvtjvK Drm GKwU wbw`Š w`tK 540 × 10<sup>12</sup> nvR`K`úv`4i GK eY`wewKiY wbtmiY Kti Ges H wbw`Š w`tK Zvi wewKiY ZxeZv nt`Q c0Z t÷ti wWqv NbtkvY  $\frac{1}{683}$  lqvU|

c`vt\_P cwigvtYi GKK : tgvj : th cwigvY c`vt\_0.012 wKtjwMg KieBÑ 12 G Aew`Z cigvYj mgvb msL`K c0\_wgK BDwU (thgb, cigvYy AYy Avqb, Btj KUb BZ`w` ev G,tjvi wbw`Š tKvbtv M0) \_vtK ZvtK 1 tgvj (mol) etj |

mvi wY

tgšwj K iwk I Zv`i GKK

iwk	iwki cŁxK	GmAvB GKK	GKŁKi cŁxK
1. ^`N®(length)	<i>l</i>	wgUvi (meter)	m
2. fi (mass)	<i>m</i>	wKŁj wMŕg (kilogram)	kg
3. mgq (time)	<i>t</i>	ŁmŁKE (second)	s
4. ZvcgvŖv (temperature)	$\theta, T$	ŁKj wfb (kelvin)	K
5. Ziŕor cŁvn (electric current)	<i>I</i>	A`wŕúqvi (ampere)	A
6. `xcB ZiŕZv (luminous intensity)	<i>I<sub>v</sub></i>	K`vŁEjv (candela)	Cd
7. c`vŁ_P cwi gvY (amount of substance)	<i>n</i>	tgvj (mole)	mol

GKŁKi ŕwYZK I Dc\_ŕYZK

AŁbK mgq tgšwj K GKK\_Łjvi fMŕsk ev ŕwYZK e`envi Kiv mŕeavRbK nq| hLb GKwU iwki gvb Lŕ eo ev Lŕ ŁŕUv nq, ZLb wŁŁPi mviwYŁZ ewYŁZ DcmMŁŁjv LŕB cŁqvRbxq nq| D`vniY `^ie Avgiv hw` evZvŁmi `ŕU AYj ga`Kvi `ŁZi wetePbv Kwi, ZvŁŁj Ł`wŁ th GB `ŁZi LŕB ŁŕUv| GwU nŁ`Q 0.000 00001 m| Avgiv hw` evi evi GB mSL`vUv e`envi Kwi, ZvŁŁj AvgvŁ`i mŕeavb ŕvKŁZ nŁe cŁZ ŁŕŁŁŁ kŁb`i mSL`v wVKgŁZv DŁj Ł. Kiv nŁqvŕ wK bv? wKŠ` GB mSL`vUvŁKB hw` Avgiv GKUv DcmMŁŁe`envi KŁi wj wŁ, ZvŁŁj 0.000 00001 m ŁK nqŁZv wj Le 0.01  $\mu$ m, GLvŁb ŕŕŕ (gvBŁŕv) DcmMŁŁ 10<sup>-6</sup> wŁŁ`R KŁi | ŁZwŁb fŁte hw` ewj AvgvŁ`i bewŁgŁZ we`ŕr Drcv`b ŁKŁ`Ł ŕŕgŁv 2000 000 000 W| GUvŁK hw` Avgiv 2000  $\times$  10<sup>6</sup> W = 2000 MW wŁŁŁŁe cŁKvŁ Kwi ZvŁŁj mŕeav nq| GKK\_Łjvi cŁe`Łki mPŁKi wŁŁgŁŁ DcmMŁŁjv AvŠRŕŁZK cŁwŁŁZŁZ e`envi AbŁgv`bŁhMŁŁ|

ŕwYZK/Dc_ŕwYZK	Drcv`K	mŁŁKZ	D`vniY
G·v (exa)	10 <sup>18</sup>	E	1 G·wUvi = 1 Em = 10 <sup>18</sup> m
ŁCUv (peta)	10 <sup>15</sup>	P	1 ŁCUwUvi = 1 Pm = 10 <sup>15</sup> m
ŁUiv (tera)	10 <sup>12</sup>	T	1 ŁUwMŕg = 1 Tg = 10 <sup>12</sup> g
wMw (giga)	10 <sup>9</sup>	G	1 wMwvBU = 1 GB = 10 <sup>9</sup> B
ŁgMv (mega)	10 <sup>6</sup>	M	1 ŁgMvŁ qU = 1 MW = 10 <sup>6</sup> W
wKŁjv (kilo)	10 <sup>3</sup>	k	1 wKŁj vŁfvŁ = 1 kV = 10 <sup>3</sup> V
ŁnŁŁv (hecto)	10 <sup>2</sup>	h	1 ŁnŁŁvRj = 1 hJ = 10 <sup>2</sup> J
ŁWKv (deca)	10 <sup>1</sup>	da	1 ŁWKwŁbDUB = 1 daN = 10 <sup>1</sup> N

WYZK/Dc WYZK	Drcv`K	ms`KZ	D`vniY
tWm (deci)	$10^{-1}$	d	1 tWm l 0g = 1 dΩ = $10^{-1}$ Ω
tmwU (centi)	$10^{-2}$	c	1 tmwUwgUvi = 1 cm = $10^{-2}$ m
wgwj milli)	$10^{-3}$	m	1 wgwj A`w`úqvi = 1 mA = $10^{-3}$ A
gvBtμv (micro)	$10^{-6}$	μ	1 gvBtμvtfvë = 1 μV = $10^{-6}$ V
b`vfbv (nano)	$10^{-9}$	n	1 b`vfbvtfm`KÊ = 1 ns = $10^{-9}$ s
wc`Kv (pico)	$10^{-12}$	p	1 wc`Kvd`vi wW = 1 pF = $10^{-12}$ F
tdg`Uv (femto)	$10^{-15}$	f	1 tdg`UwgUvi = 1 fm = $10^{-15}$ m
A`Uv (atto)	$10^{-18}$	a	1 A`Uvl qvU = 1 aW = $10^{-18}$ W

tKvfbv msL`v`K 10 Gi th tKvfbv NvZ Ges 1 t`tK 10 -Gi gta` Aci msL`vi Ydj wntmte cKvk Kiv ntj Zv`K `eÁmbK cZxK etj | thgb 6733000000 ntjv  $6.733 \times 10^9$  Ges 0.00000846 ntjv  $8.46 \times 10^{-6}$  | mZivs t`Lv hv`Q th G cZx`K cKvkZ msL`wUi 10 -Gi avZ`K mPK hZ, `kvgK w`K Wbw`tK ZZNi mivtj Avi 10 Gi FYvZ`K mPK hZ `kvgK w`K evgw`tK ZZ Ni mivtj gj msL`wU cvl qv hvq |

`eÁmbK cZx`K cKvkZ msL`vi t`t` tYi wbtg` mrvaiY wbggwU LvU :

$$10^m \times 10^n = 10^{m+n}$$

GLvfb m Ges n th tKvfbv msL`v N avZ`K ev FYvZ`K ntZ cti |

$$\text{thgb } 10^6 \times 10^7 = 10^{13}, 10^7 \times 10^{-20} = 10^{-13}$$

fivMi t`t` t wbtg` wbggwU c`hvR`

$$\frac{10^n}{10^m} = 10^n \div 10^m = 10^{n-m}$$

$$\text{thgb } 10^6 \div 10^4 = 10^2 \text{ ev } 10^3 \div 10^{-7} = 10^{3-(-7)} = 10^{10}$$

1.6 gv`v

## Dimensions

Avgiv BtZvgta` tRtbwQ th tKvfbv tfSZ iwk GK ev GKwaK tgšj K iwiki mgš`tq MwVZ | mZivs th tKvfbv tfSZ iwk`K wewfbomP`Ki (power) GK ev GKwaK tgšj K iwiki Ydj wntmte cKvk Kiv hvq | tKvfbv tfSZ iwk`Z Dcw`Z tgšj K iwk,tjvi mPK`K iwikiUi gv`v etj |

$$\text{thgb } ej = fi \times ZjY = fi \times \frac{\text{teM}}{\text{mgq}} = fi \times \frac{\%N^{\circ}}{\text{mgq}^2} \mid \text{GLvfb } \text{`tN}^{\circ} \text{ gv`v L, fti i gv`v M, mgtqi gv`v T}$$

$$\text{emtj etj i gv`v cvl qv hte } \frac{ML}{T^2} \text{ ev } MLT^{-2} \text{ A`}, \text{ etj i itqtQ fti i gv`v (1), `tN}^{\circ} \text{ gv`v (1) Ges mgtqi}$$

$$\text{gv`v (-2) | tKvfbv iwiki gv`v wbt`R Ki`Z ZZxq eÜbx [ ] e`envi Kiv nq | thgb etj i gv`v [F] = } MLT^{-2}$$







Zvi eig cŕš-ť<ťj i x `vŕM `vcb Kiťj hw` Wwb cŕš-y `vŕMi mvť\_ wgtk hvq Zťe `ťEi `N°L nťe, L = y - x | G ť<ťj i mrvŕth` wgwj wguvi chš-`N°mŕVKfŕťe gvcv hvq | Gi ťPťq m² cwi gvc KiťZ nťj e`envi KiťZ nq fwbŕvi ť<j |

fwbŕvi ť<j

mvaviY wguvi ť<ťj Avgiv wgwj wguvi chš-`N°gvcťZ cwi | wgwj wguvi i fMsk thgb 0.2 wgwj wguvi, 0.6 wgwj wguvi ev 0.8 wgwj wguvi BZ`w` gvcťZ nťj Avgvť` i e`envi KiťZ nq fwbŕvi ť<j | MŕYZ kv`ŕue` ŕctťti fwbŕvi G ť<j Aŕe°<vi Kťib | Zvi bvgvbmťi G ť<ťj i bvg fwbŕvi ť<j |



ŕPŦ : 1.1 fwbŕvi ť<j

gj ť<ťj i ŕŕiz Zg fŕťMi fMŕťki ŕbfŕ cwi gŕťci Rb` gj ť<ťj i cvťk th ťQŕU Avi GKŕU ť<j e`envi Kiv nq Zvi bvg fwbŕvi ť<j | fwbŕvi ť<jťK wguvi ť<ťj i mvť\_ e`envi Kťi wgwj wguvi i fMsk mŕVKfŕťe ŕbYŕ Kiv hvq |

fwbŕvi ť<j gj ev cŕvb ť<ťj i cvťk mshŕ ŕťK Ges cŕvb ť<ťj i cvťk ŕťq mvgťb ev ťcQťb mivťbv hvq | aiv hvK, GKŕU fwbŕvi ť<ťj `kŕU fŕM AvťQ Z\_`kŕU `ŕM KvŕU AvťQ | GB `k fŕM cŕvb ť<ťj i bqŕU ŕŕiz Zg fŕťMi mgvb (ŕPŦ : 1.1) | cŕvb ť<ťj i bqŕU ŕŕiz Zg fŕM nťjv 9 wgwj wguvi ev 0.9 ťmŕUwguvi | fwbŕvi ť<ťj i 10 fŕM thťnZcŕvb ť<ťj i 9 ŕŕiz Zg fŕťMi mgvb | mŕZivs fwbŕvi ť<ťj i fŕM,ťjv cŕvb ť<ťj i ŕŕiz Zg fŕťMi ťPťq mvgb` ťQŕU | cŕvb ť<ťj i ŕŕiz Zg GK fŕťMi ťPťq fwbŕvi ť<ťj i GK fŕM KZUKzťQŕU Zvi cwi gŕYťK ejv nq fwbŕvi a`eK (Vernier Constant) | GťK mvaviYZ VC ťjLv nq | GKŕU mnR mŦ ŕviv fwbŕvi a`eK ŕbYŕ Kiv hvq Zv nťjv, fwbŕvi a`eK =  $\frac{s}{n}$  thLvťb s cŕvb ť<ťj i 1 ŕŕiz Zg fŕťMi `N°Ges n fwbŕvi i fŕťMi mSL`v |

Dctiv³ ťŕŕťŦ s = 1 wguv Ges n = 10 fŕM

$$\therefore \text{fwbŕvi a`eK} = \frac{s}{n} = \frac{1 \text{ wguv}}{10} = 0.1 \text{ wguv} = 0.01 \text{ ťmguv}$$

ťKŕťbv ťKŕťbv mgq fwbŕvi ť<ťj i 20 fŕM cŕvb ť<ťj i 19 ŕŕiz Zg fŕťMi mgvb ŕťK Ges cŕvb ť<ťj i GK ŕŕiz Zg fŕM 1 mm -Gi ťPťq Kg ŕťK | ZLb fwbŕvi a`eK cwi enZŕ nťq hvq | fwbŕvi a`eK ŕbfŕ Kťi cŕvb ť<j | fwbŕvi ť<ťj i `ŕM KvŕU `enkťŕŕi Dci |

ˆvBW K`wj cvm©

ˆvBW K`wj cvtŕŕ Acı bvg fwbŕvi K`wj cvm© KviY GB hšš gvc†Rv†Li tejvq fwbŕvi c`vŕZ e`envi Kiv nq| GKıU AvqZKvi B`úvZ `†Ei Mtq `vM tK†U ˆvBW K`wj cvtŕŕ gj ev c`vb t`<j `Zwi Kiv nq| c`vb t`<j i th cŕš-kb` `vM KivUv `v†K A\_ŕ th cŕš-t†K t`<j i mPbv nq tŕB cŕš-GKıU avZe tPvqj AvUKv†bv `v†K| gj t`<j i ŕŕi Zg f†Mi fMŕtki vbŕŕ cwig†ci Rb` gj t`<j i Mtq tPvqj hŕ GKıU tŕUv t`<j cıv†bv `v†K| Gi bvgB fwbŕvi t`<j | (ŕP† : 1.2)|



ŕP† : 1.2 ˆvBW K`wj cvm©

GB tPvqj hŕ fwbŕvi c`vb t`<j i Dci mvg†b ev tcŕb mıv†bv hvq| GB t`<j i m†\_ GKıU `†v†K| GB `†Ei mrv†h` fwbŕvi t`<j iK c`vb t`<j i Mtq th tKv†bv RvqMvq AvUwK†q ivLv hvq| c`vb t`<j i tPvqj Ges fwbŕvi t`<j i tPvqj hLb t†M `v†K ZLb mrvıYZ fwbŕvi t`<j i kb` `vM c`vb t`<j i kb` `v†Mi m†\_ vg†j hvq|

fwbŕvi t`<j e`envi K†i vg†j vgU†i i fMŕk mıVKf†e vbYŕ Kiv hvq|

Dc†i fwbŕvi t`<j cwi "ŕ†` ewYŒ Dcv†q ˆvBW K`wj cvtŕŕ fwbŕvi a†K vbYŕ Kiv nq |

ˆvBW K`wj cvtŕŕ mrv†h` cwi gvc : g†b Kiv hvK, tKv†bv GKıU `†Ei `N°†eı K†Z n†e| `†U†K ˆvBW K`wj cvtŕŕ tPvqj `ŕıı gvSLv†b `vcb K†Z nq| fwbŕvi t`<j i m†\_ j vM†bv tPvqj t†j mvg†b Av†Z nq hv†Z c`vb t`<j i tPvqj I fwbŕvi i tPvqj e`U†K vecıxZ ŕ K t†K `úk©K†ı | `†Uı evg cŕš-c`vb t`<j i kb` (0) `v†Mi m†\_ vg†j t†q fwbŕviU mvg†b ev tcŕb mıı†q `†Ei Wvb cŕš† m†\_ vg†j†bv nq| g†b Kiv hvK, `†Ei Wvb cŕš-t`<j i M vg†g `vM AvZ†g K†ı†Q| Zı†j Gi `N°M I (M + 1) vg†g Gi gvSv†S| GB M vg†g -Gi t†q erıvZ `N° fwbŕvi e`envi K†ı †eı K†Z n†e| Gi `N°K† n†e fwbŕvi cv|

Gevı t†L†Z n†e fwbŕvi i tKvb `vMıU c`vb t`<j i tKv†bv GKıU `v†Mi m†\_ vg†j†Q| hı tKv†bv `vM bv vg†j `v†K, Zı†j t†L†Z n†e fwbŕvi i tKvb `vMıU c`vb t`<j i tKv†bv GKıU `v†Mi m†\_ m†P†q KıŕvKıwQ n††Q| fwbŕvi t`<j i GB `vMıB n†e fwbŕvi i mgcvZb|

g†b Kiv hvK, fwbŕvi i V b`ıi `vMıU c`vb t`<j i GKıU `v†Mi m†\_ vg†j†Q ev KıŕvKıwQ n††Q| m†Zıv hšš i fwbŕvi a†K VC n†j

`†Eı `N° = c`vb t`<j cv + fwbŕvi t`<j cv

$$= \text{c} \dot{\text{a}} \text{v} \text{b} \text{ } \dot{\text{f}} \text{ } < \text{j} \text{ } \text{c} \text{v} \text{V} + \text{f} \text{w} \text{b} \text{ } \text{ } \text{m} \text{g} \text{c} \text{v} \text{Z} \text{b} \times \text{f} \text{w} \text{b} \text{ } \text{ } \text{a}^{\circ} \text{e} \text{K}$$

$$A_{\text{P}}, L = M + V \times VC$$

D`vniY : aiv hvK, `tÊi B cš- cāvb f`<tj i 12 vgiw `vM AvZug Kti tQ Ges fwbqvi i 7 b`^i `vMvU cāvb f`<tj i GKvU `vMi mvt\_ vgtj tQ| Zvntj `tÊi `N°nte

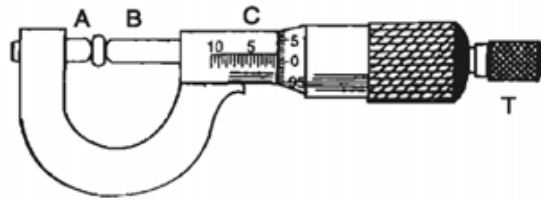
$$L = 12 \text{ vgiw} + 7 \times 0.1 \text{ vgiw} (\text{fwbqvi a}^{\circ} \text{K ntjv } 0.1 \text{ vgiw})$$

$$= 12.7 \text{ mm} = 1.27 \text{ cm}$$

cāvb f`<tj i tPqvj Ges fwbqvi f`<tj i tPqvj hLb tj tM \_vK ZLb maviYZ fwbqvi f`<tj i kb` `vM cāvb f`<tj i kb` `vMi mvt\_ vgtj hvq| A tK hšZ bvl vgi tZ cvti | ZLb eštZ nte hwsZK ÎU i tQ Ges Gi Rb` cv mstkrab Kti vbtZ nq|

ÊMR

GB hšZi mrvth` Zti i e`vma`mi` tPvOi e`vma` tQvU `N°cvi gvc Kiv hvq| GtZ i tQ `ß cš-`vU mgsi+j evÊ vnkó U AvKvZi tdg Kvrtgv F (vPÎ : 1.3)|



$$vPÎ : 1.3$$

Gi GK evÊi mgZj vcv A Gi mvt\_ GKvU mgZj cš-vnkó `Ê ev Kxj K `vqv fte AvUKvbtv i tQ Ges Aci evÊtZ i tQ GKvU ducv bj C| GB btj i tQ vgiw vgtj `vMv/4Z GKvU mij f`<j Ges GKvU tejbvKvZi Uvc T cvi vNZ GKvU Êz ÊvU ducv bj C Gi vFZi Pjvtdiv Kitz cvti | tejbvKvZi Uvc T- Gi vKbivtK maviYZ 50 ev 100 fvm Kiv nq| Êi gv\_v B hLb `vqx Kxj K ev mgZj cš-vnkó `Ê A `ukKti ZLb eÊvKvi f`<tj i kb` `vM `i vLK f`<tj i kb` `vMi mvt\_ vgtj hvq| Gi Kg Ae`vq `vU f`<tj i kb` `vM hv` vgtj bv hvq Zvntj eštZ nte hwsZK ÎU i tQ|

Uvc T GKevi Njvtj Gi hZUKzmiY NtU Ges `i vLK f`<j eivei th `N°GvU AvZug Kti ZvtK ejv nq Êi vCP (Pitch)| eÊvKvi f`<tj i gvÎ GK fvm Njvtj Ñ Gi cš-ev ÊvU hZUKzmti Avtm ZvtK ejv nq hšZi jvNó MYb (Least Count)| GtK LC v tQ cKvk Kiv nq| hšZi vCPtK eÊvKvi f`<tj i msL`v Øviv fvm Kiti jvNó MYb cvl qv hvq| mZivs,

$$j \text{ vNó MYb} = \frac{vCP}{e \text{ ÊvKvi f`<tj i fvtMi msL`v}}$$

eĖvKvi t`<tj mavi YZ 100 fM \_vřK Ges GB hřř ěP \_vřK 1 wgw |

$$\therefore j \text{wNô MYb} = \frac{1}{100} \text{ wgw} = 0.01 \text{ wgw} |$$

ŕĖMřRi mrvřh` cwi gvc : th Zvři i e`m gvcřZ nř ev th cřřZi cř "Zřtei KřřZ nř ZvřK A I B-Gi gřřS ŕ`vcb KřřZ nř | Zvi ev cřZw Ggbřře ŕ`vcb KřřZ nř hřřZ Gi GK cřk A-řK Ges Aci cřk BŕřřK ŕ`ukřři | Gevi eĖvKvi I ŕ`iLK t`<tj i cřw wřřZ nř | gřb Kiv hřK, ŕ`iLK t`<tj i cřw L wgw Ges eĖvKvi t`<tj i fM mSL`v C | mřřivs, Zvři i e`m ev cřřZi cř "Zřnř :

e`m ev cř "Zř = ŕ`iLK t`<j cřw + eĖvKvi t`<tj i fM mSL`v  $\times$  jwNô MYb

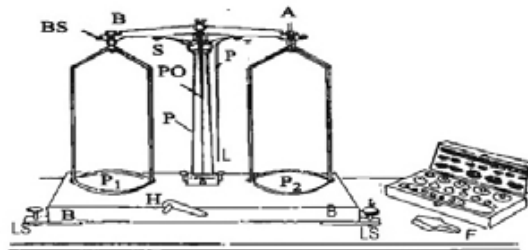
$$A_{\text{ř}} D = L + C \times LC$$

D`nri Y : gřb Kiv hřK, ŕ`iLK t`<j cřw 3 wgw Ges eĖvKvi t`<tj i fM mSL`v 20, ZLb Zvři i e`m  
 $= 3 \text{ wgw} + 20 \times 0.01 \text{ wgw} = 3 \text{ wgw} + 0.2 \text{ wgw} = 3.2 \text{ wgw} |$

ŕĖi gv\_v hLb mgZj cřř-řkř ŕ`Ė A ŕ`ukřři ZLb eĖvKvi t`<tj i kb` ŕ`m hř ŕ`iLK t`<tj i kb` ŕ`řMi mřř\_ wřřj bv hřq Zřřřj eřřřZ nř hřřřK řw i řřřř | Gi Rb` cřw mřřkvab Křř wřřZ nř |

Zřř hřř

řKřřbv řKřřbv mgq c`v\_ŕĖÁvb ev imřřřb Lř Ař cwi gřř wřřřřmi fi mřřřř wřřř KřřřZ nř, hř mavi Y wřřř wřřř Kiv hřq bv | e` ev c`ř\_ř cwi gřř hZ Kg nř Zvi fi cwi gřřři wřřř nřřZ nř ZZ mřř | Gi Kg GKw mřř wřřř nřřv Zřř hřř ev e`řřřř | GB hřř c`v\_ŕĖÁvb I imřřb j`řřřřwřřř řKřřbv Ař wřřřřmi fi mřř cwi gřřři Rb` e`eřř nř | Kvi Y j`řřřřwřř ev cixřřwřřř řKřřbv wřřřřmi fi cwi gvc mřřK bv nřř cixřřř t`řK řř djřřř Avmřř cřř Ges cixřřřwřřř Dřřř k` řĖř nřř thřř cřř |



$$\text{wřř} : 1.4$$

Zřř hřřř mavi Y wřřři gřřv ŕ`ř mgřb I Rřři cřřř P1 I P2 wřřři řcřřř\_vřř (wřř : 1.4) | GB cřřř ŕ`ř GKw ařř ŕ`Ė AB Gi řcřřř\_řř Lřřři gřř Dřřřbv Qřři cřřř Dci ŕ`ř mgřb I Rřři řdřři mrvřh` Sřřřbv\_vřřK | AB řĖři řKřř` GKw Qřři (knife) Ařřřřřř ř I qř nř | Gw wřřřři řřř Křř \_vřřK |





## 1.9 cwi gvtc ÎŰ I wbfŦZv

### Error and accuracy in measurement

me cwi gvtci wbfŦZvi B GKŰ mxgv AvtQ | e`eüZ hšġcwZ Ges cixŦŦKi `ŦŦZvi Dci cwi gvtci wbfŦZv wbfŦ KŦi | aiv hvK, GKŰ wgvUvi t`<j tŕŰUwgvUvi I tŕŰUwgvUvi i `kgvŦk (wgvj wgvUvi) `ŰM KvUv AvtQ | GB wgvUvi t`<j Øviv hw` Avgiv GB eBŰUi ``N°gvcŦZ hvB Zvntj djvdj nqtZv 0.1 cm (t`<tji ŦŦZg GKfŰM) mŰVK ev wbfŦ nŦZ cvŦi | hw` tKvŦbv NŦi i ``N°gvcv nq Zvntj wbfŦZv nqtZv AvŦiv KŦg hvŦe | KvŦY t`<jŰ KŦqKevi ci ci tiŦL ``N°gvcŦZ nŦe | cŦZ`Kevi t`<tji mŰŦ cŦŦŦ Ae`vb tŦŦŦZ wŦŦŦZ KiŦZ nŦe | Gi dtj cwi gvtci fŦji Drm Avi I teŦo hvŦe | A\_ŦŦ fŦj nl qvi mŰŦebv evŦŦ cvŦe |

cwi gvtci wbfŦZv cwi gvtci gŦZvB „i“ZcYŦ mŰZivs me cixŦŦKiB DŰPZ Zvi cixŦŦvi djvdŦji mŦ½ djvdŦji wbfŦZvi cwi gvy DŦj Ŧ Kiv | GB eB -Gi ``N°nqtZv 26.0 cm ±0.1 cm tj Lv thŦZ cvŦi | mŦŦKZ ± Gi A\_ŦŦŦjv th, eB Gi cŦKZ ``N°25.9 cm I 26.1 cm -Gi gŦa` iŦŦŦQ | 0.1 cm ntjv cwi gvtci AwbŦŦZv ev ÎŰ |

cwi gvtci tejvq mvari YZ wZb aiŦbi ÎŰ \_vKŦZ cvŦi | G\_Ŧjv ntjv :

(K) ``e ÎŰ

(L) hŰŦŦK ÎŰ

(M) e`wŦMZ ÎŰ

(K) ``e ÎŰ : tKvŦbv GKŰ a`e iŰk KŦqKevi cwi gvc KiŦj th ÎŰUi KvŦŦY cwi gvcKZ gvtb AmvgÄm` t`Lv hvq ZvŦK ``e ÎŰ eŦj | Ŧ`eŦ bvg t\_ŦKB eŦŦ hvq GB ÎŰ mŰŦŦK`AvŦMB Abgvb Kiv hvq bv Ges GB ÎŰUi cŦŦŦKZ gvb nŦe kb` | tKbbv cwi gvcKZ gvb\_Ŧjv mŰVK gvtbi Gw`K tŕŰ`K BZ`Z fŦŦe \_vKŦe Ges GKB hšġw`Ŧq GKB iŰki gvb evi evi cwi gvc KiŦj G ÎŰ\_Ŧjvi Mo gvb kb` nl qv DŰPZ | NŦi i ``N°gvcv Rb` hZeviB wgvUvi t`<jŰ NŦi i tŦŦŦZ tdjv nq ZZeviB ``e ÎŰ cwi gvtci AŦŦŦ nq | cŦZ`Kevi wgvUvi t`<j tdjvi ci mŰŦ cŦŦŦ Ae`vb wŦŦŦZ Kivi Rb` tŦŦŦZ th `ŰM t`I qv nq, Zv cŦKZ `ŰM t\_ŦK wKŦŦv mgvŦb ev tŦŦŦ t`I qv nq | GB `ŦŦMi mŦŦ wgvjŦq hLb Avevi wgvUvi t`<jŰ tdjv nq ZLb Avi I GKŰ ``e ÎŰ cwi gvtc GŦm hvq | G`ŦŦMi mŦŦ wgvjŦbvi mgqI t`<jŰ tŦŦŦi cŦŦ-KLbI `ŦŦMi wKŦŦv mŰŦL ev tŦŦŦ wgvjŦbv nq | ``e ÎŰ dtj PrvŦ-djvdj nqtZv AZ`ŦŦŦ ev LŦ Kg nŦq thŦZ cvŦi | ``e ÎŰŦK GovŦbv mŰŦ bq | ŰKŦ`, mZKŦv AeŦŦb KiŦj GB ÎŰ KvgŦq Avbv hvq | ``e ÎŰŦK KvgŦq AvbŦZ ntj cwi gvcŰ evi evi wŦŦq GŦ`i Mo wŦŦZ nq |

(L) hŰŦŦK ÎŰ : c`v\_ŕĖÁvb cixŦŦŦi Rb` Z\_v gvc-tŦŦŦLi Rb` AvgŦŦ`i hŦŦŦi cŦŦŦRb nq | tŰB hŦŦŦ hw` ÎŰ \_ŦŦK ZvŦK hŰŦŦK ÎŰ eŦj | thgb `ŰBW K`Űj cvŦŦcixŦŦY i`i`i AvŦM hw` cŰvb t`<tji kb` `ŰM Avi fŰbŦŦi t`<tji kb` `ŰM wŦj bv hvq Zvntj cŦŦ cwi gvc mŰVK nŦe bv | GŰv hŰŦŦK ÎŰ |

tZgwbfvte A`wglvri ev tfrvvglvrti i Kulv hw` hš¿i t`<tji ktb`i mvt\_ wgtj bv \_vtK Zvntj tmB hš¿i  
 ÎWU AvtQ| cix¶Y i i`i AvtM GB hws¿K ÎWU wby¶ Kti wbtZ nq| Zvici cŕB cW t`tK GB cW wqtqM  
 Kti cKZ cW tei Kitz nq|

(M) e`w³MZ ÎWU : cix¶Yi mgq Avgv` i bvbwea cW wbtZ nq| ch¶¶Kti wbtRi KviY cvtV th ÎWU  
 AvtM ZvtK e`w³MZ ÎWU etj| hw` ch¶¶Kti `wó i mgm`v \_vtK Zvntj cvtV fj nte| ch¶¶Kti  
 Ae`vb, tKvbtv `wM t`Lv ev wKQz MYbvi t¶¶Î th ÎWU nq tm,tjv e`w³MZ ÎWU| thgb t`<tji mrvth`  
 tKvbtv `tÊi `N© gvcvi mgq `tÊi gv\_v t`<tji tKvb `vtMi mvt\_ wgtjtQ Zv j`fvte bv t`tL hw`  
 wZh¶fvte t`Lv nq Zvntj cvtV ÎWU nte| GKwU tEMtRi eËvKvi t`<tji KZZg fWM `i wLK t`<tji mvt\_  
 wgtjtQ tmUv \_btZ hw` fj nq Zvntj cvtV fj Avtete| wKsev t`vj tKi t`vj bKvj wby¶qi mgq t`vj b msL`v  
 wby¶q fj Kitz mWV t`vj b Kvj cvlqv hvte bv| GmeB e`w³MZ ÎWU| GB mKj ÎWU `t Kivi mgq  
 mveavtb h\_vh\_fvte cW wbtZ nq|

AbjñÜvb 1.1

GKwU AvqZvKvi e` i GKwU cŕoi t¶¶Îdj l e` i AvqZb wbb¶|

Dt`i k` : `wBW K`wj cvm`e`envi Kti e` i `N©wbb¶|

mÎ : t¶¶Îdj ntjv tKvbtv e` i cŕoi cwigY| Avi tKvbtv e` th `vb `Lj Kti ZvtK tmB e` i AvqZb  
 etj| tKvbtv AvqZvKvi e` i tKvbtv cŕoi t¶¶Îdj A Ges AvqZb V ntj ,

$$A = L \times B \quad \dots\dots\dots (1.1)$$

$$\text{Ges} \quad V = L \times B \times H \quad \dots\dots\dots (1.2)$$

GLvfb,  $L = e` i `N©$

$$B = e` i cŕ'$$

$$H = e` i D`PZv$$

`wBW K`wj cvtm¶ mrvth` th tKvbtv `tN¶ cW wby¶qi mÎ :

$$\text{`N©} = \text{cåvb t`<j cW (M) + fwb¶vi mgcizb (V) \times fwb¶vi a`eK (VC)}$$

$$A_{\text{¶}} L \text{ ev } B \text{ ev } H = M + V \times VC$$

hš¿cwZ : `wBW K`wj cvm`AvqZKvi e` |

KvtRi aviv

1. `wBW K`wj cvmU wbtq Gi cåvb t`<tji ¶iz Zg GK fvtMi gvb Ges fwb¶vi t`<tji tgvU fWM msL`v  
 KZ Zv j¶ Ki | Gi ci hš¿wU fwb¶vi a`eK (VC) tei Ki |

2. GLb AvqZvKvi e`' i ŋN<sup>©</sup>eivei ŋBW K`wj cvŋmP`B tPqvŋtji gŋa` ŋ`vcb Kŋi tPqvŋ ŋwŋŋK e`' i ŋB cŋŋŋŋi mŋŋ ŋŋk<sup>©</sup>Kivl | GB Ae`'vq fwbŋŋŋi kb` ŋM cŋvb t`<tji th ŋM AwZμg Kŋi , ŋmB ŋŋŋi cvVB nŋŋv cŋvb t`<j cvW M |
3. GB Ae`'vq fwbŋŋŋi KZ msL`K ŋM cŋvb t`<tji th tKvŋbv GKw ŋŋŋi mŋŋ ŋŋŋ hvq Zv wŋYŋ Ki | Gw fwbŋŋi mgcvZb V |
4. e`' i ŋŋK ŋN<sup>©</sup>eivei KŋqKw Ae`'vŋ ewŋŋ 2 I 3 bs cŋŋŋŋi cŋŋŋŋŋ Ki Ges cŋŋŋ gŋb , ŋŋŋ QŋK ŋ`vcb Ki |
5. Gici e`' i ŋ cŋ' eivei ŋBW K`wj cvŋmP` tPqvŋtji gŋa` ŋ`vcb Kŋi 2 I 3 bs cŋŋŋŋŋ KŋqK RvŋMv cvW bvl Ges QŋK ŋ`vcb Ki |
6. Gevi e`' i ŋ D`PZv eivei ŋBW K`wj cvŋmP` tPqvŋtji gŋa` ŋ`vcb Kŋi 2 I 3 bs cŋŋŋŋŋ KŋqK RvŋMv cvW bvl Ges QŋK ŋ`vcb Ki |
7. cŋŋŋRbŋŋ wŋmŋŋŋi mŋŋŋŋŋ e`' i ŋ ŋN<sup>©</sup>, cŋ' I D`PZv wŋbŋŋ Kŋi (1.1) Ges (1. 2) mgŋKŋŋŋ Zv ewŋŋ AvqZKvi e`' i ŋ GKw cŋŋi tŋŋŋŋŋ I e`' i ŋ AvqZb wŋbŋŋ Ki |

#### Abŋŋŋŋŋi QK

chŋŋŋŋŋŋ

K. fwbŋŋŋi a`eK wŋbŋŋŋ :

cŋvb t`<tji i ŋŋŋ Zg GK Nŋi i gŋb,  $s = \dots$  cm

fwbŋŋŋi t`<tji i tŋŋŋ fŋM msL`v,  $n = \dots$

∴ fwbŋŋŋi a`eK,  $VC = \frac{s}{n} = \dots$  cm

L. AvqZKvi e`' i ŋN<sup>©</sup>, cŋ' I D`PZv wŋYŋŋi QK

AvqZKvi e`' i	chŋŋŋŋŋŋ msL`v	cŋvb t`<j cvW, M (cm)	fwbŋŋŋi mgcvZb V	fwbŋŋŋi a`eK VC (cm)	cvW $M + V \times VC$ (cm)	Mo cvW (cm)
ŋN <sup>©</sup> L	1.					
	2.					
	3.					
cŋ' B	1.					
	2.					
	3.					
D`PZv H	1.					
	2.					
	3.					

wnmve l djvdj :

AvqZKvi e`' i GK c#ôj t¶¶Î dj ,  $A = L \times B = \dots\dots\dots \text{cm}^2 = \dots\dots\dots \times 10^{-4} \text{m}^2$

Ges AvqZb,  $V = L \times B \times H = \dots\dots\dots \text{cm}^3 = \dots\dots\dots \times 10^{-6} \text{m}^3$

AbymÜvb 1.2

GKwU eÊvKvi c#`t`Q` wekó Zvfi i c#`t`Q` i t¶¶Î dj wbb¶|

D#i k` : `EMR e`envi Kfi Zvfi i e`vm wbb¶|

m# : t¶¶Î dj ntjv tKvfbv e`' i c#ôj cwi gvY | tKvfbv Zvfi i c#` eivei `#N¶ mv#\_j #^fvte tQ` KvU#j  
th Zj cvl qv hvq Zvi cwi gvYB nt`Q c#`t`Q` i t¶¶Î dj | tKvfbv eÊvKvi c#`t`Q` wekó Zvfi i c#`t`Q` i  
t¶¶Î dj A ntj

$$A = \pi r^2$$

GLvfb,  $r = \text{Zvfi i e`vma}^\circ$

$$\pi = 3.14 ; \text{a}^\circ \text{e msL}^\circ \text{v}$$

GLb Zvfi i e`vm d ntj  $r = d / 2$ , mZi v

$$A = \pi \left( \frac{d}{2} \right)^2$$

$$\therefore A = \frac{1}{4} \pi d^2 \dots\dots\dots (1.3)$$

`EzM#Ri mrvth` th tKvfbv `#N¶ cvW wby¶qi m# :

$$\text{`N}^\circ = \text{`iMLK } t^<j \text{ cvW } (L) + \text{eÊvKvi } t^<j \text{ i fVM msL}^\circ \text{v } (C) \times \text{jwN}^\circ \text{ MYb } (LC)$$

$$A_\# d = L + C \times LC$$

hš¿cwZ : `EzMR, Zvi |

Kv#Ri aviv

1. c¶tg `iMLK t^<j i ¶i Zg N#i i gvb l eÊvKvi t^<j i tgvU fVM msL}v t#L bvl |
2. Gi ci hš¿i wP wby¶ Ki | eÊvKvi t^<j m#úY°GKevi Njvtj GwU `iMLK t^<j eivei th `N°  
AwZpg Kfi ZvB ntjv hš¿i wP | wP#K eÊvKvi t^<j i tgvU fVM msL}v w#q fVM Kfi jwN° MYb  
(LC) tei Ki |
3. GLb ci¶¶vxb Zviw#K `EzM#Ri `vqx`Ê l `Ei gvSLvfb ti#L `Ew#K GKw`K eivei Nji tq  
KjK l `E#K Avj#Zvfvte Zvfi i Mtq `úk¶Kivl |

4. GB Ae`'vq `iWLK t`< t j i th `vMwU eE`vKvi t`< t j i eigw` tK t` Lv hvq tmB `v tMi cV bvl | GwU  
`iWLK t`< j cV (Z) | Gevi t` tLv eE`vKvi t`< t j i KZ b`^i `vM `iWLK t`< t j i `v tMi mv t\_ wgt j  
tM tQ | GwU nt jv eE`vKvi t`< t j i fVM msL`v (C) |
5. Gfite Zv t i i AŠZ cuPwU wfbaRvqMvq cV wbtq Q tK `vcb Ki |
6. c`qvRbxq wnmv t ei mvr t h` Zv t i i e`vm t ei K t i (1.3) mgyKi t Y ewm t q Zv t i i c` t` t` Q t` i t` t` t` dj  
wbb` Ki |

### AbmÜv t bi QK

ch`e`Y

K. j wNô MYb wbb` :

`iWLK t`< t j i GK f v tMi gvb,  $s = \dots$  mm

eE`vKvi t`< t j i tgvU fVM msL`v,  $n = \dots$

wcP (eE`vKvi t`< j m`uY`GKevi Nj v t j `iWLK t`< t j th `N`AwZµg K t i),

$p = \dots$  mm

$\therefore$  j wNô MYb,  $LC = \frac{p}{n} = \dots$  mm

L. Zv t i i e`vm wby`qi QK

ch`e`Y msL`v	`iWLK t`< j cV, L (mm)	eE`vKvi t`< t j i fVM msL`v C	j wNô MYb LC (mm)	e`vm $d = L + C \times LC$ (mm)	Mo e`vm (mm)
1.					
2.					
3.					
4.					
5.					

wnmve I djvdj :

Zv t i i c` t` t` Q t` i t` t` t` dj,  $A = \frac{1}{4} \pi d^2 = \dots$  mm<sup>2</sup> =  $\dots \times 10^{-6}$  m<sup>2</sup>

## Abkxj bx

K. eĒibefPnb cĕkæ

mĕVK DĒiĕUi cĕk ĕJK (√) ĕPĕ`vl |

1| tKĕqĕUĕg ZĒĕtK cĕvb Kĕib?

(K) cĕ¼

(L) AvBb ÷ vBb

(M) i v`vi tĕdW<sup>©</sup>(N) nvBĕRbevM<sup>©</sup>

2| tĕmb Kvi bĕg tĕtK GĕmĕQ?

(K) RM`xk P>`<sup>a</sup>emy(L) mĕvĕl P>`<sup>a</sup>emy(M) mĕZ>`<sup>a</sup>bv\_emy(N) kir P>`<sup>a</sup>emy

3| ĕĕPi tKĕtĕWU tĕgĕj K iĕk bq?

(K) fi

(L) Zĕc

(M) Ziĕr cĕĕv

(N) c`vĕ\_ĕ cĕi gĕY

4| GKĕU`ĒĕK`ĕBW K`ĕj cĕm<sup>©</sup>`ĕtĕbi ci th cĕv cĕl qv tĕMj Zĕ nt`Q cĕvb t`<j 4 cm, fĕbĕvi mĕcĕZb 7 Ges fĕbĕvi a`eK 0.1 mm | ĒĕUi`Ē`N`KZ?

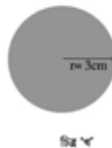
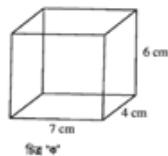
(K) 4.07 cm

(L) 4.7 cm

(M) 4.07 mm

(N) 4.7 mm

ĕĕPi ĕĕ tĕtK 5 Ges 6 cĕkæ DĒi`vl :



5| L ĕĕĕUi AvqZb

(K)  $\frac{1}{3}\pi r^3$ (L)  $\frac{4}{3}\pi r^3$ (M)  $\frac{3}{4}\pi r^3$ (N)  $\pi r^3$ 

6| K I L ĕĕĕUi AvqZĕbi AbĕvZ :

(K) 1 : 0.673

(L) 1 : 0.0673

(M) 1 : 0.763

(N) 1 : 0.637

L. mĕBkxj cĕkæ

1. iĕk`Zvi m` tKbv tĕj ĕĕq tĕYĕj i`Ē`ĕĕĕejj tĕYĕj ĕUi`Ē`ĕ11.73cm | Zvi eÜz mĕB ejj GB cĕi gĕc mĕVK bvĕ ntZ cĕti | iĕk`ejj th GB tĕj ĕĕq KĕqKĕvi cĕi gĕc Kĕi GKB dj tĕtĕQ | Zviv ĕĕĕĕi KĕQ tĕMj ĕĕĕK Zĕ`i 0.005 cm fĕbĕvi aĕK ĕĕkĕ fĕbĕvi tĕj e`ĕvi KĕtZ ej tĕb | iĕk`fĕbĕvi tĕĕj i mĕvĕth`mĕVK`Ē`cĕi gĕc Kĕj |

- K. fwbŕvi aþK Kx?
- L. tKvþbv iwiki cwi gvY cKvk KiþZ GKþKi cŕqvRb nq tKb?
- M. e`eüZ fwbŕvi t`þj i Kq fivM cÁvb t`þj i KZ fivMi mgvb vbYŕ Ki |
- N. ivþkt`i cŕg ``N`cwi gvc mivK cwi gvþci mvþ\_ msMvZcyŕQj bv hy<sup>3</sup> mnKvþi  
vj L |

#### M. mvavi Y cŕŕe

- 1 | Avgiv tKb c`v\_ŕeÁvb coe Ũ G mæúþKŕGKwJ cŕZte`b i Pbv Ki |
- 2 | ŕŕ wesk kZwäþZ c`v\_ŕeÁvþbi we`sqKi AMŕvZ NþUŕ Ũ D`vni Ymn Gi mctþŕ hy<sup>3</sup> `vl |
- 3 | (K) iwk ejþZ Kx eŕvq ?  
(L) tgŕvj K iwk I j ä iwiki gþa` cv\_ŕ` vbþ`ŕ Ki |
- 4 | (K) GKþKi AvŕRŕZK cŕvZþZ tKvb tKvb iwkþK tgŕvj K iwk aiv nþqþŕ ?  
(L) GB mKj iwiki GKþKi bvg Ki |
- 5 | gvŕv ejþZ Kx eŕ ?



# ŵØZxq Aa`vq MwZ MOTION



[Avgiv Avgvť`i Pricvťk hZ e`' t`wL, tmsťjv nq w`'i bv nq MwZkxj | w`wZ I MwZ ejťZ Avmťj Avgiv Kx ejS? GKw MwZkxj e`' i MwZi `enkó`mgn cKvťki Rb` Avgvť`i MwZ mspvš`newfbæiwiki cŇqvRb nq | GB Aa`vtq Avgiv MwZ mspvš`newfbæiwiki, Zvť`i gvĹv, GKK, Zvť`i ga`Kvi cvi`úwi K m`úK©BZ`w` wbtq Avťj vPbv Kie |]

GB Aa`vq cvW tkťI Avgiv-

1. w`wZ I MwZ e`vL`v KiťZ vie |
2. newfbæcKvi MwZi gťa` cv`K` KiťZ vie |
3. t`<jvi I tť±i iwk e`vL`v KiťZ vie |
4. MwZ m`úKŹ iwkmgñi gťa` cvi`úwi K m`úKŹetkťY KiťZ vie |
5. evavxb I gyťfvťe coš`e`' i MwZ e`vL`v KiťZ vie |
6. tjlwPťĹi mrvťh` MwZ m`úKŹ iwkmgñi gťa` m`úKŹetkťY KiťZ vie |
7. Avgvť`i Rxeťb MwZi cťve Dcjwä KiťZ vie |



Avgiv AvtMB AvtjvPbv KtiwQ tKvfbv e` w`i bv MwZkxj Zv ešvi Rb` cñ½ e` Z\_v cñ½ KvWtgv cQ` Kiv Ri`wi | GB cñ½ e` I Avgv`i AvtjvP` e` i cvi`úwi K Ae`vb hw` mgtqi mvt\_ AcwieWZŽ \_vK Zvntj AvtjvP` e` wUtk cñ½ e` i mvtctŕ w`i aiv nq| AvtjvP` e` I cñ½ e` hw` GKB w`tk GKB tetM Pjtz \_vK Zvntj I wKš` mgtqi mvt\_ e` Øtqi ga`eZP` iZj tKvfbv cwieZB NUte bv, hw` I cKZctŕ e` wU MwZkxj | Pjš-tUšbi Kigivq `ß eÜz hw` gŕLvŕL etm \_vK, Zte GKRtbi mvtctŕ Ab`Rtbi Ae`vŕbi tKvfbv cwieZB nq bv| mŕivs ejv thtZ cvi GKRtbi mvtctŕ Ab`Rb w`i | wKš` hw` tUb jvBtbi cvi k`wvfbv tKvfbv e`w³ Zv`i tK t`Lb Zte wZwb t`Lteb Zvi mvtctŕ H`ß eÜi Ae`vŕbi cwieZB nt`Q| A\_ŕ jvBtbi cvi k`wvfbv e`w³ i mvtctŕ Zviv DfqB MwZkxj |

Zvntj Avgiv t`Ltz cwrQ th, tKvfbv e` cKZctŕ w`i wK bv Zv wbfP KiQ cñ½ e` i Dci | cñ½ e` hw` cKZctŕ w`i nq Zvntj Zvi mvtctŕ th e` w`wZkxj itqtQ tml cKZctŕ w`i | G aitbi w`wZtK Avgiv cig w`wZ ejtZ cwi | A\_ŕ cñ½ e` wU hw` cig w`wZtZ \_vK ZvntjB tKvfbv e` Zvi mvtctŕ w`i \_vKtj tm e` tK cig w`wZkxj ejv thtZ cvi | tmŕc cig w`wZkxj cñ½ e` i mvtctŕ tKvfbv e` i MwZtK Avgiv cig MwZ ewj | wKš` G gnwetk; Ggb tKvfbv cñ½ e` cvi qv mæ bq hv cKZctŕ w`i itqtQ| KviY cw\_ex cÜZwbqZ mthP Pviw`tK Njtz, mthP Zvi Mh, DcMh wotq Qvict\_ Njtz| KvRB Avgiv hLb tKvfbv e` tK w`wZkxj ev MwZkxj ewj, Zv Avgiv tKvfbv AvcvZ w`wZkxj e` i mvtctŕ etj \_wK| KvRB Avgiv ejtZ cwi G gnwetk; mKj w`wZB AvtcwŕKŕ mKj MwZB AvtcwŕK| tKvfbv MwZB cig bq, cig bq tKvfbv w`wZB|

wgZtKv\_vl hvl qvi Rb` evm ÷`vÊ evtmi Rb` Atcŕv KiQ| tm t`Lj Zvi eÜzwb wi· vq ZvK AwZµg Kti hv`Q| tm etj th wi· wU MwZkxj | KviY wgZi mvtctŕ mgtqi mvt\_ mvt\_ wi· wU wbieWQbŕvte Zvi Ae`vŕbi cwieZB KiQ|

tKvfbv e` i Ae`vŕbi cwieZB wKš` `ŕfŕte ntZ cvi |

wotPi D`vniY\_tjv wetePbv Kiv hvK :

(K) tgš GKwU MvtQi wotP `wotq AvtQ Ges t`Lj th Zvi eÜzHwk Zvi t`tK t`što `š i mti hv`Q| tgš I Hwki ga`eZP` iZj mgtqi mvt\_ mvt\_ ewŕ cvi`Q| (wPŕ : 2.1K)|

(L) ivRt`i `<tji ewlŕ µxov cÜZthwMZvq t`šo cÜZthwMZvi Rb` gŕv GKwU weivU eŕvKvi U`vK Kiv ntqtQ| tmB eŕŕi gvSLvŕb `wotq ivRy t`Lj Zvi eÜzwkne H U`vK eivei t`što cÜvKwM KiQ (wPŕ : 2.1L)| ivRyetj th wkne MwZkxj, wKš`-y ivRy I wknŕei ga`eZP` iZj mgtqi mvt\_ mvt\_ tZv cwieWZŽ nt`Q bv| Zvntj Kxfŕte ejv hvte th wkne ivRj mvtctŕ MwZkxj?



চিত্র : ২.১ (ক)



চিত্র : ২.১ (খ)

প্রথম উদাহরণে মৌ –এর সাপেক্ষে সময়ের সাথে দূরত্বের পরিবর্তনের সাথে সাথে ঐশির অবস্থানের পরিবর্তন হচ্ছে। দ্বিতীয় উদাহরণে রাজুর সাপেক্ষে সময়ের সাথে শিহাবের অবস্থানের পরিবর্তন হচ্ছে, যদিও দূরত্বের পরিবর্তন হচ্ছে না। তাহলে কী পরিবর্তন হচ্ছে? রাজুর সাপেক্ষে শিহাবের অবস্থানের দিকের পরিবর্তন হচ্ছে। পর্যবেক্ষকের সাপেক্ষে গতিশীল কোনো বস্তুত্ব অবস্থানের পরিবর্তন হতে পারে দূরত্বে বা দিকে বা উভয়েই।

## ২.২ বিভিন্ন প্রকার গতি

### Types of motion

**রৈখিক গতি :** কোনো বস্তু যদি একটি সরল রেখা বরাবর গতিশীল হয় অর্থাৎ কোনো বস্তুত্ব গতি যদি একটি সরল রেখার উপর সীমাবদ্ধ থাকে, তাহলে তার গতিকে রৈখিক গতি বলে। একটি সোজা সড়কে কোনো গাড়ির গতি রৈখিক গতি।

**ঘূর্ণন গতি :** যখন কোনো বস্তু কোনো নির্দিষ্ট বিন্দু বা অক্ষ থেকে বস্তুত্ব কণাগুলোর দূরত্ব অপরিবর্তিত রেখে ঐ বিন্দু বা অক্ষকে কেন্দ্র করে ঘোরে তখন সে বস্তুত্ব গতিকে ঘূর্ণন গতি বলে। যেমন বৈদ্যুতিক পাখার গতি, ঘড়ির কাঁটার গতি ইত্যাদি।

**চলন গতি :** কোনো বস্তু যদি এমনভাবে চলতে থাকে যাতে করে বস্তুত্ব সকল কণা একই সময়ে একই দিকে সমান দূরত্ব অতিক্রম করে তাহলে ঐ গতিকে চলন গতি বলে।

একখানা বইকে ঘুরতে না দিয়ে ঠেলে টেবিলের এক প্রান্ত থেকে অন্য প্রান্তে নিয়ে গেলে এই গতি চলন গতি হবে। কারণ বই এর প্রতিটি কণা সমান সময়ে একই দিকে সমান দূরত্ব অতিক্রম করবে।

**পর্যাবৃত্ত গতি :** কোনো গতিশীল বস্তুত্বকণার গতি যদি এমন হয় যে, এটি এর গতি পথে কোনো নির্দিষ্ট বিন্দুকে নির্দিষ্ট সময় পর পর একই দিক থেকে অতিক্রম করে, তাহলে সেই গতিকে পর্যাবৃত্ত গতি বলে।

GB MvZ eĖvKvi, DceĖvKvi ev mij%wLK ntZ cvti | Nvov Kuvvi MvZ, mĕhP Pvi w`tK cġ\_exi MvZ, evŕu ev tctUvj BwĀtbi wmwj Ėvti i gta`wc÷tbi MvZ chŕeĖ MvZ |

chŕeĖ MvZm÷ubetKvĕbv KYv th wbow`Ŗ mgq ci ci wbow`Ŗ we`ĭK wbow`Ŗ w`K w`tq AwZpug Kti tmB mgqtK chŕqKvj etj |

`u`b MvZ : chŕeĖ MvZm÷ubetKvĕbv e` hŕ chŕqKvj i AĕaŔ mgq tKvĕbv wbow`Ŗ w`tK Ges ewK AĕaŔ mgq GKB ct\_ Zvi weciXZ w`tK Ptj Zte Gi MvZtK `u`b MvZ etj |

`u`b MvZi D`vniY nt`Q mij t`vjtKi MvZ, K÷ubkxj mj kĵvKv I wMvĕti i Zvti i MvZ |

## 2.3 t`<jvi iwĵ I tƒ±i iwĵ

### Scalar and vector quantities

G tƒSZ RMtZ hv wKQz cwi gvc Kiv hvq ZvtK Avgiv iwĵ ewj | tKvĕbv iwĵ hLb cwi gvc Kiv nq ZLb Zvi GKwU gvb \_vtK | GB gvb cĶvk Kitz Avgiv GKwU mSL`v Ges GKwU GKK e`envi Kwi | thgb Avgiv hŕ ewj teĀwU i `N° 1.5 wġUvi, Zvntj eŖv hvq `tN° GKK wġUvi, Avi tetĀi `N° Zvi 1.5 \_Y | wKŠ' tKej gvb w`tq mKj iwĵtK m÷uYŕtc cĶvk Kiv hvq bv | wKQz wKQz iwĵ cĶvĕki Rb` gvtbi mvt\_ w`tKi I cĶqvRb nq |

thgb Avgiv hŕ ewj GKwU Mwv NĖvq 40 wKtj wġUvi tetM Ptj tQ, Zvntj GUv eŖv hŕte th MwvU GK NĖvq 40 km `tZi AwZpug Kti tQ, wKŠ' MwvU tKvĕbw`tK tm `tZi AwZpug Kti tQ, Zv Rvbv hŕte bv | MwvU cĶZ Ae`v eŖtZ ntj MwvU tetM tKvĕbv w`tK tmUvI Dtj t Kitz nte | mYzvs t`Lv hŕt`Q wKQz wKQz iwĵ AvtQ th tĵv m÷uYŕtc cĶvk Kitz ntj gvtbi mvt\_ w`tKi Aek`B Dtj t Kitz nq | w`tKi wetePbvq Avgiv e` RMtZi mKj iwĵtK `Ĥ fvtM fvtM Kitz cwi ; h\_vN

1 | Aw`K iwĵ ev t`<jvi iwĵ

2 | w`K iwĵ ev tƒ±i iwĵ |

t`<jvi iwĵ : th mKj tƒSZ iwĵtK i aygvb w`tq m÷uYŕtc cĶvk Kiv hvq, w`K wbt`ŕki cĶqvRb nq bv Zvt`itK t`<jvi iwĵ etj | `N°, fi, `tZ, KvR, kw³, mgq, Zvcgvĭv BZ`w` t`<jvi iwĵi D`vniY |

tƒ±i iwĵ : th mKj tƒSZ iwĵtK m÷uYŕtc cĶvk Kivi Rb` gvb I w`K Dftqi cĶqvRb nq Zvt`itK tƒ±i iwĵ etj | miY, teM, ZiY, ej, Zwv ZxeZv BZ`w` tƒ±i iwĵi D`vniY |

2.1 mviY t`tK t`Lv hŕt`Q th cĶZwU tƒ±itK gvb I w`K w`tq Avi t`<jvi iwĵ tĵvK tKej gvb w`tq wbt`ŕ Kiv ntqtQ |

## সারণি ২.১

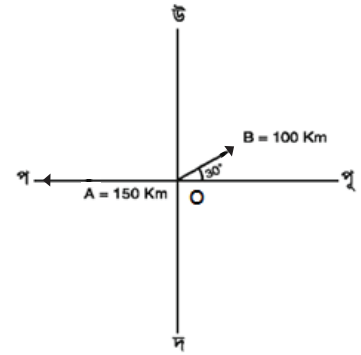
## স্কেলার ও ভেক্টর রাশির উদাহরণ

স্কেলার রাশি			ভেক্টর রাশি		
নাম	সংকেত	উদাহরণ	নাম	সংকেত	উদাহরণ
দূরত্ব	$d$	40 m	সরণ	$s$	40 m পূর্ব দিকে
দ্রুতি	$v$	$30 \text{ m s}^{-1}$	বেগ	$\mathbf{v}$	$30 \text{ m s}^{-1}$ উত্তর দিকে
সময়	$t$	15 s	বল	$\mathbf{F}$	100 N উপরের দিকে
শক্তি	$E$	2000 J	ত্বরণ	$\mathbf{a}$	$98 \text{ m s}^{-2}$ নিচের দিকে

## ভেক্টর রাশির নির্দেশনা

কোনো রাশির সংকেতের উপর তীর চিহ্ন দিয়ে ভেক্টর রাশি নির্দেশ করা হয়, যেমন  $\vec{A}$ । A বা  $|\vec{A}|$  দিয়ে ভেক্টর রাশি  $\vec{A}$  -এর মান নির্দেশ করে। ছাপার অক্ষরের ক্ষেত্রে অনেক সময়  $\vec{A}$  -এর বদলে বোল্ড হরফ A ভেক্টর এবং সাধারণ হরফ A দিয়ে রাশিটির মান প্রকাশ করা হয়। সারণি ২.১ - এ ভেক্টর রাশিকে বোল্ড হরফ দিয়ে নির্দেশ করা হয়েছে।

চিত্রে কোনো ভেক্টর রাশিকে একটি তীর চিহ্নিত সরলরেখা দ্বারা নির্দেশ করা হয়। সরলরেখার দৈর্ঘ্য রাশিটির মান এবং তীর চিহ্ন -এর দিক নির্দেশ করে। উদাহরণস্বরূপ ২.২ চিত্রে সরণ 50 km কে 1 cm দ্বারা নির্দেশ করা হয়েছে। সুতরাং ঐ চিত্রে A ভেক্টরটি যার দৈর্ঘ্য 3 cm, সেটি পশ্চিম দিকে 150 km সরণ নির্দেশ করে। B ভেক্টরটি পূর্ব দিকের সাথে  $30^\circ$  কোণে উত্তর দিকে 100 km সরণ নির্দেশ করে।



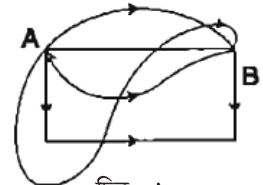
চিত্র : ২.২

## ২.৪ গতি সংক্রান্ত বিভিন্ন রাশি

## Different quantities related to motion

## দূরত্ব ও সরণ :

ধরা যাক, অভি তার স্কুলের গেট থেকে 100 মিটার দৌড়ে গেল। অভি গেট থেকে 100 মিটার দূরে আছে সত্য, কিন্তু ঠিক কোন জায়গায় আছে তা বলা যাবে না। কেননা অভি গেট থেকে উত্তর, দক্ষিণ, পূর্ব, পশ্চিম বা অন্য কোনো দিকে 100 মিটার দূরে থাকতে পারে। অভির অবস্থানের পরিবর্তন সঠিকভাবে জানতে হলে অভি কোন



চিত্র : ২.৩

w`tk 100 wguvi `ti tmtQ Zv RvbtZ nte| hw` ejv nq Awf tmu t\_tk 100 wguvi ce`w`tk t`sto tmtQ, Zvntj wlvöZfite Awfi Ae`vb Rvbr hte| tmu t\_tk tmvRv ce`w`tk 100 wguvi tmtjB Awf`tk cvlqv hte| cög t`tt` Avgiv Awfi Ae`v`bi cwieZB eSevi Rb` th iwkwU e`envi KtiwQ Zvntjv `iZi| GuU GKwU t`jvi iwkw| Avi wöZxq t`tt` Avgiv `iZi mvt\_ mvt\_ w`KI Dti t` KtiwQ NtmU miY| GuU GKwU t`i iwkw| GKwU wlv` w`tk th `iZi ev Ae`v`bi cwieZB Zv ntjv miY| mZivs wlv` w`tk cwiwkwKti mvt`tt` Ae`v`bi cwieZB`tk miY etj|

tKvbr e` i Aw` Ae`vb l tkl Ae`v`bi ga`eZPb`bZg `iZiA\_ŕ mij%iwLK `iZB nt`Q mitYi gvb Ges mitYi w`K nt`Q e` i Aw` Ae`vb t\_tk tkl Ae`v`bi w`tk|

miY e` i MwZc`i Dci wbfP Kti bv| tKvbr GKwU e` A Ae`vb t\_tk B Ae`v`b (w` 2.3) wewfbae ct\_ thtZ cvi| wKs` e` wU miY nte A t\_tk B -Gi w`tk| A l B Gi ga`eZPb`bZg `iZiA\_ŕ G t`tt` AB mij%iwLK `iZi ntjv mitYi gvb AB = s Ges w`K ntjv A t\_tk B -Gi w`tk| thtnZmitYi gvb l w`K DfqB AvtQ, KvRB GuU GKwU t`i iwkw|

mitYi gv`v ntjv ``tN` gv`v|

∴ [s] = L

mitYi GKK ntjv `tN` GKK A\_ŕ wguvi (m)| tKvbr e` i miY 60 m`w`Y w`tk ejtZ eSvq e` wU Zvi Aw` Ae`vb t\_tk 60 m`w`Y w`tk mti tmtQ|

`tZ :

aiv hvK, AvtMi D`vniY Awf H 100 wguvi `iZi 50 tmtKtÊ cvi ntjv| GKB `iZi wgz h` 40 tmtKtÊ cvi ntq\_vtk Zvntj tK `Z PjtQ? Awf bv wgz? wlvöqB wgz| tKbbv Zvi mgq Kg tj tmtQ|

gtb Kiv hvK, Awf 100 wguvi `iZi 50 tmtKtÊ cvi ntjv| wgz 75 wguvi `iZi 30 tmtKtÊ cvi ntjv| Avgiv wK ejtZ cwi Awf wgz tPtq axti PjtQ? Awf wK wgz tPtq tewk `iZi AwZµg Ktiwb? tK tewk `Z PjtQ Awf bv wgzZv RvbtZ ntj GKwU wlv` mg`q Dftqi AwZµs-`iZi Zj bv Kitz nte| aiv hvK, GB wlv` mgq nt`Q 1 tmtKtÊ| mZivs,

$$1 \text{ tmtKtÊ Awfi AwZµs-} \text{ `iZi } 100 / 50 = 2 \text{ wguvi}$$

$$1 \text{ tmtKtÊ wgz AwZµs-} \text{ `iZi } 75 / 30 = 2.5 \text{ wguvi}$$

mZivs, wgzAwfi tPtq `Z PjtQ, tKbbv 1 tmtKtÊ wgzAwfi tPtq tewk `iZi AwZµg KtiwQ|

Gi t\_tk Avgiv eStZ cwi tK `Z PjtQ Zv wbfP Kti mgq Ges AwZµs-`iZi Dci| tKvbr e` KZ `Z PjtQ Z\_v `iZi AwZµg KtiwQ Zv th iwkw w`tq cwi gvc Kiv nq ZvtK `tZ ejv nq| `tZ e` i Ae`v`bi cwieZB nvi wlv` R Kti| mg`qi mvt\_ tKvbr e` i Ae`v`bi cwieZB nvi tK `tZ etj|

e<sup>-</sup> i GKK mgṭq AwZṡṡ-`iZiṭviv`ṭZ cwi gvc Kiv nq | mṡZivs,

$$\text{`a}^{\text{a}}\text{aZ} = \frac{\text{`~iZi}}{\text{mgq}}$$

tKvṭbv MwZkxj e<sup>-</sup> hw` t mgṭq d`iZiAwZṡṡ Kṭi, Zvntj`ṭZ

$$v = \frac{d}{t}$$

`ṭZ ṭviv Ae<sup>-</sup>vṭbi cwieZṡṡbi nvi tKvṭ w`ṭK NṭUṭQ Zv Rvṭv hvq bv, dṭj`ṭZi tKvṭbv w`K ṭbB | mṡZivs  
`ṭZ GKṡU ṭ<sup>-</sup>cjvi i wṭK |

$$\text{`ṭZi gṡṭv nṭjv} \frac{\text{`~iZi}}{\text{mgq}} \text{Gi gṡṭv |}$$

$$\therefore [v] = \frac{L}{T} = LT^{-1}$$

ṭṭṭnZi`iZṭK mgq w`ṭq fṡM Kiṭj`ṭZ cvlqv hvq, KvṭRB`iṭZji GKKṭK mgṭqi GKK w`ṭq fṡM Kiṭj  
`ṭZi GKK cvlqv hwṭe | `iṭZji GKK wḡUvi (m) Ges mgṭqi GKK ṭṡṭKÊ (s) nI qvq`ṭZi GKK nṭe  
wḡUvi/ṭṡṭKÊ (m s<sup>-1</sup>) | ṭhgb tKvṭbv e<sup>-</sup> i`ṭZ 4 m s<sup>-1</sup> ejṭZ eṡvq e<sup>-</sup> wṡ cṡZ ṭṡṭKÊ 4 wḡUvi`iZi  
AwZṡṡ Kṭi |

`ṭZi GKK wḡUvi/ṭṡṭKÊ nṭjI Avgṡ`i Dcjwäi mṡeavi Rb` Avgiv AṭbK mgq`iṭZji GKK wṭṭjwḡUvi  
Ges mgṭqi GKK NÈv aṭi`ṭZi GKK wṭṭjwḡUvi/NÈv (km h<sup>-1</sup>) awi | Mwṡoi w`ṭWwḡUvi ṭh`ṭZ wṭṭ`R  
Kṭi Zv km h<sup>-1</sup> -G ṭ<sup>-</sup>I qv`vṭK |

Mo`ṭZ : tKvṭbv e<sup>-</sup> i MwZKvṭj hw` KLbI`ṭZi gṡṭbi tKvṭbv cwieZṡṡbv nq A\_ṡ e<sup>-</sup> wṡ hw` meṡv mgvb  
mgṭq mgvb`iZiAwZṡṡ Kṭi Zvntj H e<sup>-</sup> i`ṭZṭK mṡḡ`ṭZ eṭj | Avi hw` mgvb mgṭq e<sup>-</sup> mgvb`iZi  
AwZṡṡbv Kṭi Zvntj ṭmB`ṭZṭK Amg`ṭZ eṭj |

e<sup>-</sup> hw` mṡḡ`ṭZṭZ bv Pṭj Zvntj Zvi AwZṡṡ-ṭḡU`iZṭK mgq w`ṭq fṡM Kiṭj Mṡo cṡZ GKK mgṭq  
AwZṡṡ-`iZi cvlqv hvq | GṭK Mo`ṡZ ejv nq |

$$\text{mṡZivs, Mo`a}^{\text{a}}\text{aZ} = \frac{\text{ṭḡU`~iZi}}{\text{mgq}}$$

hw` tKvṭbv Mwṡo XvKv ṭṭṭK w`bvRcj hvl qvi cṭ<sub>-</sub> mKvj 7 Uvq iIbv nṭq 6 NÈvq 300 wṭṭjwḡUvi c\_  
AwZṡṡ Kṭi, Zṭe Zvi Mo`ṭZ nṡ<sup>o</sup>Q 300 km / 6 h = 50 km h<sup>-1</sup> | GLṡṭb Mo`ṭZ ejvi KviY MwṡoU ṭh  
Zvi Pji cṭ<sub>-</sub> cṡZ`K NÈvq 50 wṭṭjwḡUvi`iZiAwZṡṡ KṭiṭQ Ggb tKvṭbv K\_v ṭbB | MwṡoU KLbI Gi  
ṭṭṭq`Z wṡṭq`vKṭZ cvṭi Avei Gi ṭṭṭq Avṡ<sup>-</sup>I PjṭZ cvṭi |





hŕ MŕKxj tKŕbv e` i tetMi gvb I w`K AcwiewZŕ \_vK Zvntj tmB e` i tetMŕK mŕg tel ev mgteM etj | ktāi tel mŕg tetMi GKŕU cKŕ cKŕZK D`vniY | kā ŕbŕ ŕ gra`tg ŕbŕ ŕ Zvcgvŕ vq ŕbŕ ŕ w`K mgvb mgŕq mgvb c\_ AnZŕg Kŕi, Avŕ Zvnt`Q 0°C Zvcgvŕ vq evqŕZ cŕZ tmŕKŕÊ 332 ŕgUvi | kā tKŕbv ŕbŕ ŕ w`K cŕg tmŕKŕÊ 332 ŕgUvi, ŕŕZŕq tmŕKŕÊ 332 ŕgUvi Ges GB ŕŕc cŕZ tmŕKŕÊ 332 ŕgUvi Kŕi PjŕZ \_vK | GLvŕb ktāi tetMi gvb I w`K GKB \_vKŕq ktāi tel 332 m s<sup>-1</sup> ntjv mŕgteM |

tKŕbv e` i hŕ MŕZKŕj Zvi tetMi gvb I w`K ev Dfŕqi cwieZŕ NŕU Zvntj e` i tmB tetMŕK Amg tel etj | A\_ŕ tKŕbv e` hŕ mgvb mgŕq, mgvb `ŕZi AnZŕg bv Kŕi wKsev Pjvi mgq MŕZi w`K cwieZŕ Kŕi Zvntj tmB tel Amg tel nte | Avgiv th Pjvŕdiv Kŕi, Mŕo Pŕj BZ`w`i tel mŕaviYZ Amg tel |

ZjY I g`b :

tKŕbv e` hŕ mŕg tetM bv Pŕj Zvntj e` i tetMi gŕŕbi wKsev w`Ki wKsev Dfŕqi cwieZŕ ntZ cŕi | e` i tetMi cwieZŕ ntj Avgiv evj e` i ZjY nt`Q | aiv hvK, GKŕU Mŕo GKŕU tmvRv moŕK PjŕQ | GB MŕoŕZ etm ŕgŕy cŕZ 8 tmŕKÊ ci ci Mŕoi w`ŕŕWŕgUvi t\_ŕK MŕoiUi tel ŕjceŕ KiŕQ | wŕfŕbmŕq GB Mŕoi tel km h<sup>-1</sup> I m s<sup>-1</sup> GKŕK ŕbŕPi mŕiŕYZ ŕ`Lvŕbv ntjv |

## mŕiŕY 2.2

tel - mgq mŕiŕY

ŕŕgK bs	mgq (s)	tel (km h <sup>-1</sup> )	tel (m s <sup>-1</sup> )
1	0	0	0
2	8	14.4	4
3	16	28.8	8
4	24	43.2	12
5	32	57.6	16
6	40	72	20

GB mŕiŕY t\_ŕK ŕ`Lv hvq th, MŕoiUi tel cŕg 8 tmŕKÊ 0 t\_ŕK 4 m s<sup>-1</sup> G evŕ tctŕQ; cŕi 8 tmŕKÊI Gi tel tetŕQ 4 m s<sup>-1</sup> Ges GB ŕŕc evK mgq tel tetŕQ | mŕZiv cŕZ 8 tmŕKÊ mgq e`eavŕb MŕoiUi tetMi cwieZŕ ntŕQ 4 m s<sup>-1</sup> | Ab` K\_vq, GK tmŕKÊ MŕoiUi tetMi cwieZŕ ntŕQ 0.5 m s<sup>-1</sup> | Zvntj mgŕqi mŕ\_ MŕoiUi tetMi cwieZŕbi nvi ntjv 0.5 m s<sup>-2</sup> |

tetMi cwieZŕbi nvi Z\_v GKK mgŕq tetMi cwieZŕB ZjY | mij ct\_ Pjgvb e` i mgŕqi mŕ\_ tel evŕi nŕŕK avŕZŕK ZjY ev ZjY Ges mgŕqi mŕ\_ tel nŕŕi nŕŕK FYvZŕK ZjY ejv nq | AtbK mgq FYvZŕK ZjYŕK g`b ejv nq |

mgq i m<sub>t</sub> e<sup>-</sup> i Amg tetMi e<sup>-</sup> i nvi tK ZiY etj | tKvbr e<sup>-</sup> i Aw<sup>-</sup> teM hw<sup>-</sup> u nq Ges t mgq cti  
Zvi tkl teM hw<sup>-</sup> v nq, Zvntj

$$t \text{ mgq tetMi cwieZB} = v - u$$

$$\therefore \text{GKK mgq tetMi cwieZB} = \frac{v - u}{t}$$

$$\therefore \text{tetMi cwieZB i nvi, A}_\text{P} \text{ ZiY, } a = \frac{v - u}{t}$$

$$m_{ZiY}, \text{ ZiY} = \frac{\text{tetMi cwieZB}}{\text{mgq}}$$

ZiY GKwU t<sub>f</sub> i iwk | Gi w<sup>-</sup> K AvtQ | Gi w<sup>-</sup> K nt<sup>Q</sup> tetMi cwieZB i w<sup>-</sup> tK | thtnZtAvgiv GKwU mij tiLv  
eivei MwZ wetePbv KiwQ, KvRB tetMi cwieZB nte nq tetMi w<sup>-</sup> tK wKsev tetMi wexZ w<sup>-</sup> tK | teM hw<sup>-</sup>  
e<sup>-</sup> cvq Zvntj tetMi cwieZB nte tetMi w<sup>-</sup> tK | tmt<sup>q</sup> t<sup>q</sup> ZiY nte avZK | hw<sup>-</sup> teM nwm cvq Zvntj  
tetMi cwieZB nte tetMi wexZ w<sup>-</sup> tK | tmt<sup>q</sup> t<sup>q</sup> ZiY tK FYVZK aiv nq A<sub>P</sub> g<sup>-</sup> b nq |

$$g\hat{v} : \text{ZiY i } g\hat{v} \text{ ntv } \frac{\text{teM}}{\text{mgq}} \text{ Gi } g\hat{v} |$$

$$A_\text{P}, \text{ ZiY} = \frac{\text{teM}}{\text{mgq}} = \frac{mY}{\text{mgq} \times \text{mgq}} = \frac{mY}{\text{mgq}^2}$$

$$\therefore [a] = \frac{L}{T^2} = LT^2$$

$$\text{GKK : ZiY i GKK ntv } \frac{\text{teM}}{\text{mgq}} \text{ Gi GKK |}$$

$$A_\text{P}, \frac{m s^{-1}}{s} \text{ ev } m s^{-2}$$

tKvbr e<sup>-</sup> i ZiY 5 m s<sup>-2</sup> DEi w<sup>-</sup> tK ej tZ e<sup>-</sup> i w<sup>-</sup> i teM DEi w<sup>-</sup> tK 1 s - G 5 m s<sup>-1</sup> e<sup>-</sup> cvq |

m<sub>g</sub> ZiY | Amg ZiY : ZiY `j Ktgi ntZ cvti, h<sub>v</sub>- m<sub>g</sub> ZiY | Amg ZiY | tKvbr e<sup>-</sup> i teM hw<sup>-</sup>  
w<sup>-</sup> tK memgq GKB nvti evotZ v<sup>-</sup> tK Zvntj tm ZiY tK m<sub>g</sub> ZiY ev mgZiY etj | Avi teM e<sup>-</sup> i  
nvi hw<sup>-</sup> mgvb bv v<sup>-</sup> tK, Zvntj tm ZiY tK Amg ZiY ejv nq |

m<sub>g</sub> ZiY i GKwU D<sup>-</sup> niY ntv AwfKt<sup>q</sup> c<sup>-</sup> fte g<sup>-</sup> fte coš-e<sup>-</sup> i ZiY | hw<sup>-</sup> GKwU e<sup>-</sup> feto  
g<sup>-</sup> fte cotZ v<sup>-</sup> tK ZLb Zvi ZiY nq 9.8 m s<sup>-2</sup> A<sub>P</sub>, e<sup>-</sup> i w<sup>-</sup> hLb feto i w<sup>-</sup> tK AvmtZ v<sup>-</sup> tK ZLb Gi  
teM c<sup>-</sup> t<sup>q</sup> t<sup>q</sup> 9.8 m s<sup>-1</sup> Kti evotZ v<sup>-</sup> tK |

Avi Avgiv maviY fte th mKj Pjgvb e<sup>-</sup> t<sup>-</sup> wL, thgb Mw<sup>-</sup>, mvtKj, wi<sup>-</sup> v BZ<sup>-</sup> i ZiY nq Amg |

MwYvZK D<sup>-</sup> niY 2.1 : GKwU Mw<sup>-</sup> i teM 5 m s<sup>-1</sup> t<sup>-</sup> tK m<sub>g</sub> fte e<sup>-</sup> tctq 10 s cti 45 m s<sup>-1</sup> nq |  
Mw<sup>-</sup> i ZiY tei Ki |

Avgi v Rmb,

$$a = \frac{v - u}{t}$$

$$\begin{aligned} \text{ev, } a &= \frac{45 \text{ m s}^{-1} - 5 \text{ m s}^{-1}}{10 \text{ s}} \\ &= \frac{40 \text{ m s}^{-1}}{10 \text{ s}} \\ &= 4 \text{ m s}^{-2} \end{aligned}$$

GLvfb,

Aw` teM,  $u = 5 \text{ m s}^{-1}$   
tkl teM,  $v = 45 \text{ m s}^{-1}$   
mgq,  $t = 10 \text{ s}$   
ZjY,  $a = ?$

D :  $4 \text{ m s}^{-2}$

MwYvZK D`vniY 2.2 : GKwU Mwoi teM  $20 \text{ m s}^{-1}$  t\_tK mlgfite nwm tctq  $4 \text{ s}$  cti  $4 \text{ m s}^{-1}$

nq| MwoiUi ZjY tei Ki |

Avgi v Rmb,

$$a = \frac{v - u}{t}$$

$$\begin{aligned} \text{ev, } a &= \frac{20 \text{ m s}^{-1} - 4 \text{ m s}^{-1}}{4 \text{ s}} \\ &= \frac{-16 \text{ m s}^{-1}}{4 \text{ s}} \\ &= -4 \text{ m s}^{-2} \end{aligned}$$

GLvfb,

Aw` teM,  $u = 20 \text{ m s}^{-1}$   
tkl teM,  $v = 4 \text{ m s}^{-1}$   
mgq,  $t = 4 \text{ s}$   
ZjY,  $a = ?$

D :  $-4 \text{ m s}^{-2}$

## 2.5 MwZ mspvš-wefbæi wki cvi úwi K mæúK©. MwZi mgxKiY

### Equations of motion

gvÎ PviwU mgxKiY e`envi Kti tKvfbv MwZkxj e`' i MwZ mspvš-wefbæimgm`vi mgvavb Kiv hvq| GB mgxKiY,tjvK ejv nq MwZi mgxKiY| GB mgxKiY,tjv cðhvR` nq e`' hLb mlg ZjY mijtiLvq MwZkxj \_vK| aiv hvK, tKvfbv e`' u Aw` teM wbtq a mlg ZjY t mgq Pti s` i ZiAwZpug Kti tkl teM v cðB nq| Avgi v MwZi mgxKiY,tjv wbtq cZxK,tjvi mivvth` cKvk Kwi | GB cZxK,tjv ntjv :

$u =$  Aw` teM A\_@ mgq MYbvi `i i`Z th teM

$a =$  mlg ZjY

$t =$  AwZpvš-mgq

$$s = m_i Y A_{\text{f}} t \text{ mg} t q A_{\text{w}} Z_{\text{p}} \text{Š} \text{ } i Z_i$$

$$v = t k l \text{ t e M } A_{\text{f}} t \text{ mg} q t k t l \text{ e } ' i \text{ t e M } |$$

GB cuPw iwk “*suvat*” ci`ui Ggbfite muK<sup>3</sup> th Gi th tKv<sup>†</sup>bv wZbw iwk Rv<sup>†</sup>bv \_vK<sup>†</sup>j ewK`Bw iwk tei Kiv hvq| GB Rb` Pviw mgxKiY Av<sup>†</sup>Q| c<sup>†</sup>Z`Kw mgxKi<sup>†</sup>Y Pviw K<sup>†</sup>i iwk Av<sup>†</sup>Q| Rv<sup>†</sup>bv iwk<sub>s</sub> t<sup>†</sup>j vi gvb ew<sup>†</sup>tq GB mgxKiY<sub>s</sub> t<sup>†</sup>j vi m<sup>†</sup>vn<sup>†</sup>th` AÁvZ iwk<sub>s</sub> t<sup>†</sup>j v m<sup>†</sup>tR w<sup>†</sup>bY<sup>†</sup> Kiv hvq|

2.4 Ab<sup>†</sup>“Q<sup>†</sup>” Avgiv t<sup>†</sup> tLwQ Z<sup>†</sup>j Y,

$$a = \frac{v - u}{t}$$

$$\therefore v = u + at \quad (2.1)$$

Averi H Ab<sup>†</sup>“Q<sup>†</sup>” Avgiv t<sup>†</sup> t<sup>†</sup>q<sup>†</sup>Q,

$$\text{Mo` } aZ = \frac{A_{\text{w}} Z_{\text{p}} \text{Š} \text{ } i Z_i}{\text{mg} q}$$

$$\text{ev, } \frac{u + v}{2} = \frac{s}{t}$$

$$\therefore s = \frac{(u + v)}{2} t \quad (2.2)$$

wnmve Ki : ( 2.1) mgxKi<sup>†</sup>Yi v Gi gvb (2.2) mgxKi<sup>†</sup>Y ewl |

$$\therefore s = ut + \frac{1}{2} at^2 \quad (2.3)$$

wnmve Ki : ( 2.1) mgxKiY t<sup>†</sup> tK t Gi gvb tei K<sup>†</sup>i (2.2) mgxKi<sup>†</sup>Y ew<sup>†</sup>tq eR<sup>†</sup>Yb Ki Ges c<sup>†</sup> t<sup>†</sup>j v<sup>†</sup> K web<sup>†</sup>“Í Ki |

$$\therefore v^2 = u^2 + 2as \quad (2.4)$$

hw` tKv<sup>†</sup>bv m<sup>†</sup>gm<sup>†</sup>vq ejv nq e<sup>†</sup> w<sup>†</sup> i Ae<sup>†</sup> vb t<sup>†</sup> tK hv<sup>†</sup> v<sup>†</sup> i“ K<sup>†</sup> i t<sup>†</sup>Q, Z<sup>†</sup> v<sup>†</sup> t<sup>†</sup>j Aw<sup>†</sup> t eM  $u = 0$  nte|

MwYwZK D`vniY 2.3 : w<sup>†</sup> i Ae<sup>†</sup> vb t<sup>†</sup> tK Pj Š-GKw Mmo<sup>†</sup> tZ 2 m s<sup>-2</sup> Z<sup>†</sup> j Y c<sup>†</sup> q<sup>†</sup> M Kiv n<sup>†</sup> t<sup>†</sup> j Gi t eM 20 m s<sup>-1</sup> n<sup>†</sup> t<sup>†</sup> j v| KZ mgq a<sup>†</sup> t<sup>†</sup> i Z<sup>†</sup> j Y c<sup>†</sup> q<sup>†</sup> M Kiv n<sup>†</sup> t<sup>†</sup> q<sup>†</sup> j?

Avgiv Rwb,

$$v = u + at$$

$$\text{ev, } t = \frac{v - u}{a}$$

$$= \frac{20 \text{ m s}^{-1} - 0}{2 \text{ m s}^{-2}}$$

$$= 10 \text{ s}$$

D : 10 s

GLv<sup>†</sup> b,

Aw<sup>†</sup> t eM,  $u = 0$

t k l t eM,  $v = 20 \text{ m s}^{-1}$

Z<sup>†</sup> j Y,  $a = 2 \text{ m s}^{-2}$

mgq,  $t = ?$

MwYwZK D`vniY 2.4 : 54 km h<sup>-1</sup> teM Pj Š-GKwU MwotZ 5 s hveZ 4 m s<sup>-2</sup> ZiY cċqM Kiv ntjv |  
MwotUi tkl teM KZ Ges ZiYKvjtj KZ `iZiAwZμg Ki te?

Avgiv Rwb,

$$\begin{aligned} v &= u + at \\ &= 15 \text{ m s}^{-1} + 4 \text{ m s}^{-2} \times 5 \text{ s} \\ &= 35 \text{ m s}^{-1} \end{aligned}$$

Avevi,

$$\begin{aligned} s &= ut + \frac{1}{2} at^2 \\ &= 15 \text{ m s}^{-1} \times 5 \text{ s} + \frac{1}{2} \times 4 \text{ m s}^{-2} \times (5 \text{ s})^2 \\ &= 75 \text{ m} + 50 \text{ m} \\ &= 125 \text{ m} \end{aligned}$$

D : tkl teM 35 m s<sup>-1</sup> ; `iZi 125 m

MwYwZK D`vniY 2.5 : tmvRv iv`lvq w`i Ae`vb t`tk GKwU evm 10 m s<sup>-2</sup> mltg ZiY Pjvi mgq 80 m `iZi iv`lv cċk `wotbv GK e`w<sup>3</sup>tk KZ teM AwZμg Ki te?

Avgiv Rwb,

$$\begin{aligned} v^2 &= u^2 + 2as \\ \text{ev, } v^2 &= 0 + 2 \times 10 \text{ m s}^{-2} \times 80 \text{ m} \\ &= 1600 \text{ m}^2 \text{ s}^{-2} \\ \therefore v &= 40 \text{ m s}^{-1} \end{aligned}$$

D : 40 m s<sup>-1</sup>

$$\begin{aligned} &\text{GLvfb,} \\ &\text{Aw`teM, } u = 54 \text{ km h}^{-1} \\ &= 54 \frac{\text{km}}{\text{h}} = \frac{54 \times 10^3 \text{ m}}{3600 \text{ s}} = 15 \text{ m s}^{-1} \\ &\text{ZiY, } a = 4 \text{ m s}^{-2} \\ &\text{mgq, } t = 5 \text{ s} \\ &\text{tkl teM, } v = ? \\ &\text{`iZi, } s = ? \end{aligned}$$

$$\begin{aligned} &\text{GLvfb,} \\ &\text{Aw`teM, } u = 0 \\ &\text{ZiY, } a = 10 \text{ m s}^{-2} \\ &\text{`iZi, } s = 80 \text{ m} \\ &\text{tkl teM, } v = ? \end{aligned}$$

## 2.6 coŠ-e` i MwZ

### Motion of falling bodies

AwfKI©: GB gnwetkji cċZ`KwU e` KYvB GtK AcitK wotRi w`tk AvKIȳ Kti | GB gnwetkji th  
tKvbtv `yU e` i gta` th AvKIȳ ZvtK gnvKI©ej | `yU e` i GKwU hw` cċex nq Zte ZvtK AwfKI©ej  
A\_ȳ tKvbtv e` i Dci cċexi AvKIȳtk AwfKI©ejv nq | gnwetkji th tKvbtv `yU e` i AvKIȳ mȳutK©  
wotDUtbi GKwU mĤ AvtQ hv wotDUtbi gnvKI©mĤ bvtg cwi wPZ |

wotDUtbi MwZi wOZxq mĤ t`tk Avgiv Rwb th ej cċy ntj tKvbtv e` i ZiY nq, mZivs AwfKI©ej i  
cċvte e` i ZiY nq | GB ZiYtk AwfKIR ZiY ejv nq |

AwfKI©ej i cċvte fctō gȳ fte coŠ-tKvbtv e` i teM ewri nvi tk AwfKIR ZiY etj | GtK g w`tq  
cċvk Kiv nq |

thtnZiAwfKIR ZiY GK cċvi ZiY, mZivs Gi gvĤv nte [LT<sup>-2</sup>] Ges GKK nte m s<sup>-2</sup> |

feþôï tKvþv `vþb g -Gi gvþbi iwkgyjv nt`Q

$$g = \frac{GM}{R^2}$$

GLvþb,  $M = c_{\mathbb{W}}\text{exi fi}$

$$G = GK_{\mathbb{W}} \text{ wekRbxb a}^{\circ}eK | G\ddot{t}K \text{ gnvKI} \mathbb{R} q \text{ a}^{\circ}eK \text{ etj} |$$

$$R = c_{\mathbb{W}}\text{exi e}^{\circ}\text{vma}^{\circ}$$

thþnZi  $c_{\mathbb{W}}\text{ex m}^{\circ}\text{úY}^{\circ}\text{tMjvKvi bq, tgi}^{\circ} \text{ A}\hat{\text{A}}\text{tj GKULwbo Pivc, ZvB } c_{\mathbb{W}}\text{exi e}^{\circ}\text{vma}^{\circ}\text{RI a}^{\circ}eK \text{ bq} | \text{ m}\ddot{Z}\text{ivs}$   
 feþôï me $\mathbb{P}$  g Gi gvb mgvb bq | tgi $^{\circ}$  A $\hat{\text{A}}$ tj  $c_{\mathbb{W}}\text{exi e}^{\circ}\text{vma}^{\circ}\text{R metP}^{\circ}\text{tq Kg etj tmLvþb g -Gi gvb}$   
 metP $^{\circ}\text{tq temk} | \text{ Avi wel}\mathbb{P} \text{ A}\hat{\text{A}}$ tj R-Gi gvb metP $^{\circ}\text{tq temk etj g -Gi gvb metP}^{\circ}\text{tq Kg} |$

feþô wevfbæ`vþb g -Gi gvb wevfbæ etj  $45^{\circ} \text{ A}\mathbb{P}\text{vstK mgy}^{\circ}\text{mgZtj g -Gi gvb}^{\circ}\text{tK Av}^{\circ}\text{k}^{\circ}\text{g vb aiv nq} | \text{ g -Gi}$   
 $\text{G Av}^{\circ}\text{k}^{\circ}\text{g vb nt}^{\circ}\text{Q } 9.80665 \text{ m s}^{-2} | \text{ wntmtei mjeavi Rb}^{\circ} \text{ Av}^{\circ}\text{k}^{\circ}\text{g vb aiv nq } 9.8 \text{ m s}^{-2} \text{ ev } 9.81 \text{ m s}^{-2} |$

coš-e $^{-}$  :

tKvþv e $^{-}$  tK Dci t $_{\text{tK}}$  tQto w t $j$  AwfKt $\mathbb{P}$  c $\mathbb{F}$ vte fwtZ t $\mathbb{C}$ Qvq | GKB D $^{\circ}$ PZv t $_{\text{tK}}$  GKB mgq GK $\mathbb{W}$   
 fix I GK $\mathbb{W}$  njKv e $^{-}$  tQto w t $j$  G $_{\text{tjv}}$  wK GKB mg $\mathbb{t}$ q feþô t $\mathbb{C}$ Qvte?

GK UKiv cv $_i$  I GK UKiv K $\mathbb{M}$ R GKB D $^{\circ}$ PZv t $_{\text{tK}}$  tQto w t $j$  t $^{\circ}$  Lv hvq th, cv $_i$  w K $\mathbb{M}$ t $\mathbb{R}$ i Av $\mathbb{M}$ B gw $\mathbb{U}$ tZ  
 t $\mathbb{C}$ Qvq | thþnZi e $^{-}$  i Dci w $\mathbb{P}$ qkxj AwfK $\mathbb{I}$  R ZiY e $^{-}$  i f $\mathbb{t}$ i i Dci w $\mathbb{B}$ f $\mathbb{P}$  K $\mathbb{t}$ i bv, ZvB K $\mathbb{M}$ R I cv $_{\text{ti}}$  i  
 Dci w $\mathbb{P}$ qkxj AwfK $\mathbb{I}$  R ZiY GKB | m $\ddot{Z}$ ivs Zv $^{\circ}$  i GKB mg $\mathbb{t}$ q gw $\mathbb{U}$ tZ t $\mathbb{C}$ Qv $\mathbb{t}$ bvi K $_v$  | evZv $\mathbb{t}$ mi evavi Rb $^{\circ}$   
 e $^{-}$  `w $\mathbb{U}$  wfbomg $\mathbb{t}$ q gw $\mathbb{U}$ tZ t $\mathbb{C}$ Qvq | evZv $\mathbb{t}$ mi evav bv  $_v$ Ktj G $_{\text{tjv}}$  Aek $^{\circ}$ B GKB mgq gw $\mathbb{U}$ tZ t $\mathbb{C}$ QvZ |

coš-e $^{-}$  i m $\mathbb{F}$ vevj : coš-e $^{-}$  m $\circ$ ú $\mathbb{t}$ K $\mathbb{M}$ wjwj I wZb $\mathbb{U}$  m $\mathbb{F}$  tei K $\mathbb{t}$ i b | G $_{\text{tjv}}$  tK coš-e $^{-}$  i m $\mathbb{F}$  etj | GB  
 m $\mathbb{F}$   $_{\text{tjv}}$  GKgv $\mathbb{I}$  w $^{\circ}$  i Ae $^{-}$ v $\mathbb{b}$  t $_{\text{tK}}$  webv evavq coš-e $^{-}$  i t $\mathbb{P}$ t $\mathbb{I}$  c $\mathbb{H}$ vR $^{\circ}$  A $_P$  e $^{-}$  covi mgq w $^{\circ}$  i Ae $^{-}$ v $\mathbb{b}$   
 t $_{\text{tK}}$  cote, Gi tKvþv Aw $^{\circ}$  teM  $_v$ K $\mathbb{t}$ e bv | e $^{-}$  webv evavq g $\mathbb{P}$ f $\mathbb{v}$ te cote A $_P$  Gi Dci AwfK $\mathbb{I}$  R ej  
 Qvov Ab $^{\circ}$  tKvþv ej w $\mathbb{P}$ qv K $\mathbb{t}$ e bv | thgb $\mathbb{N}$  evZv $\mathbb{t}$ mi evav Gi Dci w $\mathbb{P}$ qv K $\mathbb{t}$ e bv |

c $\mathbb{U}$ g m $\mathbb{F}$  : w $^{\circ}$  i Ae $^{-}$ v $\mathbb{b}$  I GKB D $^{\circ}$ PZv t $_{\text{tK}}$  webv evavq coš-mKj e $^{-}$  mgvb mg $\mathbb{t}$ q mgvb c $_A$  AwZ $\mathbb{P}$ g K $\mathbb{t}$ i |

w $\mathbb{Z}$ xq m $\mathbb{F}$  : w $^{\circ}$  i Ae $^{-}$ v $\mathbb{b}$  t $_{\text{tK}}$  webv evavq coš-e $^{-}$  i w $\mathbb{B}$ w $^{\circ}$   $\mathbb{B}$  mg $\mathbb{t}$ q (t) c $\mathbb{H}$ B teM (v) H mg $\mathbb{t}$ qi mgvb $\mathbb{P}$ wZK  
 A $_P$ ,  $v \propto t$

ZZxq m $\mathbb{F}$  : w $^{\circ}$  i Ae $^{-}$ v $\mathbb{b}$  t $_{\text{tK}}$  webv evavq coš-e $^{-}$  w $\mathbb{B}$ w $^{\circ}$   $\mathbb{B}$  mg $\mathbb{t}$ q th  $^{\circ}$  i Zi (h) AwZ $\mathbb{P}$ g K $\mathbb{t}$ i Zv H mg $\mathbb{t}$ qi  
 (t) et $\mathbb{M}$  $\mathbb{P}$  mgvb $\mathbb{P}$ wZK A $_P$ ,  $h \propto t^2$

coš-e<sup>-</sup> i mgxKiY :

aiv hvK, tKvbn e<sup>-</sup> u Aw` teM wbtq AwfKtP cFvte gP fvt e cotQ | t mgq cti e<sup>-</sup> wU v teM cõB nq | e<sup>-</sup> wU hw` GB mgq h` iZjtbtg Avtm, Zvntj MwZi mgxKiY` iZj s Gi cwietZ<sup>h</sup> Ges ZjY a Gi cwietZ<sup>h</sup> AwfKtP ZjY g emvtj B coš-e<sup>-</sup> i MwZi wbtg<sup>3</sup> mgxKiY<sub>s</sub> tjt v cvl qv hvte |

$$v = u + gt$$

$$h = \frac{(u + v)}{2} t$$

$$h = ut + \frac{1}{2} gt^2$$

$$v^2 = u^2 + 2gh$$

MwYwZK D`vniY 2.6 : 50 m DPz`vjvbi Qv` t<sub>tk</sub> tKvbn e<sup>-</sup> tQto w` tj GwU KZ tetM feõtk AvNvZ Kiŧe ? g = 9.8 m s<sup>-2</sup>

Avgiv Rwb, coš-e<sup>-</sup> i tŧtŧ

$$v^2 = u^2 + 2gh$$

$$\text{ev, } v^2 = 0 + 2 \times 9.8 \text{ m s}^{-2} \times 50 \text{ m}$$

$$= 980 \text{ m}^2 \text{ s}^{-2}$$

$$\therefore v = 31.3 \text{ m s}^{-1}$$

$$D: 31.3 \text{ m s}^{-1}$$

GLvfb,  
Aw` teM,  $u = 0$   
AwZpvsŧ` iZj,  $h = 50 \text{ m}$   
tkl teM,  $v = ?$   
 $g = 9.8 \text{ m s}^{-2}$

## 2.7 MwZ I tj LwPŧ

### Motion ang Graph

#### 1. iZj mgq tj LwPŧ

mgq AwZewwZ nI qvi mvŧ\_ mvŧ\_ GKwU MwZkxj e<sup>-</sup> i Ae<sup>-</sup>vŧbi cwieZ<sup>B</sup> NtU | e<sup>-</sup> i AwZpvs<sup>-</sup> iZj mgq i Dci wbfP Kti | GB m<sup>u</sup>K<sup>G</sup> GKwU tj LwPŧ i gva<sup>tg</sup> cKvk Kiv hvq | GB tŧtŧ QK KwMŧRi x ÑAŧ eivei mgq (t) Ges Y- Aŧ eivei AwZpvs<sup>-</sup> iZj (s) v<sup>cb</sup> Kiv nq | GB tj LwPŧ tK` iZj Nmngq tj LwPŧ ejv nq | GB tj LwPŧ t<sub>tk</sub> mnŧR e<sup>-</sup> i teM wbyŧ Kiv hvq | wbt<sup>am</sup> g teM I Amg tetMi tŧtŧ` iZj Nmngq tj LwPŧ t<sub>tk</sub> teM wbyŧi c<sup>am</sup> AwZ AvtjvPbv Kiv ntjv | RmUj Zv cwinvŧi i Rb<sup>u</sup> Avgiv GLvfb tKej mij tiLv eivei Pjgvb e<sup>-</sup> i MwZ AvtjvPbv Kie | GB tŧtŧ GKwU MwZkxj e<sup>-</sup> i tetMi w` tKi tKvbn cwieZ<sup>B</sup> nte bv ; mZivs tKej gvŧbi cwieZ<sup>B</sup> i Rb<sup>u</sup> tetMi cwieZ<sup>B</sup> Nuŧe |



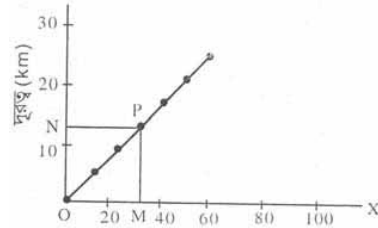
(K) মূল্য তেতিমি তীতি :

এই হক, তীব্র তীব্র মগজ ইব্রি মগব্র (CNG) পয়জ `তয় গ্যে GKU Aতুমি· v PjতQ| চাঁজ 12  
মগব্র ci`ui Gi Aম্ভ্রস-` িজিওপি মবিম্ভ্র ত` ল্ভব ন্ভব

` িজি -মগ মবিম্ভ্র

মগ, t (min)	` িজি, s (km)
0	0
12	6
24	12
36	18
48	24
60	30

মবিম্ভ্র 2.3



পট : 2.5

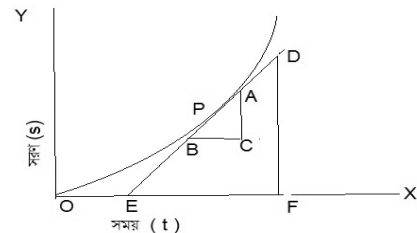
ড্টি মবিম্ভ্র এম্ভ্র ম্ভ্রি র্ভ` ` িজি -মগ ত্জ ল পট 2.5 পট ত` ল্ভব ন্ভব | GB পট ত` িজি ত্জ তীব্র  
মগ্ভ্র এই হক, 32 মগব্র Aতুমি· ম্ভ্র KZ Aম্ভ্রস-` িজি ত্জ তীব্র | GRB` অগ্ভ্র িজি চাঁজ X-  
Aতুমি Dci 32 মগব্র ম্ভ্র` Rkvix ম্ভ্র` M) ম্ভ্র KtZ ন্ভে | Zvici H ম্ভ্র` ত্জ ত্জ ল্ভ্রি Dci Y  
Aতুমি মগ্ভ্র Gku ti Lv Aম্ভ্র ন্ভে | গ্ভ্র তীব্র হক, ti Lv ত্জ ল্ভ্রি Dci P ম্ভ্র` িজি ম্ভ্র Z ন্ভে | GLb P  
ম্ভ্র` ত্জ Y Aতুমি Dci j` UvতZ ন্ভে | GB j` Y Aতুমি ত্জ ম্ভ্র` িজি (N) ত্জ` Kt Zv ন্ভে 32 মগব্র  
Aম্ভ্রস-` িজি (ON) | ত্জ` ল্ভ্র হক, Aতুমি· ম্ভ্র G মগ্ভ্র 16 km ` িজি Aম্ভ্র Kt ত্জ | ম্ভ্র, ত্জ ল্ভ্রি ত্জ  
ত্জ তীব্র মগ্ভ্র t = OM Gi Rb` Aম্ভ্রস-` িজি s = PM চ্ভ্র হক

$$\therefore \text{teM} = \frac{\text{` িজি}}{\text{মগ}} = \frac{PM}{OM} = \frac{ON}{OM}, \text{ GLভ, } \frac{PM}{OM} \text{ ত্জ OP ti Lv Xij (slope) etj |}$$

ম্ভ্র Ki : GKU QK KMR ব্র | GB KMR ত্জ c`v` গ্ভ্র I ম্ভ্র RbK GKK ম্ভ্র D্টি  
মবিম্ভ্র এম্ভ্র ম্ভ্রি র্ভ` ` িজি -মগ ত্জ ল পট A/4b Ki | GB ত্জ ল্ভ্রি 32 মগব্র Aম্ভ্র  
` িজি Ges teM ত্জ Ki | 44 মগব্র Aম্ভ্র ` িজি teM KZ ন্ভে?

(L) অম্ভ্র তেতিমি তীতি :

2.6 পট অম্ভ্র তেতিমি ম্ভ্রি GKU e` i ` িজি -মগ ত্জ ল্ভ্রি  
ত্জ ল্ভ্রি ত্জ ত্জ ত্জ ত্জ e` ম্ভ্র মগ্ভ্র মগ্ভ্র ` িজি  
Aম্ভ্র Kt ব্র Zv ত্জ ল্ভ্রি ম্ভ্র ti Lv ন্ভে | Gku GKU  
eμ ti Lv ন্ভে | ত্জ ত্জ ত্জ e` ম্ভ্র ম্ভ্র PjতQ ব্র,  
KtRB ম্ভ্রি mKj গ্ভ্র ZGi teM মগ্ভ্র ন্ভে | এই হক,



পট : 2.6

tKv̄bv GK wētkl gn̄Z<sup>Ⓢ</sup> w̄li tēM tēi KīZ n̄tē, hv̄tK eμ ti LwŪtZ P wē`y<sup>Ⓢ</sup> t̄q w̄b̄t`R Kiv n̄tq̄tQ | P wē`jZ tēM w̄bY<sup>Ⓢ</sup> KīZ n̄tj Avgv̄t`ītK GKwU AwZ ¶ī<sup>a</sup> mḡtKvYx w̄l f̄R ABC wētePbv KīZ n̄tē hvi AwZf̄R AB GZ ¶ī<sup>a</sup>th GwU P wē`j AwZ m̄wbK̄tU eμ ti Lvi m̄v̄t\_ Kv̄hZ w̄gtj hvq | Ab` K\_vq, Avgiv GB eμ ti Lvi GKwU LĒvsk wētePbv KinQ thwU mij ti Lv ̄t̄c MY` Kivi ḡtZv h̄t\_ó ¶ī<sup>a</sup>

Zv̄n̄tj, P wē`jZ

$$tēM = \frac{AC \text{ Øviv w̄b̄t`KZ } \sim i Z_i}{BC \text{ Øviv w̄b̄t`KZ mgq e`eavb}}$$

$$ev, v = \frac{AC}{BC}$$

w̄KŠ' GZ t̄QvU w̄l f̄R wētePbv K̄ti Zvi t\_̄tK cw̄igv̄c K̄ti m̄wK dj cvl qv ḡk̄wKj | ZvB Avgiv P wē`jZ ED ̄ú̄k̄R AwK Ges ABC w̄l f̄t̄Ri m`k w̄KŠ' Āt̄c¶vKZ eo w̄l f̄R DEF A¼b Kw̄i |

$$GLb \text{ w̄l f̄R } ABC \text{ Ges w̄l f̄R } DEF \text{ t_̄tK cvB, } \frac{AC}{BC} = \frac{DF}{EF}$$

$$v = \frac{DF}{EF}$$

$$w̄KŠ' \frac{DF}{EF} \text{ n̄tjv ED -Gi Xvj |}$$

m̄Zivs P wē`jZ tēM n̄tjv H wē`jZ Aw¼Z ̄ú̄k̄K̄i Xvj | ZvB ejv hvq ̄t̄Zi mgq tj LwP̄t̄i th tKv̄bv wē`jZ Aw¼Z ̄ú̄k̄K̄i Xvj H wē`jZ tēM w̄b̄t`R K̄ti |

## 2. tēM-mgq tj LwP̄t̄i

Amg tēM Pjgvb e` i tēM mḡtqi Dci w̄b̄f̄P̄ K̄ti | GB m̄æúK̄GKwU tj LwP̄t̄i gra`tg c̄K̄v̄c Kiv hvq | GB t̄¶̄t̄t̄ QK Kw̄m̄t̄Ri X -A¶̄ eivei mgq (x) Ges Y-A¶̄ eivei tēM (v) ̄`v̄cb Kiv nq | GB tj LwP̄t̄i tēM̄mgq tj LwP̄t̄i ejv nq | GB tj LwP̄t̄i t\_̄tK m̄n̄t̄R th tKv̄bv gn̄Z<sup>Ⓢ</sup>tēM Ges ZiY A\_̄P̄ mḡtqi m̄v̄t\_ tēM̄i cw̄ieZ̄bi nvi w̄bY<sup>Ⓢ</sup> Kiv hvq | w̄b̄tḡem̄lg Zīt̄Yi t̄¶̄t̄t̄ tēM-mgq tj LwP̄t̄i t\_̄tK ZiY w̄bY<sup>Ⓢ</sup>qi c̄v̄w̄Z Av̄t̄jvPbv Kiv n̄tjv |

m̄lg Zīt̄Yi t̄¶̄t̄t̄ :

GKwU e` hLb m̄lg Zīt̄Y P̄t̄j ZLb Zvi mgvb mḡtq tēM̄i ēv̄v̄ mgvb nq | m̄Zivs X-Āt̄¶̄i w̄t̄K mgq (x) Ges Y-Āt̄¶̄i w̄t̄K tēM (v) w̄b̄t̄q tēM̄mgq tj LwP̄t̄i AwK̄t̄j t̄m̄w GKwU mij ti Lv n̄tē (w̄P̄t̄: 2.7) | GLb Avgiv GB tj LwP̄t̄i Dci th tKv̄bv GKwU wē`y P t̄bB | P t\_̄tK X-Āt̄¶̄i Dci PM j̄æ^ Uwb | Zv̄n̄tj th tKv̄bv mgq OM -Gi Rb` tēM̄i cw̄ieZ̄B PM cvl qv hvq |

$$m\ddot{Z}i\text{ vs }Z\ddot{i}Y\text{ a} = \frac{\text{teM}i\text{ cwi eZ}\ddot{B}}{mgq\text{ e'eavb}} = \frac{PM}{OM}$$

$$m\ddot{K}\ddot{S}' \frac{PM}{OM} \text{ n}\ddot{t}''Q\text{ OP} -Gi\text{ Xij} |$$

ZvB ejv hvq teM-mgq tj LwPŕĤi th tKvŕbv we`ŕZ Aw¼Z ŕúkŕKi Xij H  
we`ŕZ ZjY wŕb`ŕ Kŕi |

wŕbŕ Ki : wŕbPi mviwYŕZ cŕP tŕtKŬ ci ci GKŭ Mmwi teM ŕ`l qv nŕjv |

mviwY : 2.4

mgq (s)	teM ( km h <sup>-1</sup> )	teM (m s <sup>-1</sup> )
0	0	0
5	9	2.5
10	18	5.0
15	27	7.5
20	36	10.0
25	45	12.5
30	54	15.0

GKŭ QK KŭMR bŕl | GB KŭMŕR tZŕgvi cŔ`gtZv mŕeavRbK GKK wŕbq Dcŕi i mviwYŕZ ewYŕ MŭZi Rb`  
teM-mgq tj LwPŕĤ wA¼b Ki | GB tj LwPŕĤ tŕtK 12 tŕtKŕŬi mgq MmwiU teM l ZjY tei Ki |

## AbŕnŬvb-2.1

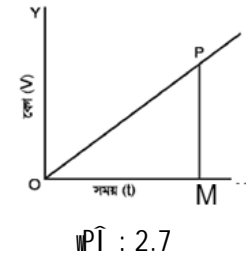
GKŭ XijyZŕvi Dcŕi gŕteŕ Mmŕtq cotZ w`ŕq Mo`ŕZ wŕbYŕ |

DŕĤi k` : weŕfbŕe ZjŕY AwZŕvŕŕ-GKB`ŕtZj Rb` mgq wŕbYŕ Kŕi cŕZŕŕĤŕĤ Mo`ŕZ wŕbYŕ |

hŕŕcŭZ : Zŕv, wŕUvi ŕ`<j, gŕteŕ, ŕvgv Nŕo |

KŕŕRi aviv :

1. hŕmŕe jŕŕv GKŕlvŕ Zŕv bŕl | wŕUvi ŕ`<tj i mŕvŕth` Gi`ŕNŕwŕbYŕ Ki |
2. Zŕvi GK cŕŕŕŕ wŕbP BU ev eB w`ŕq DŕŕKi, dŕj Zŕwŭ Xijyntq ŕvKŕe |
3. Zŕwŭi Dcŕi i cŕŕŕŕ-GKŭ gŕteŕ ai | gŕteŕwŭ tŔtŕ ŕ`l qvi mŕtŕ mŕtŕ ŕvgv Nŕo PŕjyKi | gŕteŕwŭ  
hLb Zŕv tetq fŕgtZ AvNŕZ Kiŕe ZLb ŕvgv Nŕowŭ eŬ Kŕi`ŕl |
4. Zŕvi`ŕNŕK Zŕv gŕteŕj i AwZŕvŕŕ-`ŕZŕK GB mgq w`ŕq fŕM Kŕi Mo`ŕZ wŕbYŕ Ki |
5. Zŕvi Dŕŕcŕŕŕ wŕbP Avŕiv BU ev eB w`ŕq GŕK Avŕiv DŕŕKŕiv Aŕ ZŕwŭŕK Avŕiv teŕk Kŕi XijyKi |
6. cŕivq gŕteŕ tŔtŕ w`ŕq mgq cwi gŕv Kŕi Mo`ŕZ wŕbYŕ Ki |
7. GBŕŕe weŕfbŕXŕtj i Rb` Mo`ŕZ cwi gŕv Ki |



## AbjñÜvtbi QK

cV	AmZµvš-`i Zi Z_v Z³vi ^N <sup>®</sup> (m)	mgq (s)	Mo `ªaZ = $\frac{\text{`i Zi}}{\text{mgq}}$ (m s <sup>-1</sup> )
1			
2			
3			
4			
5			
6			
7			

1. Mo `iZi cwi eZŕbi Kvi Y AvtjvPbv Ki |

## AbjñÜvb-2.2

bvbwea Kvhŕtgi gva`tg wefŕbœKvi MwZi gŕWj cŕkŕ |

Dŕŕi k` : wkŕv\_ŕi fwgKwŕfbq Kvhŕtgi gva`tg wefŕbœKvi MwZi gŕWj cŕkŕ Kiv Ges MwZmgŕni  
cv\_ŕ AbjñÜvb Kiv |

hš¿cwiZ : jªv`wo, PŕKi ŕtov ev Pb |

KvŕRi aviv :

1. `<tj i gŕV ev Avŕkcvŕki tKvŕbv tLjvi gŕV tmvRv Kŕi jªv PŕKi ev Pŕbi `wL`vl |  
A\_ev tmvRv Kŕi GKŕvŕQ jªv`wo weQv |
2. GLb tmvRv `woi`vŕMi cvk w`tq t`ŕto Aci cŕŕŕ-hvl |
3. gŕVi tKvŕbv RvqMvq GKwU wPŕ`vl | tmb wPŕŕi Dci GKŕb`wov | Gi ci Ab` GKŕb evg nvZ  
w`tq k³ Kŕi Zvi Wb nvZ ai | ZZxq Rb evg nvZ w`tq wŒZxq Rŕbi Wb nvZ ai | GB fŕŕe  
µgvŕŕtq KŕqKŕb nvZ aivawi Kŕi`wov | GKUv tmvRv I jªv wkKŕi gŕZv`Zwi nŕe |
4. GLb GB wkKŕj i evBŕi i tKD tKvŕbv Bkviv Kŕtj ev kã mwŕ Kŕtj cŕgRbŕK tK`ªKŕi nvZ aŕi  
tiŕL Ggb fŕŕe mevB Avŕŕ Avŕŕ t`ŕovl hvŕZ wkKj bv fŕŕO ev Gjvŕgŕjv bv nq |
5. gŕVi GK cvŕk KŕqK wguvi (aiv hvk`k wguvi) jªv GK MwQ`wo tmvRv Kŕi weQv | `woi`ŕ  
cŕŕŕ-ŕ Rb Ges`woi wK gvSLvŕb GKŕb`wov | GLb GKŕb GKŕb Kŕi cŕg Rŕbi KvQ  
tŕŕK hvŕv`i` Kŕi GKbfŕŕe tñU`woi Aci cŕŕŕ-wŒZxq Rŕbi tœŒv | ZvŕK tKej`úkKŕi bv  
tŕŕg Avevi cŕg Rŕbi KvQ wŕŕi Avŕm | cŕg RbŕK`úkKŕi Avevi wŒZxq Rŕbi KvQ hv | bv  
tŕŕg GB ŕc KŕqKevi Ki |
6. aviv -2 G Dvj wLZ MwZi`ewkŕŕtjv LvZvq wjwceŕ Ki | GwU`i wLK MwZ | GwU`i wLK MwZ nŕl qvi  
Kvi Y evL`v Ki |

7. aviv -4 G Duj wLZ MwZi `enkó` ,tjv LvZvq wjwce` Ki | Gt`ŕt` cŕZ`tKi MwZ eĖvKvi MwZ Ges chĖĖ MwZ | GB MwZ eĖvKvi MwZ Ges chĖĖ MwZ nIqvi KviY e`vL`v Ki |
8. aviv -5 G Duj wLZ MwZi `enkó` ,tjv LvZvq wjwce` Ki | Gt`ŕt` cŕZ`tKi MwZ chĖĖ MwZ Ges `ú`b MwZ | GB MwZ chĖĖ MwZ Ges `ú`b MwZ nIqvi KviY e`vL`v Ki |
9. GB AbmÜvŕbi gva`tg cŕB wewfbeMwZi Zj bv Ki | G ,tjvi gta` cv\_ŕ` wj L |

### AbmÜvb-2.3

100 wgvvi t`što wk`ŕv\_ŕi `ŕZ wbyĖ Ges tj LwPŕt` Zv wetkŕv |

Dŕt`k` : wewfbe mgŕq AmZµvš-`iZi wbyĖ Kŕi Mo `ŕZ wbbĖ, `iZi-mgq tj LwPŕt` A¼b Ges th tKvŕbv mgŕq Zvr`ŕwYK `ŕZ Ges Mo ZiY wbyĖ |

hšZcwZ : wgvvi t`<j , \_vgv Nwo, `wo A\_ev gvc wdZv |

KvŕRi aviv :

1. `<tji tLjvi gŕtVi (`<tji wbr`^ gŕv bv \_vKtj Ab` tKvŕbv gŕtV) GK cŕš-GKwU `wo tmiRv Kŕi weQv |
2. GB `wo t`tK 25 wgvvi `ŕi `ŕi Avŕiv PviwU `wo weQv | mZivs tkl `wou nte 100 wgvvi `ŕi |
3. cŕg `woi KvŕQ Zvg `vovl Ges ewk PviwU `woi cvŕk tZvgvi Pvi eÜzPviwU \_vgv Nwo wbtq `wvŕe |
4. wk`ŕK ewkŕZ dat`l qvi mvŕ\_ mvŕ\_ Zvg t`šo`i` Kŕe Ges cŕZ`tK hvi hvi \_vgv Nwo PjyKŕe |
5. t`šowe` hLb hvi mgŕtbi `wo AmZµg Kŕe ZLb tm Zvi \_vgv Nwo eÜ Kŕe | Nwoi cv t`tK H `iZi Rb` mgq cvl qv hvŕe |
6. `iZŕK mgq w`ŕq fŕM Kŕi H mgq e`eavŕbi Rb` ev H `iZi Rb` Mo `ŕZ cvl qv hvŕe |
7. GLb GKwU QK KŕMŕ X -Aŕŕi w`ŕK mgq (x) Ges Y -Aŕŕi w`ŕK `iZi (d) `vcb Kŕi GKwU tj LwPŕt` A¼b Ki |
8. tj LwPŕt` t`tK th tKvŕbv mgŕq AmZµvš-`iZi Ges GB mgq e`eavŕbi Mo `ŕZ Ges H gnŕZP Zvr`ŕwYK `ŕZ wbyĖ Ki |
9. tj LwPŕt`w cŕivq A¼b Ki | GLb th tKvŕbv `wU mgŕqi Rb` Zvr`ŕwYK `ŕZ tei Ki | `ŕZi cv\_ŕ`ŕK mgq e`eavb w`ŕq fŕM Kŕi Mo ZiY wbyĖ Ki |
10. wewfbe ŕZŕZ tntU Ges t`što GB cix`ŕYwU cŕiveĖ Ki |
11. GBfvŕe cŕZ`K wk`ŕv\_ŕcix`ŕYwU m`úbeKŕi |

### AbmÜvŕbi QK

cW	AmZµvš-`iZi (m)	mgq (s)	Mo `ŕZ = $\frac{\text{`iZi}}{\text{mgq}}$ (m s <sup>-1</sup> )
1			
2			
3			
4			

## Abkxj bx

K. eũbePbx cķæ

mWVK DĖiWUi cvk WUK (√) WPK `v |

1 | Zi tYi GKK tKvbwU?

(K)  $m s^{-1}$ (L)  $m s^{-2}$ 

(M) N s

(N)  $kg s^{-2}$ 

2 | Nvwi KuUvi MwZ Kx i Kg MwZ ?

(K) iWVK MwZ

(L) DceĖvKvi MwZ

(M) chĖĖ MwZ

(N) ėb MwZ

3 | W' i Ae'vb t\_K webv evavq coš-e' wv Ė mgtq th t Zi AwZµg Kti Zv H mgtqi -

(K) mgvbwZK

(L) eMĖ mgvbwZK

(M) e'ĖbwZK

(N) eMĖ e'ĖbwZK

4 | GKWU e' W' i Ae'vb t\_K a mgZi tY Pj tQ | wv Ė mgtq GB e' i AwZµvš t Zi nte -

(i)  $s = \frac{(u+v)}{2} t$

(ii)  $\therefore s = ut + \frac{1}{2}at^2$

(iii)  $s^2 = u^2 + 2at$

wbPi tKvbwU mWVK?

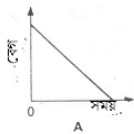
(ক) i

(খ) ii

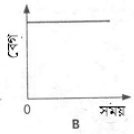
(গ) ii ও iii

(ঘ) i, ii ও iii

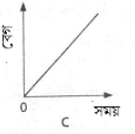
5 | wbPi teM-mgq tj LwPĖ i tKvbwU gv fve coš-e' i tj LwPĖ wb R Kti?



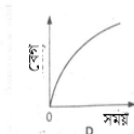
A



B



C



D

(K) A

(L) B

(M) C

(N) D

L. mRbkxj cķæ

1 | ivRxeiv mcwievĖi wtj tUi Rvdj s teovZ hvev Rb GKWU gvBtµvevĖm i l bv ntj v | tm hvĖvi i i "

t\_K wtj U hv qv chš-cĖZ 5 min ci ci Mwvi w'utWwgUvi t\_K teMi gvb Z\_v ėvZ wj tL

wbj | teMi gvb tcj h\_vµtg cĖZ NvUvq 18,36,54,54,54,36 l 18 Wktj wgvUv |

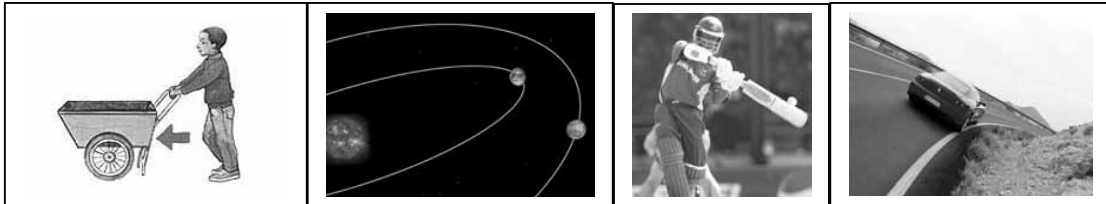
(K) ZvĖWYK ėvZ Kx ?

(L) mĖgtetM MwZkxj tKvbw e' i Zi Y e'vL'v Ki |

(M) cĖg 5 wgvbwU MwviUi AwZKš t Zi wvYĖ Ki |

(N) msMpxZ DcvĖ w tq teM-mgq tj LwPĖ AsKb Kti Zv e'vL'v Ki ?

# ZZxq Aa`vq ej FORCE



m`vi AvBRvK wbdUb e` i MwZ wbtq e`vcK MtelYv Ktib | wZwb MwZi tgšvj K bmxZ, tjtK wZbwU mŕi i gva`tg cKvk Ktib | G Aa`vq Avgiv MwZ wclqK GB mŕ tjt AvtjvPbv Kie | G Qvovl e` i RoZv, ej, etji cKwZ, fiŕeM, NIŕ I wbiwc` āgY wbtq G Aa`vq Avtj wPZ nŕe |

GB Aa`vq cW tkŕl Avgiv Ņ

1. e` i RoZv I etji ŭYZ aviYv wbdUŕbi MwZi cŕg mŕ e`envi Kti e`vL`v KiŕZ cvie |
2. wewfbačKvi etji cKwZ e`vL`v KiŕZ cvie |
3. mvq` I Amvq` etji cŕve e`vL`v KiŕZ cvie |
4. fiŕeM Ges msNI e`vL`v KiŕZ cvie |
5. MwZ Ges e` i AvKvŕi Dci etji cŕve wtkkY KiŕZ cvie |
6. wbdUŕbi MwZi wŕZxq mŕ e`envi Kti ej cwigvc KiŕZ cvie |
7. wbdUŕbi MwZi ZZxq mŕ e`envi Kti wuqv I cŕZwuqv ej e`vL`v KiŕZ cvie |
8. wbiwc` āgŕY MwZ Ges etji cŕve wtkkY KiŕZ cvie |
9. wewfbačKvi NIŕ Ges NIŕ ej e`vL`v KiŕZ cvie |
10. e` i MwZi Dci NIŕYi cŕve wtkkY KiŕZ cvie |
11. NIŕ nwm-eyŕ Kivi Dcvq e`vL`v KiŕZ cvie |
12. Avgvŕ i Rxetb NIŕYi BwZevPK cŕve wtkkY KiŕZ cvie |

### 3.1 RoZv Ges etj i ŕYMZ avi Yv- wDUtbi cŕg mŕ

#### **Inertia and qualitative concept of force- Newton's first law**

w`wZ, MwZ, miY, teM, ZiY BZ`w` mæútk©Avgiv BtZvgta`B tRtbwQ Avgiv Avgv` i Pricrk bvbv aitbi e` t`LtZ cvB| Gt` i tKvbwU w`i, Avevi tKvbwU MwZkxj | w`i e` ŕtjvi gta` itqtQ tPqvi, tUvej, Niewo, KvŕVi ŕwo BZ`w` | Avevi MwZkxj e` ŕtjvi gta` itqtQ PjŠ-wi·v, evm, mvBtKj, cZbkxj e` BZ`w` | w`i e` ŕtjv wK wbtR t`tK wbtRt` i MwZkxj KitZ cvti? AvR ivtZ tZvgvi covi tUvejtk thLvfb t`LtZ tctj AvMgxKvj mKtj GwU wK tmLvfb \_vKte? Gme ev`ŕe AwfÁZv t`tK Avgiv Kx t`LtZ cvB? Avgiv t`wL th e` ŕtjv w`i wQj tmŕtjv w`iB itqtQ| Gŕtjv wbtR t`tK MwZkxj ntZ cvti bv| Avevi ai, tZigvi GK eÜmgZj iv`-vq mvBtKj Pwj tq hv`Q| tKvbw GK mgq tm mvBtKtj c`vWj t` lqv eÜ Kti w`j | mvBtKjwU wK mstM mstM t`tg hvte? Avgiv t`LtZ cvB mvBtKjwU wKQzc\_ Pjvi ci Avt`ŕ Avt`ŕ t`tg hvq| hw` evqj evav Ges iv`-vi NIŕ bv \_vKZ Zvntj mvBtKjwU wK Aweivg MwZtZ PjtZ \_vKZ?

G mKj NUbv t`tK Avgiv eŕtZ cwi, cŕZ`K e` B th Ae`vq AvtQ, tmB Ae`vqB \_vKtZ Pqv| tKvbw e` hw` w`i \_vtK, Zte GwU w`iB \_vKtZ Pqv| Avevi e` MwZkxj \_vKtj GwU MwZkxj \_vKtZ Pqv| e` i wbr` Ae`v eRvq ivLtZ Pvl qvi th cŕYZv ev ag©ZvB ntjv RoZv| mZivs e` th Ae`vq AvtQ wPi Kvj tm Ae`vq \_vKtZ Pvl qvi th cŕYZv ev tm Ae`v eRvq ivLtZ Pvl qvi th ag©ZvK RoZv etj |

tKvbw e` i RoZv Gi ftii Dci wbfŕ Kti | A\_ŕ fi nt`Q Gi RoZvi cwigvc| th e` i fi tenk Zvi RoZv tenk| Ab`fvte ejv hvq, th e` i RoZv tenk ZvtK MwZkxj Kiv, teM nwm ev eŕŕ Kiv wKsev tetMi w` K cwi eZŕ Kiv ZZ KwWb|

wbtR Ki

- GKwU Kjg l GKwU eB tUvejti Dci ivL| Gevi KjgwUtk nvZi AvOj w`tq tUvKv `vl | Kx t`LtZ tctj? KjgwU tUvejti Dci LwWbKUv`ŕi mti tmj |
- Gevi eBwUtk AvtMi gtZvB AvOj w`tq tUvKv`vl | eBwU Avt`Š miqtQ bv| Gevi eBwUtk nvZ w`tq av`v`vl | GLb eBwU GK`vb t`tK Ab`v`v`b mti hvte|

Kjg l eBtqi gta` eBtK mivtZ tenk tPóv KitZ ntqtQ KvY, Kjgti tPtq eBtqi fi tenk A\_ŕ RoZv tenk|

RoZvi D`vniY

t`tg \_vKv evm nVr PjtZ`ii" Kitj emhvŕxi tctbi w`tK tntj ctob| Gi KvY ntjv w`wZ RoZv| evm hLb w`i Ae`vq \_vtK ZLb hvŕxi kixil w`i \_vtK| wKŠ` evm PjtZ AviæcKitj hvŕxi kixii evm



msj MæAsk MmZkxj nq| wKš' kixtii Dctii Ask w`wZRoZvi Rb` w`i Ae`'vq \_vKtZ Pvq| ZvB kixtii  
wbtpi Ask mxtctq| Dctii Ask wcuQtq cto| hvi dtj hvix tcQtbi w`tk tntj ctob| Avevi Pj š-evm  
nVvr teK Kitj hvixiv mvgtbi w`tk StK ctob| evm hLb Pj š-Ae`'vq \_vtK, ZLb evtmi hvixl evtmi  
mvt\_ GKB MmZc0B nq| evm nVvr t\_tg tMtj evtmi mvt\_ mvt\_ hvixi kixtii wbtpi Ask w`i nq| wKš'  
evmhvixi kixtii Dctii Ask MmZ RoZvi Rb` mvgtbi w`tk GmMtg hvq|

Mmo Pvj vtbvi mgq Mmoi Pvj KMY wbi vEv KvitY wUteë eufab| Gi KviY Kx? Gi gštj itqtQ RoZv|  
hw` wZwb wUteë e`envi bv Ktib, Zte`Z teK Klvi KvitY MmZ RoZvi Rb` mvgtbi w`tk StK coteb|  
Gi dtj wZwb Zvi mvgtb Mmoi w÷qwmn Ab`vb` e`tZ mtrvti AvNvZ Kiteb, dtj gvi vZK  
`N0bv NUtZ cvti| iay Pvj K bb, th mKj Mmo tZ wU tetëi e`e`v AvtQ tmB mKj Mmoi  
hvixt`i i wU teë evav DvPZ |

ej

Avgt`i `bwb AwfÁZv t\_tK ej mæutK©GkuU maviY aviYv AvtQ| Avgiv hLb tkvtbv e` tk Uwb ev  
tvvj, ZLb Avgiv ewj th e` wU tZ ej c0qm Kiv ntqtQ| GB chp ej w`i e` tk MmZkxj KitZ cvti,  
Avevi MmZ mwi tPóv KitZ cvti| Avevi e` wU hw` MmZkxj Ae`'vq \_vtK, Zvntj chp ej e` wU tk  
\_vgtZ cvti ev tel mwi tPóv KitZ cvti| Dfq tqtT ej c0qvtMi Rb` ej c0qmKvixi Ges e` i cZ`  
ms`uk©c0qvRb| Gaitbi ej tk ejv nq`uk©ej| `wU e` ci`uti ms`utK©v \_vKtj I GtK Actii Dci  
ej c0qm KitZ cvti| Ggb GKw AwZ cwi vPZ ej nt`Q gnvKI©ej, hvi ev`e D`vniY ntjv e` i IRb|  
tZvgvi nvZ t\_tK hLb tkvtbv e` cto hvq, ZLb Zv`Z gnuUtk`uk©kti| Gi KviY Kx? e` i Dci  
c0`exi AvKI©ej Z\_v e` i IRtbi Rb` GgbwU NtU| G ej tk Avgiv ewj gnvKI©ej| Ggwbftc cKwZi  
bvbv NUBvq Avgiv wvfb0aitbi etji Aw`ÍZi Abyfe Kwi|

thgb `wU tPŠ`K tgiy ga`Kvi ga`eZ tPŠ`K ej, `wU AwvZ e` i gta` Zvov ej, wbdKxqvmti gta`  
wbdKxq ej |

GLb Avgiv t`Le wbdUtbi c0g mT t\_tK Kxfvte RoZv I ej mæutK©aviYv jvf Kiv hvq| wbdUtbi MmZ  
wvqK c0g mT wU ntjv-

0ewv`K tkvtbv ej c0qm bv Kitj w`i e` w`i \_vKte Ges MmZkxj e` mlg`tZtZ mijct\_ PjtZ  
\_vKte|0

wbdUtbi c0g mT wU c`vt\_P RoZv agK cKvk Kti Ges etji msAv c0vb Kti|

wbdUtbi c0g mT t\_tK t`Litz cvB th, tkvtbv e` wbtR t\_tK Zvi Ae`'vi cwieZB NUvZ cvti bv| e`  
w`i \_vKtj wPiKvj w`i \_vKtZ Pvq, Avi MmZkxj \_vKtj wPiKvj mlg`tZtZ mijct\_ PjtZ Pvq| e` i G  
agB ntjv RoZv| A\_v wbdUtbi c0g mT t\_tK RoZvi aviYv cvl qv hvq|

Avevi ɯbDUʔbi cŋg mʔ t\_ʔK Rɨbv hɨq th, e⁻ i Ae⁻vi cwiēZʔ NUVʔZ nʔj evBʔi t\_ʔK GKUv ɯKQz cŋqM KiʔZ nʔe | A\_vʔ hɨ e⁻ i Ae⁻vi cwiēZʔ KiʔZ eva⁻ Kʔi ev KiʔZ Pɨq ZvB nʔQ ej | ZvB ɯbDUʔbi cŋg mʔ t\_ʔK etʔi ʔYMZ mʔAv cvl qv hɨq | ɯbDUʔbi cŋg mʔ vɨmʔi hɨ ɯ⁻ i e⁻ i Dci ɯɨqv Kʔi ZvʔK MɯZkɨj Kʔi ev Kivi ʔPóv Kʔi ev hɨ MɯZkɨj e⁻ i Dci ɯɨqv Kʔi Zvi MɯZi cwiēZʔ Kʔi ev Kivi ʔPóv Kʔi ZvʔK ej etʔ |

### 3.2 etʔi cKɯZ

#### Nature of force

⁻úkeʔj :

⁻⁻bɯ⁻b Rxeʔb ɯeɯfbəaitʔbi etʔi mʔ½ Avgvʔi cwiPq NʔU | Gʔi cKɯZI ɯeɯfbəaitʔbi | Gʔi ʔKvʔbɯ ʔɯ e⁻ i cŹ⁻ŋ ms⁻úʔkʔ dʔj mɯó nq | Avevi Ggb KZK\_ʔjv ej iʔqʔQ thLvʔb ʔɯ e⁻ i cŹ⁻ŋ ms⁻úʔkʔ cŋqRb ʔbB | th ej mɯó Rb⁻ ʔɯ e⁻ i cŹ⁻ŋ ms⁻úʔkʔ cŋqRb ZvʔK ⁻úkeʔj etʔ | hLb Avgiv nvZ ɯʔq ʔKvʔb e⁻ ʔK ʔVɨj ev Uvb ZLb Avgvʔi nvZ e⁻ i Dci GKɯ ej cŋqM Kʔi | GB ʔVjv ev Uvb ej nʔQ ⁻úkeʔj | ʔKbbv nvZ I e⁻ i cŹ⁻ŋ ms⁻úʔkʔ dj kŋZ nʔQ G ej | ⁻úkeʔj i D⁻niY nʔjv- NIʔ ej , Uvb ej Ges msNʔIʔ mgq mó ej |

Avgiv Rɯb, GKɯ e⁻ hLb Ab⁻ GKɯ e⁻ i Dci ɯʔq PjʔZ ʔPóv Kʔi ev PjʔZ ʔvʔK ZLb e⁻ ʔʔqi ⁻úkeʔj MɯZi ɯei⁻⁻ eva⁻ vbKvix NIʔ etʔi mɯó nq | GLvʔb ʔɯ e⁻ i Zʔj gʔa⁻ cŹ⁻ŋ ms⁻úʔkʔ dʔj NIʔ etʔi D⁻ni nq | ʔgʔSi Dci ɯʔq GKɯ ev ʔK ʔvʔb ʔbqv mgq Avgiv Uvb ej cŋqM Kwi | ev⁻ i MɯZi ɯecixZ ɯʔK ZLb NIʔ etʔi mɯó nq |

A⁻úkeʔj :

ʔɯ e⁻ i cŹ⁻ŋ ms⁻úkeʔQvovB th ej ɯɨqv Kʔi ZvʔK A⁻úkeʔj etʔ | thgb ʔɯ e⁻ i gʔa⁻ ɯɨqvɨj AvKIʔgʔK gnvKIʔej , ʔɯ AɯnZ e⁻ i gʔa⁻ ɯɨqvɨj AvKIʔ ev ɯeKIʔKvix Zɯor ej , ʔɯ Pɔ⁻ʔKi ʔgi⁻ i gʔa⁻ AvKIʔ ev ɯeKIʔgʔK ej A\_ev GKɯ Pɔ⁻K I GKɯ ʔPɔ⁻K c⁻vʔ\_P gʔa⁻ ɯɨqvɨj AvKIʔ ej nʔjv A⁻úkeʔj Z\_v⁻⁻ ʔeZʔetʔi D⁻niY |

ɯbʔR Ki t Zɨg nvZ t\_ʔK Kɨg ev ʔcɯYj ev Ab⁻ th ʔKvʔb GKɯ e⁻ ʔQʔo ʔvI |

e⁻ ɯ ɯbʔPi ɯʔK cote | ʔKD ɯbŋqB e⁻ ɯʔK ɯbʔPi ɯʔK UvbʔQ | ʔK UvbʔQ ? cɯ\_ex e⁻ ɯʔK Zvi ɯʔK UvbʔQ , hw I e⁻ I cɯ\_exi gʔa⁻ mivmvi ʔKvʔb mʔhM ʔbB A\_ʔ cɯ\_ex e⁻ ɯʔK ⁻úkeʔKʔi bɨB | cɯ\_ex e⁻ i Dci gnvKIʔej cŋqM KiʔQ | GLvʔb gnvKIʔej nʔQ A⁻úkeʔj | gnɯetʔi th ʔKvʔb ʔɯ e⁻ ci⁻úʔi Dci gnvKIʔej cŋqM Kʔi ʔvʔK | Aek⁻ cɯ\_ex hLb ʔKvʔb e⁻ i Dci gnvKIʔej cŋqM Kʔi ZLb ZvʔK AɯFKIʔej ejv nʔq ʔvʔK |

cKwZtZ Avgiv eü i Ktgi etj i t`Lv tctj I Pviw nt`Q tgsñj K ej | evKx,tj v Gt` i tKvfbv bv tKvfbv i fcl  
 th mKj ej gj ev`vaxb A\_ŕ th mKj ej Ab` tKvfbv ej t\_tK Drcbæñq bv ev Ab` tKvfbv etj i tKvfbv  
 ãc bq eis Ab`vb` ej GB mKj etj i tKvfbv bv tKvfbv ãci cKvk Zt` i tK tgsñj K ej etj |  
 cKwZtZ we`gvb Pviw tgsñj K ej wbgæc:

1. gnvKI`ej :
2. ZwoZtPš`K ej
3. `ŕŕ wbdKxq ej
4. mej wbdKxq ej |

gnvKI`ej :

GB gnwetk|cŕZ`K e` GtK AcitK GKw ej Øviv AvKI` Kti | gnwetk| th tKvfbv `yU e` i ga`Kvi  
 GB cvi`üwi K AvKI` ej tK gnvKI` etj | e` i fti i KvitYB GB AvKI` NtU| Pviw tgsñj K etj i gta`  
 gnvKI` etj nt`Q Zj bvgj Kfvte `ŕŕZg ej | Avgv` i I Rb gnvKI` etj i dj kŕZ| tmši RMtZi Mñ,tj v  
 gnvKI` etj i cfvte mñŕK tK`Kti mñhP Pviw tK Nj tQ| gnvKI` etj i cvj v Amxg chS-we`ÍZ|

ZwoZtPš`K ej :

`yU AwnZ KYv ev e` Zt` i Avatbi KvitY GtK Acti i Dci th ej cŕqM Kti ZtK ZwoZtPš`K ej etj |  
 GB ej AvKI`agŕŕ weKI`agŕŕ Dfŕ cKvti i ntZ cŕti | hLb AwnZ KYv `yU w`i \_vtK ZLb Zt` i gta` tKej  
 Zwor ej wqv Kti | AwnZ KYv,tj v MvZkxj ntj Zwor etj i cikvñk KYv,tj vi gta` tPš`K etj i mŕŕ nq| `yU  
 tPš`K tgi`i ga`eZi AvKI` ev weKI` ej | ZwoZtPš`K ej | `yU AwnZ tgsñj K KYvi gta` wqvKxj Zwor ej  
 Gt` i gta` wqvKxj gnvKI` etj i Zj bvg AtbK tenk kvkvx| Zej mejZvi wePti Zwor ej nt`Q gvSwi  
 aitbi | NI`ej , w`cŕ ej BZ`w AwnZ KYv,tj vi gta` Zwor etj i KvitYB mŕŕ nq|

`ŕŕ wbdKxq ej :

th `ŕi cvjŕi Ges `ŕi gvŕbi ej wbdKxqvŕmi Af`šit` tgsñj K KYv,tj vi gta` wqv Kti ZtK `ŕŕ  
 wbdKxq ej etj | GB etj i KvitYB wbdKxqvŕm Aw`wZkxj Zvi mŕŕ nq Ges wbdKxqvŕm ntZ weUvŕŕq ( $\beta$ -  
 decay) nq| Awakvsk tZRw`Eq fivOb wewqv `ŕŕ wbdKxq etj i KvitY msNwJZ nq| G etj i cvj v  $10^{-16}$  m  
 -Gi I Kg|

mej wbdKxq ej :

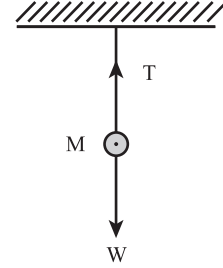
Avgiv Rwb, cigvYj wbdKxqvŕmi gta` tclÜb I wbdÜb bvgK `yU KYv AvtQ| Gt` i tK mstŕŕt c wbdKxqb  
 etj | cigvYj wbdKxqvŕmi wFZti `yU wbdKxqvŕmi gta` th kvkvx ej KvR Kti ZtK mej wbdKxq ej  
 etj | G ej wbdKxqb,tj v tK GKtŕ Ave` ivtL| wbdKxqvŕmi `wŕtZj Rb` `vqx ntj v mej wbdKxq ej |  
 GB ej Lŕ `ŕi cvjŕi Ges AvKI`agŕŕ Gi cvj v  $10^{-15}$  m hv wbdKxqvŕmi e`vmŕtaP mgvb| tgsñj K ej,tj vi  
 gta` G ej B metPŕŕ kvkvx|

### ৩.৩ সাম্য ও অসাম্য বল

#### Balanced and unbalanced forces

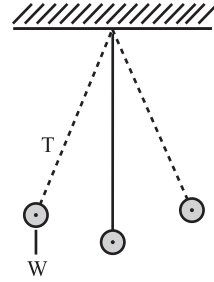
কোনো বস্তু উপর একাধিক বল ক্রিয়া করলে যদি বলের লব্ধি শূন্য হয় অর্থাৎ বস্তু কোনো ত্বরণ না হয়, তখন আমরা বলি বস্তুটি সাম্যাবস্থায় আছে। যে বলগুলো এই সাম্যাবস্থা সৃষ্টি করে তাদেরকে সাম্য বল বলে।

চিত্রে দেখা যাচ্ছে একটি গোলককে বা কোনো বস্তুকে একটি সুতার সাহায্যে ঝুলিয়ে দেওয়া আছে। এখন বস্তু উপর পৃথিবীর আকর্ষণ বল তথা বস্তু ওজন  $W$  খাড়া নিচের দিকে ক্রিয়া করছে। আবার সুতার টান  $T$  খাড়া উপরের দিকে ক্রিয়া করছে। এখানে বল দুটি সমান ও বিপরীতমুখী হওয়ায় একে অপরের ক্রিয়াকে নিষ্কর্য করে দিয়ে সাম্যাবস্থার সৃষ্টি করেছে।



চিত্র : ৩.১

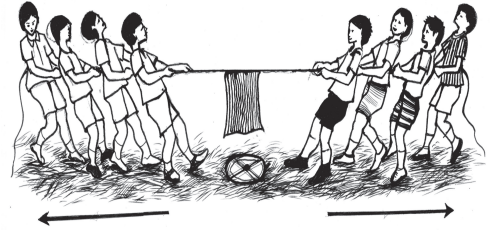
যদি উপরিউক্ত চিত্রে সুতা কেটে দেওয়া হয় তাহলে বস্তু উপর কেবলমাত্র পৃথিবীর আকর্ষণ তথা অভিকর্ষ বল ক্রিয়া করবে। ফলে বস্তুটি অভিকর্ষ ত্বরণ, সহকারে নিচের দিকে পড়তে থাকবে। এখানে অভিকর্ষ বল বা বস্তু ওজন হচ্ছে অসাম্য বল।



চিত্র : ৩.২

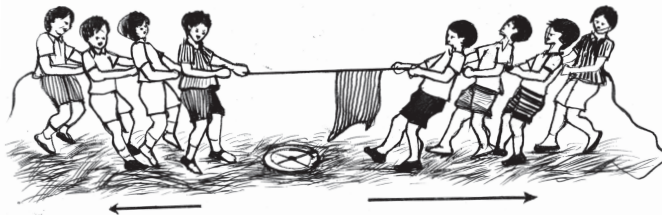
যদি বস্তুটিকে একপাশে একটু টেনে নেওয়া হয় তাহলে সুতার টান  $T$  এবং বস্তু ওজন  $W$  একই সরল রেখায় থাকবে না। ফলে সাম্যাবস্থার সৃষ্টি না হয়ে বস্তুটির ওপর একটি লব্ধি বল কাজ করবে। এর ফলে বস্তুটি দুলতে থাকবে। এটা অসাম্য বলের একটি উদাহরণ।

সাম্য ও অসাম্য বলের অন্য উদাহরণ তোমরা রশি টানাটানি প্রতিযোগিতায় দেখে থাকতে পারো। এই প্রতিযোগিতায় রশির মাঝখানে একটি রুমাল বাধা থাকে। প্রতিযোগিতার সময় সমান সংখ্যক প্রতিযোগী রশির দুই প্রান্ত ধরে তাদের দিকে রশিটিকে টেনে রুমালটিকে তাদের দিকে সরাতে চেষ্টা করে। রুমালটি যদি কোনো দিকে না সরে তা হলে বুঝা যায় দু দলই সমান বল প্রয়োগ করেছে ফলে রশিটি তথা রুমালটি সাম্যাবস্থায় আছে। এখানে দুই দলের প্রদত্ত বল হলো সাম্য বল।



চিত্র : ৩.৩

আর যদি কোনো একদল বেশি বল প্রয়োগ করতে পারে, তাহলে লব্ধি বল তাদের দিকে ক্রিয়া করে অসাম্য বলের সৃষ্টি করবে এবং রুমালটি তাদের দিকে সরে যাবে। ফলে প্রতিযোগিতায় তারা বিজয়ী ঘোষিত হবে।



চিত্র : ৩.৪

### 3.4 fi teM

#### Momentum

MuZkxj e<sup>-</sup> i fi l teMi mgš<sup>^</sup>tq th tfšZ iwki D<sup>m</sup>e nq Zv ntjv H e<sup>-</sup> i fi teM | fi teM e<sup>-</sup> i fi Ges teMi Dci wbfP<sup>o</sup>kxj | gijevnx GKwU U<sup>o</sup>K Ges GKwU c<sup>o</sup>B<sup>o</sup>fU Mmoi K<sub>v</sub> wPŠ<sup>o</sup>-Ki | gtb Ki, `wU MmoB mg `tZ<sup>o</sup>Z GKwU w<sup>o</sup>w<sup>o</sup> ó w<sup>o</sup> tK MuZkxj | Mmo `wU<sup>o</sup>tK GKB `tZ<sup>o</sup>i gta<sup>o</sup> \_vgv<sup>o</sup>Z nte | tKv<sup>o</sup>bv MmoU<sup>o</sup>tK \_vgv<sup>o</sup>Z kw<sup>o</sup>kvjx teK c<sup>o</sup>qM Ki<sup>o</sup>tZ nte? U<sup>o</sup>K<sup>o</sup>tK | KviY U<sup>o</sup>K Ges Mmo GKB `tZ<sup>o</sup>Z MuZkxj \_vKv m<sup>o</sup>tE<sup>o</sup>l U<sup>o</sup>K th tfšZ iwki teM aviY K<sup>o</sup>t Zv ntjv Gi fi teM |

tKv<sup>o</sup>bv MuZkxj e<sup>-</sup> tK \_vgv<sup>o</sup>bv KZ Kóma<sup>o</sup> ev KwB fi teM nt<sup>o</sup>Q Zvi GKwU cwigv<sup>o</sup> | fi teM etj i m<sup>o</sup>½ m<sup>o</sup>úwK<sup>o</sup>Z | w<sup>o</sup>DU<sup>o</sup>tbi w<sup>o</sup>Zxq m<sup>o</sup>t<sup>o</sup> G m<sup>o</sup>úK<sup>o</sup>w cwigv<sup>o</sup>YMZfv<sup>o</sup>te cvl qv hvq |

tKv<sup>o</sup>bv e<sup>-</sup> i fi l teMi \_Ydj<sup>o</sup>tK Gi fi teM etj |

awi, GKwU e<sup>-</sup> i fi =  $m$

$$teM = v$$

$$\therefore \text{fi teM} = mv \quad (3.1)$$

fi teM GKwU tf<sup>o</sup>i iwki | Gi w<sup>o</sup> K teMi w<sup>o</sup> tK |

mgxKiY (3.1) t<sup>o</sup>tK t<sup>o</sup> Lv hvq, tKv<sup>o</sup>bv e<sup>-</sup> i fi hZ teM nte Ges e<sup>-</sup> hZ `Z Pj<sup>o</sup>te Zvi fi teMl ZZ teM nte |

GKK: fi teMi GKK ntjv, f<sup>o</sup>i i GKK  $\times$  teMi GKK A<sub>o</sub> kg  $\times$  ms<sup>-1</sup> ev kg ms<sup>-1</sup> |

1 kg f<sup>o</sup>i i tKv<sup>o</sup>bv e<sup>-</sup> 1ms<sup>-1</sup> teM Pj<sup>o</sup>tj Gi fi teM nte 1kg ms<sup>-1</sup> |

fi teMi gv<sup>o</sup>l<sup>o</sup> : [p] = MLT<sup>-1</sup>

### 3.5 MuZi Dci etj i c<sup>o</sup>ve

#### Effect of force on motion

ch<sup>o</sup>y<sup>o</sup> ej tKv<sup>o</sup>bv w<sup>o</sup> i e<sup>-</sup> tK MuZkxj Ki<sup>o</sup>tZ cv<sup>o</sup>i |

hLb tKv<sup>o</sup>bv tL<sup>o</sup>tjvqvo w<sup>o</sup> i dUej<sup>o</sup>tK wK<sup>o</sup>K<sup>o</sup>K<sup>o</sup>t<sup>o</sup>b ZLb Kx N<sup>o</sup>tU? t<sup>o</sup> Lv hvq th ejw<sup>o</sup> w<sup>o</sup> i Ae<sup>-</sup>v t<sup>o</sup>tK th w<sup>o</sup> tK ejw<sup>o</sup>tK wK<sup>o</sup>K<sup>o</sup>K<sup>o</sup>iv ntqt<sup>o</sup>Q tm w<sup>o</sup> tK MuZkxj nq | A<sub>v<sup>o</sup></sub> G<sup>o</sup>t<sup>o</sup>q<sup>o</sup>t<sup>o</sup> ejw<sup>o</sup> w<sup>o</sup> i Ae<sup>-</sup>v t<sup>o</sup>tK ZiY jvf K<sup>o</sup>t | G<sup>o</sup>t<sup>o</sup>q<sup>o</sup>t<sup>o</sup> m<sup>o</sup>ó Zi<sup>o</sup>t<sup>o</sup>Yi gvb aYvZK Ges Zi<sup>o</sup>t<sup>o</sup>Yi w<sup>o</sup> K ntjv wK<sup>o</sup>tKi gva<sup>o</sup>t<sup>o</sup>g th w<sup>o</sup> tK ej c<sup>o</sup>qM Kiv nq tmB w<sup>o</sup> tK |

ch<sup>o</sup>y<sup>o</sup> ej MuZkxj e<sup>-</sup> i teM e<sup>o</sup> K<sup>o</sup>tZ cv<sup>o</sup>i |

w<sup>o</sup>t<sup>o</sup>KU tL<sup>o</sup>jvq w<sup>o</sup>t<sup>o</sup>KU ejw<sup>o</sup> th w<sup>o</sup> tK MuZkxj e<sup>-</sup> v<sup>o</sup>mg<sup>o</sup>v<sup>o</sup>b hw<sup>o</sup> tmBw<sup>o</sup> K eivei ejw<sup>o</sup>tK Av<sup>o</sup>NvZ K<sup>o</sup>t<sup>o</sup>b Zte ejw<sup>o</sup>l teM Kx nte ? Z<sup>o</sup>ug t<sup>o</sup> L<sup>o</sup>tZ cv<sup>o</sup>te th, ejw<sup>o</sup> c<sup>o</sup>te<sup>o</sup> t<sup>o</sup>P<sup>o</sup>t<sup>o</sup>q teM teM MuZkxj nte | G<sup>o</sup>t<sup>o</sup>q<sup>o</sup>t<sup>o</sup> ejw<sup>o</sup>l ZiY av<sup>o</sup>vZK Ges Gi teM e<sup>o</sup> cv<sup>o</sup>te | Mov<sup>o</sup>bv g<sup>o</sup>te<sup>o</sup> tUvKv w<sup>o</sup> tj Gi teM e<sup>o</sup> cv<sup>o</sup>q |









e`ŕKi ŵj tQov

hLb tKvbr e`w³ e`ŕK ntZ ŵj tQovob, ZLb wZwb tcQibi w`ŕK GKw av°v Abŕfe Ktib| tKb Ggbw nq?

Gtŕŕŕŕ ŵj I e`ŕKi wqv I cŕZwqv ej mgvb mgqevcx KvR Kti| wDUtbi wZxq mŕvbmŕti, ŵj I e`ŕK mgvŕbi wKš' wecixZgŕx fiŕem jvŕ Kti| dtj th fiŕem wbtq ŵj mgvŕbi w`ŕK AMŕhi nq, e`ŕK mgvŕbi wKš' wecixZgŕx fiŕem wbtq tcQibi w`ŕK aweZ nte| hvi `i`b H e`w³ tcQibi w`ŕK av°v Abŕfe Ktib| Aek` e`ŕKi fi tenk nl qvq e`ŕKi cŕv`teM ŵj i Zj bvq AZš-Kg nte|

msNI ©

tZvgiv hviv gŕteŕ tLŕjQ Zviv mŕeZ t`LŕZ tctqQ Kŕfŕte GKw gŕteŕ Ab` GKw gŕteŕtK AvNvZ Kti| GQov mŕev`cŕ ev tUwŕfkŕbi gŕaŕtg tZvgiv wŕfŕbŕitŕbi moK`Nŕbvi Lei RvbtZ cvi| G aiŕbi NUbv ntjv msNŕIŕ eŕŕe D`vniY|

A\_vŕ hLb GKw MwZkxj e` Ab` GKw w`i ev MwZkxj e`ŕK av°v t`q, ZLb e` `ŵi gŕa` msNI © ntŕtQ ejv nq| msNŕIŕ dtj e` `ŵi cŕZ`Kwŕi Dci GKw ej wqv Kti| cŕg e` KZŕ wZxq e` i Dci cŕŕ ejŕK wqv ej ejv ntj wZxq e` KZŕ cŕg e` i Dci cŕŕ ejŕK cŕZwqv ej ejv nq| msNŕIŕ mgq wqv kvj GB `ŵ etj i gvb mgvb wKš' wecixZgŕx| msNŕIŕ mgq `ŵ e` i gŕa` wqv I cŕZwqv ej e`ZxZ ewn`K tKvbr ej KvR Kti bv| wDUtbi wZxq mŕ t`ŕK Avgiv cvB

$$F = \frac{mv - mu}{t}$$

G mgxi Yw t`ŕK Avgiv fiŕetMi cwi eZŕK wbgŕtc cKvk KiŕZ cwi -

$$F \times t = mv - mu \quad (3.3)$$

A\_vŕ

ej × mgq = fiŕetMi cwi eZŕ|

wKš' ej I mgŕqi YdŕtK ejv nq etj i NvZ|

∴ etj i NvZ = fiŕetMi cwi eZŕ

aiv hvK  $m_1$  I  $m_2$  fiŕenwó `ŵ e` A I B h\_vŕtg  $u_1$  Ges  $u_2$  teM wbtq GKB mij tiLv eiŕei PjŕQ| A -Gi teM B -Gi teŕMi tŕtq tenk ntj tKvbr GK mgq A e` w B e` wŕtK av°v w`te [wŕŕ 3.6]|

B e` i Dci A e` i G cŕŕ ej ntjv wqv  $F_1$ , B e` wŕ A e` wŕtK  $F_2$  ej cŕqM Kiŕe GB  $F_2$  ej ntjv cŕZwqv| wDUtbi MwZi ZZxq mŕvbmŕti  $F_2 = -F_1$

msNŕIŕ mgq wqv I cŕZwqv ej GKB mgqevcx KvR Kti| aiv hvK, wqv I cŕZwqv mgqKvj t| msNŕIŕ ci e` `ŵ cwi ewZŕ teŕM GKB mij tiLv PjŕZ vKŕe| aiv hvK A I B -Gi cwi ewZŕ teM h\_vŕtg  $v_1$  I  $v_2$  wqv I cŕZwqv dtj A I B e` `ŵi ZjY h\_vŕtg  $a_1$  I  $a_2$  ntj ,

$$F_1 = -F_2$$

$$\text{ev, } m_1 a_1 = -m_2 a_2$$

$$\text{ev, } m_1 \frac{v_1 - u_1}{t} = -m_2 \frac{v_2 - u_2}{t}$$

$$\text{ev, } m_1 v_1 - m_1 u_1 = -m_2 v_2 + m_2 u_2$$

$$\text{ev, } m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$$

AZGe, A l B e' `jli msNtI P cteP l cti i fi tetMi mgwó mev mgvb \_tK | GiUB fi tetMi msi qY mî |  
MwYwZK D`vniY 3.3 : 20 kg fti i GKwU e' i Dci 2000 N ej 0.1 s mgqe`vcx KvR Kti | e' i  
fi tetMi cwieZB KZ nte?

Avgiv Rwb

$$\text{fi tetMi cwieZB} = ej \times mgq$$

$$mv - mu = Ft$$

$$= 2000 \text{ N} \times 0.1 \text{ s}$$

$$= 200 \text{ kg ms}^{-2} \text{ s}$$

$$= 200 \text{ kg ms}^{-1}$$

GLvfb,

$$\text{chp ej, } F = 2000 \text{ N}$$

$$\text{etj i wuqv Kvj, } t = 0.1 \text{ s}$$

$$\text{fi tetMi cwieZB, } mv - mu = ?$$

$$\text{DËi : fi tetMi cwieZB} = 200 \text{ kg ms}^{-1}$$

MwYwZK D`vniY 3.4: GKwU e`K t\_tK 500 ms<sup>-1</sup> tetM 10 g fti i GKwU \_wj tQov ntjv | e`Kti fi 2  
kg ntj e`Kti cÖvr teM wbyq Ki |

aiv hvK \_wj i tetMi w`K A\_v m`g w`K abvZK |

fi tetMi msi qY mî t\_tK Avgiv Rwb

$$m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$$

$$\text{ev } m_1 \times 0 \text{ ms}^{-1} + m_2 \text{ kg} \times 0 \text{ ms}^{-1} = 10^{-2} \text{ kg} \times 500$$

$$\text{ms}^{-1} + 2 \text{ kg} \times v_2$$

$$\text{ev } v_2 = -\frac{5 \text{ kg ms}^{-1}}{2 \text{ kg}}$$

$$= -2.5 \text{ ms}^{-1}$$

GLvfb,

$$\text{wj i fi, } m_1 = 10 \text{ g}$$

$$= 10 \times 10^{-3} \text{ kg}$$

$$= 10^{-2} \text{ kg}$$

$$\text{e`Kti fi, } m_2 = 2 \text{ kg}$$

$$\text{wj i Aw`teM, } u_1 = 0 \text{ ms}^{-1}$$

$$\text{e`Kti Aw`teM, } u_2 = 0 \text{ ms}^{-1}$$

$$\text{wj i tkl teM, } v_1 = 500 \text{ ms}^{-1}$$

$$\text{e`Kti cÖvr teM, } v_2 = ?$$

GLvfb e`Kti teM FYvZK, A\_v e`KwU wQb w`K MwZkxj nte

$$\text{DËi : cÖvr teM} = 2.5 \text{ ms}^{-1}$$

### 3.8 wbyc` ágY: MwZ l ej

#### Safe journey : force and motion

wbyc` ágYi Rb` Mwmoi MwZ wbyqšY AZ`š` iZcyqelq | Avgiv Avgv` i `bw`b cÖqvRb wGUvfbvi Rb`  
MwotZ ágY Kwî | ágYi mgq Avgiv wvfbvbevb e`envi Kwî | KLtbr evtm, KLtbr tUtb Avevi  
KLtbr e`wMZ hvbevb e`envi Kwî | Gme hvbevtb ágYi mgq hvbevtbi MwZ Ges ej l ZtcÖZ fite  
RwOZ | wbyc` ágYi tqtî Mwmoi MwZ gL` fvgKv cyjb Kti | Mwmoi MwZ ev teM Ggb nI qv DwPZ bq hv

wbqšY Kiv mæe bq| `ieZxMšte" ágti Yi Rb" cŭtgB Mše"tj hvl qvi iv`lv Ges cwi tek mæutKAvtM  
t\_tK tRtb tbi qv cŭqvRb|

ágY`riyKivi cteB Mmoi Pij KtK Zvi Mmoi fvtjvfvte cixŕlv Kti wbtZ nte| D`vniY`ŕc- Mmoi Uvqi  
I teK mivK AvtQ wKbv, Mmoi BwAb, e`eüZ e`vUwi, mvgtbi Ges tcQtbi ewZmgñ, Mmoi IqvBcvi Ges  
`ŕcvtki mstKZ t`I qvi ewZ\_tjv mivK Ges fvtjvfvte KvR KiQt wKbv Zv wbowZ KiQt nte| GQov  
MmoQtZ e`eüZ `cŕ\_tjv mivKfvte DcthvRb Kti wbtZ nte|

Mmo Pij bvi mgq cŭtgB WŕBfvi Ges Avti vnt`i wmu teë teŕa tbi qv DvPZ| t`Lv hvq th, AwKvsk moK  
`Nŕbv Lp `ŕ Mmo Pijvfbvi Rb" NtU \_vtK| ZvB Mmoi MwZ wbqšYi gta" ivLtZ Pij KtK mtpÓ \_vKtZ  
nte| MwZ ejvri dtj MwZkw³ tenk nq| thgb- Mmoi teM wŕ\_Y ntj Gi MwZkw³ cteŕ Zj bvq Pvi \_Y teŕo  
hvq| teM wZb\_Y ntj Gi MwZkw³ bq \_Y nq| dtj Mmoi teM Kgvtbv ev wbqšY Kwb ntq cto Ges  
`Nŕbv fqven nq|

Mmoi Pij K Ggb hvbevb Pijvteb, thw Pijvfbvi ceAwfÁZv Zvi itqtQ| nVv Kti bZb tKvfbv hvbevb  
Pijvfbvi tPón Kiv DvPZ bq| t`Lv hvq th, Zi`Yiv AvteŕMi etk bZb Mmo Pijvri tPón Kti | GwU tgvU  
DvPZ bq| Mmo Pijvfbvi mgq hLbB wecixZ w`K t\_tK tKvfbv Mmo AvmQtZ t`Lv hte ZLbB Mmoi MwZ  
Kvgtq tdjtZ nte| UwdK mivBb Ges UwdK AvBb tgbt Pjv Mmo Pij tKi bvmwi K`wqZj| Mmo Pij bvi mgq  
Pij KtK Zvi Mmo Pij bvi w`K mævŕc gtbwteK KiQt nte|

### 3.9 NIŕ I NIŕ ej

#### Friction and force of fricction

`bw`b Rxtb Avgiv NIŕYi m½ bvbvfvte cwiwPZ| wDUtbi MwZi cŭg mŕ t\_tK Avgiv Rwb th, tKvfbv  
e`i Dci ej wqv bv Kijt nq e`w w`i \_vKte, bv nq e`w mgteŕM mijct\_ PjtZ \_vKte| ev`ŕte  
Ggbw NtU Kx? Zng GKwU gteŕ bvl Ges GtK tqtStZ MmoQt `vl | gteŕwUŕK Zng hLb MmoQt `vl ZLb  
Gi Dci Zng ej cŭqvM Ki| hvi dtj gteŕwU gwU Dci w`tq MwZkxj nq| wDUtbi cŭg mŕvbjvqx  
gteŕwU mgteŕM MwZkxj \_vKvi K\_v| wKš' ev`ŕte t`Lv hvq th, gteŕwU LwbKuv `tZi AwZµg Kivi ci  
t\_tg hvq| tqtSi NIŕYi Rb`B Ggbw NtU| gteŕwU hLb tqtSi Dci MwZkxj \_vtK, ZLb gteŕ I tqtSi  
cvi`úwi K NIŕYi dtj GKwU NIŕ etji DrcwE nq| G ej MwZi wecixZ w`K wqv Kti Ges MwZtK  
evamŕŕ Kti| hw tqtSi NIŕ bv \_vKZ Zvntj gteŕwU GKB teM wbtq Aweig MwZtZ PjtZ \_vKZ|

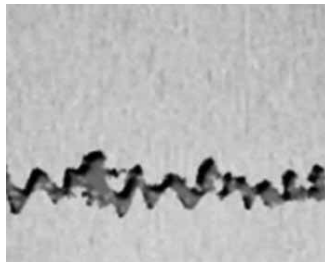
GKwU e` hLb Ab GKwU e`i ms`utkŕ\_tK GtKi Dci w`tq AciwU PjtZ tPón Kti ev PjtZ \_vtK  
ZLb e` ŕtqi`úktj MwZi weŕŕ GKwU evavi DrcwE nq, G evavtK NIŕ etj| Avi GB evav`wbKvi  
ejtK NIŕ ej ejv nq|

NIŕ ej me`v MwZi wecixZ w`K wqv Kti| NIŕ memgq MwZtK evav t`q|

NIŕYi DrcwE

hLb GKŭ e<sup>-</sup> i Zj Aci e<sup>-</sup> i Ztj i Dci w`tq MŭZkxj nq, ZLb cŕZ`K e<sup>-</sup> Aci e<sup>-</sup> i Dci NIŲ ej cŕqŭM Kti | GLb cŕkeAvŕm NIŲ tKb nq? NIŲ ntjv th tKvŕbv `Ųŭ Ztj i AvbqŭgZ cŕkŭZi dj | cŕZ`K e<sup>-</sup> i B Zj AvŕQ | Avevi Zj gmŲ A<sub>ev</sub> AgmŲ `ŲB ntZ cvŕi | AvcvZ `ŲŕŕZ tKvŕbv e<sup>-</sup> i Zj tK gmŲ etj gŕb ntj | AbŕŕŲY hŕŕŕi mŕvŕh` t`Ltj Gi Dci AŕbK DŕzŭbPzLvR j ŲŲ Kiv hvq [ŲŲ 3.7] | hLb GKŭ e<sup>-</sup> Ab` GKŭ e<sup>-</sup> i Dci w`tq MŭZkxj nq, ZLb Dŕq e<sup>-</sup> i `ŭkZtj i G LvR<sub>ŕ</sub>tjv GKŭi wŕZi Avŕi Kŭ XŕK hvq A<sub>ŕ</sub> LvR<sub>ŕ</sub>tjv ci`ŭi AvŭtK hvq | hvi dtj GKŭ Ztj i Dci w`tq Aci Ztj i MŭZ evaŕcŕŕ nq |

tKvŕbv Ztj i DŕŕŕŭbPzLvR hZ ŕŕk Ges Mŕxi nŕe A<sub>vŕ</sub> Zj hZ ŕŕk AgmŲ nŕe, GK Ztj i Dci w`tq Ab` Ztj i MŭZ ZZ ŕŕk evaMŕŕ nŕe | dtj NIŲ etj i gŕb tŕto hŕŕe | `ŭkZtj i GB evaŕK AvZŭg KiŕZ cvŕtj ZŕŕB e<sup>-</sup> ŭ MŭZkxj `ŕK | NIŲi dtj e<sup>-</sup> i MŭZ nŕm cvq Ges Aŕkŕŕ t<sub>ŕ</sub>g hvq |



ŲŲ 3.8 :

NIŲi cŕviŕf`

NIŲ mŕaviYZ Pŕi cŕvŕi i nq-

- 1 | w`ŭZ NIŲ (Static friction)
- 2 | ŭQj vŕbv NIŲ (Sliding friction)
- 3 | AveZŲNIŲ (Rolling friction)
- 4 | cŕvŕx NIŲ (Fluid friction)

w`ŭZ NIŲ

`Ų Ztj i GKŭ Aciŭi mŕŕŕŲ MŭZkxj bv ntj Gŕ i gŕa` th NIŲ mŲŕ nq Zv ntjv w`ŭZ NIŲ |

A<sub>vŕ</sub> hLb GKŭ e<sup>-</sup> i Dci ej cŕqŭM Kiv nq, ŭKŕ` G ej e<sup>-</sup> i MŭZ mŲŕ KiŕZ cvŕi bv ZLb w`ŭZ NIŲ KvR Kti | Avevi tŕŕSi Dci Aŕŕ`Z GKŭ ŕvix e<sup>-</sup> tK ŭŕvi ci | MŭZkxj bv ntj th NIŲ ej Dŕcbŕ nq Zv ntjv w`ŭZ NIŲ ej | A<sub>ŕ</sub> cŕŕ etj i ŕecixZ w`ŭZ NIŲ ej Dŕcbŕnq Ges MŭZ mŲŕ bv nŕ qv chŕŕ-G ej KvR Kti |

`Ų w`i e<sup>-</sup> ci`ŭŕi ms`ŭŕk<sub>v</sub> Ae`vq GKŭtK Aciŭi Dci w`tq MŭZkxj Kivi tŲŕv Kiv ntj, Gŕ i gŕa` AvŕŕŲŲ MŭZ mŲŕ bv nŕ qv chŕŕ-th NIŲ ej ŭŲqŭ Kti ZŕK w`ŭZ NIŲ etj |

ŭQj vŕbv NIŲ :

hLb GKwU e`' Ab` GKwU e`' i Z\_v Ztji Dci w`tq wQwj tğ (Slide) ev Ntł PjtZ tPón Kti ev Pjt ZLb th NIŕYi mŕó nq ZvtK wQj vtbv NIŕ ev wemcŕNIŕ etj |

wcwQj iv`Ívq Pjvi mgq AtbK mgq Avgiv cto hvB Ges wQwj tğ AtbKwU `j ZjAwZµg Kwi | `ZteŕM MwZkxj tKv tbv MwotZ nWŕeK Kłtj Mwotw bv t\_tg wQwj tğ LwbKwU `t ZjAMŕi nq |

AveZŕNIŕ :

hLb GKwU e`' Aci GKwU Ztji Dci w`tq Mwotq Pjt ZLb MwZi wei`tŕ th NIŕ wµqv Kti ZvtK AveZŕ NIŕ etj |

mBtKtji Pkvi MwZ, gŕteŕji MwZ ntjv AveZŕNIŕYi D`vniY | ágtYi mgq gvjvgvj cwi entbi Rb` Avgiv Pkvi j wMv tbv j vŕMR e`envi Kwi | hw` j vŕMŕ Pkvi j wMv tbv bv \_vKZ ZLb GwŭtK GK `vb t\_tK Ab` `v tb wQwj tğ tUtb wbtZ tek Kó ntZv | wKš` Pkvi j wMv tbv dtj j vŕMR tUtb tbi qv tek mnRZi nq | A\_vŕ AveZŕNIŕ etj wQj vtbv NIŕYi Zj bvq Kg |

cŕvnx NIŕ :

hLb tKv tbv e`' th tKv tbv cŕvnx c`v\_ŕhgb- Zij ev evqexq c`v\_ŕ gŕa` MwZkxj \_vtK ZLb th NIŕ wµqv Kti ZvtK cŕvnx NIŕ etj |

hLb cKti mwZi KvUv nq ZLb cKti cmbi ga` w`tq GKwU evatK AwZµg KłtZ nq | Avi G evavB ntjv cŕvnx NIŕ | c`v vŕmŭ evqj evatK KvŕR j wMŭtq KvR Kti | GLv tb evqj evav ntjv GK aitbi NIŕ etj hv cŭ\_exi AwfKł etji weciŭtZ wµqv Kti | tLvjv Ae`vq c`v vŕmŭŭi ewntii Ztji tŕŭŭdj AtbK tewk nŭlqv evqj evav cwi gYI tewk nq, hvi dtj Avŭvnx cZtbi MwZ AtbK nŕm cvq | dtj Avŭvnx axŭi axŭi gwŭtZ wbi vct` tbtg Avŭm |

### 3.10 MwZi Dci NIŕYi cŕve

#### Effect of friction on motion

tKv tbv e`' i MwZi Dci NIŕYi e`vcK cŕve itqtQ | NIŕ ntjv GK aitYi evav vbKvix ej, hv e`' i MwZtK gš'i Kti | NIŕ Avgŕt` i `b w`b Rxetb AtbK mŕm`v mŕó Kłtj I PjvPj I hvbevnb Pjv bvi Rb` NIŕ Mj`ZcYŕŕŕgKv cvj b Kti | G Abŕ`Qŭ` Uvqŭtii cŕ, iv`Ívi gŕYZv Ges MwZ wloqš\_ztY NIŕYi ŕŕgKv wbtq AvŭjvPbv Kiv nte |

Uvqŭtii cŕ :

Mwot Uvqvi Ges iv`Ívi ga`eZŕNIŕ AvŭQ etj B Mwot Pjv bv mŕe ntqtQ | Uvqvi Ges iv`Ívi ga`eZŕG NIŕ etji gvb wbfŕ Kti Uvqŭtii cŕ Ges iv`Ívi Ztji ewn`K Ae`vi Dci | GwU Mwot I Rŭbi Dci I wbfŕ Kti | Mwot Uvqŭtii ivetii Dci wewŕfbabKkvq `wZ ev LwR



wŕŭ : 3.9

KvUv \_v̄tK [wPĭ 3.9] | G LwR\_ŋjv \_vKvi dtj Uvqv̄t̄i i cō DPz-wbPz nq | Uvqvi hLb bZb \_v̄tK ZLb GB DPz  
wbPz LwR\_ŋjv m̄yúó \_v̄tK weavq iv̄-ŋv I Uvqv̄t̄i i ga'eZx̄NĪŋ ej m̄ter̄P nq | Ab̄ w̄ t̄K Uvqvi hLb c̄j t̄bv  
ntq hvq ZLb Gi LwR\_ŋjv w̄ḡw̄j t̄q hvq Ges Uvqv̄t̄i i cō mgZj ntq cto | Gi dtj iv̄-ŋv I Uvqv̄t̄i i NĪŋ ej  
Āt̄bKuv K̄tg hvq | Gi dtj Kx Am̄eav nt̄Z c̄t̄i ej |

iv̄-ŋvi gm̄YZv :

e- ' i MwZi Dci iv̄-ŋvi gm̄YZvi c̄f̄ve Āt̄bK t̄enk | iv̄-ŋv gm̄Y ntj iv̄-ŋvq hvbevb PjvPj mnRZi nq  
Ges āgY Aviḡv̄qK nq | iv̄-ŋv hZ t̄enk gm̄Y nte evav̄wbKvix NĪŋ et̄ji gvb ZZ Kg nte | Mwoi Uvqvi  
Ges iv̄-ŋvi ga'eZx̄NĪŋ et̄ji gvb Uvqv̄t̄i i Ges GKB m̄v̄\_ iv̄-ŋv gm̄YZvi Dci w̄b̄f̄P K̄t̄i | NĪŋ et̄ji  
c̄w̄iḡY Āt̄bK K̄tg t̄M̄t̄j b̄v̄b̄v āt̄t̄bi m̄gm̄v̄i I m̄yó nq | ZvB iv̄-ŋv̄t̄K L̄p̄ t̄enk gm̄Y Kiv w̄VK b̄q | iv̄-ŋv  
t̄enk gm̄Y ntj t̄eK c̄ŋ̄q̄M̄ Kiv m̄t̄Ēj Mwot̄K m̄ȳb̄w̄ ̄v̄t̄b \_vḡv̄t̄bv m̄ēe ntq I t̄v̄ b̄v | Mwoi MwZi Rb̄  
NĪŋ L̄p̄ i "Z̄c̄ȲP̄ iv̄-ŋv t̄enk gm̄Y ntj c̄ŋ̄q̄R̄bx̄q c̄ŋ̄Z̄w̄q̄v ej m̄yó nq b̄v | iv̄-ŋv t̄enk gm̄Y ntj NĪŋ et̄ji  
gvb AZ̄w̄aK K̄tg hvq, dtj Mw̄o m̄vḡt̄bi w̄ t̄K AM̄hi nq b̄v | ZvB iv̄-ŋvi gm̄YZv Ggb nte hv̄t̄Z K̄t̄i iv̄-ŋv  
c̄ŋ̄q̄R̄bx̄q NĪŋ et̄ji t̄h̄v̄M̄v̄b t̄̄q |

MwZ w̄b̄q̄š̄Y Ges t̄ēt̄Ks ej

hvbevb PjvP̄t̄j i mgq c̄ŋ̄q̄R̄b Ab̄h̄v̄q̄x hvbevb̄t̄bi MwZ̄t̄K ēv̄v̄ ev̄ n̄m̄ Kīt̄Z nq | A\_v̄P̄ hvbevb̄t̄bi MwZ̄t̄K  
w̄b̄q̄š̄Ȳt̄i c̄ŋ̄q̄R̄b cto |

t̄eK nt̄Q Ggb GK ēe- 'v̄ hv̄ NĪŋYi c̄w̄iḡY ēv̄v̄ K̄t̄i Mwoi MwZ Z\_v̄ PvKvi NȲŋ̄t̄K c̄ŋ̄q̄R̄b Ab̄h̄v̄q̄x  
w̄b̄q̄š̄Ȳ K̄t̄i | Gi ḡv̄āt̄g hvbevb̄t̄K w̄b̄w̄ ̄v̄t̄b \_vḡv̄t̄bv m̄ēēci nq | hLb Mwoi P̄v̄j̄K t̄eK c̄ŋ̄q̄M̄  
K̄t̄ib, ZLb Gm̄t̄e÷t̄mi ̄Z̄wī m̄yev̄ c̄W̄ PvK̄v̄q̄ Aew̄ 'Z̄ av̄Zē PvK̄w̄Z̄t̄K av̄v̄ t̄̄q | c̄W̄ I PvK̄w̄Z̄i ga'eZx̄  
NĪŋ PvKvi MwZ̄t̄K K̄v̄ḡt̄q̄ t̄̄q | dtj Mwoi t̄eM̄ n̄m̄ c̄v̄q |

### 3.11 NĪŋYi n̄m̄ ēv̄v̄

#### Increasing and decreasing friction

NĪŋ Avḡv̄t̄ i ̄̄b̄w̄b̄ R̄x̄t̄bi m̄v̄\_ I Z̄t̄c̄ŋ̄Z̄f̄v̄te R̄w̄ot̄q̄ Av̄t̄Q | c̄ŋ̄q̄R̄t̄b NĪŋ̄t̄K ēv̄v̄ Kiv hvq, Avev̄i  
c̄ŋ̄q̄R̄t̄b NĪŋ̄t̄K n̄m̄ I Kiv hvq | G Ab̄j̄Q̄t̄ NĪŋ̄t̄K K̄x̄f̄v̄te n̄m̄ I ēv̄v̄ Kiv hvq Zv̄ w̄b̄t̄q̄ Av̄t̄j̄v̄P̄bv̄ Kiv  
nt̄j̄v̄ |

NĪŋYi n̄m̄

Z̄j̄t̄K gm̄Y Kiv

NĪŋYi dtj GK̄w̄ e- ' t̄K GK ̄v̄b̄ t̄̄t̄K Ab̄ ̄v̄t̄b̄ m̄iv̄t̄Z̄ t̄ek S̄v̄t̄ḡj̄v̄ t̄c̄v̄v̄t̄Z̄ nq | ai Z̄v̄ḡ GK̄w̄ f̄v̄ix  
ev̄ t̄K t̄ḡt̄Si Dci w̄ t̄q̄ m̄iv̄t̄Z̄ P̄v̄l | h̄w̄ ̄uk̄Z̄t̄j̄i NĪŋYi c̄w̄iḡY L̄p̄ t̄enk nq Z̄t̄e ev̄ w̄Ūt̄K m̄iv̄t̄Z̄ Āt̄bK  
t̄enk c̄w̄īk̄ḡ Kīt̄Z̄ nte | Z̄j̄t̄K gm̄Y Kiv ḡv̄āt̄ḡ G NĪŋ̄t̄K K̄ḡv̄t̄bv̄ t̄h̄t̄Z̄ c̄t̄i |



Rȳvi wbp LuR KvUv

nvUvi Rb` NIȳ LpB cŋqvRb| tZvgiv t`LtZ cvte Rȳvi Zjt`k tXD tLjvfbv ev LuRKvUv \_vK| Rȳv cvtq nvUvi mgq Rȳvi LuR,tjv iv`lvK AvKto ati ivL Ges cŋqvRbxq NIȳ etji thvWvb t`q| Rȳv I iv`lvi ga`eZr<sup>©</sup>NIȳ ep<sup>Ⓢ</sup> Kivi Rb`B Rȳvi Zjt`k G<sup>ḡ</sup>c ntq \_vK| Rȳv cjt<sup>Ⓢ</sup>bv ntq tMtj LuR,tjv AtbKvst<sup>Ⓢ</sup>k wgvj t<sup>Ⓢ</sup>q hvq| hvi `i`b wcvQj ev tFRv iv`lvq Rȳv cvtq nvUv KóKi ntq I tV| j<sup>¶</sup> Ki t<sup>Ⓢ</sup> t`Lte Avgv<sup>Ⓢ</sup>`i cvtqi Zjvl mgZj bq|

cvnvto AvtinvY

th mKj e<sup>w</sup>3 c<sup>Ⓢ</sup>nvto AvtinvY Ktib Zvt`i tK wkvjLÉ ev c<sup>Ⓢ</sup>nvtoi ZjtK fvtjvfvte cv Ges nvZ Øviv AwKto ati ivLtZ nq| ati ivLvi Rb` Zviv PK cvDWi e`envi Ktib|

tLtjvqv<sup>Ⓢ</sup>i t`i etUi wbp `uvBK \_vK hvZ t`Sovt<sup>Ⓢ</sup>bvi mgq cti bv hvq|

### 3.12 NIȳ : GKwU cŋqvRbxq Dc`e

#### **Friction: a necessary evil**

NIȳvi AtbK Am<sup>Ⓢ</sup>jeav \_vKv mtÉj NIȳtK GKwU cŋqvRbxq Dc`e wntmte MY` Kiv nq| Gi KviY Kx? tKbbv NIȳ Qvov Avgiv tKvfbv wKQB Kitz cwi bv| hw` NIȳ bv \_vKZ Zv ntj e` i tKvfbv MwZB Avi tkl ntZv bv, weivgnxbfvte PjtZ \_vKZ| NIȳ AvtQ etjB t`qv<sup>Ⓢ</sup>tj GKwU tctiK w`i fvte AvUtK \_vK| NIȳvi Kv<sup>Ⓢ</sup>itYB cvKv `jvb I emo-Ni wgv<sup>Ⓢ</sup> Kiv m<sup>Ⓢ</sup>e ntqtQ| NIȳvi dtj KvMtR tcbw<sup>Ⓢ</sup>j ev Kjg w`tq wj LtZ c<sup>Ⓢ</sup>ivQ| Avgv<sup>Ⓢ</sup>`i Rȳv Ges gvU<sup>Ⓢ</sup>i gta` m<sup>Ⓢ</sup>ó NIȳvi Kv<sup>Ⓢ</sup>itY Avgiv nvUv-Pjv Kitz cwi| NIȳvi Rb` Avgiv cŋqvRb Abjhvx Mw<sup>Ⓢ</sup>oi MwZi w`K cwi eZB Kitz cwi| evZvtmi NIȳ AvtQ etjB c`ivm<sup>Ⓢ</sup>j e`envi Kti wgvb t`tK w<sup>Ⓢ</sup>ivct` gvU<sup>Ⓢ</sup>tZ bvgv m<sup>Ⓢ</sup>e ntqtQ| GZme DcKvix w`K \_vKv mtZj NIȳvi Rb` Avgv<sup>Ⓢ</sup>`i Kg Sv<sup>Ⓢ</sup>tgjv tcvntZ nq bv| AwZwi<sup>3</sup> NIȳvi Kv<sup>Ⓢ</sup>itY hvbevb mntR PjtZ cvti bv| hš<sup>Ⓢ</sup>cwZi MwZkxj Ask,tjvi gta` NIȳvi dtj Giv ¶qcŋB nq Ges wQto hvq| th tKvfbv aitbi hvbevb Zv Mw<sup>Ⓢ</sup>o, tbŠKv ev DtovRvnr tnvK bv tKb, AwZwi<sup>3</sup> NIȳtK AwZ<sup>Ⓢ</sup>ug Kitz AwZwi<sup>3</sup> Ryjw<sup>Ⓢ</sup>b LiP Kitz nq| hvi `i`b NIȳvi dtj Ryjw<sup>Ⓢ</sup>bi kw<sup>3</sup>i AcPq nq|

NIȳvi dtj kw<sup>3</sup>i th AcPq nq Zv cŋvbZ Zvckw<sup>3</sup>š<sup>Ⓢ</sup>tc Awef<sup>Ⓢ</sup> nq| NIȳvi dtj i`ayth kw<sup>3</sup> Zvtc cwiYZ nq ZvB bq, Gi dtj BwÄtbi hš<sup>Ⓢ</sup>usk AZ`waK DÉB ntq I tV| hvi `i`b BwÄb bó ntq thtZ cvti| NIȳvi dtj Rȳvi tmj ¶qcŋB nq Ges wQto hvq| ZvB Avgv<sup>Ⓢ</sup>`i KvRKg<sup>©</sup> Rxb hvcb mnR Kivi Rb` NIȳ thgb cŋqvRb, tZgvb AwZwi<sup>3</sup> NIȳ AtbK ¶q¶wZi I KvY| ZvB cŋqvRbxq NIȳ m<sup>Ⓢ</sup>ó<sup>Ⓢ</sup>i Rb` NIȳtK w<sup>Ⓢ</sup>bqš<sup>Ⓢ</sup>Y Kitz nq| KLt<sup>Ⓢ</sup>bv Avgiv NIȳtK w<sup>Ⓢ</sup>efbæcŋqv<sup>Ⓢ</sup>i gva`tg Kgv<sup>Ⓢ</sup>tZ PvB, Avevi KLt<sup>Ⓢ</sup>bv GtK evovtZ PvB| A<sup>Ⓢ</sup> NIȳtK thgb c<sup>Ⓢ</sup>ivc<sup>Ⓢ</sup>i ev` t`lqv hvq bv, tZgvbfvte AtbK t¶t<sup>Ⓢ</sup> NIȳ Avgv<sup>Ⓢ</sup>`i DcKv<sup>Ⓢ</sup>i Avtm| GRb` NIȳtK ejv nq GKwU cŋqvRbxq Dc`e|



côZte`b i Pbv

3.9 t<sub>1</sub>K 3.12 Abt`Q<sub>1</sub> i AvtjvK Avgv` i Rxeib NI<sub>1</sub>bi BvZevPK c<sub>1</sub>ve m<sub>1</sub>utK<sup>6</sup>GKwJ côZte`b c<sub>0</sub>' Z K<sub>1</sub>i wk<sub>1</sub>tiK<sub>1</sub> K<sub>1</sub>Q Dc`'vcb Ki |

wk<sub>1</sub>tiK metP<sub>1</sub>q f<sub>1</sub>tjv côZte`b wbePb K<sub>1</sub>i tk<sub>1</sub>Y K<sub>1</sub>ti Dc`'vcb Ki<sub>1</sub>Z ej<sub>1</sub>eb |

AbmÜvb 3.1 : tK<sub>1</sub>tv e`' i lci ch<sub>1</sub> ej cwi gvc

D<sub>1</sub>i k` : mnR cix<sub>1</sub>ti m<sub>1</sub>nvth` ej cwi gvc Kiv |

m<sub>1</sub> : Avgiv Rwb, tK<sub>1</sub>tv e`' i Dci F ej w<sub>1</sub>qv Kitj Ges ej c<sub>0</sub>qvMi dtj m<sub>0</sub> Z<sub>1</sub>Y a ntj ,  $F = ma$   
GLv<sub>1</sub>b m e`' i fi | AwfKl<sub>1</sub>etj i t<sub>1</sub>ti e`' i Z<sub>1</sub>Y a -tK g Øviv c<sub>0</sub>vk Kiv hvq | A<sub>1</sub> AwfKl<sub>1</sub>ej ev e`' i l Rb,  $W = mg$  | GLv<sub>1</sub>b etj i D`niY w<sub>1</sub>tmte Avgiv e`' i l Rb cwi gvc Kie |

hš<sub>1</sub>cwZ t w<sub>1</sub>š w<sub>1</sub><sup>3</sup>, e`' |

K<sub>1</sub>ti Ri aviv :

1. w<sub>1</sub>DUb GK<sub>1</sub>K w<sub>1</sub>w<sub>1</sub><sup>1</sup>/<sub>4</sub> Z GKwJ w<sub>1</sub>š w<sub>1</sub><sup>3</sup> t`qv<sub>1</sub> Sj<sub>1</sub>q bvl |
2. Gevi w<sub>1</sub>š -Gi w<sub>1</sub>tPi utK e`' w<sub>1</sub> Sj<sub>1</sub>q v<sub>1</sub> |
3. w<sub>1</sub>š w<sub>1</sub><sup>3</sup> i t`c<sub>1</sub> t<sub>1</sub>K e`' i l Rb Z<sub>1</sub>v AwfKl<sub>1</sub>etj i c<sub>1</sub>v ti KW<sub>1</sub>Ki Ges Q<sub>1</sub>K emvl |
4. GKBF<sub>1</sub>te 3 bs c<sub>1</sub>qv Abm<sub>1</sub>Y K<sub>1</sub>i K<sub>1</sub>qKevi e`' i l Rb w<sub>1</sub>Y<sub>1</sub> Ki Ges Q<sub>1</sub>K v<sub>1</sub>cb Ki |
5. Gevi e`' i lci ch<sub>1</sub> Mo ej ev l Rb w<sub>1</sub>Y<sub>1</sub> Ki |

μgK msL <sup>-1</sup>	e`' i l Rb (w <sub>1</sub> DUb)	Mo l Rb w <sub>1</sub> DUb
1.		
2.		
3.		
4.		
5.		

GLb GB e`' i cwietZ<sub>1</sub>ewf<sub>1</sub>b e`' w<sub>1</sub>tq K<sub>1</sub>qKevi cix<sub>1</sub>tiY mgv<sub>1</sub>3 Ki Ges Z<sub>1</sub>te` i l Rb w<sub>1</sub>Y<sub>1</sub> Ki |

## Abkxj bx

(K) e<sub>1</sub>mbepbx c<sub>1</sub>kæ

m<sub>1</sub>wK D<sub>1</sub>ti i c<sub>1</sub>vk w<sub>1</sub>K (v) w<sub>1</sub>P<sub>1</sub>y v<sub>1</sub> |

1 | e`'th Ae<sub>1</sub>vq Av<sub>1</sub>Q w<sub>1</sub>Pi Kv<sub>1</sub> tm Ae<sub>1</sub>vq v<sub>1</sub>KtZ Pvl qvi th c<sub>0</sub>YZv ev ag<sub>1</sub>Z<sub>1</sub>vk K<sub>1</sub>x etj ?

(K) ej

(L) Z<sub>1</sub>Y

(M) RoZ<sub>1</sub>

(N) teM

2 | etj i gv<sub>1</sub>v tK<sub>1</sub>tbw<sub>1</sub>U?

(K) MLT<sup>-2</sup>

(L) MLT<sup>-1</sup>

(M) ML<sup>-2</sup>T<sup>-2</sup>

(N) M<sup>-1</sup>LT<sup>-2</sup>

- 3 | tKvb ej w tenk kw<sup>3</sup>kvj x?  
 (K) gnvKI ej (L) `pP wbdKxq ej  
 (M) ZwoZtPŠKxq ej (N) mej wbdKxq ej
- 4 | fi tetMi GKK tKvbwU?  
 (K) kg m (L) kg ms<sup>-1</sup>  
 (M) kg m<sup>2</sup>s<sup>-1</sup> (N) kg ms<sup>-2</sup>
- 5 | 5 kg fti i GKw e<sup>-1</sup> l ci 50 N ej cQqM Kiv ntj , Gi Zij Y nte-  
 (K) 12 ms<sup>-2</sup> (L) 8 ms<sup>-2</sup>  
 (M) 13 ms<sup>-2</sup> (N) 10 ms<sup>-2</sup>
- 6 | 10 kg fti i tKvbw e<sup>-1</sup> 10 ms<sup>-1</sup> tetM MwZkxj ntj Gi fi tetM nte-  
 (K) 10 kg ms<sup>-1</sup> (L) 120 kg ms<sup>-1</sup>  
 (M) 100 kg ms<sup>-1</sup> (N) 1 kg ms<sup>-1</sup>

(L) mRbkxj cKæ

- 1 | dviK 4kg fti i GKw ev. GKw tqtSi Dci w tq mgetj tUtb wbj | ev. I tqtSi gaKvi NI<sup>9</sup>  
 etj i gvb nj 1.5N | ev. wUtk tUtb tbl qvq Gi Zij Y nj 0.8 ms<sup>-2</sup> | Gici ev. wUtk NI<sup>9</sup>wenxb  
 tqtStZ GKB ej cQqM Kti Uvbw ntj v |  
 K) mvg<sup>9</sup> ej KvK etj ?  
 L) NI<sup>9</sup> ej tKb Drcbwq?  
 M) cUg tQt<sup>9</sup> ev. wU i Dci chp<sup>9</sup> etj i gvb wby<sup>9</sup> Ki |  
 N) NI<sup>9</sup>h<sup>9</sup> I NI<sup>9</sup>wenxb tqtStZ Zij tYi Kxj cwi eZ<sup>9</sup> nte? MwYwZKfvte e<sup>9</sup>L<sup>9</sup> Ki |

(M) mvavi Y cKæ

- 1 | RoZv KvK etj ? RoZv Kq cKvi ?
- 2 | ej KvK etj ?
- 3 | tKvbw w<sup>-1</sup> i e<sup>-1</sup> i RoZv Kx Øviv cwi gvc Kiv nq?
- 4 | tgSwj K ej KZ cKvi I Kx Kx? Gt<sup>-1</sup> i ZxeZvi Zij bv Ki |
- 5 | mvg<sup>9</sup> ej I Amvg<sup>9</sup> ej etjZ Kx eS ?
- 6 | tKvbw e<sup>-1</sup> i fi tetM KvK etj ?
- 7 | t<sup>-1</sup>LvI th, ej = fi × Zij Y |
- 8 | fi tetMi msi Qt<sup>9</sup>Y bwZ etjZ Kx eS?
- 9 | NI<sup>9</sup> KvK etj ? wewfbæcKvi NI<sup>9</sup>Yi bvg wj L |
- 10 | NI<sup>9</sup> GKw cQqRbxq Dc<sup>-1</sup> Gi mctQt<sup>9</sup> h<sup>9</sup> vI |

PZL<sup>©</sup>Aa`vq  
 KvR, ¶gZv I kw<sup>3</sup>  
**WORK, POWER AND ENERGY**



[Avgv`i cŕZ`wnK Rxetb tKv`bv wKQzKiv`K KvR ejv ntj I c`v\_ŕeÁvb KvR ōviv GKwU mybw`ŕ avi Yv`K eSvq | GB Aa`vqi `i`i`Z Avgiv tmB avi Yv`K Dc`'mcZ Kie | ŕeÁvbi metPtq `i`ZcY`welq nt`Q kw<sup>3</sup> | Avgiv Avgv`i AwfÁZv t`tK t`wL kw<sup>3</sup> Ōvov RMr APj | ŕewfb`ŕc Avgiv kw<sup>3</sup> cvB | MwZkxj e`' i Rb` MwZkw<sup>3</sup>, fetōi LwbK Dcti e`' i Ae`'vbi Rb` ŕefe kw<sup>3</sup>, GKwU mstKwPZ ev cŕwvi Z w`ŕs Gi kw<sup>3</sup>, Mig e`' i Zvc kw<sup>3</sup>, AvwZ e`' i Zwor kw<sup>3</sup> BZ`w | kw<sup>3</sup> μgvMZ GK ŕc t`tK Ab` ŕc ŕcŕŕw Z nt`Q, hw`I gnwetk`i tgvU kw<sup>3</sup> i cwigvY AcwievZbq Ges mybw`ŕ | GB Aa`vq Avgiv kw<sup>3</sup> i ŕcŕŕi NUbv Ges ŕeÁvbi `i`ZcY`bwxZ`tjvi GKwU kw<sup>3</sup> i msi ¶Ykxj Zvi bwxZ wbtq AvtjvPbv Kie |]

GB Aa`vq cW tk`I Avgiv-

1. KvR I kw<sup>3</sup> i m`úK`e`vL`v Ki`Z cvie |
2. KvR, ej I mi`Yi gta` m`úK`'vcb Ki`Z cvie |
3. MwZkw<sup>3</sup> I ŕefe kw<sup>3</sup> e`vL`v Ki`Z cvie Ges wmwie Ki`Z cvie |
4. Drtm kw<sup>3</sup> i ŕcŕŕi e`vL`v Ki`Z cvie |
5. A`ŕbwxZK, mvgwRK I cwi`tekMZ cŕŕe ŕetePbvq kw<sup>3</sup> i cŕvb Drmmg`ni Ae`vb wetk`Y Ki`Z cvie |
6. kw<sup>3</sup> i ŕcŕŕi Ges kw<sup>3</sup> i wZ`Zvi gta` m`úK`e`vL`v Ki`Z cvie |
7. kw<sup>3</sup> i ŕcŕŕi I Gi e`envi cwi`teki fvimvg` e`vnZ Kti e`vL`v Ki`Z cvie |
8. Dbqb Kvhp`tg kw<sup>3</sup> i KvRi e`envi e`vL`v Ki`Z cvie |
9. kw<sup>3</sup> i KvRi I w`ivc` e`envi m`PZb ntev |
10. fi kw<sup>3</sup> i m`úK`e`vL`v Ki`Z cvie |
11. kw<sup>3</sup> i `vbrŕi Ges ¶gZvi gta` m`úK`'vcb Ki`Z cvie |
12. Kg`¶Zv cwigvK Ki`Z cvie |

## 4.1 KvR

## Work

``bwb`b Rxeþb tKvþbv wKQz KivþK KvR ejtj l weÁvþb wKŠ` tKvþbv wKQz Kiv ntjB KvR nq bv| weÁvþb  
 KvR GKwU weþkl A\_`enb Kti| GKRb `vþivqvb mivv¶Y eþm eþm GKwU evmv cnrviv w`tjb| wZwb ejþeb  
 wZwb Zvi KvR KtiþQb| tKvþbv tmþtZi b`x ev Lvþj GKwU tbŠKv tþþm hw`Qj, Kwig mvþne tmUvþK tUþb  
 ati ivLþQb| wZwb ejþeb wZwb KvR Kti tbŠKwUþK tVwKtq tiþLþQb bZev tmwU tmþtZi Uvþb tKv\_vq tþþm  
 thZ| ``bwb`b Rxeþb G\_þjvþK KvþRi `xKwZ w`tj l weÁvþbi `wóþZ wKŠ` G\_þjv KvR nqwb| eis  
 `vþivqvb eþm eþm cnrviv bv w`tq hw` tntU tntU cnrviv w`tZb wKsev tbŠKwU hw` tmþtZi Uvþb tþþm thZ  
 Zvntj wKQz KvR ntZv| weÁvþb KvþRi A\_` ``bwb`b Rxeþb KvþRi At\_þ tþtq wfþZi| Avmtj weÁvþb KvR  
 ntZ tþtj ej l Zvi mvþ\_miy msukO\_vKþZ nq| tKvþbv e` i Dci tKvþbv ej wþqv Kti hw` e` wJi wKQz  
 miY NUvq Zvntj tKej KvR nq| Avgiv Avgvþ`i ``bwb`b Rxeþb Avgvþ`i Pri cvþk KvþRi AtþK D`vniY  
 t`LþZ cvB| ej` givþ jvOj UvbþQ, GKRb kþgK tvjv Mwmo tvjþQb, þxov cþZþhwMwZvq tKD tj Šn tMvj K  
 wbþ¶c KiþQ BZ`w` |

Wb†Pi D`vniY,tjv we†ePbv Kiv hvK :

(K) i Zb GK c`v†KU eB nvZ w`†q a†i `w†q Av†Q |

(L) wqZv c`v`eA vb eLbv tK tVtj tUwtj i Dci w`tq GK cš- t- tK Ab` cš- w t q ht`Q |

(M) bxi " GKwJ fvi x e"vM†K vmo w` tq Dc†i DVv†"Q|

(N) wi wg tRv†i t` qvj ‡K tVj ‡Q |

thñZr GKwU ej ðiv tKvbr e' MwZkj ntjB tKej KvR nq, mZivs Dwj qLZ D`vniY,tjvZ (L) Ges (M)-Gi t¶t¶ KvR ntqQ; mKŠ' (K) Ges (N) Gi t¶t¶ tKvbr KvR nqwb | Avgiv tKvbr e' tK Dcti DVvZ ev wotP bvgvZ ev GK `vb t\_tK Ab` `vrb wotZ ej cðqm KiZ cwi | Avgiv ej cðqm Kti tKvbr e' i AvKvi cwieZB KiZ cwi | G mKj t¶t¶ KvR nq |

hw̃ GKRb wbgw̃ klgK̃ kLlvb BU wbtq̃ tKṽbv fε̃bi t̃vZjvq D̃tVb, Z̃ε wZwb GKLlvb BU wbtq̃ H̃ t̃vZjvq DṼtj̃ th̃ KṽR KĩtZb Zvĩ t̃P̃tq̃ tε̃nk̃ KṽR Kĩtεb, t̃Kbbv ZṽtK̃ tε̃nk̃ ej̃ c̃tq̃M̃ KĩtZ̃ nq̃| ZṽtK̃ Aṽt̃iṽ tε̃nk̃ KṽR KĩtZ̃ ñtε hw̃ wZwb H̃ `kLlvb BUB̃ wZbZjvq̃ DṼvb̃| m̃Zivs̃ Kṽt̃Rĩ cwĩ gw̃ wbf̃P̃ K̃tĩ c̃h̃p̃ ε̃t̃jĩ Dcĩ Ges̃ `t̃t̃Z̃ĩ Dcĩ| t̃Kṽbṽ ε̃-̃ ĩ Dcĩ c̃h̃p̃ ej̃ Ges̃ ε̃t̃jĩ w̃t̃K̃ ε̃-̃ ĩ AñZ̃μ̃s̃-̃t̃t̃Z̃ĩ̃ .Ydj̃ Øviṽ KṽR cwĩ gvc̃ Kiṽ nq̃| m̃Zivs̃,

$$K \vee R = e_j \times e_{\dagger j} \text{ i } w \dagger K \wedge Z_{\mu \nu} \dot{S} \cdot \dagger Z_i$$

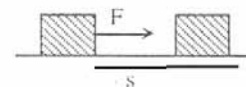
[illegible]

$$W = Fs \quad (4.1)$$

Kv†Ri †Kv†bv w` K †bB| KvR GKwU †<jvi i wkk|

$$Kv\ddagger Ri \text{ } g\hat{v}I\text{ } v : Kv\ddagger Ri \text{ } g\hat{v}I\text{ } v \text{ } n\ddagger e \text{ } e_j \times mi\ddagger Yi \text{ } g\hat{v}I\text{ } v$$

$$K_{VR} = e_j \times m_i Y = f_i \times Z_{ji} Y \times m_i Y$$

 $w^{\hat{P}} : 4.1$

$$\begin{aligned}
 &= f_i \times \frac{m_i Y}{mgq^2} \times m_i Y \\
 &= f_i \times \frac{m_i Y^2}{mgq^2} \\
 \therefore [W] &= \frac{ML^2}{T^2} = ML^2 T^{-2}
 \end{aligned}$$

KvRi GKK : etji GKKtK `tZi GKK w`tq ŸY Kitj KvRi GKK cvlqv hvq| thtnZetji GKK wDUB (N) Ges `tZi GKK ntjv wglvi (m), mZivs KvRi GKK nte wDUB-wglvi (N m)| GtK Rj ejv nq| RjtK J w`tq cKvk Kiv nq| tKvbn e` i Dci GK wDUB ej cKqvMi dtj hw` e` wli etji w`tK GK wglvi miY nq Zte m`ubKvRi cwigvYtK GK Rj etj |

$$1 \text{ J} = 1 \text{ N m}$$

hw` ej cKqvMi dtj e` etji w`tK mti hvq Zvntj tmB KvRtK etji Øviv KvR etj |

GKw Wv÷vi tUetji Dci t\_tK tqtStZ tdtj w`tj Wv÷viw AwfKI`etji cFvte wbtPi w`tK cote| Gtq|t AwfKI`Øviv KvR ntqtQ|

hw` ej cKqvMi dtj e` etji wecixZ w`tK mti hvq Zvntj tmB KvRtK etji wei`KvR etj |

GKw Wv÷vi hw` tqtS t\_tK tUetji Dci DVtbn nq Zvntj AwfKI`etji wei`KvR nte| tKbbv, G tqtAwfKI`ej th w`tK wqv Kti miY Zvi wecixZ w`tK nq|

MwYvZK D`vniY 4.1 : 70 kg fti i GK e`w<sup>3</sup> 200 m Dpzcwvto AvivniY Kitj wZwb KZ KvR Kiteb?

$$\begin{aligned}
 &\text{Avgiv Rwb,} \\
 &W = F_s \\
 &= 686 \text{ N} \times 200 \text{ m} \\
 &= 1.372 \times 10^5 \text{ J} \\
 &\text{DËi : } 1.372 \times 10^5 \text{ J}
 \end{aligned}$$

$$\begin{aligned}
 &\text{GLvrb,} \\
 &e`w^3 i f_i, m = 70 \text{ kg} \\
 &ej, F = e`w^3 i l Rb = mg \\
 &= 70 \text{ kg} \times 9.8 \text{ m s}^{-2} \\
 &= 686 \text{ N} \\
 &\text{miY, } s = 200 \text{ m} \\
 &\text{KvR, } W = ?
 \end{aligned}$$

4.2 kw<sup>3</sup>

## Energy

kw<sup>3</sup> Qvov tKvbn wKQzPjtZ ev KvR KitZ cvti bv| Avgv` i tetP\_vKvi Rb` kw<sup>3</sup> i cKqvRb nq| cKZwb Avgiv th KvR Kw Zv wbfP Kti Avgv` i KZUKzkw<sup>3</sup> AvtQ Zvi Dci | Avgiv th Lvev LvB Zv t\_tK G kw<sup>3</sup> cvB| Dw`ti i ew`i Rb` kw<sup>3</sup> jvM| tKvbn hšZi KvR Kivi Rb` kw<sup>3</sup> i cKqvRb nq| tKvbn tKvbn hšZi we`yr e`envi Kti Avev tKvbn Rvjwb cyotq kw<sup>3</sup> cvq| Rvjwbi gta` kw<sup>3</sup> mwAZ\_vtK|

kw<sup>3</sup> ejtZ Avgiv Kx eys? kw<sup>3</sup> ejtZ tKvbn e` i KvR Kivi mvg\_K efs\_wK| th e` KvR KitZ mg\_ Zvi gta`B kw<sup>3</sup>\_vtK, th e` KvR KitZ mg\_ Zvi gta` tKvbn kw<sup>3</sup>\_vtK bv|

Avgiv hLb ewj tKvbn e` i gta` kw<sup>3</sup> wbnZ AvtQ, ZLb Avgiv eys e` w Ab` wKQz Dci ej cKqvM KitZ cvti Ges Zvi Dci KvR m`ub KitZ cvti | Avev Avgiv hLb tKvbn e` i Dci KvR Kti\_wK, ZLb Avgiv Zvi Dci KvRi mgcwY kw<sup>3</sup> thvM Kti\_wK|

tKvfbv e` i KvR Kivi mvg\_ŋ nť"Q kw³ | KvR Kiv gvtb kw³ tK GK Ae`v t\_ťK Ab` Ae`vq ăcvšwi Z Kiv | Gi A\_ŋ nť"Q e` wU meŋgU th cwigvY KvR KiťZ cvťi ZvB nť"Q kw³ | thťnZtKvfbv e` i kw³ i cwigvY Kiv nq Zvi ŋviv măubăKvťRi cwigvY t\_ťK, mŹivs kw³ | KvťRi cwigvY Awfbă

AZGe, KZ KvR = e`wqZ kw³

kw³ i tKvfbv w` K tbB | KvťRB kw³ t`<jvi iwkk |

kw³ i GKK | KvťRi GKK GKB Ges Zv nťjv Rj (J) |

kw³ i wewfbăc : wewfbăcKvi KvR Kivi Rb` Avgť` i wewfbăcťi kw³ i cŋqRb nq | thgb cwb Mig KiťZ nťj Zvc kw³ i cŋqRb nq | GKwU ě`jwZK evj | t\_ťK Avgiv Avťjv kw³ cvB | Avgiv th mšMxZ i`wb Zvi gťa` kă kw³ wbnZ AvťQ | tKvfbv e` tK Avgť` i miťZ ev Dcťi DVťZ tčkk kw³ i cŋqRb nq | tKvfbv ě`jwZK hšZťK PjvťZ nťj wějŕ kw³ i cŋqRb nq | Zwor tKvťl iwmvqbK wewpqi gvaťg Avgiv iwmvqbK kw³ cvB | GK UKiv KMR evqy kw³ i KviťY Dťo hvq | hLb cigvYmga tRiov jvťM ev fťŋ0 ZLb wbdKxq kw³ wbmŹ nq |

kw³ AvťQ etjB RMr MmZkxj | kw³ bv \_vKťj RMr APj nťq cote | Avťjv kw³ AvťQ etjB Avgiv t`LťZ cvB, kă kw³ AvťQ etjB Avgiv i`bťZ cvB | hwsZK kw³ i et`šjťZ Avgiv Pjvťdiv KiťZ cwi | wějŕ kw³ i mnvťh` cvLv Njťŋ, Kj Kvi Lvbv Pjťŋ | G gnwětk; kw³ bvbŕăc weivR KiťQ | tgvUvgUfvtē Avgiv kw³ i wbtgăc ăcťjv chŋeŋY Kwi | h\_vŇ hwsZK kw³, Zvc kw³, kă kw³, AvťjvK kw³, tPš^K kw³, wějŕ kw³, iwmvqbK kw³, wbdKxq kw³ Ges tmš i kw³ |

kw³ i meťPťq mvaviY ăc nť"Q hwsZK kw³ | tKvfbv e` i Ae`vb ev MmZi KviťY Zvi gťa` th kw³ wbnZ \_ťK ZvťK hwsZK kw³ etj | GB Abť"Ōť` Avgiv hwsZK kw³ i `jU fMŇ MmZi KviťY th kw³ MmZkw³ Ges Ae`vťbi KviťY th kw³ wefe kw³ Zv wbtq AvťjvPbv Kie |

MmZkw³ : Avgiv wťtKU tLjvq t`LťZ cvB AtbK mgq wťtKU ej ÷văŭťK AvNvZ Kťi ZvťK Dmŋťq wbtq hvq | tKvfbv KvťPi Rvbjvq k³ wKŌ AvNvZ Kiťj KvP tťŋ0 hvq | wXj Ōťo Avg ev eiB ciov hvq | G D`vniY,ťjv t\_ťK t`Lv hvq th, MmZkxj e` i gťa` kw³ \_ťK | tKvfbv MmZkxj e` Zvi MmZi Rb` KvR Kivi th mvg\_ŋjvť Kťi ZvťK MmZkw³ etj |

wbtR Ki : tZvgvi mvgťbi tUwěťi ev tWť`<i Dci GKwU Kjg ivL | Kjťgi mvgťb GKwU nvj Kv e` ivL | KjgwťK H e` i wťK nvZ wťq tUvKv`vl |

e` wU RvqMv t\_ťK mťi tMj tKb? tUvKvi dťj KjgwU MmZkxj nťjv | GťZ Zvi gťa` KvR Kivi mvg\_ŋZ\_v MmZkw³ Rbťj | tm Rb` e` tK miťZ cvij |

tKvfbv w` i e` tZ teťMi mĂvi Kiv Avi MmZkxj e` i teM eŋŕ Kivi A\_ŋť"Q e` wUťZ ZjY mŋŋ Kiv | Avi G Rb` ej cŋqM KiťZ nťe | dťj e` i Dci KvR Kiv nťe | GťZ e` wU KvR Kivi mvg\_ŋjvť Kiťe Ges G KvR e` tZ MmZkw³ wntmťe Rgv \_vKťe | tm KviťY mKj mPj e` B MmZkw³ i AwaKvix | e` w`wZťZ Avmvi cťeŋ cwigvY KvR măubăKiťZ cviťe |

aivhvK, m fťi i GKwU w` i e` i Dci F ej cŋqM Kivq e` wU v teM cŋŔ3 nťjv | aivhvK, G mgq e` wU etj i wťK s`ťZiAwZŋg Kťi | e` wUťK GB teM wťZ KZ KvRB e` i MmZkw³ |

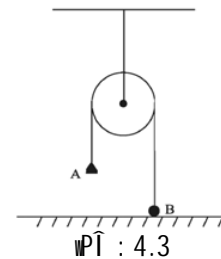


wefe kw<sup>3</sup> : Qv`i Dci t\_`tK GK LÊ cv\_i ev BU tKv`bv e`' i Dci cotj Zv`K P`v`bv Kti tdj`tZ cvti ev tf`to tdj`tZ cvti | cv\_i ev BU hLb Qv`i Dci w`'i wQj ZLb Zvi gta` kw<sup>3</sup> Rgv wQj | cv\_i wU hLb w`bP cto ZLb H kw<sup>3</sup> KvR Kti | cv\_i wU gta` kw<sup>3</sup> w`bwnZ wQj tKbbv GwU fe`p t\_`tK Dcti wQj |

GKwU w`u`stK Uvb Uvb Kti Gi `B gv\_v `wU e`' i mvt\_ AvUtK tQto w`tj Kx nte? e`' Bq Q`U Gtm ci`utii mvt\_ av`v Lvte | Uvb Uvb w`u`st hw`l w`'i Ae`'vq wQj Z\_wc Zvi gta` kw<sup>3</sup> mw`AZ wQj | w`u`stU tQto w`tj GwU KvR Ki`tZ cvti | Uvb Uvb w`u`st -G kw<sup>3</sup> w`bwnZ wQj tKbbv GwU weKZ Ae`'vq wQj |

`vfwek Ae`'vb t\_`tK cwieZB Kti tKv`bv e`' tK Ab` Ae`'v`b ev `vfwek Ae`'v cwieZB Kti Ab` tKv`bv Ae`'vq Avbtj e`' KvR Kivi th mvg\_©ARB Kti Zv`K wefe kw<sup>3</sup> eti |

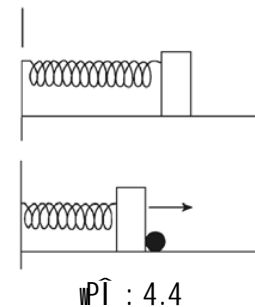
m`u`mwiZ KgKvÊ : GKwU c`ij w`b`q Zvi Dci GKwU `wo cwi`q `vl | `woi GK c`t`SÍ GKwU fvi`x e`' A Ges Aci c`t`SÍ nvj Kv e`' B eva thb A e`' fe`p t\_`tK Dcti Ges B e`' fe`p`o \_v`K (wPÎ : 4.3) | nvZ tQto `vl |



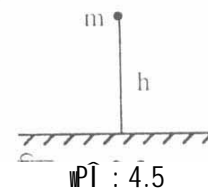
Kx t`L`tZ tctj? A e`' w`bP bvg`to Avi B e`' Dcti DV`tQ | A e`' wU Zvi `vfwek Ae`'vb fe`p t\_`tK Dcti \_vKvi Kv`tY Zvi tfZi KvR Kivi mvg\_©Z\_v wefe kw<sup>3</sup> mw`AZ wQj | GwU fe`p chS-wd`ti AvmtZ KvR Ki`tZ cvti | A\_` B e`' tK Dcti DV`tZ cvti |

cix`Y : GKwU w`u`st w`b`q Gi GK c`t`SÍ GKwU `p Ae`'v`bi mvt\_ AvUKvl Ges Aci c`t`SÍ GKwU eK mshy` Ki | G\_`tjv`K GKwU gmY Ztji Dci `v`cb Ki | GLb eKwU`tZ ej c`t`qM Kti w`u`stU`K msKwPZ Ki Ges eKwU mvg`b Ab` GKwU e`' ivL (wPÎ : 4.4) | GLb nvZ tQto `vl |

e`' wU wQU`K `ti mti tMj tKb? w`u`stU Zvi AvtMi wkw\_j Ae`'v`b wd`ti Avmvi mgq KvR Ki`tZ cvij Ñ Ab` e`' tK miv`tZ cvij | w`u`stU GB th Zvi `vfwek Ae`'v cwieZB Rb` KvR Kivi mvg\_©jvf Kij tmuU Zvi wefe kw<sup>3</sup> | `vfwek Ae`'vb ev Ae`'v t\_`tK cwieZB Kti tKv`bv e`' tK Ab` tKv`bv Ae`'vb ev Ae`'vq AvbtZ hw` tKv`bv etji wei`v`v tKv`bv KvR Kiv nq ZLb e`' wU H cwigvY KvR Kivi mvg\_©jvf Kti A\_` kw<sup>3</sup> m`Aq Kti | GB K\_wU Lv`U msi`YKxj ej h\_v gnvKI`ej, Zwor ej, tP`v`K ej, w`u`st ej BZ`w`i c`fve ejtqi gta` | GB c`fve ejq`K H etji ejt`qÎ ejv nq | thgb gnvKI`qÎ, Zwor t`qÎ BZ`w` | Avgiv hLb fe`p t\_`tK tKv`bv e`' tK Dcti Zvj ZLb AwfKI`etji wei`v`v KvR KwU | dtj H e`' wKQz wefe kw<sup>3</sup> jvf Kti | e`' wU hw` fe`p cto ZLb H cwigvY KvR Ki`tZ cvti |



m fti i tKv`bv e`' tK fe`p t\_`tK h D`PZvq (wPÎ : 4.5) DV`tZ KZ KvRB nt`Q e`' tZ mw`AZ wefe kw<sup>3</sup> i cwigv | Avi G t`qÎ KZ KvR nt`Q e`' i Dci chy` AwfKI`ej Z\_v e`' i l Rb Ges D`PZvi \_Ydtji mgvb |







kw<sup>3</sup>i AwZ cwiwPZ Drm ntjv Kqjv, LwR tZj | cökwZK M'im | fAfŠti Kqjv, tZj ev cökwZK M'im  
cvl qv hvq hv miwmi ev mqvbw cwi tkwaZ Kti Rjw wntmte e'envi Kiv hvq |

Kqjv : kw³i Drm,tjvi gta` Kqjvi cwi wPwZ meŧPtq tewk| Kqjv GKñU `Re c`v\_Ⓢ cw\_extZ GK mgq  
AþbK MwQcvjv wQj | newfbaecñKwZK wechē I ^vfweKfvte MtQi cvZv ev KvÊ gwñI wbŧP Pvcv çto Ges  
RgtZ \_vtK| MtQi cvZv I KvÊ imvqvwbK cwieZŧbi dtj Kqjvq žucvšwi Z nq| Kqjv cyotq miwmwi Zvc  
cvi qv hvq| GñU GKñU AwZ cwi wPZ Ryj wlv| Zte Ryj wlv wntmte e`envi QrovI Kqjv t\_tK eũ cñqvRbxq  
c`v\_®Drcw`Z nq| Gt`i gta` i tqŧQ ŧKvj M`vm, Avj KvZiv, tewÄb, A`vtgwbqv, Ujyqb cñvZ | ivbeKiŧZ  
I ev®uxq BwÄb PujvtZ Kqjv e`euZ nq| AvaybK Kvŧj Kqjvi cäv b e`envi we`yr Drcv`b ŧKŧ`<sup>9</sup>  
Zvcwe`yr ŧKŧ`<sup>9</sup> cäv b Dcrv`b Kqjv|

Kqjv Pwjj Z we`jr Drcv`b tKt>`i cãvb mgm`v nt`Q GwU mjj dv`i i tauqv wBMGY Kti | GB tauqv GwmW ewó i mjo Kti | GB GwmW hw`l Lp`ep, wKŠ` Zv cKti, n` I Lvtj wetj gvQ tgi tdtj, eb ašm Kti Ges cãvb cv`ti tLv`B Kiv KvR bó Kti tdtj |

LwBR tZj : kw³i Ab²Zg cāvb Drm LwBR tZj ev tctUñj qvg| eZgᵛb mf²Vzq tctUñj qrtgi e⁻envi AZ²š-  
e⁻vcK| Mōtgi KtoNi t₊tK i⁻i⁻ Kti AyaᵛbKZg cwienb e⁻e⁻v meᵛB Gi e⁻envi i₊tqQ| tctUñj qvg  
t₊tK wᵇ®<wᵇKZ tZj tctUñj, cvKv iv⁻īvi Dci t₊l qv wCp, tKti wmb l Pvl ver⁻i Rb⁻ e⁻eüZ i vᵛvqᵇbK mvi  
cvl qv hvq| cwientbi Ryj wᵇb wntmte tctUñj i Ryo tbB| tctUñj qvg t₊tK Avti v cvl qv hvq bᵛbᵛb i Kg  
Kwᵗg e⁻ᵗ| G₊tjv ntjv tUwi vj b, cwj tq ÷vi, K⁻vkwj b BZ⁻w | GQvov tctUñj qvg t₊tK ^Zwi nq bᵛbᵛ  
i Kg cāvabx| GZme e⁻envi \_vKv m₊Ēi Gi gj e⁻envi Ryj wᵇb wntmte| tctUñj qvgRvZ mvgMbi cāvb  
e⁻envi ntjv Zwor l hvišZK kw³ Drcv⁻b| tctUñj qvg GKw j⁻wᵇb kā| Guᵇ ^Zwi ntqQ tctUñj l Awj qvg  
wgtj | j⁻wᵇb fvlvq tctUñj ktāi A₊cv\_i Ges Awj qvg ktāi A₊Zj | mZivs tctUñj qvg ntjv cv\_tii tZj A₊  
cv\_tii gta⁻ mᵛĀZ tZj | Uvᵛkwᵛi h₊M A₊ AvR t₊tK cᵛP Qq tKwᵇ eQi AvtM mgt⁻i Zj t₊tK cvjwj K wᵇjvi  
⁻īti ⁻īti Mᵇcvjv l mvgv⁻ K cāv⁻ Pvcv cto hvq| vevf bᵇv vᵛvqᵇbK cwi eZᵇbi dtj Giv ᵗcvšwi Z nq LwBR tZj |  
AvRtKi ⁻j fctMi A₊tᵇKusk cāvMvZnmK h₊M mgt⁻i Zj t₊tK wQj |

c0KwZK M'vm : c0KwZK M'vm kw<sup>3</sup>i GKwU cwuPZ Drm| wełKl Kti ejsjv`tk c0KwZK M'vfm e`envi e`vcK| Dbz t`k\_tjvZl c0KwZK M'vfm e`envi Lp tenk| wefbooki KviLvbiq Gi e`envi i`qtQ| Gi e`envi c0vbZ Rjvwb wntmte| ejsjv`tk i`vbi KvR Gi e`vcK e`envi i`qtQ| GQovvl e`envi i`qtQ A`bK mvi KviLvbiq| M'vfm mwnth` Zvckw<sup>3</sup> Drcw`Z nq Ges Zv t`K Zvc we`jr tKt`^a Drcw`Z nq we`jr|

c0KwZK M'vm cvl qv hvq fMf<sup>0</sup>t\_tK | mMfxi Ke Lbb Kti fMf<sup>0</sup>t\_tK G M'vm DtEj b Kiv nq | c\_w\_xi  
AfŠti cDÊ Zvc I Pvc G ai†Yi M'vm mYoi gj KviY | t†tUwj qvg Ke t\_tK | c0KwZK M'vm cvl qv hvq |  
c0KwZK M'v†mi c†vb Dcv' vb w†\_b M'vm | GB mKj kw<sup>3</sup>tK Rxev† kw<sup>3</sup> ejv nq |

Dcti kw<sup>3</sup>i th wZbwU Drm mæutK<sup>®</sup>AvtjvPbv Kiv ntjv gvb|li kw<sup>3</sup>i Pwn`v epxi dtj G<sub>3</sub>tjv Lp`Z dwtq  
Awtq| cw<sub>exi</sub> eZgvb tFZ Ae`v hv ZvtZ Kti G mKj Drm thgb Kqjv, LwbR tZj, cKwZK M`vm Avi  
bZb Kti mw<sub>o</sub> nlqvi bq Gt`i tK AbervqbtwM` kw<sup>3</sup> ejv nq| dtj kw<sup>3</sup>i weKí Drtmi w`tK StKtQ  
gvb| G mKj kw<sup>3</sup>i wecixtZ weKí th mKj Drm e`envtji w`tK gvb| AvKó nt`Q Zvi gta` tmsíkw<sup>3</sup>,

cmb cēvn t\_ŕK cŕB kw³, tRqvī ŅfvUv kw³, fĀZvcxq kw³, evqykw³, evtqvgvm BZ`w` Drm,tjv cāvb | G Drm,tjv cŕ`ŕ ev cŕivŕfvte mŕhP Dci wbfPkvj | hZw`b cŕ\_ex mŕhP Avtjv tctZ \_vKte ZZw`b chS-G mKj Drm t\_ŕK kw³i mieivn cvl qv mæe nte | ZvB GB mKj DrmŕK bevgbŕhM` kw³i Drm ejv nq |

tmŕi kw³ : mŕhŕ\_ŕK th kw³ cvl qv hvq ZvŕK etj tmŕi kw³ | Avgiv Rwb mŕhMkj kw³i Drm | cŕ\_extZ hZ kw³ AvtQ Zvi cŕq meB tKvŕbv bv tKvŕbvfte mŕhŕ\_ŕK Avmv ev mŕhMkiY e`eüZ ntqB ^Zwi ntqŕQ | thgb AvaybK mF`Zvi avi K Rxevkŕ Ryjwlb (Kqjv, LwbR tZj, cŕKwZK M`vm) Avmtj eü w`ŕbi mwĀZ tmŕi kw³ |

cŕPxbKvj t\_ŕK gvbl mŕhMkiYŕK mivmwi e`envi KiŕQ tKvŕbv wKQz`i Kvŕbvi KvŕR | eZŕvŕb mŕhP kw³ŕK memgq e`envŕi i Rb` gvbl bvbvb iKg Dciq Aeja`b KiŕQ | tjY ev `cŕYi mivnŕh` mŕhŕi wKŕK AwfMvi x Kŕi Av\_b Ryjvŕbv hvq | mŕhMkiYŕK avZe cŕZdjŕKi mivnŕh` cŕZdj Z Kŕi ^Zwi nq tmŕi Puj | G Puj tZ i vbeKiv hvq |

Kŕi t`L : 15 cm ev 20 cm tdivKvm`ŕZj GkŕU AeZj `cŕY bvl | `cŕYwŕK mŕhP w`ŕK gŕ Kŕi ai | Kwŕŕi UkiwU nvŕZ wŕtq `cŕYi mivnŕh` Kwŕŕi Dci mŕhŕjvK tK`ŕfZ Ki | Gfvte Kwŕŕi UkiwUŕZ Av\_b bv Ryjv chSĀ aŕi \_vK |

tmŕi kw³ŕK kŕZi t`ŕk Niemo Mig Kivi KvŕR e`envi Kiv nq | km`, gvQ, mewR`i Kvŕbvi KvŕR tmŕi kw³ e`eüZ nq | gvQ`i wKŕq`i wK ^Zwi Kŕi Zv eüw`b mŕiŕY Kiv hvq | tmŕi kw³i Avtjv D`vniY nt`Q Ņ tmjvi lqvUvi wUvi, tmjvi Kkvi BZ`w` |

AvaybK tKŕkj e`envi Kŕi ^Zwi ntqŕQ tmŕiŕKvl | tmŕiŕKvl i`ewkŕ` ntjv Gi Dci mŕhP Avtjv cotj G t\_ŕK mivmwi Zwor cvl qv hvq | tmŕiŕKvl i bvb iKg e`envi iŕqŕQ |

- 1 | Kwĭg DcMŕn Zwor kw³ mieivŕni Rb` G tKvl e`eüZ nq | G Rb` Kwĭg DcMŕ eüw`b aŕi Zvi Kŕŕct\_ NyŕZ cvŕi |
- 2 | wevfbeBtj KUwbK hŕ\_cwZ thgb cŕKU K`vj KŕjUi, cŕKU tiwŕl, Btj KUwbK Nwo tmŕi kw³i mivnŕh` Pujvŕbv nt`Q |
- 3 | eZŕvŕb Avgv`i t`ŕkl tmŕi kw³i mivnŕh` AtbK Mŕtg, evmv-ewo ev Awdŕm we`jr kw³ Drcv`b Kŕi we`jŕZi Pwv`v tgUvŕbv nt`Q |

tmŕi kw³ e`envŕi i mŕeav ntjv G kw³ e`envŕi cwŕtek`ŕŕYi mæebv Kg | G kw³ e`envŕi wect`i Avk¼v tbB ejtjB Pŕj | tmŕi kw³i mnmv wŕttkl ntq hvl qvi tKvŕbv mæebv tbB | G kw³i ZvB cŕPuj Z kw³ Drm Rxevkŕ Ryjwlb i weKĭ wntmte e`envŕi i mæebv Lp tewk |

Rjwe`jr (hwiŕ\_K kw³i ŕŕcŕŕi)

cmb bevgbŕhM` kw³i Ab`Zg Drm | cmbi tmŕZ l tRqvī ŅfvUvŕK e`envi Kŕi kw³ Drcv`b Kiv hvq | cēwnZ cmbi tmŕZ wevfbe aiŕbi kw³ AvtQ thgb MwZkw³ l wefe kw³ | cmbi cēvn ev tmŕZŕK KvŕR jwŕtq th Zwor ev we`jr Drcv`b Kiv nq ZvŕK ejv nq Rjwe`j | cŕ\_exi wevfbeŕ`ŕki Rjwe`j cŕKŕi Rjwe`j Drcv`ŕbi Rb` wefe kw³ e`envi Kiv nq | cēwnZ cmbi tmŕZŕK e`envi Kŕi we`jr Drcv`ŕbi cŕuqwu mnR | cmbi tmŕZi mivnŕh` GkŕU UveŕBb tNviŕbv nq | GB Uveŕŕbi NYŕ t\_ŕKB GLvŕb hwiŕ\_K kw³ l tPŕa`Kkw³i mgŕ`q NUvŕbv nq |

cēwnZ cwbī tmtZ t\_ŋK hws\_ŋK kw³ msMōh Kti tPš^K kw³i mgs^ŋq Zwor Drcv`b Kiv nq etj G

gŋWj ^Zwi : cošf cwbī kw³ŋK KvŋR jwMŋq  
UveŋBb Nyi ŋq GKwU Wqbvtgv Pwj ŋq Rjwe`jr  
Drcv`b tKt`ŋ GKwU gŋWj ^Zwi Ki | wPŋ :  
(4.6)|



aiŋYi ZwoŋZi bvg Rjwe`jr | Avgvŋ`i t`ŋK KvŋBv we`jr Drcv`b tKt`ŋ cwbī wefe kw³ŋK e`envi Kti  
we`jr Drcv`b Kiv nq |

b`x ev mgŋ`ŋ cwbī tRvqiŋŋfvi kw³ŋK e`envi i cŋPóv gvb | eūw`b t\_ŋK Pwj ŋq hvŋ`Q | tRvqiŋŋfvi  
kw³ŋK KvŋR jwMŋq wefboŋš\_ Pj bvi e`vciwU AŋbKw`b AvŋMB D`mweZ ntqŋQ |

dtY tRvqiŋŋfvi kw³i mrvŋth` Zwor kw³ cŋKŋ mdj Zvi mvŋ\_ KvR KiŋQ | eZŋvŋb cū\_exi wefboŋ`ŋk  
tRvqiŋŋfvi kw³ŋK KvŋR jwMŋq Zwor Drcv`b tbi tPóv Pj ŋQ |

evqykw³ : cū\_ex cŋi Zvcgŋvi cū\_ŋK`i KvŋY evqycēwnZ nq | evqycēwnRwbZ MwZkw³ŋK Avgiv hws\_ŋK  
ev Zwor kw³ŋZ ŋcŋšw Z KiŋZ cwi | kw³ ŋcŋšŋi Gŋc hš\_ŋK evqKj etj | evqycēwnŋK KvŋR jwMŋq  
cŋPxbKŋtj gvbŋi v Kgv t\_ŋK cwb tZvjv, Rvnr Pjvŋb BZ`w` KvR m`uv`b KiŋZv | tšKvq cvj Zŋj  
AvRi evqykw³ŋK KvŋR jwMŋq nq | eZŋvŋb cū\_ŋK e`envi Kti evqKj KvŋR jwMŋq Zwor Drcv`b Kiv  
nt`Q |

fŋZvcxq kw³ : fŋAF`šŋi ZvcŋK kw³i Drm wntmte e`envi Kiv thŋZ cvŋi | fŋAF`šŋi Mfxŋi Zvŋci  
cwi gY GZ tēw th Zv kxjvLŋŋK Mj ŋq tŋjŋZ cvŋi | G Mj Z kxjvŋK g`wgv etj | fZwŋŋK cwi eZŋbi  
dtj KLŋb KLŋb GB g`wgv Dcŋi w`ŋK DŋV Avŋm hv feŋi LwbK wŋP Rgv nq | G mKj RvqMv nU  
`ūU (Hot spot) bŋg cwi wPZ | f-Mf` cwb G nU `ūŋUi ms`ŋŋGŋm evŋ`ū cwi YZ nq | GB evŋ` fŋMŋf`  
AvUKv cŋo hvq | nU `ūŋUi Dci MZ`Kŋi cvBc XwKŋq D`P Pŋŋc GB evŋ`ŋK tei Kti Avb hvq hv w`ŋq  
UveŋBb Nyi ŋq we`jr Drcv`b m`e | wŋDwRj`ŋŋ G i Kg we`jr Drcv`b tKt`ŋ AvŋQ |

evŋqvgm kw³ : tmsi kw³i GKwU ŋŋ`fMsk hv meR MvQcgv ŋv v mŋjvK mŋkŋY cū\_qvq i mŋqwbK kw³ŋZ  
ŋcŋšw Z ntq evŋqvgmŋŋc MvQcgv wefboŋ Astk gRy `vŋK | evŋqvgm ejŋZ tmB me `Re c`v\_ŋK eŋvq  
hvŋ`ŋK kw³ŋZ ŋcŋšw Z Kiv hvq | gvbŋm AŋbK cŋYx Lv` wntmte evŋqvgm MōY Kti ZvŋK kw³ŋZ  
ŋcŋšw Z Kti Rxeŋbi Kgŋvŋ mPj iŋL | evŋqvgmŋK kw³i GKwU eūgŋx Drm wntmte weŋPbv Kiv hvq |  
`Re c`v\_ŋŋn hvŋ`ŋK evŋqvgm kw³i Drm wntmte e`envi Kiv hvq tm\_jv nt`Q MvŋŋMvŋx, Rjv wŋ Kw,  
Kvŋvi eR, km, avŋbi Zŋ I Kzv, j ZvŋcvZv, ci cwiLi gj, tcŋi eR`BZ`w` | evŋqvgm cūvZ Kveŋ I  
nvŋŋWŋRb ŋv v MwZ | bevqŋŋwM` kw³i Ab`Zg Drm evŋqvgm |

evŋqvgm t\_ŋK mŋR Drcv`b Kiv hvq evŋqvgm | G M`m Avgiv cŋKwZK M`vŋmi weKŋ wntmte iŋvŋi KvŋR  
GgbwK we`jr Drcv`b tbi KvŋRI e`envi KiŋZ cwi | Gi Drcv`b c`wZŋI tek mŋR | GKwU Aveŋ cŋŋi

gta" tMveI l cwbi wgiŕ 1 t 2 AbcvtZ tiŕL cPřbv ntj evqM'vm Drcbæq| hv bŕji mrvŕh" tewiŕq Avŕm| G M'vm ivbwi KvŕR e"envi Kiv hvq| 4/5 Rŕbi GKw cwi evŕii ivbŕeI ewZ Ryjvŕbvi M'vŕmi Rb" 2/3 wJ Mi"i tMveI B hŕ\_ó|

wbDKxq kw<sup>3</sup> : wbDKxq wewuqvq Drcbækw<sup>3</sup> e"envi Kŕi wējŕ Drcv`b Kiv hvq| th wbDKxq wewuqvq cŕŕB kw<sup>3</sup>ŕK wējŕ Drcv`b e"envi Kiv nq tmb wewuqvŕK ejv nq wbDKxq wdkb| GŕZ BDŕiwbqvŕgi mŕŕ\_ wŕw`ŕ kw<sup>3</sup>i wDUŕŕbi wewuqv NUŕbv nq| wbDKxq Pj ŕŕZ GB wewuqv NUŕbv nq|

wbDKxq wewuqvq mŕaviYZ c`v\_ŕZ\_v fi kw<sup>3</sup>ŕZ ŕŕcŕŕŕi Z nq| Aek" wbDKxq wewuqvq tgvU fŕii tKej GKwU ŕŕi`fMŕsk kw<sup>3</sup>ŕZ ŕŕcŕŕŕi Z nq| c`v\_ŕkw<sup>3</sup>ŕZ ŕŕcŕŕŕi Z ntj hw` E cwi gvY kw<sup>3</sup> cvl qv hvq, Zvntj

$$E = mc^2$$

GLŕŕb m nt"Q kw<sup>3</sup>ŕZ ŕŕcŕŕŕi Z fi Ges

c nt"Q Avŕjvi teM hv  $3 \times 10^8 \text{ m s}^{-1}$  Gi mgvb|

cixŕŕv Kŕi ŕ`Lv tMŕQ GKwU wdkb wewuqvq A\_ŕ GKwU wŕw`ŕ kw<sup>3</sup>i wDUŕb hw` GKwU BDŕiwbqvq

wbDKxqvŕŕK AvNvZ Kŕi Zvntj cŕŕ

$$200 \text{ Mev} = 200 \times 10^6 \text{ ev} = 200 \times 10^6 \times 1.6 \times 10^{-19} \text{ J} = 3.2 \times 10^{-11} \text{ J} \text{ kw}^3 \text{ wBMZ}$$

nq| thŕnZwdkb wewuqv GKwU k;Lj wewuqv, gŕŕZŕP gŕa" tKwU tKwU wewuqv msNwUZ nq Ges wecj cwi gvY kw<sup>3</sup> wBMZ nq|

wŕmve Ki : 1 kg e`ŕ tK hw` mŕuYŕŕc kw<sup>3</sup>ŕZ ievŕŕŕi Z Kiv mŕe ntZv, Zvntj KZ wKŕjvl qvU NŕUv kw<sup>3</sup> DrcbæŕZv? 1 wKŕjvl qvU NŕUv (1kWh) =  $3.6 \times 10^6 \text{ J}$

GB wewuqvq cŕŕB kw<sup>3</sup>ŕK wŕqvŕŕZ Dcvŕq D"P Přŕci Kveŕ WwB A. vBW M'vŕmi Af`ŕŕŕY kw<sup>3</sup> wŕŕŕte wŕievŕQbŕŕte cvŕu Kŕi Ab" cvŕŕŕ tŕlqv nq| GB DĚŕB M'vm GKwU wŕŕkl evŕu eqjvŕii PřŕcŕŕKŕNŕi eqjvŕii wŕZŕii evŕuŕK DĚŕB Kŕi hv UveŕBb Nyiŕq wējŕ Drcv`b Kŕi| wbDKxq wewuqvq GK Ub BDŕiwbqvq tŕŕK th kw<sup>3</sup> cvl qv hvq Zv`k j ŕŕ Ub Kqv vŕŕŕŕŕ cvl qv kw<sup>3</sup>i mgvb|

wKŕŕ' wbDKxq wējŕ Drcv`b tKŕŕ`ŕ AŕŕK Amŕeav AvŕQ| wbDKxq Ryjwŕi eRŕ AmZgvŕŕv tZRŕŕŕ Ges GB eRŕŕK wŕivŕŕ cwiYZ KiŕZ nvRvi nvRvi eŕi aŕi mŕi ŕŕY KiŕZ nq| Gŕvov wbDKxq Pj ŕŕZ D"P Zvcgvŕŕv l Přc`Zwi nq| ZvB GŕK Ggb c`v\_ŕŕŕŕŕ ŕŕŕ KiŕZ nŕe thb Zv mn" KiŕZ cvŕi| tKŕŕbv`Nŕbv th KZ gvivZŕK Zv Avgiv tŕwŕŕŕŕZ BDŕbqvŕbi (eZŕŕŕb BDŕŕŕbi) tPŕŕŕwŕj Ges Rvcŕŕbi dKŕkgv Gi AwfÁZv tŕŕK Rwb| Zŕe wbDKxq wējŕ Drcv`b cwiŕŕŕk wŕw` nvDm M'vm Kg Drcbæq|

bevqbŕhŕM" kw<sup>3</sup>i mŕgvŕRK cŕŕve l mŕeav : Avgŕŕi mŕgvŕRK Rŕŕb bevqbŕhŕM" kw<sup>3</sup> e"envŕii mŕŕŕ cŕŕvi cŕŕve iŕŕŕQ| Avgŕŕi tŕŕk Pŕm`vi Zj bvq cŕKwZK kw<sup>3</sup> thgb Kqvŕ, LŕbR tŕZ l cŕKwZK M'vŕmi gRŕ AwZ bMY" ZvB Avgŕŕi kw<sup>3</sup>i cŕŕqvRb tgvŕŕZ Agj" ŕŕŕŕŕK gŕŕ e`q Kŕi wŕŕk tŕŕK LŕbR tŕZ, Kqvŕ Avg`wb KiŕZ nq| wKŕŕ' Avgŕŕi tŕŕk th mKj bevqbŕhŕM" kw<sup>3</sup>i Drm iŕŕŕQ tŕŕŕŕ wŕŕkl Kŕi evŕqM'vm Drcv`b l e"envŕi cŕŕŕŕŕŕŕi gŕbŕŕŕK Dŕŕŕŕ KiŕZ cvŕŕj mŕŕŕB Avgŕŕi cŕŕŕŕŕŕŕi tPŕvŕv e`ŕŕŕ tŕŕ qv mŕe nŕe|

evqKj e`envi Kti we`jr Drcv`tbi w`tKl Avgiv bRi w`tZ cwi | Mtel Yvi gva`tg tmši kw³i e`envi mj f  
Ki tZ cvi tj Avgi` i kw³i hveZxq c᎐qvRb Adi š-G Drm t`tK tgUvfbv m᎐e nte |

bevqbthw᎐ kw³ e`envi i c᎐vb mjeavB nt`QNG Drm tkI ntq hvl qvi Avk¼v tbB | ZvQvor cwi tek` tYi  
nvZ t`tK t` ktk evPvfbv m᎐e nte |

## 8.8 kw³i ᎐cviš

### Transformation of energy

kw³ Ani n GK᎐c t`tK Ab`᎐c ᎐cviš Z nt`Q | G gnwetk| bvbv NUbv c᎐vn Pj tQ kw³i ᎐cviš AvtQ etj |  
kw³ GK᎐c t`tK GKwaK᎐c ᎐cviš Z ntj | gnwetk| tgvU kw³ fvEvti tKvfbv cwieZ᎐ nt`Q bv |

gvb| , Kw᎐DUvi wKsev tKvfbv hš`tK tKvfbv KvR Ki tZ ntj wKsev tKvfbv c᎐qv ev cwieZ᎐ mvab Ki tZ  
ntj kw³i ᎐cviš i c᎐qvRb nq | GK᎐ci kw³ tK Ab` ᎐ci kw³ Drcv`tbi e`envi Kiv th tZ cvi |  
cKZct᎐, GK᎐ci kw³ mviv᎐YB Ab`v᎐᎐ci kw³ tZ cwieZ᎐ nt`Q | GwUB kw³i ᎐cviš wntmte  
cwi wPZ | hLb tKD wUvi evRvq ZLb Kx nq? wíxi nvZi Avtj i tciw kw³ K᎐vgb Zv i hws`K kw³ tZ  
᎐cviš Z ntq hv mgaj wgdwRK᎐c k᎐ kw³ tZ ᎐cviš Z ntq Avgi` i Kvfb c᎐ek Kti | hLb Kw ev Lwo  
tcvovfbv nq, ZLb ivmivbK kw³ g᎐ nq Ges Zv Zvc I Avtj vK kw³ tZ ᎐cviš Z nq | GKw Zvor tKv i  
Af`š i ivmivbK w᎐qv NtU Ges GB mKj w᎐qv ivmivbK kw³ Zvor kw³ tZ ᎐cviš Z nq hv bvbwea  
KvR e`euZ nq |

GK᎐ci w᎐`᎐ cwi gvY kw³ Ab`᎐c ᎐cviš Z Ki tj KZUKi kw³ cvlqv hvte? kw³i wB`Zv ev  
msi ᎐YKxj Zv bwiZ t`tK Zv Rv bv hvq | kw³ hLb GK᎐c t`tK Ab`᎐c cwieZ᎐ nq ZLb kw³i tKvfbv ᎐q  
nq bv | GK e` th cwi gvY kw³ nvivq Aci e` wK tmB cwi gvY kw³ jvf Kti | cKZct᎐ Avgiv bZb  
tKvfbv kw³ m᎐ Ki tZ cwi bv ev kw³ a᎐mI Ki tZ cwi bv | A`᎐ wetk| mvwMK kw³ fvEvti tKvfbv  
Zvi Zg` NtU bv | G wek| m᎐i c᎐g g᎐Z`th cwi gvY kw³ wQj AvRI gnwetk| tmB cwi gvY kw³ eZ᎐b |  
GUvB kw³i Awebk| Zv ev wB`Zv ev msi ᎐YKxj Zv |

kw³i msi ᎐YKxj Zv bwiZ : kw³i m᎐ ev wevk tbB, kw³ tKej GK᎐c t`tK Aci GK ev GKwaK᎐c  
cwieZ᎐ ntZ cvi | gnwetk| tgvU kw³i cwi gvY w᎐`᎐ I AcwieZ᎐xq |

kw³i ᎐cviš : Avgiv AvtMB wewfbecKvi kw³i K\_v etj wQ tm`tjv mKtjB ci`uti i mvf\_ m᎐wKZ | A`᎐  
tKvfbv GKUv t`tK Ab`UvZ cwieZ᎐ m᎐e | G cwieZ᎐K kw³i ᎐cviš etj | Avtj c᎐q c᎐Z`K c᎐KwZK  
NUvfbK kw³i ᎐cviš wntmte aiv th tZ cvi | w᎐P kw³i ᎐cviš i KtqKw D`vni Y`l qv ntjv :

1 | hws`K kw³i ᎐cviš : nvZ nvZ NI tj Zvc Drcv`tbi Gt᎐t᎐ hws`K kw³ Zvc kw³ tZ ᎐cviš Z nq |  
Kj tgi Lwj g᎐L d᎐v tj hws`K kw³ k᎐ kw³ tZ ᎐cviš Z nq | cw᎐ hLb cvvvo ce᎐Zi Dcti `vK ZLb  
Zv tZ wefe kw³ m᎐ÁZ `vK | GB cw᎐ hLb Sibv ev b`᎐c Dci t`tK w᎐P tb t᎐ Avtm ZLb wefe kw³  
MwZkw³ tZ cwiYZ nq | GB cw᎐ c᎐vni mvvth` PvKv N᎐i t᎐ we`jr Drcv`tbi Kiv nq | Gfite hws`K kw³  
Zvor kw³ tZ ᎐cviš Z nq |







$$1 \text{ W} = \frac{1 \text{ J}}{1 \text{ s}} = 1 \text{ Js}^{-1}$$

I qvU Lp tQvU GKK nI qvq AþbK mgq Gi tPtq nvRvi ,Y eo GKK wKtjvI qvU e`envi Kiv nq|

1 wKtjvI qvU = 1000 I qvU

Zug nqtZv KLbI Ak! ŕlgZvi K\_v i`tb \_vKtZ cvi | AvþM ŕlgZvi GB GKKwU e`envi Kiv ntZv| GLbI AþbK mgq Mmo ev tgvUti i ŕlgZv eþvþbvi Rb` GwU e`envi Kiv nq|

1 Ak! ŕlgZv = 746 I qvU|

Zug wK wKtjvI qvU NÈvi K\_v i`tbþQv? GwU Kx eþvq? Avmtj GwU KvR ev kw³i GKwU GKK| Avgiv ewo Ni Kj Kvi Lvþv BZ`w tZ e`eüZ w`jr kw³i w`jr wj GB GKtK cwi tkva Kti \_wK| GK wKtjvI qvU NbUv ejtZ eþvq GK wKtjvI qvU ŕlgZvm`ubæKvþbv hšZ GK NÈv aþi KvR Kiti th kw³ e`q nq Zv| tKvþbv ewZi Mvtq 60 I qvU tj Lv \_Kvi A\_ŕ ewZwU cãZ tmtKtÛ 60 Rj Zwor kw³tK Avtjv I Zvc kw³tZ žvcšwi Z Kti |

tKvþbv e`jZK cvlqvi t÷kþbi ŕlgZv 200 tgmIqvU ejtZ eþvq H cvlqvi t÷kbwU cãZ tmtKtÛ 20000000 Rj Zwor kw³ mieivn KitiQ| G Zwor kw³ Avgiv ewo Ni, Kj Kvi Lvþv I Awdm Av`vj tZ e`envi KiwQ|

MwYwZK D`vniY 4.4 : 70 kg fti i GK e`w³ cãZwU 25 cm DPz30wU wmo 15 s -G DVtZ cvtib| Zvi ŕlgZv KZ? ( $g = 9.8 \text{ ms}^{-2}$ )

Avgiv Rwb,

$$\begin{aligned} P &= \frac{KvR}{mgq} = \frac{Fs}{t} \\ &= \frac{686 \text{ N} \times 7.5 \text{ m}}{15 \text{ s}} \\ &= 343 \text{ W} \end{aligned}$$

DÈi : 343 W

GLvþb,

e`w³i fi,  $m = 70 \text{ kg}$

ej,  $F = e`w³i \text{ I Rb} = mg$

$$= 70 \text{ kg} \times 9.8 \text{ ms}^{-2}$$

$$= 686 \text{ N}$$

miY,  $s = 30 \times 25 \text{ cm} = 750 \text{ cm}$

$$= 7.5 \text{ m}$$

mgq,  $t = 15 \text{ s}$

ŕlgZv,  $P = ?$

Kti t`L : tZvgvi t`<tji ev ewmvi ev tKvþbv `vjvþbi Qvþ` I Vvi wmo i msL`v MYbv Ki | cãZwU wmo i D`PZv t`<tji mivnþh` wBYŕ Ki | Gi t`tK Qvþ` i D`PZv KZ wgvUv wBYŕ Ki | Itqu tgmktþbi mivnþh` tZvgvi fi KZ wKtjwMŕg Zv wbbŕ Ki | tZvgvi fiþK 9.8 w`tq ,Y Kiti tZvgvi I Rb KZ wBDUb Zv cvte| Gi ci Zug t`sto Qvþ` i Dci IV| ÷c I qvþPi mivnþh` Qvþ` I Vvi tgvU mgq wBYŕ Ki |

tZvgvi KZ KvR nte tZvgvi I Rb  $\times$  tgvU D`PZv|

tZvgvi ŕlgZv nte tZvgvi tgvU KZ KvR  $\div$  tgvU mgq A\_ŕ  $\frac{KZ \text{ KvR}}{\text{tgvU mgq}} |$

tZvgvi eÜþ` i mvt\_ wbtq GB KgRvÈwU cwiPvjbv Ki Ges Zvþ` i mvt\_ tZvgvi ŕlgZv Zjþv Ki | tZvgvi Krtki metPtq ŕlgZvevb wKŕv\_ŕwU tK?

4.6 Kg<sup>⊙</sup>ŒZv

## Efficiency

kw<sup>3</sup> ʒcʒŒŒi mnvqZvq Avgiv ˆˆbˆb RxeŒbi cŒqvRb tgvUvB | thgb tctŒŒj mwÄZ imvqubK kw<sup>3</sup> MwZkw<sup>3</sup>ŒZ ʒcʒŒŒi gvaˆtg Avgiv BwÄb PjvŒZ cwi | kw<sup>3</sup>i msi ŒYKxj Zv bmxZ AbyvŒi tKvŒv BwÄb ŒŒK tmB cwi gvY kw<sup>3</sup> Avgvˆi cvl qv DvPZ th cwi gvY kw<sup>3</sup> BwÄb cŒ È nq | wKSˆ GUv Œ Lv hvq th cwi gvY kw<sup>3</sup> BwÄb cŒ È nq meˆvB Zvi tPŒq Kg cwi gvY kw<sup>3</sup> jvf Kiv hvq | GwU cŒvbZ nq GB KvŒY th BwÄb NIŒ etji weiˆŒ th KvR KiŒZ nq, Zv Zvc kw<sup>3</sup>ʒŒc AcPq nq | BwÄb ŒŒK th cwi gvY kw<sup>3</sup> cvl qv hvq ZvŒK jf KvŒŒi kw<sup>3</sup> etj | GŒŒŒ kw<sup>3</sup>i mgxKiY ˆwovq :

$$cŒ È kw^3 = jf KvŒŒi kw^3 + AbˆfŒe eˆwqZ kw^3 |$$

tKvŒv hŒŒi Kg<sup>⊙</sup>ŒZv ejŒZ eŒvq, hŒŒ th cwi gvY kw<sup>3</sup> cŒvb Kiv nq Zvi KZ Ask KvŒŒi kw<sup>3</sup> wŒŒŒe cvl qv hvq | mŒZivs, Kg<sup>⊙</sup>ŒZv ejŒZ tgvU th KvŒŒi kw<sup>3</sup> cvl qv hvq Ges tgvU th kw<sup>3</sup> Œ lqv nŒŒŒQ Zvi AbyvŒŒK eŒvq | GŒK mvaviYZ kZKiv wŒŒŒe cŒvK Kiv nŒŒŒ \_vŒK |

$$Kg^{\odot}ŒZv, \eta = \frac{jf KvŒŒi kw^3}{tgvU cŒ È kw^3} \times 100 \% \quad (4.5)$$

GKwU mvaviY weˆjŒ Drcvˆb tKŒˆ, AŒbK avŒc kw<sup>3</sup>i ʒcʒŒŒ NŒU | GB ʒcʒŒŒ Kqjv, ŒZj, cŒKwZK Mˆvm ev BDŒwovq ŒŒK i iˆ KŒi weˆjŒ kw<sup>3</sup> cvl qv chŒ-PjŒZ \_vŒK | Œ Lv ŒŒŒQ kw<sup>3</sup>i GB ʒcʒŒŒmgŒni ŒŒŒŒ cŒ È kw<sup>3</sup>i cŒq 70 % chŒ-AcPq nq Ges Zvc kw<sup>3</sup>ʒŒc nwi Œq hvq |

cŒ È kw<sup>3</sup>i tKej 30 % Œkl chŒ-eˆenviŒwM Zwor kw<sup>3</sup>ŒZ ʒcʒŒŒ Z nq | mŒZivs Avgiv ejŒZ cwi th Drcvˆb tKŒˆ Œ Kg<sup>⊙</sup>ŒZv gvŒ 30 % |

MwYwZK DˆviY 4.5 : GKwU 50 N lRŒbi eˆˆ ŒK 5 m DˆPZvq DVŒvbi Rbˆ GKwU eˆˆwZK tgvUi eˆenvi Ki nŒjv | GwU 65 J Zwor kw<sup>3</sup> eˆenvi KŒi |

(K) tgvUi KZŒ AcPqKZ kw<sup>3</sup>i cwi gvY KZ?

(L) tgvUŒi Kg<sup>⊙</sup>ŒZv KZ?

$$(K) GLvŒb eˆwqZ kw^3 = KZ KvR = ej \times miY = lRb \times D^{\circ}PZv$$

$$= 10 \text{ N} \times 5 \text{ m}$$

$$= 50 \text{ J}$$

$$mŒZivs AcPqKZ kw^3 = mieivn KZ kw^3 \text{ ŒeˆwqZ kw^3}$$

$$= 65 \text{ J} - 50 \text{ J}$$

$$= 15 \text{ J}$$

$$(L) Kg^{\odot}ŒZv, \eta = \frac{jf KvŒŒi kw^3}{tgvU cŒ È kw^3} \times 100 \%$$

$$= \frac{50 \text{ J}}{65 \text{ J}} \times 100 \%$$

$$= 76.92 \%$$

## AbjñÜvbÑ 4.1

ŕmno ŕ`tq t`što D†V ŕkŕŕ\_v\_ŕŕ ŕlgZv ŕbbŕ|

D†I k` : ŕlgZv ŕbYŕ Ges ŕb†Ri ŕewfbømg†q cŕŕqMKZ ŕlgZvi Zj bv Ges Acti i ŕlgZvi m†\_ Zj bv|

hš¿cwZ : \_vgv Nŕo|

K†Ri aviv :

1. GKŕŕ ŕ`vj vb ŕWK Ki (ŕZbZjv t\_†K QqZjvi g†a` n†j f†jv nq)| tŕŕŕ tZvgvi ŕ`<j , evmŕ ev th tK†bv feb n†Z c†i |
2. GB ŕ`vj†bi Q†` DVvi ŕmŕoi mSL`v MYbv Ki |
3. GKŕŕ ŕmŕoi D`PZv t`<†j i mŕv†h` ŕbYŕ K†i Z†K ŕmŕoi mSL`v ŕ`tq \_Y K†i Q†` i tgvU D`PZv ŕbYŕ Ki |
4. GKŕŕ I†qU tgv††bi (I Rb gvcvi hš¿) mŕv†h` tZvgvi fi ŕbYŕ Ki |
5. Zŕg hZ tR†i c†iv t`što Q†` i Dci I V|
6. \_vgv Nŕoi mŕv†h` Q†` I Vvi mgq ŕbYŕ Ki |
7. Gi ci Zŕg Av†` I t`što, tR†i t†U, ŕ`ŕfŕeK f†te t†U Ges Av†` I Av†` I t†U GKBF†te Q†` I Vvi mgq ŕbYŕ Ki |
8. ŕb†ŕŕŕ QK Abjñ†i cŕZ†ŕ†† tZvgvi ŕlgZv tei Ki |

AbjñÜ†bi QK

tZvgvi fi ,  $m =$  kg

Q†` i D`PZv ,  $h =$  m

ŕŕfK I R Zj Y ,  $g = 9.8 \text{ m s}^{-2}$

cW	t`štoi cKŕZ	Q†` DVvi mgq , $t$ (s)	$\ddot{y}gZv = \frac{mgh}{t}$ (W)
1	tR†i t`što		
2	Av†` I t`što		
3	tR†i t†U		
4	ŕ`ŕfŕeK f†te t†U		
5	Av†` I t†U		

9. ŕewfbømg†q tZvgvi ŕlgZv ŕewfbø†jv tKb , Zv Av†jvPbv Ki |
10. GKB f†te cŕŕ tZvgvi eÜ†` i ŕlgZvi m†\_ tZvgvi ŕlgZvi Zj bv Ki |
11. tZvgvi K†ki met††q teŕk Ges met††q ŕlgZv cŕŕqMKvi x cŕPRb ŕkŕŕ\_v\_ŕŕ bvg ŕj L|

## AbjñÜvb - 4.2

ev†qvgŕm t\_†K ev†qŕŕŕm Drcv`b|

D†I k` : beŕqb†hŕŕ kŕŕ i e`enŕi cŕKŕ|

hš¿cwZ/DcKi Y : tŕŕei , P†D†j i Z† , K†Vi ŕ†ov , cŕŕ÷K ev K†Pi eo tevZj (ev j`ŕeti Uwi tZ \_vK†j KŕbK`vj dv` ) , KKŕbj BZ`ŕ |

KvRi aviv :

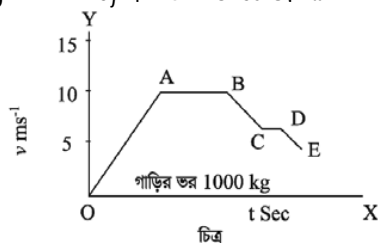
1. tevZtji gta" tMvei, Zi, KvVi , ttorv wgv Ges cwb 1 t 2 AbvrtZ bvl |
2. Geri bj j vMrbv KK" tq tevZtji ev dvf. i gL eÜ Kti `vl |
3. btji gLwL KK" tq fvrtjv Kti eÜ Kti `vl |
4. tevZj ev dvf wLtk Nti i GK tKrtY ti tL `vl |
5. `yGK w`b ci btji gL Li KK"mwi tq t`L M`vm tei nt"Q wK bv |
6. M`vm tei ntj btji gL Rj Š-w qvkjvBtqi KwV ai ||
7. M`vfm Av, b Rj te |

### Abkxj bx

eÜberPbx cKæ:

- 1| KvRi GKK tKvbwU ?  
(K) Rj (L) wbDUb  
(M) tKj wfb (N) I qvU
- 2| GKwU e` tK Uvb Uvb Kiti Gi gta" tKvb kw<sup>3</sup> Rgv `vtK ?  
(K) MwZ kw<sup>3</sup> (L) wefe kw<sup>3</sup>  
(M) Zvc kw<sup>3</sup> (N) i vmiqwbK kw<sup>3</sup>
- 3| m fti i GKwU e` tK 20 m, 30 m, 40 m | 50 m Dcti i vLv ntjv | tKvb Ae`vfb Zvi wefe kw<sup>3</sup> metPtq tek?  
(K) 20 m (L) 30 m  
(M) 40 m (N) 50 m

wbPi tjL wPÎ Abvnti 4 | 5 bs cKæ DEi `vl |



- 4| tjL wPÎ i tKvb Astk tel mgvtqi mgvbrvrtZ evx` cqv N  
(K) OA Astk (L) AB Astk  
(M) CDAstK (N) DE Astk
- 5| mtePP MwZ kw<sup>3</sup> KZ ?  
(K)  $1.25 \times 10^5$  J (L)  $5 \times 10^4$  J  
(M)  $1.25 \times 10^4$  J (N)  $6.2 \times 10^3$  J

- 6| kŕ³i msi ¶ŶYkxj Zv bŕwZ t\_†K cvl qv hvq Ñ  
 (i) kŕ³i mŕó I webvk bŕB| gnwe†kŕi tgvU kŕ³ ŵbŕ ó I Acwi eZŦxq|  
 (ii) Abevqb†hŵM kŕ³ `Z ŵb†kŕl ntq hvte, ZvB bevbq†hŵM kŕ³ e`envi Ki†Z nte|  
 (iii) kŕ³†K i ¶Ŷ Ki†Z Gi Kv†ŕi e`envi Ges ŵ†÷g j m Kg†bŕ Riŕi |

ŵb†Pi †KvŵU mŵVK

- (K) i (L) ii  
 (M) iii (N) i, ii, iii

mRbKxj cŕæ

- 1| 40 kg f†i i GKŵU evj K Ges 60 kg f†i i GKŕB hŕK GKŵU fe†bi ŵbPZjv t\_†K GK m†\_ t`šo i i y  
 K†i t`šo GKB mg†q Q†`i GKB RvqMvq t†Q†j b| t`†oi mgq D††qi teM ŵQj 30 m/min|  
 (K) ¶ŶgZv ŵK ?  
 (L) 50J KvR ej†Z Kx eŖvq ?  
 (M) hŕ†Ki MŵZkŕ³ ŵbYŕ Ki  
 (N) Q†` DVvi †¶†† `Ŗbvi ¶ŶgZv mgvb ŵQj ŵKbŕ MŵYŵZK hŕ³mn hvPvB Ki

M. mŕavi Y cŕæ

- 1| GKŵU t`qvKj vB Gi KŵV t`qvKj vB ev†. 5 N e†j NŶv ntjv| KŵVŵ†K 5 cm Uvbŕ ntjv|  
 (K) KŵV NŶ†Z KZ kŕ³ e`q ntjv ?  
 (L) KŵV Uvb†Z hŵ 0.5 s mgq jv†M Zvntj KZ ¶ŶgZv j vMj ?
- 2| GKŵU Rjŵe`ŕ cŕ†i i ŵi Rv†ŕi mgŕ³mgZj t\_†K 800 m D††Z Ges cvl qvi t÷kbŵ 250 m D††Z  
 Aew`Z| ŵi Rv†ŕi i cŵb cv†ci gŕ†g G†m cvl qvi t÷k†bi Uve†Bb Njvq| ŵi Rv†ŕi  $2 \times 10^8$   
 ŵj Uvi cŵb Av†Q| hŵ 1 ŵj Uvi cŵbi fi 1 kg nq, Z†e ŵi Rv†ŕi i cŵb†Z KZ ŵefe kŕ³ mŵÁZ  
 Av†Q|
- 3| 40 kg f†i i GK evj K ŵŵŵ ŵ†q 12 s Q†` D†V| ŵŵŵ†Z av†ci mŖL`v 20 ŵU Ges cŕZŵU av†ci  
 D`PZv 20 cm|  
 (K) H evj†Ki I Rb KZ ?  
 (L) evj KŵU tgvU KZ D`PZvq Av†ivŶY K†i ŵQj ?  
 (M) Q†` I V†Z tm KZ KvR Ki j ?  
 (N) ŵŵŵ ŵ†q t`šo DV†Z tm KZ ¶ŶgZv Kv†R j vMj ?
- 4| th mKj cvl qvi t÷kb Rŕev†Rj ŵb e`envi K†i Z†`i i t††q ŵbDKxq kŕ³ Drcv`†bi GKŵU g`ŕeo  
 mŕeav n†`Q th, G†Z ŵŵŵvDm M`vm Drcbæŕq bŕ|  
 (K) ŵbDKxq kŕ³ e`env†i Ab`vb` mŕeav,†jv Kx Kx ?  
 (L) ŵbDKxq kŕ³ e`env†i Amŕeav,†jv Kx Kx ?

cÂg Aa`vq

c`v\_ŋeAvb Ae`v I Pvc

**PRESSURE AND STATES OF MATTER**

[Avgiv c`v\_ŋeAvb Ae`vi K\_v Rwb-Kwb, Zij I evqexq| c`v\_ŋeAvb Avtiv GKw Ae`v AvtQ hvi bvg cyRgv| Zij I evqexq c`v\_ŋeAvb c`v\_ŋeAvb ntZ cvi etj G`iK c`v\_ŋeAvb etj| c`v\_ŋeAvb Pvc c`v\_ŋeAvb Kti| c`v\_ŋeAvb Pvc Kti Kti jwMti AtbK Kiv mntR Kiv hvq| c`v\_ŋeAvb GKw wtkl ag`ntjv w`vZ`vcKZv| eZgvb Aa`vq Avgiv G me wq wtkl Avtiv Pbv Kie|]

GB Aa`vq cW tkI Avgiv-

1. ej I t`I dtji cwieZbi mvt\_ Pvc cwieZb e`vL`v KiZ cie|
2. NbZi e`vL`v KiZ cie|
3. `b`b Rxtb NbZi e`envi e`vL`v KiZ cie|
4. evqgEj i Pvc e`vL`v KiZ cie|
5. Zij `I`D`PZv e`envi Kti evqgEj xq Pvc cwigvc KiZ cie|
6. D`PZv e`envi mvt\_ evqgEj i Pvc cwieZb wtkl KiZ cie|
7. Avenl qvi Dci evqgEj xq Pvc cwieZb wtkl KiZ cie|
8. w`i Zi ti gta` tKtbr w`i Pvc i wkgvj v cwigvc KiZ cie|
9. Zi ti wbgvZ e`i EaYgix Pvc Abf`v e`vL`v KiZ cie|
10. e`i tKb cwbZ fvtm Zv e`vL`v KiZ cie|
11. evsjv`tk tbSc`\_`Nbv KviY wtkl KiZ cie|
12. c`v\_ŋeAvb m` e`vL`v KiZ cie|
13. c`v\_ŋeAvb m` i e`envi K wq c`k KiZ cie|
14. cxob I wkwZ e`vL`v KiZ cie|
15. utKi m` e`vL`v KiZ cie|
16. c`v\_ŋeAvb AvYwK MvZZEj e`vL`v KiZ cie|
17. c`v\_ŋeAvb cyRgv Ae`v e`vL`v KiZ cie|



hvpvB Ki :

mgvb BtUi i`Zvq Lwj cvtq nUv Avi BtUi tLvqi Dci w`tq nUv | tKvbU Kóma` | e`vL`v Ki?

Ptci GKK

etj i GKKtK t¶¶dij i GKK w`tq fM Ki tj Ptci GKK cvl qv hvq | AZGe Ptci GKK  $N m^{-2}$  | GtK c`vmtKj (Pa) etj |

$$\therefore 1 \text{ Pa} = 1 \text{ Nm}^{-2}.$$

c0Z  $1 m^2$  t¶¶dij i Dci 1N ej j`^fvte wuqv Ki tj th Pvc nq ZvtK 1Pa etj |

MwYvZK D`miY 5.1 : Rzvi cvtq tKtbr gnvj fi 50 kg | Zvi Rzvi Zjvi t¶¶dj 200  $cm^2$  ntj Pvc tei Ki |

Avgi v Rwb

$$\begin{aligned} Pvc, p &= \frac{F}{A} = \frac{W}{A} \\ &= \frac{490 \text{ N}}{200 \times 10^{-4} \text{ m}^2} = 2.45 \times 10^4 \text{ Pa} \end{aligned}$$

$$\begin{aligned} \text{t`l qv AvtQ, fi, } m &= 50 \text{ kg} \\ \text{ej, } F = W = mg &= 50 \text{ kg} \times 9.8 \text{ ms}^{-2} \\ &= 490 \text{ N} \\ \text{Rzvi Zjvi t¶¶dj, } A &= 200 \text{ cm}^2 \\ &= 200 \times 10^{-4} \text{ m}^2 \end{aligned}$$

## 5.2 | NbZj

### Density

tKtbr e`-` th RvqMv Rto \_vtK ZvtK Gi AvqZb etj | mgvb AvqZtbi GK UKiv KK®Avi GK UKiv tjvrv cmbtZ t0to w`tj t`Lv hvte KtK® UKiv tftm AvtQ Avi tjvrv UKiv Wte tMtQ | mavi Yfvte ejv hvq KtK® tPtq tjvrv NbZj tenk ZvB Wte tMtQ | Avmtj AvqZb mgvb ntj | hvi NbZj tenk tmuU fviX Avi hvi NbZj Kg tmuU nvj Kv | tKtbr e`-` i GKK AvqZtbi fi tK Zvi Dcv`vbi NbZj etj | NbZj c`vt`P GKwU mavi Y ag® NbZje`-` i Dcv`vbi I Zvcgv¶vi Dci wbf®kxj |

NbZtK  $\rho$  Øiv cKvk Kiv nq |  $m$  fti i tKtbr e`-` i AvqZb  $V$  ntj, NbZj  $\rho$  nte |

$$\rho = \frac{m}{V} = \frac{e^- \text{ i fi}}{e^- \text{ i AvqZb}} \quad (5.2)$$

NbZj GKK  $kg m^{-3}$

KvR :

`yU RM bvl hv` i AvqZb mgvb | GKwU RM cmb Øiv fi Ges GKwU gayØiv cY®Ki | nvZ w`tq DVvl | tKvbU fviX gtb nt`Q?

gayfWZ®RMU tenk fviX gtb nte KvY gay NbZj tenk |





evqgÊj Zvi IRtbi Rb` feðò cðZ GKK t¶Îdñj j`^fvte th cwi gvb ej cðqM Kti ZvK H`^vñbi evqgÊj xq Pvc etj |

Uwi ñmj i cix¶v I evqgÊj xq Pvc ci cwi gvc

cðq GK wguvi j`^v, GKgt tLvñ Ges mlg e`mhy³ cij KvPi bj bvl | bjñU we`ñ cvi` Øviv cY°Kti KvPbtñ tLvñgt AvOj w`tq AvUwKtq bjñU Kti Dèv Kti GKñU cvi`cY°cvtÎ i gta` Wpvl (wPÎ 5.3) | Gevi AvOj mwi tñ bjñK Lvov Kti iLvñ e`e`^v Kiti t`Lv hvte cvi` wKQy t tbtg Gtm w`^i nñq` wotq AvtQ | AvcvZ` wotq gñb nte th btñi wfZti i cvi`Z` Avcbv-Avcwb` wotq AvtQ, wKŠ` ev`Îte Zv bq | evqgÊj xq Pvc i`p Gñc nñQ | cvtÎ i cvti` Dci evqgÊj me`v Pvc w`tQ | GB Pvc cvti` i ga` w`tq mÃñj Z nñq btñi wfZti DañgtL wuqv Kti | GB PvcB btñi wfZti cvi`Z`K ati iñL | GB Pvc bv`vKtj AwfKtI° Rb` btñi wfZti i cvi` wotq tbtg AvmZ | mZivs evqgÊj xq Pvc = btñi cvi`Z`K Pvc | maviY t¶Ît btñi wfZti th cvi`Z`K vKte Zvi D`PZv cðq 76 cm A` evqgÊj i Pvc 76 cm DPz cvi`Z`K ati iLvñ m¶lg | Gfvte Zij`^t` D`PZv e`envi Kti evqgÊj xq Pvc ci cwi gvc Kiv hvq |



চিত্র ৩.৬ : উরিসেলির পরীক্ষা

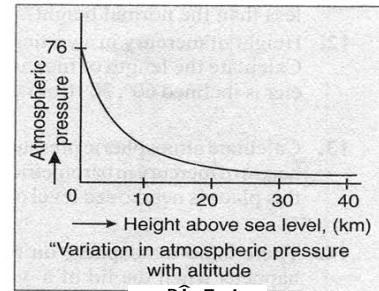
wPÎ 5.3

KvPbtñ th cvi`Z` wotq`vK Zvi Dci btñi e`ñ cðZ chŠZ`^v kb` | GB i b`^vbtK Uwi ñmj i kb`^v etj | GLvñb mvgv` cvi` ev`u`vK | evqj Pvc cwi gvc Kivi hŠZtK e`ñ wguvi etj |

## 5.4 | D`PZv I evqgÊj xq Pvc

### Altitude and atmospheric pressure

evqgÊj xq Pvc wbf° Kti evqgÊj i D`PZv Ges evqj NbñZñ Dci | feðò A` mgy` mgZñ evqj maviY Pvc nñjv 76cm cvi`Z`K Pvc mvgb | feðoi mgy` mgZñ t`tK hZ Dcti DV hvq ZZ evqjZ` I Rb Ges NbñZ Dfqb nñm cvq | GRb` D`PZv e`ñ mvt` mvt` evqgŠWj xq Pvc Kg nq | Gfvñó ceZkt½ i Dcti evqgÊj xq Pvc mgy` mgZñ i Pvc cðq 30% | tmRb` tenk



wPÎ 5.4

D`PZv DVñj klm-clkm tbi qv KóKi nq | Avevi tenk D`PZv evqgÊj xq Pvc tñq gvbñ i i³Pvc tenk`vK etj bñK w`tq i³ cotZ cvti | AvRKvj wegvb hLb tenk D`PZvi wbgPvc AÃj w`tq Dto hvq ZLb Gi Af`ŠZti hvñt` i mjeavt`^vfvñek Pvc eRvq iLvñ e`e`^v Kiv nq | feð t`tK hZ Dcti DV hvq ZZ evqgÊj xq Pvc Kg | D`PZvi mvt` evqgÊj xq Pvc ci eZñ tj LuPñ t`Lvñbv nñjv (wPÎ 5.4) |

## 5.5 | evqgÊj xq Pvc ci eZñ I Avenl qv

### Change in atmospheric pressure and weather

tKvñbv`^vñb mgñqñ mñ½ mñ½ evqgÊj xq Pvc ci eZñ NñU | Gi KviY evqñZ Dcw`Z Rj xq evt`ui cwi gñYi nñmñv Z`v evqj NbñZñ ci eZñ nq | Avgiv evqgÊj xq Pvc ci eZñ eŠZ cwi e`ñ wguvi i cvi`Z`K D`PZvi ci eZñ t`tL |

- 1| e`vfiwguvfi i cvi`-Zt`d D`PZv axti axti KgZ \_vKtj tevSv hrte evqfZ Rjxq evt`ui cwi gY axti axti evotQ| Kvi Y Rjxq evt`u evqj tPtq nvj Kv| Gt`ŕt` ewócvfZi m`tebv AvtQ|
- 2| nVvr hw` cvi`-Zt`d D`PZv Lp Ktg hvq Zte eStZ nte Pviw tK evqgÉj i Pvc mnmv Ktg tMtQ Ges H`-vfb wbgPvtfci m`wó ntqtQ| cvk`ZP D`PPvtfci`-vb t\_tK c`ej tetM evqy H wbgPvtfci AĀtj QfU Avmte| m`Zivs Stoi m`tebv AvtQ|
- 3| e`vfiwguvfi cvi`-Zt`d D`PZv axti axti evotj eStZ nte evqgÉj t\_tK Rjxq evt`u Acmmwiz nt`Q Ges i`< evZvm tmB`-vb AnaKvi Ki tQ| m`Zivs; Avenvl qv i`< I cwi`<vi \_vKte| Gfite evqj Ptfci cwieZB e`vfiwguvfi ōviv wbyq Kti Avenvl qvi celfm t` I qv hvq|

## 5.6| w`i Zitji gta` tKvfbv we`jZ Pvc

### Pressure at a point in a liquid at equilibrium

Zij c`v\_ŕeÁvb w`fZti tKvfbv we`jZ Pvc ejtZ wK H we`j Pviw tK cĀZ GKK tŕŕt`dj i Dci j`^fite AbfZ ejtK eSvq| 5.5 bs wPtŕ GKw cvtŕ wKQcwi gY Zij c`v\_ÁvtQ|

$$\text{aiv hvK, cvtŕi fwi tŕŕt`dj} = A$$

$$\text{Zitji NbZi} = \rho$$

$$\text{Zitji Mfxi Zv} = h$$

$$\text{AwfKIR ZiY} = g$$

$$\text{Avgiv Rwb, Pvc} = ej \div tŕŕt`dj$$

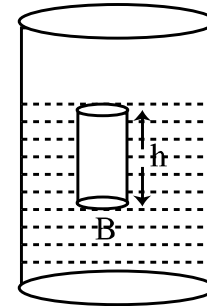
$$\text{GLvb A tŕŕt`dj chŕ ej} = \text{Zitji IRb}$$

$$= \text{Zitji fi} \times g$$

$$= \text{Zitji AvqZb} \times \text{NbZi} \times g$$

$$= \text{Zitji tŕŕt`dj} \times \text{Zitji Mfxi Zv} \times \text{NbZi} \times g$$

$$= A h \rho g$$



wPt 5.5

$$\therefore \text{Pvc, } p = A h \rho g / A$$

$$\text{ev Pvc, } p = h \rho g$$

(5.3)

$$\text{Aveni thtnZig aŕK ZvB, } p \propto h \rho$$

A\_ŕ w`i Zitji Af`Šti tKvfbv we`jZ Pvc H we`j Mfxi Zv I NbZi mgvbywZK| m`Zivs Zitji Mfxi Zv evotj Pvc evto Ges NbZi evotj I Pvc evto| Mfxi Zv evotj Pvc evto weavq wPtŕ tenk Mfxi Zvi wQ`^t\_tK wBMZ Zitji teM tenk (wPt 5.6)|

MwYwZK D`miY 5.4: GKw cvtŕ tKtiwmb AvtQ| tKtiwmtbi

Dcwi Zj t\_tK 75 cm Mfxi tKvfbv we`jZ Ptfci gvb wbyq Ki |

tKtiwmtbi NbZi 800 kg m<sup>-3</sup>.

wPt 5.6

Avgiv Rwb,

$$p = h \rho g$$

$$= 0.75 \text{ m} \times 800 \text{ kg m}^{-3} \times 9.8 \text{ ms}^{-2} = 5880 \text{ Pa}$$

$$\text{D: } 5880 \text{ Pa}$$

t` I qv AvtQ'

Zitji Mfxi Zv,

h = 75 cm = 0.75 m

Zitji NbZi,  $\rho = 800 \text{ kg m}^{-3}$

Pvc p = ?

## 5.7 | cēvxi Pvc I cēZv

### Pressure of a fluid and buoyancy

th c`v\_ŕeÁvb nq ev ntZ cūi ZvK cēvxi (fluid) etj | Zij I evqexq G`β tkilYi c`v\_ŕeÁvb AŠfP |

cēvxi Pvc: tKvfbv Ztj w`i Ae`vq t\_ŕK cēvxi Zvi cūZ GKK tŕŕŕ dŕj j`^fŕte th ej cūqM Kti Zvi gvbŕK cēvxi Pvc etj | hw GKw Ztj i tŕŕŕ dŕj A Ges cēvxi KZK j`^fŕte chP ej F nq Zvntj Pvc,  

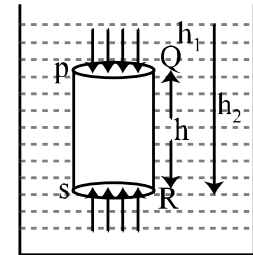
$$p = \frac{F}{A}.$$

cēZv : cwbcY GKw KjmŕK cwbi gŕa` miŕfbv hZ mnR, cwbtZ bv tiŕL miŕfbv ZZ mnR bq | cwbi gŕa` WpŠ-Ae`vq Kjmŕ tek nvj Kv gŕb nq Kvi Y Kjmi Dci GKw Daŕgŕ ej KvR Kti |

Zij ev evqexq c`v\_ŕeÁvb AvsŕK ev mŕŕYŕte wbgwZ tKvfbv e`i Dci Zij ev evqexq c`v\_ŕeÁvb j`^fŕte th Daŕgŕ ej wŕqv Kti ZvK cēZv etj | cēZvi gvb e`i wbgwZ Ask KZK Acmwŕ Z Zij ev evqexq c`v\_ŕeÁvb I Rŕbi mgvb nq |

cēZvi gvb :

Zitji gŕa` tKvfbv KwVb e`i tK wbgwZ Kti e`i cūZ wŕŕZ meŕgŕ Pvc AbŕfZ nŕe | aiv hvK A cūŕŕQŕ i Ges h D`PZvi GKw wŕwŕ Ővi PQRS | Gŭv ρ NbtZi cēvxiZ mŕŕYŕwbgwZ AvŕQ (wŕŕ : 5.7) | Zitji gŕ Zj t\_ŕK wŕwŕ Ővŕti Dctii Ges wŕŕPi cŕŕi Mfxi Zv h\_vŕtg h<sub>1</sub> I h<sub>2</sub>



wŕŕ : 5.7

mŕZivs  $h = h_2 - h_1$

wŕwŕ Ővŕti Dci cŕ PQ-G Zij KZK wbggŕ ej,  $F_1 = Ah_1\rho g$

wŕwŕ Őviŕi wbgacŕ SR- G Zij KZK Daŕgŕ ej,  $F_2 = Ah_2\rho g$

wŕwŕ Ővŕti eŕcŕŕ Zij KZK chP cvkPvc ci`ŕi weciXZgŕ I mgvb weavq bvKP ntq hvq |

mŕZivs jwä Daŕgŕ ej ev cēZv -

$$\begin{aligned} &= F_2 - F_1 \\ &= Ah_2\rho g - Ah_1\rho g \\ &= A(h_2 - h_1)\rho g \\ &= Ah\rho g \\ &= (hA)\rho g \\ &= V\rho g, [V = hA = \text{wŕwŕ Ővŕti i AvqZb}] \\ &= e`i KZK Acmwŕ Z cēvxi I Rb | \end{aligned}$$

mŕZivs wbgwZ e`i Dci wŕqvŕ Daŕgŕ ej ev cēZv e`i KZK Acmwŕ Z cēvxi I Rŕbi mgvb | GB Eaŕgŕ etji Rb`B Zitj wbgwZ e`i I Rb nviq etj gŕb nq |

## 5.8 e`i fŕmb I wbgwZ

### Floatation and immersion of a body

w`i Zitj tKvfbv e`i tK tŕŕo w`tj e`i ŕi Dci GKB mŕŕZ`ŕ ej wŕqv Kti -

1 | e`i I Rb wŕŕ Lvov wŕŕPi w`tK wŕqv Kti



AbjmiY Kti mZKkZvi mvt\_ tbShvb Pjvfbv DvPZ| tbShvbi iUcY©b· vi Rb`l AþbKmgq fiþK`a cwi enZz ntq `N@bv NUvq| KLbl AwZwi 3 hvix ntq tbShvfb DVv wK bq|

## 5.10| c`vmþKtj i mî

### Pascal's Law

tKvfbv Avev Zij ev evqexq c`vt\_þ tKvfbv Astk Pvc c@qM Kiti tmB Pvc mew þK mÂwvj Z nq| c`vmþKj Prci G mÂvj b m@þK@btg@ mî c@vb KtibN

Avev cvtî Zij ev evqexq c`vt\_þ tKvfbv Astki Dci evBti tþK Pvc c@qM Kiti tmB Pvc wKQygvî bv Ktg Zij ev evqexq c`vt\_þ mew þK mgvbfvte mÂwvj Z nq Ges Zij ev evqexq c`vt\_þ msj Mæcvtî i Mvtq j m^fvte wqvKti |

c`vmþKtj i mî i MwYwZK e`vL`v : ej e`vKiY bwxZ

Avev Zij c`vt\_þ qî Zg Astki Dci w÷b @viv tKvfbv ej c@qM Kiti Gi enEg w÷b tmB etji eû,b tenk ej chþ ntZ cvti | GþK ej e`vKiY bwxZ etj |

aiv hvK,  $C_1$  l  $C_2$  `wU wmvj Ôvi (wPî 5.10)| Gþi c@t`Qt`i tñîdj h\_vutg  $A_1$  l  $A_2$  wmvj Ôvi `wU GKwU bj @viv mshþ Ges c@Z`K wmvj Ôvti GKwU Kti w÷b wbw`Q`fvte j vMvfbv AvtQ| GLb wmvj Ôvi `wU th tKvfbv Zij c`vt\_©cY©Kti hw` tQvU w÷þb  $F_1$  ej

c@qM Kiv nq Zvntj H w÷þb AbfZ Prci gyb  $\frac{F_1}{A_1}$  |

c`vmþKtj i mî vbmvti G Pvc Zij c`v\_©@viv mew þK mÂwvj Z nte| mZivs eo w÷þb chþ DvPvc  $\frac{F_1}{A_1}$  nte|

G Prci Rb` eo w÷þb AbfZ DvGlx ej nte, Pvc

$\times$  tñîdj ev  $\frac{F_1}{A_1} \times A_2$  Gi mgvb| mZivs eo w÷þb

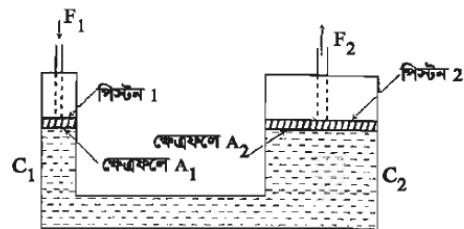
AbfZ DavGlx ej  $F_2$  ntj ,

$$F_2 = \frac{F_1}{A_1} \times A_2$$

$$\therefore \frac{F_2}{F_1} = \frac{A_2}{A_1}$$

(5.4)

KvRB eo w÷þbi c@t`Qt`i tñîdj hZ tenk nte ej l ZZ tenk AbfZ nte| tQvU w÷þbi tþq eo w÷þb hw` 100 % eo nq Zvntj tQvU w÷þb 1 wDUB ej c@qM Kiti eo w÷þb 100 wDUB DavGlx ej AbfZ nte|



wPî 5.10

5.11 |  $w'wZ'vcKZv$ :  $cxob$  |  $wKwZ$ **Elasticity : stress and strain**

mvaviY AwfÁZv t`tk Avgiv Rmb GKUv ievti i wdzv Uvbtj Zv `tN°tefo hvq | Avevi Uvb t0to w`tj cbivq cteP `N°wdti cvq ev wdti tctZ tPÓv Kti | GLvfb Uvbn A\_°ej c0qm Kiv Avi `N°tefo hvlqv A\_°ekZ nIqv | gj Z : hLbB e`' weKZ nq ZLbB e`' i wfZti GKUv evav`vbKvix etji mjo nq hvi Rb` cteP Ae`'vq wdti AvmtZ mtpÓ nq |

ewn`K ej c0qm Kti tKvfbv e`' i AvKvi ev AvqZb ev Dftqi cwieZ°bi tPÓv Kiti, th atgP Rb` e`' w GB c0PÓvK evav`tq Ges ej Acmw Z nti e`' Zvi cteP AvKvi ev AvqZb wdti cvq tmB ag°K w'wZ'vcKZv etj | th me c`v`P GB ag°AvtQ Zt` i tK w'wZ'vcK c`v`°ej | Zte etji GKw mxgv AvtQ, hvi tewk ej c0qm Kiti e`' Avi cteP AvKvi wdti cvq bv | GB mxgvK w'wZ'vcK mxgv etj |

hLb w'wZ'vcK e`' i Dci ewn`K ej c0qm Kiv nq ZLb e`' i AYtjv ci`ui t`tk mti hvq | Zvi dtj e`' i `N°, AvqZb ev AvKwZi cwieZ° NtU | GKK `tN° ev GKK AvqZbi GB cwieZ°K weKwZ etj | ewn`K etji c°ve tKvfbv e`' i gta` weKwZi mjo nti w'wZ'vcKZv Rb` e`' i wfZti GKw c0Zti va etji D°e nq | GB c0Zti va ej ewn`K ej tK evav`vbi tPÓv Kiti | e`' i wfZi GKK t°t dtj j`v°vte D°G c0Zti vaKvix ej tK cxob etj |

utKi m° (**Hooke's law**) : weÁvbx i evU°K w'wZ'vcKZv gj m° w Awe`vi Kiti b | GB m° vbm°ti -

$w'wZ'vcK$  mxgi gta` cxob weKwZi mgvbcwZK |

MwYwZKfvte

$cxob \propto weKwZ$

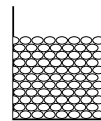
$\therefore cxob = a^°K \times weKwZ$

ev,  $\frac{cxob}{weKwZ} = a^°K$

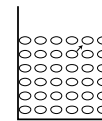
GB a°KwZtK e`' i Dcv`vbi w'wZ'vcK  $\frac{1}{4}$  etj | Dtj t` th weKwZi tKvfbv GKK tbB | cxotbi GKK  $N m^{-2}$  | w'wZ'vcK  $\frac{1}{4}$  i GKKI  $N m^{-2}$  |

5.12 |  $c`v`P$  AvweK MwZZ°j**Molecular Kinetic Theory of Matter**

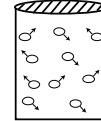
$c`v`P$  AYtjv MwZkxj Ae`'vq AvtQ, GB avi Yv atj tbi qvB  $c`v`P$  AvweK MwZZ°j gj weIq | wbgewZ `xKv°tjvi Dci  $c`v`P$  AvweK MwZZ°j c0ZwZ:



কঠিন পদার্থ



তরল পদার্থ



গ্যাস

ৱপ্টি 5.11

1 | th tKvfbv  $c`v`P$  AmsL° °jz° °jz° KYvi mgS°tq MwZ |

GB KYv tjtjvK  $c`v`P$  AYyetj |

2 | AYtjv GtZv °jz° th Zvt` i tK we`°er wetePbv Kiv nq |

3 |  $c`v`P$  KYv tjtjv me°v MwZkxj |

- 4| M'v̄mi t̄ŋt̄ŋ AY<sub>u</sub>t̄jv tek `ŋi `ŋi \_v̄t̄K, G Rb` Zv̄t̄`i gta` tKv̄bv AvKl̄ŋ ev weKl̄ŋ ej KvR K̄ti bv ej t̄jB Pt̄j | Zi t̄j i t̄ŋt̄ŋ AY<sub>u</sub>t̄jv wKQ̄v `ŋi `ŋi \_v̄Kt̄j l Zv̄t̄`i gta` AvKl̄ŋ ej KvR K̄ti Ges Zij t̄K cv̄t̄ŋi AvK̄ti aviY Ki t̄Z eva` K̄ti | Kw̄b c`v̄t̄\_P t̄ŋt̄ŋ KY<sub>u</sub>t̄jv L̄p̄ KvQ̄vKw̄Q \_v̄t̄K Ges Zv̄t̄`i gv̄t̄S Zxe<sup>a</sup>AvKl̄ŋ ej KvR K̄ti weav̄g Kw̄b c`v̄t̄\_P w̄bR`^ AvK̄vi l AvqZb \_v̄t̄K |
- 5| M'vm l Zi t̄j i t̄ŋt̄ŋ KY<sub>u</sub>t̄jv Gt̄jv̄gt̄jv Q̄v̄vQ̄v K̄ti GRb` Giv ci`ūt̄i i mv̄t̄\_ Ges cv̄t̄ŋi t̄`qv̄t̄j i mv̄t̄\_ msN̄t̄l ŋj̄ ŋq

### 5.13| c`v̄t̄\_P c̄v̄Rgv Ae`-v

#### Plasma state of matter

c`v̄t̄\_P PZ<sub>L</sub>°Ae`-vi b̄vg c̄v̄Rgv | GB c̄v̄Rgv n̄t̄jv AwZ D`P Z̄vcgv̄ŋvq Avq̄wbZ M'vm | c̄v̄Rgv i eo Drm n̄t̄Q m̄h̄ Z̄vQ̄v Ab`vb` b̄ŋt̄ŋ t̄jv l c̄v̄Rgv i Drm | c̄q̄ K̄t̄qK n̄v̄vi w̄w̄M̄t̄mj̄w̄mq̄m Z̄vcgv̄ŋvq c̄v̄Rgv Ae`-vi Dr̄c̄w̄ŋ n̄q | M'v̄mi b̄v̄q c̄v̄Rgv i t̄Kv̄bv w̄b`° AvK̄vi ev AvqZb t̄bB | c̄v̄Rgv KY<sub>u</sub>t̄jv Z̄v̄or Av̄avb enb K̄ti Z̄vB c̄v̄Rgv Z̄v̄or c̄wi ev̄x̄ w̄n̄t̄m̄t̄e KvR K̄ti | w̄k̄i Kv̄i Lv̄bvi c̄v̄Rgv UP̄ŋ t̄q avZe c`v\_ŋv̄v n̄q |

### Ab̄m̄Üvb 5.1

Kw̄b e`- i NbZ̄j̄wbȲŋ

D̄t̄ŋ k` : th t̄Kv̄bv AvK̄ti i Nbe`- i NbZ̄j̄wbȲŋ Kiv |

h̄Œ̄c̄w̄Z : gvc̄t̄P̄v̄O, w̄b̄w̄<sup>3</sup>, th̄t̄Kv̄bv AvK̄ti i Nbe`-

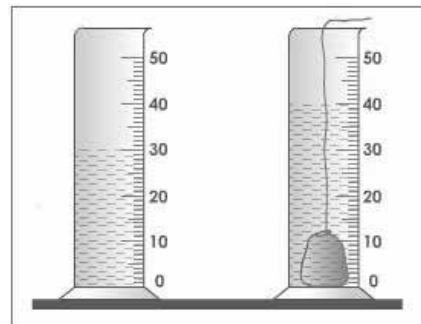
Z̄ŋj̄ : t̄Kv̄bv Kw̄b e`- h̄ZUK̄z`-v̄b` L̄j K̄ti \_v̄t̄K Z̄v̄t̄K H e`-Zi AvqZb et̄j | Av̄i e`- i GKK AvqZ̄t̄bi fi t̄K Z̄vi NbZ̄j̄et̄j |

t̄Kv̄bv Kw̄b e`- t̄K Zij c`v̄t̄\_°m̄s̄ūȲ°W̄et̄j Z̄vi w̄b̄t̄Ri AvqZ̄t̄bi mḡyb Zij `v̄bP̄jZ K̄ti | Kw̄b e`- t̄K c̄wb̄t̄Z W̄et̄bvi c̄ŋēl c̄ti gvc̄t̄P̄v̄O i c̄wb̄i D̄c̄wi f̄v̄t̄Mi c̄v̄ h\_v̄μ̄t̄g  $V_1 \text{ cm}^3$  Ges  $V_2 \text{ cm}^3$  n̄t̄j Kw̄b e`- i AvqZb,

$$V = (V_2 - V_1) \text{ cm}^3 \dots \dots \dots (1)$$

GLb e`- i fi  $M \text{ gm}$  n̄t̄j, Gi NbZ,

$$d = \frac{M \text{ gm}}{V \text{ cm}^3} = \frac{M}{V} \times 10^3 \text{ kg m}^{-3} \dots (2)$$



w̄P̄ŋ 5.12

K̄v̄t̄Ri av̄iv :

1. GK̄w̄U w̄b̄w̄<sup>3</sup> i m̄v̄v̄t̄h` cix̄ŋȲx̄q Kw̄b e`- w̄U i fi w̄bȲŋ Ki |
2. gvc̄ t̄P̄v̄O i Āt̄aR̄ c̄wb̄ ō̄iv c̄ȲŋK̄ti c̄wb̄i D̄c̄wi f̄v̄t̄Mi c̄v̄ b̄v̄l |
3. Kw̄b e`- w̄U t̄K m̄j̄Z̄v w̄ t̄q t̄et̄a m̄veav̄t̄b t̄P̄v̄O i c̄wb̄t̄Z W̄et̄l th̄b Z̄v t̄P̄v̄O i Z̄j̄vq Ae`-v̄b K̄ti | GB Ae`-v̄q c̄wb̄ w`-i n̄t̄j Gi D̄c̄wi f̄v̄t̄Mi c̄v̄ b̄v̄l |
4. gvc̄ t̄P̄v̄O w̄ēf̄b̄ac̄wi gv̄Y c̄wb̄ w̄b̄t̄q 2 l 3 bs c̄ŋ̄μ̄qv c̄p̄iv̄w̄ŋ̄E K̄ti c̄v̄ Q̄t̄K D̄c`-v̄cb̄ Ki |
5. c̄ŋ̄qv̄R̄bx̄q w̄m̄v̄t̄e i m̄v̄v̄t̄h` Kw̄b e`- i AvqZb w̄bȲŋ K̄ti 2 bs mḡx̄Ki t̄Ȳi m̄v̄v̄t̄h` NbZ̄j̄wbȲŋ Ki |





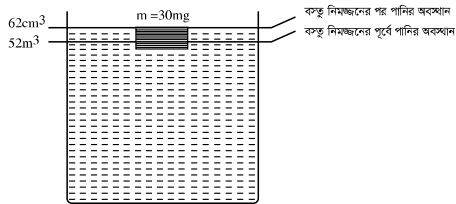
wḃPi ṫKvḃU ṁVK ?

- K. i  
M. iii

- L. ii  
N. i, ii I iii

(L) mRbkxj ċkæ

ẆṖṪ ṫL̇ wḃPi ċkæ ṫj vi ḊĖi `vI :



K) NbZ; Kv̇ṫj ėṫj ?

L) ẆṖṪ ėU̇i Gḟv̇te ṫḟṫm \_vKvi Kvi Y ėv̇L̇v̇ Ki |

M) ėU̇i NbZ; ẆḃẎQ̇ Ki |

N) Zi̇ṫj i Żv̇ċġv̇Ṫv̇ µ̇ġv̇ṀŻ ėẆẋi ḋj v̇ḋj ėv̇L̇v̇ Ki |

(M) ṁv̇vi Y ċkæ:

1 | ėj , Ṗvc I ṫṖṪ ḋṫj i ṁu̇K̇K̇ẋ?

2 | NbZ; Kv̇ṫK ėṫj ? Gi GKK K̇ẋ?

3 | ėv̇q̇ġĖj̇ẋq̇ Ṗvc Kv̇ṫK ėṫj ?

4 | U̇wi ṫṁẇj i k̇ḃv̇ḃ ẆK ċK̇Ż ċṫṖ k̇ḃv̇? ėv̇L̇v̇ Ki |

5 | Zi̇ṫj i Ṗvc I ḊṖŻvi ġṫȧ ṁu̇K̇ẆḃẎQ̇ Ki |

# I ô Aa`vq e`' i Dci Zv̄tci cĕŕve

## EFFECT OF HEAT ON SUBSTANCES



[Zvc GKcĕŕvi kv̄ hv c`v̄\_P AVj M̄zi m̄t\_ m̄ūm̄KZ̄| Zvcgv̄v̄ n̄t`Q Zvc̄k̄w̄³ t̄Kvb w̄ t̄K cĕŕv̄n̄Z n̄te Zvi GK̄ū  
wb̄t`RK| Zvc cĕŕq̄t̄M ev Ac̄m̄vīt̄Y K̄w̄b c`v̄\_P Av̄K̄v̄t̄i i c̄w̄ieZ̄B N̄t̄U, Zi j c`v̄\_P Av̄q̄Zb c̄w̄ieZ̄B n̄q Ges  
ev̄q̄ex̄q c`v̄\_P Av̄q̄Zb I P̄t̄ci c̄w̄ieZ̄B N̄t̄U| Zvc cĕŕq̄t̄M ev Ac̄m̄vīt̄Y c`v̄\_ĖGK Ae`'v̄ t̄\_K Ab` Ae`'v̄q̄ q̄c̄v̄š̄m̄i Z  
n̄q| e`' i Dci Zv̄tci G m̄Kj cĕŕve GB Aa`v̄q̄ Av̄t̄j v̄P̄bv̄ Kiv̄ n̄te|]

GB Aa`v̄q̄ c̄v̄ t̄k̄t̄l Av̄ḡiv-

1. Zvc I Zvcgv̄v̄ e`v̄L̄v̄ Kīt̄Z c̄v̄ie|
2. c`v̄\_P Zvcgv̄v̄ K aḡe`v̄L̄v̄ Kīt̄Z c̄v̄ie|
3. dv̄t̄i b̄v̄BU, t̄m̄j w̄m̄q̄m Ges t̄Kj w̄f̄b t̄`<t̄j i ḡt̄a` m̄ūK̄ēt̄k̄Y Kīt̄Z c̄v̄ie|
4. e`' i Af̄š̄ix̄Y kv̄³ ev̄v̄i m̄v̄t̄t̄q̄ Zvcgv̄v̄ ev̄v̄ e`v̄L̄v̄ Kīt̄Z c̄v̄ie|
5. c`v̄\_P Zvc̄q̄ c̄h̄vīY e`v̄L̄v̄ Kīt̄Z c̄v̄ie|
6. K̄w̄b c`v̄\_P `N̄, t̄q̄t̄dj Ges Av̄q̄Zb c̄h̄vīY e`v̄L̄v̄ Kīt̄Z c̄v̄ie|
7. Zīt̄j i Av̄c̄v̄Z Ges c̄K̄Z c̄h̄vīY e`v̄L̄v̄ Kīt̄Z c̄v̄ie|
8. c`v̄\_P Ae`'vi c̄w̄ieZ̄B Zv̄tci cĕŕve e`v̄L̄v̄ Kīt̄Z c̄v̄ie|
9. M̄j b, ev̄ūx̄f̄eb I N̄bx̄f̄eb e`v̄L̄v̄ Kīt̄Z c̄v̄ie|
10. M̄j b̄v̄¼ I Ć̄b̄b̄v̄¼ e`v̄L̄v̄ Kīt̄Z c̄v̄ie|
11. M̄j b̄v̄¼ i Dci P̄t̄ci cĕŕve e`v̄L̄v̄ Kīt̄Z c̄v̄ie|
12. Ć̄b̄b̄ I ev̄ūq̄b e`v̄L̄v̄ Kīt̄Z c̄v̄ie|
13. M̄j b Ges ev̄ūx̄f̄eb̄i m̄ȳB̄Zvc e`v̄L̄v̄ Kīt̄Z c̄v̄ie|
14. ev̄ūq̄b kv̄Z̄j̄x̄Kīt̄Yi Kv̄īY e`v̄L̄v̄ Kīt̄Z c̄v̄ie|
15. ev̄ūq̄t̄bi Dci w̄b̄q̄v̄t̄Ki cĕŕve e`v̄L̄v̄ Kīt̄Z c̄v̄ie|
16. Av̄t̄c̄v̄q̄K Zvc I Zvc̄avīY q̄ḡZ̄v̄ e`v̄L̄v̄ Kīt̄Z c̄v̄ie|
17. Zvc c̄w̄īgv̄t̄ci ḡj̄b̄m̄Z e`v̄L̄v̄ Kīt̄Z c̄v̄ie|

## 6.1 Zvc I ZvcgvĠv

### Heat and temperature

Zvc :

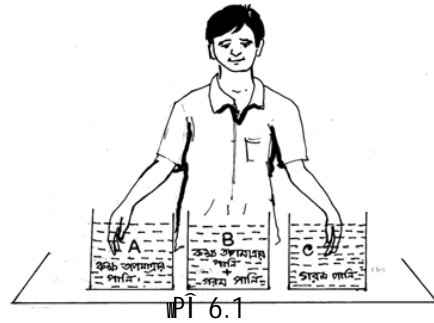
Zvc ntġv GK cKvi kw<sup>3</sup> hv VŪv I Mitġi AbyfWZ RŕMvq | Zvc DòZi e` t\_ġK kxZjZi e` i w\_ġK cĕwnZ nq | mŕZivs DòZvi cv\_ġK i Rb` th kw<sup>3</sup> GK e` t\_ġK Ab` e` tZ cĕwnZ nq ZvġK Zvc etġ |

c`vġ\_P AYġ,tġv me mgq MŕZkxj Ae`vq \_vġK | ZvB Gġ i MŕZkw<sup>3</sup> AvġQ | tKvġbv c`vġ\_P tġvU Zvġci cwi gŕY Gi ga`w`Z AYġ,tġvi tġvU MŕZkw<sup>3</sup> i mgvbycwZK | tKvġbv e` tZ Zvc cŌvb Kiv ntġ AYġ,tġvi MŕZ teġo hvq dtġ MŕZkw<sup>3</sup> I teġo hvq |

Zvġci GKK : SI c`vŕwZtZ Zvġci GKK ntġv Rj (J) | cġe©Zvġci GKK wŕmvġe K`vjwi (Cal) e`eüZ ntZv | K`vjwi Ges Rġj i gġa` m`uKġntġv 1 cal = 4.2 J |

KvR :

tUvġtġ i w\_ġZ wZbŕU cvġĠ A, B, C tġtġj `v |  
cvġġtġvi A-tZ Kġ | ZvcgvĠvi cwb Ges C -tZ  
tek Mig cwb (Zġ tZvgvi nvġZ mnbxq) bv | B  
-tZ LwbKŪv Mig I Kġ | ZvcgvĠvi cwb tġkŕv |  
Gevi A -cvġĠ tZvgvi Wb nvZ Ges C- cvġĠ evg  
nvZ Wvŕ | GK wġvU ci nvZ `ŕU DVŕ Ges  
GKmvġ\_`Ģ nvZ B -cvġĠ Wvŕ | Gevi tZvgvi `Ģ  
nvġZi AbyfWZ Kx ?

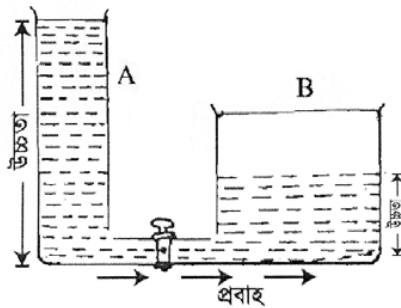


hw` I C- cvġĠ GKŕU wŕv` ZvcgvĠvi cwb AvġQ Zeġ | Wb nvġZ Mig Ges evg nvġZ VŪv AbyfZ ntġ |  
KviY Wb nvZ AvġM th cwb i gġa` Wvġbv ŕQj Zvi tġġ B Gi cwb i ZvcgvĠv tewk | Abyġfvġe evg nvġZ  
VŪv AbyfZ ntġ KviY evg nvZ AvġM th cwb i gġa` Wvġbv ŕQj Zvi tġġ B Gi cwb i ZvcgvĠv Kg |

ZvcgvĠv

ZvcgvĠv nt`Q tKvġbv e` i Ggb GK Zvcxq Ae`v hv wbaŕY Kġi H e` ŕU Ab` e` i Zvcxq ms`uġKġGtġ  
e` ŕU Zvc nvivġe bv MŕY Kiġe |

ZvcgvĠvġK Zitġi gŕĢ Zġi mvġ\_ Zġbv Kiv thġZ cvġi |  
Avgiv Rwb D`PZi Zġ t\_ġK Zij me©v wŕvZi Zġi w\_ġK  
cĕwnZ nq | ŕġĠ A cvġĠi Zitġi D`PZv B cvġĠi Zitġi  
D`PZvi tġġ tewk | wKš` A cvġĠ Zitġi cwi gŕY Kg Ges B  
cvġĠ Zitġi cwi gŕY tewk | ÷c KK S Lġj w\_ġj A cvġ t\_ġK  
B cvġĠ Zij cĕwnZ ntZ \_vKġe hZġY bv Dfġ cvġK Zitġi  
D`PZv mgvb nq | tZġmbfvġe Zvcxq mstġwM `vcb Kiġj DòZi  
e` t\_ġK kxZjZi e` tZ Zvc cĕwnZ nq hZġY bv Dfġq  
ZvcgvĠv mgvb nq |



th e` i ZvcgvĠv tewk tm Zvc nvivq Avi th e` i ZvcgvĠv Kg

তম Zvc MhY Kti | ZvcgvIv cwi gvtci htšzi bvg \_vtgngUvi |

ZvcgvIvi GKK: AvšRZK cñwZtZ ZvcgvIvi GKK tKjwfb (K) |

tKjwfb : th wlv̄ ̄ ZvcgvIv I Ptv̄ cwb wZb Ae'v̄tZB A\_̄ eid, cwb Ges Rjxq ev̄úic̄ Ae'v̄b Kti  
Zv̄tK cwb̄i ^̄Tame`y (Triple Point) etj | GB ^̄Tame`y ZvcgvIv 273 K aiv nq | cwb̄i ^̄Tame`y  
ZvcgvIvi  $\frac{1}{273.16}$  f̄m tK GK tKjwfb (1 K) etj |

## 6.2 চ'ব্বে ZvcgwI K aḡ

### Thermometric properties of matter

ZvcgvIv cwi gvtci t̄t̄t̄ চ'ব্বে w̄et̄kl w̄et̄kl aḡK Kv̄R jv̄w̄t̄bv nq | ZvcgvIvi Zvi Zt̄ḡi Rb̄ c'v̄t̄P  
th aḡw̄bq̄qZfv̄te cwi enZ̄ nq Ges GB cwi eZ̄ j̄ t̄t̄ mnR I m̄z̄fv̄te ZvcgvIv w̄b̄r̄cb Kiv hv̄q t̄mB  
aḡKB c'v̄t̄P ZvcgwI K aḡetj | H c'v̄t̄P ZvcgwI K c'v̄t̄P etj | \_vtgngUv̄i ḡt̄ā ZvcgwI K c'v̄t̄P  
e'envi Kiv nq |

ZvcgwI K aḡetjv n̄t̄Q c'v̄t̄P Av̄qZb, t̄iva, P̄vc BZ'w̄ | cvi` \_vtgngUv̄i t̄t̄t̄ Kv̄Pi ^̄K̄k̄K b̄t̄j̄  
w̄f̄Z̄t̄i īw̄t̄Z̄ cvi` t̄K ZvcgwI K c'v̄t̄P Ges cvi` ^̄N̄t̄K ZvcgwI K aḡetjv nq | GKBfv̄te M̄vm  
\_vtgngUv̄i t̄t̄t̄ ā'e Av̄qZb̄ c̄t̄t̄ īw̄t̄Z̄ M̄vm̄t̄K ZvcgwI K c'v̄t̄P Ges M̄v̄t̄mi P̄v̄t̄K ZvcgwI K aḡetjv  
nq |

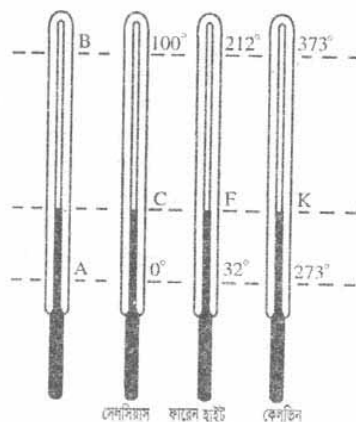
## 6.3 : t̄mjw̄mq̄m, dv̄ti b̄nvBU I t̄Kjw̄fb t̄<t̄j̄ ḡt̄ā m̄x̄úK̄

### Relation between Celsius, Farenheit and Kelvin scale

t̄Kv̄t̄bv e' i ZvcgvIv m̄w̄Kfv̄te w̄b̄t̄R̄ Kivi Rb̄ ZvcgvIvi GK̄w̄ t̄<j̄ c̄q̄v̄Rb̄ | ZvcgvIvi t̄<j̄ ^̄Z̄wi  
Rb̄ ^̄ȳU w̄lv̄ ̄ ZvcgvIv̄t̄K w̄' i āt̄i t̄bl̄qv nq | GB ZvcgvIv ^̄ȳŪt̄K w̄' īv̄¼ etj | w̄' īv̄¼ ^̄ȳU-  
w̄b̄ḡe' īv̄¼ I EāȳP' īv̄¼ | c̄ȳv̄ P̄tv̄c th ZvcgvIv̄q̄ w̄e' īv̄ eid M̄t̄j̄ cwb nq A\_̄ev̄ w̄e' īv̄ cwb R̄tḡ eid  
nq Zv̄t̄K w̄b̄ḡe' īv̄¼ etj | Ḡt̄K w̄nḡv̄¼ ev̄ eid w̄e' īv̄ etj | Avēvi c̄ȳv̄ P̄tv̄c d̄Ūš-w̄e' īv̄ cwb th  
ZvcgvIv̄q̄ R̄j̄x̄q̄ ev̄t̄ú̄ cwi YZ nq Zv̄t̄K EāȳP' īv̄¼ etj | EāȳP' īv̄¼ t̄K Ñ̄lv̄b̄v̄s̄K ev̄ e'̄ú̄me`y etj |  
w̄' īv̄¼ ^̄ȳU ḡa'eZ̄P̄ ZvcgvIvi e'̄eav̄t̄K t̄ḡš̄j̄K e'̄eav̄t̄ etj | t̄ḡš̄j̄K e'̄eav̄t̄K b̄v̄b̄fv̄te f̄m̄ K̄t̄i  
ZvcgvIvi w̄e' f̄b̄t̄<j̄ ^̄Z̄wi Kiv n̄t̄q̄t̄Q | ZvcgvIvi c̄ȳv̄j̄ Z̄ t̄<j̄ w̄Z̄b̄w̄ : t̄mjw̄mq̄m, dv̄ti b̄nvBU I t̄Kjw̄fb̄ |  
t̄mjw̄mq̄m, dv̄ti b̄nvBU I t̄Kjw̄fb̄ t̄<t̄j̄ ZvcgvIvi GKK  
h\_v̄p̄t̄ḡ °C, °F Ges K | t̄mjw̄mq̄m t̄<t̄j̄ w̄b̄ḡe' īv̄¼  
0°C, dv̄ti b̄nvBU t̄<t̄j̄ 32°F Ges t̄Kjw̄fb̄ t̄<t̄j̄ 273  
K | DāȳP' īv̄¼ t̄mjw̄mq̄m t̄<t̄j̄ 100°F, dv̄ti b̄nvBU  
t̄<t̄j̄ 212°F Ges t̄Kjw̄fb̄ t̄<t̄j̄ 373K |

ZvcgvIvi w̄e' f̄b̄t̄<t̄j̄ ḡt̄ā m̄x̄úK̄'v̄cb :

w̄b̄ḡe' īv̄¼ A Ges EāȳP' īv̄¼ B w̄P̄r̄Z̄ GK̄w̄  
\_vtgngUvi t̄bl̄qv̄ n̄t̄j̄v̄ (w̄P̄ 6.3) | Z̄v̄ci t̄mjw̄mq̄m,  
dv̄ti b̄nvBU I t̄Kjw̄fb̄ t̄<t̄j̄ ^̄w̄w̄¼Z̄ Av̄t̄iv̄ w̄Z̄b̄w̄  
\_vtgngUvi c̄v̄k̄v̄c̄w̄k̄ īv̄Lv̄ n̄t̄j̄v̄ | AB \_vtgngUv̄i P̄  
Ae'v̄t̄bi c̄w̄ Aci w̄Z̄b̄w̄ t̄<t̄j̄ h\_v̄p̄t̄ḡ C, F Ges K |



mZi vs GB wZb t`<tj PA`iZih\_wptg C-0, F-32 Ges K-273 | Avevi  $\frac{PA}{BA}$  a`eK nI qvq tj Lv hvq,

$$\frac{PA}{BA} = \frac{C-0}{100-0} = \frac{F-32}{212-32} = \frac{K-273}{373-273}$$

$$ev, \frac{C}{100} = \frac{F-32}{180} = \frac{K-273}{100}$$

$$ev, \frac{C}{5} = \frac{F-32}{9} = \frac{K-273}{5} \quad (6.1)$$

mgxKiY (6.1) ntjv tmjwmqvm, dvti bnvBU I tKjwfb t`<tj i gta` m`uK`b t` R Kti |

Zte tmjwmqvm I tKjwfb t`<tj i mnR m`uK`ntjv- tmjwmqvm t`<tj i cvtVi mvt\_ 273 thvM Kiti  
tKjwfb t`<tj cvl qv hvq | thgb 1°C Zvcgvîv = (1+273) K = 274K Zvcgvîv |

Zte Zvcgvîvi cv`R` 1°C ntj tmUv 1K Gi mgvb nte |

MwYwZK D`vniY 6.1 : mY` gvbti i t`tni Zvcgvîv 98.4°

F | tmjwmqvm t`<tj GB Zvcgvîv KZ nte?

Avgiv Rmb

$$\frac{C}{5} = \frac{F-32}{9}$$

$$ev \frac{C}{5} = \frac{98.4-32}{9}$$

$$ev C = 36.89^0 C$$

DËi : 36.89° C

t`I qv AvtQ,  
dvti bnvBU t`<tj Zvcgvîv,  
F=98.4° F  
tmjwmqvm t`<tj Zvcgvîv, C = ?

## 6.4 e`' i Zvcgvîv e`v I Af`šixY kw³

### Raise of temperature and internal energy of a body

c`vt\_ŕ AvYweK MwZZtËji wfvËtZ Avgiv Rmb th, c`vt\_ŕ AYytjv me`v MwZkxj | KwB c`vt\_ŕ AYytjv  
GK`v`tb t`tK Gw`K-lw`K `úw`Z nq | Zij I M'vnxq c`vt\_ŕ AYytjv Gtjvtgtjvfvte QvUvUw Kti |  
AYytjvi GB MwZi Rb` MwZkw³ i m`Ávi nq | Avevi KwB c`vt\_ŕ AYytjvi gta` AvKIŕ-weKIŕ ej AvtQ  
etj wefekw³ AvtQ | M'vnxq c`vt\_ŕ AYytjvi gta` AvKIŕ-weKIŕ ej tbB etj wefekw³ tbB | c`vt\_ŕ  
AYytjvi MwZkw³ I wefekw³ i mgwótk Af`šixY kw³ etj | `úóZ Af`šixY kw³ i GK Ask MwZkw³ Aci  
Ask wefekw³ | tKv`bv e`' tZ Zvcxq kw³ c`vb Kiti Zvi Af`šixY kw³ ervo | Zte Af`šixY kw³ i  
MwZkw³ AskUKzi` agvî Zvcgvîv e`v Nuvq |

## 6.5 c`vt\_ŕ Zvcxq c`hviY

### Thermal expansion of substance

c`q mKj c`v\_Ŕ Zvc c`qvtM c`hviZ nq Avi Zvc AcvitiY msKuPZ nq | hLb tKv`bv e`' DËB nq, ZLb  
e`' wUi c`Z`K AYj Zickw³ Z\_v MwZkw³ e`v cvq | KwB c`vt\_ŕ tejvq AvšAvYweK etji weci`tZ  
AYytjv Avti`v ewaZ kw³tZ `úw`Z ntZ `vtK dtj mgv`ve`'v t`tK AYytjvi miY e`v cvq | wKš' tKv`bv



$$\begin{aligned} \text{Avgiv Rwb, } \alpha &= \frac{l_2 - l_1}{l_1(\theta_2 - \theta_1)} \\ &= \frac{0.033 \text{ m}}{100 \text{ m} \times 30 \text{ K}} \\ &= 11 \times 10^{-6} \text{ K}^{-1} \end{aligned}$$

ত`l qv AvtQ,  
 Aw` N°,  $l_1 = 100 \text{ m}$   
 tkI N°,  $l_2 = 100.033 \text{ m}$   
 Aw` ZvcgvIv,  $\theta_1 = 20^\circ \text{C}$   
 tkI ZvcgvIv,  $\theta_2 = 50^\circ \text{C}$   
 ZvcgvIv ewx,  $\theta_2 - \theta_1 = 30 \text{ K}$   
 N°ewx,  $l_2 - l_1 = 0.033 \text{ m}$   
 N°cñviY mnM,  $\alpha = ?$

chñeñY: tij jvBtb thLvfb `yU tijvni evi wgwj Z nq tmLvfb duK \_vtK tKb?

tiŠ`ñ Zvtc I PvKvi NIñY tijvni DEB nqñ cñwiZ nq| GB  
 cñviñYi mñeavi Rb` duK ivLv nq| duK bv \_vKñj cñviñYi Rb` tij  
 jvBb teñK hvte|

tññI cñviY I tññI cñviY mnM:

GKuW KuWb e` i ZvcgvIv ewx Kiñj Gi tññI dj ewx cñq| GñK  
 tññI cñviY etj | aiv hvK  $\theta_1$  ZvcgvIvq tKvfbv KuWb c`v\_ñ cññi  
 Aw` tññI dj =  $A_1$

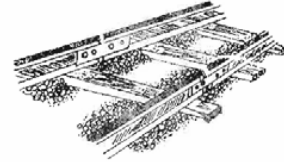
ZvcgvIv ewx Kñi  $\theta_2$  Kiñj tkI tññI dj =  $A_2$

mñZivs ZvcgvIv ewx =  $\theta_2 - \theta_1$

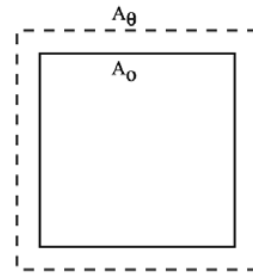
tññI dj ewx =  $A_2 - A_1$

tññI cñviY mnMñK ß ðviv cñK Kiv nq hvi i wkgvjv

$$\begin{aligned} \beta &= \frac{A_2 - A_1}{A_1(\theta_2 - \theta_1)} \\ &= \frac{\text{tññI dj ewx}}{\text{Aw` tññI dj} \times \text{ZvcgvIv ewx}} \end{aligned} \quad (6.3)$$



ৱেল লাইন ও ফিসপ্রেট  
 পি 6.5



পি 6.6

6.3 bs mgxKiñY hw` Aw` tññI dj  $A_1 = 1 \text{ m}^2$  Ges ZvcgvIv ewx  $(\theta_2 - \theta_1) = 1 \text{ K}$  nq Zñe

$\beta = A_2 - A_1 = \text{tññI dj ewx}$

mñZivs  $1 \text{ m}^2$  tññI dtñj i tKvfbv KuWb c`v\_ñ ZvcgvIv  $1 \text{ K}$  ewx i dtñj hZUKñtññI dj ewx cñq ZvtK H  
 e` i Dcñ vñbi tññI cñviY mnM etñj | Gi GKK  $\text{K}^{-1}$

Zvgvi tññI cñviY mnM  $33.4 \times 10^{-6} \text{ K}^{-1}$  ejñZ eñsq th  $1 \text{ m}^2$  tññI dtñj i tKvfbv Zvgv Ltñi ZvcgvIv  $1 \text{ K}$   
 ewx Kiñj Zvi tññI dj  $33.4 \times 10^{-6} \text{ m}^2$  ewx cñq|



AvqZb cñvi Y I AvqZb cñvi Y mnM

tKv̄bv Kw̄b c`v\_Á Zvcgv̄v eiv̄s Ki t̄j Gi AvqZb eiv̄s c̄vq| Gt̄K AvqZb cñvi Y e t̄j |

aiv hvK, tKv̄bv Kw̄b c`v\_Á Aw̄ AvqZb  $V_1$  Ges Aw̄ Zvcgv̄v  $\theta_1$  |

Gi Zvcgv̄v emot̄q hLb  $\theta_2$  Kiv nt̄jv ZLb AvqZb eiv̄s t̄ct̄q  $V_2$  nt̄jv| m̄Zivs AvqZb eiv̄s =  $V_2 - V_1$  | Zvcgv̄v eiv̄s =  $\theta_2 - \theta_1$  |

AvqZb cñvi Y mnM̄K  $\gamma$  Øviv cK̄vk Kiv nq hvi i m̄kgvjv w̄b̄c,

$$\gamma = \frac{V_2 - V_1}{V_1(\theta_2 - \theta_1)} \quad (6.4)$$

$$= \frac{\text{AvqZb eiv̄s}}{\text{Aw̄ AvqZb} \times \text{Zvcgv̄vi eiv̄s}}$$

6.4 bs mgxKi t̄Y hw̄ Aw̄ AvqZb  $V_1 = 1 \text{ m}^3$  Ges Zvcgv̄v eiv̄s  $\theta_2 - \theta_1 = 1 \text{ K}$  nq Zt̄e

$$\gamma = V_2 - V_1 = \text{AvqZb eiv̄s} |$$

m̄Zivs  $1 \text{ m}^3$  AvqZt̄bi tKv̄bv Kw̄b c`v\_Á Zvcgv̄v  $1 \text{ K}$  eiv̄s d̄t̄j hZUKz AvqZb eiv̄s c̄vq Zv̄t̄K H e` i Dc̄v̄t̄bi AvqZb cñvi Y mnM e t̄j |

Zvgvi AvqZb cñvi Y mnM  $50.1 \times 10^{-6} \text{ K}^{-1}$  ej t̄Z eS̄vq  $1 \text{ m}^3$  AvqZt̄bi Zvgvi Zvcgv̄v  $1 \text{ K}$  eiv̄s Ki t̄j AvqZb  $50.1 \times 10^{-6} \text{ m}^3$  eiv̄s c̄t̄e |

Gt̄ i ḡt̄a` m̄ūK°.

$$\gamma = 3\alpha \text{ Ges } \beta = 2\alpha$$

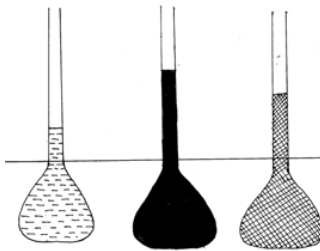
## 6.7 Zij c`v\_Á cñvi Y

### Expansion of liquid

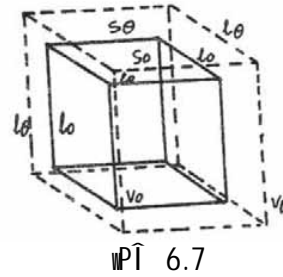
Zij c`v\_Á w̄b̄s `N°ev t̄q̄t̄dj t̄bB| Zt̄e w̄b̄s AvqZb Av̄Q| Zi t̄j Zvcgv̄v eiv̄s Ki t̄j Gi AvqZb eiv̄s c̄vq| m̄Zivs Zi t̄j cñvi Y ej t̄Z Zi t̄j AvqZb cñvi Y t̄KB t̄evS̄vq| Zvcgv̄v eiv̄s m̄v̄t̄\_ m̄v̄t̄\_ m̄Kj Zij mgvb nv̄t̄i eiv̄s c̄vq bv̄| GKB Zvcgv̄v eiv̄s Rb̄ mg-AvqZt̄bi w̄ev̄f̄b̄e Zij c`v\_Á cñvi Y w̄ev̄f̄b̄onq |

cix̄q̄v :

j̄b̄v b̄jh̄p mgAvqZt̄bi I mgAvK̄v̄i K̄t̄qK̄u K̄v̄Pi ev̄j̄ t̄bl̄qv nt̄jv| Gt̄Z mgAvqZb c̄wb, A`vj̄t̄K̄v̄nt̄jv, t̄K̄tiw̄mb, B̄vi c̄f̄w̄Z K̄t̄qK̄u Zij t̄bl̄qv nt̄jv (w̄P̄ : 6.8) Gevi GK̄u Āt̄c̄q̄v̄K̄Z eo cv̄t̄ K̄q̄ Zvcgv̄vi c̄wb w̄ot̄q Zvi ḡt̄a` GB ev̄j̄ t̄j̄v̄t̄K Dj̄ c̄f̄v̄t̄e `v̄cb Kiv nt̄jv| me K̄u ev̄t̄j̄i ḡt̄a` Zi t̄j Dc̄wi Zj GKB `v̄K̄t̄e| GLb cv̄t̄ w̄K̄Oz Mig c̄wb X̄ijv nt̄jv| w̄K̄Oq̄Y ci hLb ev̄j̄ t̄jv D̄P Zvcgv̄v c̄ŌB



w̄P̄ : 6.8



n̄te ZLb t̄Lv hv̄te ev̄tj̄i b̄tj Zītj̄i DcwiZj GKB D"PZvq tbB, newfb̄eb̄tj Zītj̄i D"PZv newfb̄e G  
t̄t̄K tevSv h̄vq th̄w̄ C̄ Zvcav̄v̄ ev̄t̄Z mgAv̄qZ̄bi newfb̄eZ̄it̄j̄i Av̄qZb c̄viY newfb̄onq|

6.8 Ziṭji cKZ l AvcvZ cṁviY

### Real and apparent expansion of liquids

Zij tK me v tKv tbr cv t t tL D E B Ki tZ nq | Zvc c l q M Ki t j Zij l cv t D f t q i B c h n i Y N t U | GB  
Kvi t Y Zi t j i th c h n i Y Avg i v j K w i Z v Zvi c K Z c h n i Y b q - A v c i Z c h n i Y | m y z i v s Zi t j i c h n i Y  
B c K v i :

K)  $c\ddot{K}Z\ c\ddot{u}vi\ Y$  | L)  $AvcvZ\ c\ddot{u}vi\ Y$

cKZ cñviY : Zij tK tKufbv cvtî bv ti tL (hî mæ nq) Ziv wî tj Zvi th AvqZb cñviY nîZv Zv tK  
Zi tji cKZ cñviY etj | Zte Zv mæ bq dtj cvtîi cñviY we tPbv Kti cKZB Zi tji th UKz cñviY  
NîU Zi b cKZ cñviY | G tK V<sub>r</sub> Øviv cKvk Kiv nq |

AvcıZ cñviY : tKıtv cvtİ Zij tiİL Zvc w`tj Ziİji th AvgZb cñviY t`LİZ cvl qv hvq, A\_İ cvtİ cñviY wetePbvq bv Gİb Ziİji th cñviY cvl hv hvq ZvtK Ziİji AvcıZ cñviY etj | GİK V<sub>a</sub> Øiv cKvk Kiv nq |

cKZ cñviY | AvcvZ cñvi†Yi g†a" mᄡúK©:

GKUv `wM KuUv mi" bjwemkó KvPi evj|wbq Zvi A `wM chS-tKvbr Zij Øviv cY©Kiv ntjv| GLb Zij  
 Ítð w`tK j¶|tíL evj|wK Mig Kíj t`Lv hte th, Zíj|i Dcwí Zj A t`tK B `wM chS-tbtg Avtm|  
 Zvici Avevi B `wM t`tK íi" Kíi A `wM AwZug Kíi C `wM chS-ltV| Gi KviY Zvc cØq¶M cØtg  
 evj|wí AvqZb ew¶ c¶q| hvi Rb" Zij A t`tK B tZ tbtg hvq| cti Zij thB Mig nq tmB Zvi AvqZb  
 ew¶ íi" nq Ges B t`tK C chS- ltV| KwB c`v.¶ tPtq Zíj|i c¶wiY temk weavq Giε NtU| AvrcZ  
 `wóZ gtb nte Zij cØtg A `wM chS-wj Ges mektí C `vM DtvTQ| ZvB CA ntjv AvrcZ c¶wiY|  
 CB ntjv cKZ c¶wiY Ges AB ntjv c¶íi c¶wiY|

WPI t\_K t`Lv hvq th,

$$CB = CA + AB$$

$$e v c \ddot{K} Z c \ddot{h} v i Y = A v c v Z c \ddot{h} v i Y + c v \hat{t} i c \ddot{h} v i Y$$

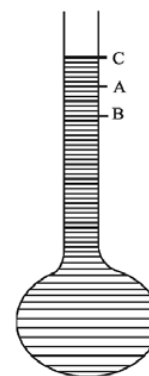
$$V_r = V_a + V_g \quad (6.5)$$

6.9 c`v† © Ae`'vi cwi eZ†b Zv†ci c†ve

### Effect of heat on change of state.

c`v`@wZbU Ae`vq\_vKtZ cvti| thgb- KwB, Zij l evqexq| cwbI wZbU  
Ae`v Argiv mKtjB Rwb- eid, cwb l Rjxqer®ú| G wZbU Ae`vtK h\_vutg  
KwB, Zij l evqexq ejv nq| cwbI GB Ae`v\_v.tjv wbf® Kti evqPvc l  
Zvcqvîvi Dci|

tkvfbv KwB c`v PK Zvc c0qM Kti Ziti cwiYZ Kiv hvq, GtK Mjb etj | c0tg Zvc w`tj e`'i  
Zvcgvlv evotZ JvtK Ges GK ch0q Zvc c0qM Kiti I e`'i Zvcgvlv evto bv | G mg0q th Zvc e`'  
tkvY Kti Zv 0viv KwB c`v 0J Ziti cwiYZ nq | 00C Zvcgvlvi w0Pi eidtK Zvc w`tZ vKti Zvcgvlv



WPI 6.9



## 6.11 Mj br $\frac{1}{4}$ i Dci Prtci c`ve

### Effect of pressure on boiling point

wbtr Kti t`tlv: `B UKtiv eidtk GK m $\frac{1}{2}$  wbtq wKQY Rvti tPtc ati tQto `vl | Kx t`Ltz cr`Q? UKiv `Bw tRvov tjtm wMtqtQ | tKb?

eid UKiv `tUvi `ukZtj Pvc covq tmlvrb Mj br $\frac{1}{4}$  Ktg hvq A\_@ Mj br $\frac{1}{4}$  0°C Gi tPtg Kg nq | wKs' `ukZtj i DòZv 0°C \_vtK | ZvB `ukZtj i eid Mtj hvq | Mjvi Rb' c@qvRbxq Zvc eid t\_tK mslmxZ nte | Pvc Acuvi Y Kij Mj br $\frac{1}{4}$  cbivq 0°C- nq |

ZvB `ukZtj i eid Mjv cwb Rtg eitd cwiYZ nq | GB

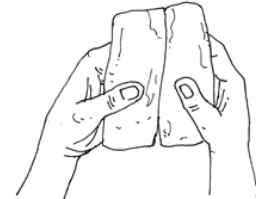
Kvi tY Pvc c@qM Kij `B UKiv eid GK UKivq cwiYZ nq |

Pvc w`tg KwB e'` tK Zitj cwiYZ Kti | Pvc nwm Kti Avevi

KwB Ae'`vq Avbtk cptwkjxfeb etj |

c`vt\_@ Dci Prtci nwm-er`vi Rb' Mj br $\frac{1}{4}$  cwiemZ nq | Prtci Rb' Mj br $\frac{1}{4}$  cwieZB `B fvtetnz cti |

- KwB t\_tK Zitj qcvstti mgq thme c`vt\_@ AvqZb nwm cvq (thgb eid), Pvc evotj Zvt`i Mj br $\frac{1}{4}$  Ktg hvq A\_@ Kg Zvcgvivq Mtj |
- KwB t\_tK Zitj qcvstti mgq thme c`vt\_@ AvqZb tetò hvq (thgb tgvq), Pvc evotj Zvt`i Mj br $\frac{1}{4}$  tetò hvq A\_@ tewk Zvcgvivq Mtj |



wT 6.10

## 6.12 Mj tbi myZvc I ev@uxfetbi myZvc

### Latent heat of fusion and Latent heat of vaporisation

Mj tbi myZvc: Avgiv Rwb, Zvc c@qvMi dtj KwB c`vt\_@ Zvcgviv hLb Mj br $\frac{1}{4}$  tcSqv ZLb m`uY© c`v\_©Zitj ievs-wiZ nlqv chS- Zvcgvivi Avi cwieZB nq bv | GLvrb th cwigvY Zvc KwB c`v\_@K Zij Ae'`vq qcvstti Kij ZvB Mj tbi myZvc |

GB Zvc e'` i Zvcgvivi cwieZB Kti bv wKsAvstAvYweK eÜb wkwj Kitz e`q nq |

ev@uxfetbi myZvc: Zij c`v\_@K Zvc c@qM Kitz \_vKtj hLb Zvcgviv Übbr $\frac{1}{4}$  Ptj Avtm ZLb hZB Zvc c@qM Kiv tnvK bv tKb m`uY©Zij evt@u ievs-wiZ nlqv chS- Zvcgviv w'`i \_vtK | GLvrb th cwigvY Zvc Zij c`v\_@K ev@uxq Ae'`vq qcvstti Kij ZvB ev@uxfetbi myZvc |

ev@uqtb kxZj Zvi D`e: Mitgi w`tb bZb gwUi Kjm tZ cwb ivLtj H cwb VvÜv nq | gwUi Kjwmi Mtq Amsl` wQ`\_vtK H wQ`\_w`tg me`v cwb PBtg ewnti Avtm | evt@u cwiYZ nq | GRb' c@qvRbxq myZvc Kjwmi cwb mieivn Kti Ges VvÜv nq |

KvP ev wZtj i cvt` cwb ivLtj Zv VvÜv nq bv | KviY, H cvt`i Mtq wQ`\_vtK bv Ges ev@uqtb i tKvrbv mthv m`v nq bv |

Gevi ej tZigvi t`n t\_tK hLb Nig tei nq; ZLb cvLvi evZvrm VvÜv AbyfZ nq tKb?

6.13 wewfbceel tqi Dci er<sup>®</sup>úvg tbi wbf<sup>©</sup>kxj Zv

## Dependence of evaporation on various factors

Woburn, MA 01801

evqycēn : Zi tji Dci evqycēn er tctj er<sup>u</sup>qab `Z ng |

$$Z_i \dagger j_i \text{ } D_{Cw_i} Z \dagger j_i$$

$t_{\hat{t}}^{\hat{t}} dj$  : Zi tj i Dcwi Ztj i  $t_{\hat{t}}^{\hat{t}} dj$  hZ teuk ng, er<sup>®</sup>uq b ZZ `Z ng |

Zitji cKwZ : weifbē Zitji er<sup>u</sup>uqtbi nvi weifbē Zitji ūlvb¼ Kg ntj er<sup>u</sup>uqtbi nvi teik  
nq| Dŏvq Zitji er<sup>u</sup>uqtbi nvi meŏak|

Zitji Dci Pvc : Zitji Dci evotj Etji Pvc evotj eruvqbi nvi Ktg hvq| Pvc Kgtj eruvqbi nvi  
erto| kb'v'tb eruvqbi nvi mwaK

Zij | Zij msj Moe

erqj DòZv : Zij l Zij msj Mævqj DòZv evotj er®úvq b`z ng|

evqj i<sup>®</sup><Zv : Zij c`v<sub>t</sub><sup>®</sup> Dcwi Ztj i evZm hZ i<sup>®</sup>< nte, A<sub>v</sub><sup>®</sup> evqZ hZ Kg cwigvY Rjxq  
er<sup>®</sup>ú<sub>v</sub>Kte er<sup>®</sup>úq<sub>b</sub> ZZ `Z nte| kxZKtj evqj i<sup>®</sup>< \_vtK etj wFRv K<sub>v</sub>co Z<sub>v</sub>ovZmo  
i K<sub>v</sub>q|

6.14 Zvcavi Y 𐀓𐀕Zv

## Thermal capacity

$\text{tKr}^{\text{tr}}\text{bv} \text{ e}^{-} \text{ i } \text{Zvcg}\hat{\text{v}} \text{ 1K } \text{evor}^{\text{t}}\text{Z } \text{th } \text{cwi} \text{g}\hat{\text{v}} \text{ Zv}^{\text{t}}\text{ci } \text{c}\hat{\text{q}}\text{vRb } \text{Zv}^{\text{t}}\text{K } \text{H } \text{e}^{-} \text{ i } \text{ZvcaviY } \text{q}\hat{\text{g}}\text{Zv } \text{ej}^{\text{t}}\text{ |}$   
 $\text{ZvcaviY } \text{q}\hat{\text{g}}\text{Zv } \text{e}^{-} \text{ i } \text{Dc}^{\text{r}}\text{wb } \text{Ges } \text{f}^{\text{t}}\text{i } \text{Dci } \text{wb } \text{f}^{\text{t}}\text{Kj}^{\text{t}}\text{ | Gi } \text{GKK } \text{JK}^{-1}\text{ | } \text{tKr}^{\text{tr}}\text{bv} \text{ e}^{-} \text{ i } \text{ZvcaviY } \text{q}\hat{\text{g}}\text{Zv } 10$   
 $\text{JK}^{-1} \text{ ej}^{\text{t}}\text{Z } \text{e}\hat{\text{S}}\text{g } \text{th } \text{H } \text{e}^{-} \text{ i } \text{Zvcg}\hat{\text{v}} \text{ 1K } \text{evor}^{\text{t}}\text{Z } 10 \text{ J } \text{Zv}^{\text{t}}\text{ci } \text{c}\hat{\text{q}}\text{vRb} \text{ |}$

$$|K_{\text{eff}}| = \frac{Q}{\Delta\theta}$$

$$m_{Z_i} \text{ vs } Z_{\text{vac}i} \text{ Y } \text{flg} Z_i, C = \frac{Q}{\Delta\theta} \quad (6.6)$$

c`v_°	Avtci¶K Zvc (J kg <sup>-1</sup> K <sup>-1</sup> )
cwb	4200
eid	2100
Rj xq er®ú	2000
mxmv	130
Zvgv	400
ifcv	230

## 6.16 Avtci¶K Zvc I ZvcaviY ¶lgZvi m®úK®

### Relation between specific heat and thermal capacity

Avgi v Rwb, tKvtrv e<sup>-</sup> i Zvcgv¶v 1 K evovtZ th Zvtci c¶qvRb nq ZvtK H e<sup>-</sup> i Zvc aviY ¶lgZv etj | Avevi hw<sup>-</sup> e<sup>-</sup> i Dcv`vbi Avtci¶K Zvc S nq, Zte GKK fti i e<sup>-</sup> i Zvcgv¶v 1 K evovtZ S Rj Zvtci c¶qvRb nq |

AZGe,

1 kg e<sup>-</sup> i Zvcgv¶v 1 K evovtZ Zvtci c¶qvRb= S Rj

$$m \text{ kg} \quad 0 \quad 0 \quad 1 \text{ K} \quad 0 \quad 0 \quad 0 = mS \text{ Rj}$$

GUvB mkg fti i e<sup>-</sup> i Zvc aviY ¶lgZv |

$$\text{AZGe, ZvcaviY ¶lgZv } C = mS \text{ Rj} \quad (6.8)$$

ev, ZvcaviY ¶lgZv= fi × Avtci¶K Zvc

$$\text{mZivs, Avtci¶K Zvc} = \frac{\text{ZvcaviY ¶lgZv}}{fi}$$

GUvB, Avtci¶K Zvc I ZvcaviY ¶lgZvi m®úK®

## 6.17 K`vjwi wgvZi gj bwxZ

### Fundamental principle of calorimetry

wfbæZvcgv¶vi `yU e<sup>-</sup> tK Zvcxq ms`útk®Avbv ntj Zvt`i gta<sup>-</sup> Zvtci Av`vb-c¶vb nq | th e<sup>-</sup> i Zvcgv¶v tewk tm Zvc eR® Ki te Avi th e<sup>-</sup> i Zvcgv¶v Kg tm Zvc M®Y Ki te | Zvtci GB M®Y I eR® Pj tZ \_yK te hZ¶Y bv Dftqi Zvcgv¶v mgvb nq |

hw<sup>-</sup> M®Y I eR®bi mgq tKvtrv Zvc bó bv nq, Zte tewk Zvcgv¶vi e<sup>-</sup> th cwi gvY Zvc eR® Ki te Kg Zvcgv¶vi e<sup>-</sup> tmB cwi gvY Zvc M®Y Ki te |

$$A_\text{¶} \text{ tgvU emRZ Zvc} = \text{tgvU MinZ Zvc} \quad (6.9)$$

GUvB K`vjwi wgvZi gj bwxZ |

## AbymÜvb bs 6.1

eiđdi Mj bv¼ wbYq|

Dĩĩ k` : eiđdi Mj b chē¶Y I Mj bv¼i mĩ\_ Zvcgvĩvi mũKqwbYq I tj LwPĩ A¼b|

hš¿cwĩZ: tĩj wmqm \_vtgũgUvi, eid, ÷ vÜ, evYq, weKvi, ÷ cl qvP|

Kvhē¶wĩZ : 1. wKQyeid wbtq PY¶Kti GKwU weKviti ivL|

2. \_vtgũgUviĩK mZKZvi mĩ\_ eid P¶Y¶ gta` Wpvl hvZ evj w eiđdi gta` \_vtK wKš` weKviti i Mĩtq bv j vM|

3. Zvc cũqM Kti axti axti Zvcgvĩv ti KW¶Ki tZ nte|

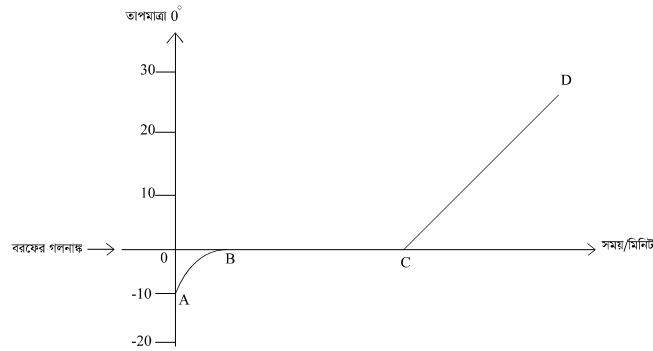
4. cũZ wgvbtU Zvcgvĩv ti KW¶Ki hZ¶¶Y chē— me eid bv Mĩj hvq|

5. Dctii wbtq eid mũY¶Mĩj cwmb nevi ci I Zvc w tZ \_vtKv hZ¶¶Y bv Zvcgvĩv 20°C-25°C nq| cũZ wgvbtU Zvcgvĩv wj wce¶¶ Ki |

6. cũZ Zt\_`i Avtj vK Zvcgvĩv ebvg mgq tj LwPĩ A¼b Ki |

7. tj LwPĩ ev Mĩd t\_`K eiđdi Mj bv¼ tei Ki |

8. tj LwPĩ i cKwZ Avtj vPbv Ki |



## AbymÜvb bs 6.2

cix¶vi bvg: cwmbi Übv¼ wbYq|

Dĩĩ k` : cwmbi Übv chē¶Y I Übv¼i mĩ\_ Zvcgvĩvi mũKqwbYq Kiv|

hš¿cwĩZ: \_vtgũgUvi, evbq, weKvi, ÷ c I qvP|

Kvhē¶wĩZ : 1. GKwU weKviti K¶ Zvcgvĩvi cwmb bvl Ges weKviti i cwmbZ \_vtgũgUvi w Ggbfite `vcb Ki thb evj w weKviti i Mĩtq bv j vM|

2. evbq i mrvth` cwmbZ Zvc `vl Ges 1 wgvbtU ci ci cwmbi Zvcgvĩv ev¶ ti KW¶Ki |

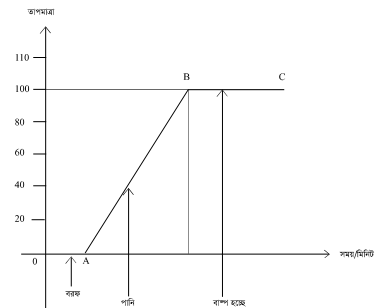
3. j¶ Ki cwmbi Zvcgvĩv 100°C nĩ qvi ci Avi hZB Zvc ev¶ Ki Q Zvcgvĩv ev¶ cvt`Q bv|

4. cũZ Zt\_`i Avtj vK Zvcgvĩv-mgq tj LwPĩ A¼b Ki |

5. tj LwPĩ t\_`K eiđdi Mj bv¼ wbYq Ki |

6. tj LwPĩ i cKwZ Avtj vPbv Ki |

Zvcgvĩv ebvg mgq tj LwPĩ (Graph) A¼b|



## Abkxj bx

K. eũbePbx cŁæ

mWVK DĒiũi cvtk WUK (√) WƳ`vI |

1| tij jvBb wogvƳi mgq `tUv tij thLvtb wgvj Z nq tmLvtb GKUzdvKv i vLv nq tKb ?

K. tjvrv mvktŁ Kivi Rb`|

L. MƳKvŁj tij jvBtbi ZvcgvĬv ewx nvm Kivi Rb`|

M. tij Mmo Pjvi mgq LU LU kã Kivi Rb`|

N. Zvcxq cŁvi tYi Rb` tij jvBtbi weKwZ cwi nvi Kivi Rb`|

2| NgƳ t`tn cvLvi evZvm Avig t`q tKb ?

K. cvLvi evZvm Mtqi Nvg tei ntZ t`q bv ZvB

L. evũvqb kxZj Zvi mwó Kti ZvB

M. cvLvi evZvm kxZj Rjxq evũ avi Y Kti ZvB

N. cvLvi evZvm miwmi tjvgKc w`tŁ kixti XtK hvq ZvB|

3| mƳZvtci gra`tg Ń

i. e`' i ZvcgvĬv ewx nq|

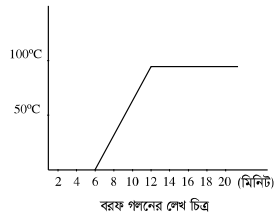
ii. e`' i Ae`'vi cwieZŁ nq|

iii. e`' i Af`šĬixY kw³ বৃন্দ্রি cıq|

wbŁPi tKvbwU mWVK ?

K. i L. ii M. ii I iii N. i, ii I iii

WƳĬi mrvtŁh 5 I 6 bs cŁKc DĒi `vI



4| mœYœid Mj tZ KZ mgq tj tMŁj ?

K. 2 wgvbU

L. 4 wgvbU

M. 6 wgvbU

N. 8 wgvbU

5| Mwj Z cwi bi ZvcgvĬv ũlvvt¼ tcsQvtZ cŁqvRbxq mgq KZ wgvbU

K. 6

L. 8

M. 12

N. 18

mRbkxj cŁæ

1| `yU `e`jwZK ŁyUi ga`eZx` tZj 30 m| ŁyU `yUi mŁ 30.01m ``tN`P Zvgvi Zvi thw`b mstŁvM

t`qv nq H w`b evqj ZvcgvĬv ŁQj 30° C | Zvgvi ``N`cŁvi Y mnM  $16.7 \times 10^{-6} \text{ K}^{-1}$  | kxZKvtj thw`b evqj ZvcgvĬv 4° C ntj v tmw`b Zvi ŁU ŁŁto tMj |

K. cwi bi `Ławe`j ms½v `vI |

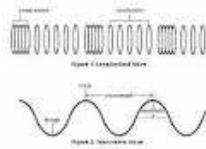
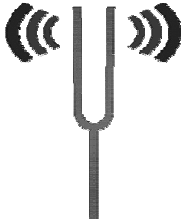
L. `yU e`'i Zvc mgvb ntj I Gt`i ZvcgvĬv wfŁontZ cvti WŁ? e`vL`v Ki |

M. evqj ZvcgvĬvtŁ dvti bnvBU t`Łj cŁkv Ki |

N. Zvi ŁU ŁŁto hvevi Kvi Y MwYwZK hƳmn e`vL`v Ki |



mŕBg Aa`vq  
 Zi ½ I kã  
**WAVES AND SOUND**



[cKt̥i i cwb̥t̥Z w̥xj Qp̥t̥j Avgiv Zi ½ t̥L̥t̥Z cvB | Zi ½ kw̥³t̥K GK ˈvb̥ t̥t̥K Ab̥ ˈv̥t̥b̥ et̥q w̥b̥t̥q hv̥q |  
 kã GK cKvi Zi ½ | kã kw̥³ Avgv̥t̥ i̥t̥K k̥t̥Yi Ab̥f̥w̥Z R̥w̥w̥q | kt̥ãi gvḁt̥gB Avgiv Z̥ ˈt̥c̥Y Ki̥t̥Z  
 cwi | Zv̥B kã Avgv̥t̥ i̥ R̥x̥t̥bi m̥v̥t̥ I Z̥t̥c̥Z̥f̥v̥t̥e R̥w̥oZ | Avei kã ˈt̥Y Avgv̥t̥ i̥ gvi̥v̥Z̥K ʔ̥w̥Z K̥t̥i | GB  
 Aḁv̥t̥q Avgiv Zi ½, kã, kt̥ãi c̥Z̥ḁv̥nb̥, kt̥ãi t̥eM, kã ˈt̥Y c̥f̥w̥Z w̥b̥t̥q Av̥t̥j̥v̥P̥bv̥ Kie |]

GB Aa`vq cvV tk̥t̥l Avgiv-

1. Zi̥t̥½i ˈenk̥ó ˈe̥v̥L̥v̥ Ki̥t̥Z̥ cvie |
2. Zi̥½ms̥w̥k̥ó i̥w̥k̥mg̥t̥ni g̥t̥ḁ mij M̥w̥Y̥w̥Z̥K m̥ḁúK̥ˈv̥cb Ges cwi gvc Ki̥t̥Z̥ cvie |
3. kã Zi̥t̥½i ˈenk̥ó ˈe̥v̥L̥v̥ Ki̥t̥Z̥ cvie |
4. c̥Z̥ḁv̥nb̥ m̥w̥ó ˈe̥v̥L̥v̥ Ki̥t̥Z̥ cvie |
5. ˈb̥w̥ˈb̥ R̥x̥t̥b̥ c̥Z̥ḁv̥nb̥i ˈe̥envi ˈe̥v̥L̥v̥ Ki̥t̥Z̥ cvie |
6. kt̥ãi t̥eM, K̥ḁúv̥¼ Ges Zi̥½ ˈt̥N̥ˈP̥ M̥w̥Y̥w̥Z̥K m̥ḁúK̥ˈv̥cb Ges Zv̥ t̥t̥K i̥w̥k̥mg̥n̥  
 cwi gvc Ki̥t̥Z̥ cvie |
7. kt̥ãi t̥e̥t̥Mi cwi e̥Z̥b̥ ˈe̥v̥L̥v̥ Ki̥t̥Z̥ cvie |
8. k̥t̥e̥Z̥vi m̥x̥gv̥ I G̥t̥ i̥ ˈe̥envi ˈe̥v̥L̥v̥ Ki̥t̥Z̥ cvie |
9. kt̥ãi c̥x̥P̥ I Z̥v̥ʔ̥Z̥v̥ ˈe̥v̥L̥v̥ Ki̥t̥Z̥ cvie |
10. kã ˈt̥t̥Yi K̥vi̥Y̥ I d̥j̥v̥dj̥ Ges c̥Z̥t̥iv̥tai t̥K̥š̥kj̥ ˈe̥v̥L̥v̥ Ki̥t̥Z̥ cvie |

## 7.1 chŋeĚ MmZ, ũ`b ev Qm`Z MmZ

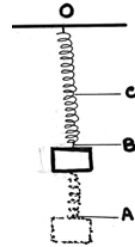
### Periodic motion, oscillatory or harmonic motion

chŋeĚ MmZ : tKvŋbv MmZKxj e` KYvi MmZ hw` Ggb nq th, GmU Gi MmZcŋi tKvŋbv mŋw` ŋe` ŋK mŋw` ŋe` mgq cici GKB w` K t\_ŋK AmZµg Kŋi Zŋe tmB MmZŋK chŋeĚ MmZ etj | Nmoi Kvŋv Ges `e` ŋZK cvLvi MmZ eĚvKvi chŋeĚ MmZ | w` ŋs Gi mŋŋKvPb I cŋviŋYi MmZ ŋimLK chŋeĚ MmZ | chŋeĚ MmZmŋubŋetKvŋbv e` i GKmU cY`chŋq mŋubŋeKiŋZ th mgq jvŋM ZvŋK chŋq Kvj etj |



ŋPĤ 7.1

ũ`b MmZ : chŋeĚ MmZmŋubŋetKvŋbv KYv hw` Zvi chŋq Kvŋji Aŋaŋ mgq th w` ŋK Pŋj , evKx Aŋaŋ mgq Zvi weciX w` ŋK Pŋj Zŋe tmB MmZŋK ũ`b MmZ etj | GKmU w` cŋŋK tKvŋ `p Aeŋ`b t\_ŋK Sŋj ŋq w` ŋq Zvi mŋŋPi cŋŋs— GKmU e` AvUKvŋbv nŋj [ŋPĤ 7.2] Gevi hw` e` w` ŋŋK GKUz Lmb tUŋb tQto t`lqv hvq, Zvŋŋj e` i Dci-mŋP ŋjŋZ ŋKŋe | e` w` ŋi GB MmZ nŋjv ũ`b MmZ ev t`vj b MmZ ev Kŋub MmZ | mij t`vjŋKi MmZ, mj kvKvi Kŋutbi MmZ ũ`b MmZ |



ŋPĤ 7.2

## 7.2 Zi ½

### Waves

cKŋi i w` i cmbŋZ GKmU wŋj Qŋto gvi v nŋjv | wŋj wU hLb cmbŋZ AvNvZ Kŋi ZLb H ŋ`vŋbi cmbi KYv,ŋjv Avŋ`wŋj Z nq | GB Avŋ`wŋj Z KYv,ŋjv cvkŋZxŋ` i KYv,ŋjvŋK Avŋ`wŋj Z Kŋi | Gfvŋe KYv nŋZ KYvŋZ ŋ`vŋŋZwi Z nŋq Avŋ`vj b Aeŋŋŋi cKŋi i wKbvŋq wŋŋq tcsŋvq | cmbi KYv,ŋjv i ay Dci mŋŋP I Vbŋvŋ Kŋi wKŋ' mŋŋŋbi w` ŋK Amŋi nq bv | cŋZ`K KYvi GB aiŋbi MmZi dŋj th chŋeĚ Avŋ`vj b cmbi Dci w` ŋq Pŋj hvq ZvŋKB Zi ½ etj | cmbŋZ Avŋ`vj ŋbi KvŋŋY cmbi KYvmŋŋn th hŋŋŋK kŋŋi mŋŋŋ nq Zv Kŋutbi gvaŋŋg GK`vb nŋZ Ab`ŋ`vŋb mŋwŋj Z nq | mŋZi v Zi ½ ŋv i v kŋŋ GK`vb t\_ŋK Ab`ŋ`vŋb mŋwŋj Z nq |



ŋPĤ 7.3

th chŋeĚ Avŋ`vj b tKvŋbv Ro gvaŋŋgi GK`vb t\_ŋK Ab`ŋ`vŋb kŋŋ mŋwŋj Z Kŋi wKŋ' gvaŋŋgi KYv,ŋjvŋK ŋ`vqxfvŋe ŋ`vŋŋZwi Z Kŋi bv ZvŋK Zi ½ etj |

Kwŋb, Ziŋ ev M`mŋq gvaŋŋg th Ziŋ½i D`mŋe nq Zv hŋŋŋK Zi ½ | cmbi Zi ½, kŋ Zi ½ cŋŋZ hŋŋŋK Zi ½ | hŋŋŋK Zi ½ mŋwŋj ŋbi Rb` w` wZ`vcK gvaŋŋgi cŋŋqRb | Avi GK aiŋbi Zi ½ Avŋŋ hv mŋwŋj ŋbi Rb` tKvŋbv gvaŋŋg jvŋM bv | Giv nŋjv ZmŋZ tPŋŋKxq Zi ½ |

Dŋj ŋ` th eZŋvŋ Aa`vŋq Avgvŋ` i AvŋjvPbv i agvŋ hŋŋŋK Ziŋ½i gŋa` mŋgveŋ i vLŋev | GLvŋb Zi ½ ejŋZ w` wZ`vcK gvaŋŋg mŋŋ Zi ½ŋK eŋŋev |

Ziŋ½i ŋenkŋ`mŋn wŋgŋc:

1. gvaŋŋgi KYv,ŋjvi ũ`b MmZi dŋj Zi ½ mŋŋŋ nq wKŋ' KYv,ŋjvi ŋ`vq ŋ`vŋŋŋŋ nq bv |

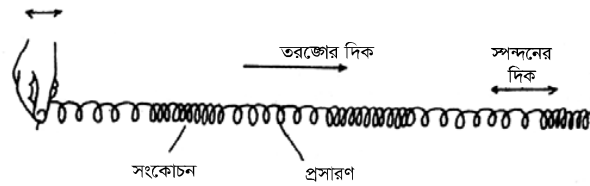
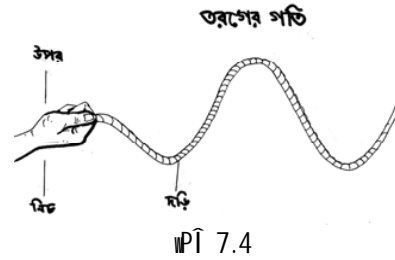
2.  $h\nu \geq K$  Zi  $\frac{1}{2}$  mÁvj tbi Rb" gra" g cġqvRb |
3. Zi  $\frac{1}{2}$  GK" vb t\_ tK Ab" vrb kw<sup>3</sup> mÁvj b Kti |
4. Zi  $\frac{1}{2}$  i teM gra" tgi cKwZi Dci wbfP Kti |
5. Zi  $\frac{1}{2}$  i cġZdj b I cġZmi Y I DcwicvZb NtU |

Zi  $\frac{1}{2}$  i cKvitf` :

Zi  $\frac{1}{2}$  `β cKvi: 1) Abcġ' Zi  $\frac{1}{2}$  2) Ab% N° Zi  $\frac{1}{2}$  |

KvR : wPtġi b"vq GKw j s" v` wo bvl | `woi GKcġS– GKw k<sup>3</sup> Ae j s" tbi mvt\_ AvUKvl | Aci cġS– a"ti nvZ Dci –wbP ev Wrb–evtg mÁvj b Ki |

`woZ Gevi 7.4 wPtġi b"vq GKw Zi  $\frac{1}{2}$  i m"o nte | j ġ Ki nvZi mÁvj b ev K s" tbi w K Dci –wbP ev Wrb–evtg wKs' Zi  $\frac{1}{2}$  i MwZi w K AbfugK | GLrb K s" tbi w K Zi  $\frac{1}{2}$  i MwZi w tKi mvt\_ AvovAwmo ev cġ' eivei | GB Zi  $\frac{1}{2}$  B nt"Q Abcġ' Zi  $\frac{1}{2}$  | mZivs Avgiv ejtZ cwi, th Zi  $\frac{1}{2}$  K s" tbi w tKi mvt\_ j s" fvtē AMñi nq ZvtK Abcġ' Zi  $\frac{1}{2}$  etj | cwi Zi  $\frac{1}{2}$  Abcġ' Zi  $\frac{1}{2}$  i D`vniY |



wPt 7.5

GKw w cġtK wPtġi b"vq 7.5 AvUKvrbv ntjv | Gevi Avgiv D<sup>3</sup> w"uñi ġy<sup>3</sup> cġSZ a"ti wPtġi b"vq mvgtb–wġtQ nvZ mÁvj b Kw | nvZ mvgtb i w tK wbtj w"uñ–G GKw mġ $\frac{1}{4}$ vPb cġvtni m"o nte Avevi nvZ wġtbi w tK wbtj GKw cñviY cġvtni m"o nte | mġ $\frac{1}{4}$ vPb I cñviY cġvtni mvgtb i w tK AMñi ntZ \_vtK | GLrb nvZi mÁvj b ev K s" tbi thw tK Zi  $\frac{1}{2}$  i tmb w tK AMñi nq | A\_ ġ GLrb K s" tbi w K Ges Zi  $\frac{1}{2}$  i MwZi w K ci \_ui mgrsZivj ev GKB | mZivs Avgiv ejtZ cwi, th Zi  $\frac{1}{2}$  K s" tbi w tKi mvt\_ mgrsZivj fvtē AMñi nq ZvtK Ab% N° Zi  $\frac{1}{2}$  etj | evqygra"tg ktāi Zi  $\frac{1}{2}$  Ab% N° Zi  $\frac{1}{2}$  i D`vniY |

Abcġ' Zi  $\frac{1}{2}$  i mteP I mteP w tK Zi  $\frac{1}{2}$  xl° I Zi  $\frac{1}{2}$  cv` etj | Ab% N° Zi  $\frac{1}{2}$  Abje iwk nt"Q mġ $\frac{1}{4}$ vPb I cñviY |

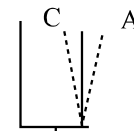
### 7.3 Zi $\frac{1}{2}$ msñkġ iwk

#### Wave Related Quantities

cY° \_w`b : Zi  $\frac{1}{2}$  i Dci" tKvrbv KYv GKw w b w"e s" y t\_ tK hvġv i i y Kti Avevi GKB w K t\_ tK tmb w"e s" tZ wġti ġtj ZvtK GKw cY° \_w`b ejv nq |

chġKvj : th mgq ci ci Zi  $\frac{1}{2}$  i cpivē NtU | A\_ ġ th mgq Zi  $\frac{1}{2}$  i Dci" tK

tKvb KYvi GKw cY° \_w`b m s" ubenq ZvtK chġKvj etj | chġKvj tK T ġviv cKv Kiv nq | Gi GKK tmtKŲ (s) |



৭.৮ সুরশলাকার চিত্র

wPt 7.6



$$1 \text{ tmtKtÜi GB } \tilde{u}^b \text{ msL}^v \text{B K}^u \text{v} \frac{1}{4} \mid \text{m}^Z \text{ivs K}^u \text{bv} \frac{1}{4} f = \frac{1}{T} \quad (7.1)$$

Zi ½ teM I Zi ½ % tN<sup>q</sup> gta<sup>~</sup> m<sup>u</sup>K<sup>q</sup>.

Avgin Rwb 1 tmtKtÜ hZ<sub>u</sub>tjv cY<sup>q</sup>u<sup>~</sup> b m<sup>u</sup>b<sup>u</sup>enq ZvK K<sup>u</sup>v<sup>1</sup>/<sub>4</sub> etj | Avevi 1 w cY<sup>q</sup>u<sup>~</sup> tbi mgtq

Zi ½ i AwZ<sub>uv</sub>SZ<sup>~</sup> i Z<sub>i</sub>K Zi ½ % N<sup>q</sup> etj | m<sup>z</sup>ivs Zi ½ % N<sup>q</sup> λ ntj ,

1 w cY<sup>q</sup>K<sup>u</sup>tbi mgtq Zi ½ i AwZ<sub>uv</sub>SZ<sup>~</sup> i Z<sub>i</sub> = λ

f w cY<sup>q</sup>K<sup>u</sup>tbi mgtq Zi ½ i AwZ<sub>uv</sub>SZ<sup>~</sup> i Z<sub>i</sub> = f λ

thtnZ<sub>i</sub>K<sup>u</sup>v<sup>1</sup>/<sub>4</sub> f ZvB f w cY<sup>q</sup>Zi ½<sup>~</sup> Zwi nq 1 tmtKtÜ

m<sup>z</sup>ivs 1 tmtKtÜ Zi ½ i AwZ<sub>uv</sub>SZ<sup>~</sup> i Z<sub>i</sub> = f λ

GuvB Zi ½ teM v. m<sup>z</sup>ivs Zi ½ teM

$$v = f \lambda \quad (7.2)$$

MwYwZK D<sup>~</sup>vniY 7.1 : GKw e<sup>~</sup> evZv<sup>u</sup>m th kã m<sup>u</sup>ó Kti Zvi Zi ½<sup>~</sup> N<sup>q</sup> 20 cm | evZv<sup>u</sup>m ktãi teM 340 ms<sup>-1</sup> ntj Gi K<sup>u</sup>v<sup>1</sup>/<sub>4</sub> I ch<sup>q</sup>Kij tei Ki |

Avgin Rwb,

$$\text{teM, } v = f \lambda$$

$$f = \frac{v}{\lambda} = \frac{340 \text{ ms}^{-1}}{0.2 \text{ m}} = 1700 \text{ Hz}$$

$$T = \frac{1}{f} = \frac{1}{1700 \text{ s}^{-1}} = 0.000588 \text{ s}$$

$$= 5.88 \times 10^{-4} \text{ s}$$

wb<sup>u</sup>Y<sup>q</sup> K<sup>u</sup>v<sup>1</sup>/<sub>4</sub> 1700 Hz ; ch<sup>q</sup>Kij 5.88 × 10<sup>-4</sup> s

t<sup>~</sup> I qv Av<sup>u</sup>Q,

Zi ½ % N<sup>q</sup>, λ = 20 cm = 0.2 m

ktãi teM, v = 340 ms<sup>-1</sup>

K<sup>u</sup>v<sup>1</sup>/<sub>4</sub>, f = ?

ch<sup>q</sup>Kij, T = ?

## 7.5 kã Zi ½

### Sound Wave

Avgin Rwb kã GK cKvi kw<sup>3</sup> | GB kw<sup>3</sup> m<sup>u</sup>Awj Z nq kã-Zi ½ i gva<sup>u</sup>tg | kã Zi ½ ntjv GKw Abj<sup>u</sup> N<sup>q</sup>

Zi ½ | GB Zi ½ m<sup>u</sup>Awj tbi mgq gva<sup>u</sup>gi KYv<sub>u</sub>tjvi ev<sup>~</sup> Zimg<sup>u</sup>ni

ms<sup>u</sup>KvPb I ch<sup>u</sup>vi<sup>u</sup>Yi m<sup>u</sup>ó nq (wP<sup>u</sup> 7.9) | gva<sup>u</sup>g w<sup>u</sup>tg m<sup>u</sup>Awj Z ntq

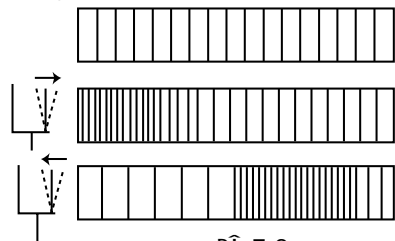
GB kã-Zi ½ Avgv<sup>u</sup> i Kv<sup>u</sup>tb G<sup>u</sup>tm k<sup>u</sup>tYi Abj<sup>u</sup>WZ R<sup>u</sup>Mvq | D<sup>u</sup>tj t<sup>~</sup> th

Dr<sup>u</sup>mi K<sup>u</sup>ub Q<sup>u</sup>ov ktãi Drc<sup>u</sup>É nq bv | m<sup>u</sup>j k<sup>u</sup>jvKv, K<sup>u</sup>mv<sup>u</sup> ew<sup>u</sup>U,

~<tj i N<sup>u</sup>lv hLb ev<sup>u</sup>R ZLb nvZ w<sup>u</sup>tg Av<sup>u</sup>~Z Av<sup>u</sup>~Z<sup>~</sup> úk<sup>u</sup>Ki t<sup>u</sup>j

e<sup>u</sup>ŒZ cv<sup>u</sup>te th I Uv K<sup>u</sup>ctQ | hLb Z<sup>u</sup>g K<sub>v</sub> ej ZLb h<sup>u</sup>w tZ<sup>u</sup>gvi

KÉbjx<sup>~</sup> úk<sup>u</sup>Ki t<sup>~</sup> L<sup>u</sup>te tZ<sup>u</sup>gvi KÉbjx<sup>~</sup> K<sup>u</sup>ctQ |



wP 7.9

KgR<sup>u</sup>É :

GKw K<sup>u</sup>mv<sup>u</sup> ew<sup>u</sup>U<sup>u</sup>Z cwb bv | ew<sup>u</sup>U<sup>u</sup>K Av<sup>u</sup>NvZ Ki | kã i<sup>u</sup>b<sup>u</sup>Z cv<sup>u</sup>Qv | cwb<sup>u</sup>tZ Œ<sup>u</sup>i<sup>u</sup> Œ<sup>u</sup>i<sup>u</sup> tXDI t<sup>~</sup> L<sup>u</sup>tZ cv<sup>u</sup>Qv | Gevi nvZ w<sup>u</sup>tg ew<sup>u</sup>U<sup>u</sup>U<sup>u</sup>K a<sup>u</sup>tiv | kã wK GLb i<sup>u</sup>b<sup>u</sup>Z cv<sup>u</sup>Qv? cwb<sup>u</sup>i tXD wK Av<sup>u</sup>Q?

hZŋY ewUwU kã mŋó KiwQj ZZŋY tmwU tKtctQ ZvB ŋj`a ŋj`a  
 Zi½i mŋó ntqtQ| ewUwUi kã t\_tg tMtj Zvi KãubI t\_tg  
 tMtQ Avi tXDI t\_tg tMtQ| mZivs tevSv tMj Kãugvb e` kã  
 mŋó Kti| wKS` tKvfv e` KuctjB th Avgiv tmB kã i`btZ  
 cvi`ev Ggb tKvfv K\_v tbB| ktãi Drm I tktZvi gŋS GKwU  
 Ro gva`g \_vktZ nte Ges Drtmi Kãw¼ 20Hz t\_tK  
 20,000Hz Gi gta` ntZ nte|



wPĭ 7.10

kã Zi½i `enkó`:

tKvfv e`Íi Kãúbi dtj kã Zi½ mŋó nq Ges mÁvj tbi Rb` w`wZ`vcK Ro gva`gi cŋqvRb nq|  
 ZvB kãtK GKwU hws`K Zi½ ejv nq| GB Zi½i cŋvni w`K Ges Kãúbi w`K GKB etj GwU GKwU  
 AbŋN° Zi½| kã Zi½i teM gva`gi cKwZi Dci wbfPkvj| evqexq gva`g Gi teM Kg, Zi½ Zvi  
 tPtq tewk, KwB c`vt`Aviv tewk| ktãi ZxeZv Zi½i we`Zvtii e`Mŋ mgvbcwZK| A\_ŋ Zi½i  
 we`Ívi tewk ntj ktãi ZxeZv tewk nte| kã Zi½i cŋZdj b, cŋZmiY I Dcwi cvZb mæ| ktãi teM  
 gva`gi Zvcgvĭv I Ar`Zvi Dci I wbfPkvj|

## 7.6 cŋZaŋb

### Echo

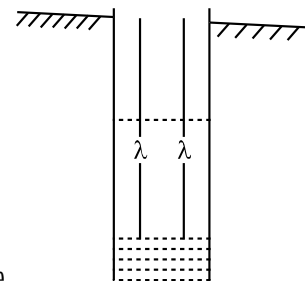
b`xi cvto `wotq kã Kiti wKŋY ci tmB ktãi cbiveŋ tkvbi AwfÁZv nqtZv Avgv`i A`btKiB  
 AvtQ| cvno ev `vjvbi KvQ tRvti kã Kiti Abŋc NUBv NtU| eo Lwĭ Ntĭi GKcŋSZ aŋb Kiti  
 wKŋY ci wK tmB kã tkvbi hvq| Gme NUBv ktãi cŋZdj tbi Rb` NtU|  
 hLb tKvfv kã gj kã t\_tK Avjv`v ntq gj ktãi cbiveŋ Kti, ZLb H cŋZdwj Z kãtK cŋZaŋb etj|  
 mnR K\_vq cŋZdj tbi Rb` aŋbi cbiveŋ Kti cŋZaŋb etj|  
 cŋZdj tKi bb`Zg` tZ;

tKvfv ŋY`vqx kã ev aŋb Kvfb tkvbi ci tmB ktãi tik cŋ  $\frac{1}{10}$  tmKŮ hver Avgv`i gw`Zt`< t\_tK hvq|  
 GtK kãbvŋZi `vqxZkvj etj| GB  $\frac{1}{10}$  tmKtŮi gta` Ab` kã  $\frac{1}{10}$  Kvfb Gtm tcsŋtj Zv Avgiv Avjv`v Kti  
 kptZ cvB bv| mZivs tKvfv ŋY`vqx ktãi cŋZaŋb i`btZ ntj cŋZdj KtK Drm t\_tK Ggb `tZ; i`vLtZ nte  
 hvZ gj kã cŋZdwj Z ntq Kvfb wdti AvmtZ AšZZ  $\frac{1}{10}$  tmKŮ mgq tbq| hw` 0°C Zvcgvĭvq evqZ ktãi  
 teM  $332 \text{ ms}^{-1}$  aiv nq Zvntj  $\frac{1}{10}$  tmKtŮ kã  $33.2 \text{ m}$  hvq| mZivs  
 cŋZdj KtK tktZv t\_tK Kgctŋ  $\frac{33.2}{2}$  ev  $16.6 \text{ m}$  `tZ; i`vLtZ nte| Geri  
 ej tQvE Ntĭi ktãi cŋZaŋb tkvbi hvq bv tKb?

## 7.7 cŋZaŋbi e`envi

### Uses of echo

Ktci MfxiZv wYŋ : cŋZaŋbi mnvth` Lŋ mntR Ktci gta` cwbĭ  
 Dcwi Zj KZ Mfxi AvtQ Zv wYŋ Kiv hvq| Ktci Dcti tKvfv kã Drcbæ  
 Kiti tmB kã cwb cŋ t\_tK cŋZdwj Z ntq wdti Gtj cŋZaŋb tkvbi hvq|



wPĭ 7.11

GLb kã DrcbæKiv I tmB ktãi cãZaŕvb tkvbi ga`eZxmgq \_vgv Nŕoi mrvn`th` wbyq Kiv hvq|aiv hvK, cwbcbjõi Mfxi Zv =  $h$ ,

kã DrcbæKiv I cãZaŕvb tkvbi ga`eZxmgq =  $t$ ,

ktãi telM =  $v$ ,

GLb kã DrcbæKiv qvi ci cwb cbõ cãZdwj Z ntq tktZvi KvqQ wdti AvmtZ thtnZt2h `tZi AmZµg Kti

AZGe,  $2h = v \times t$

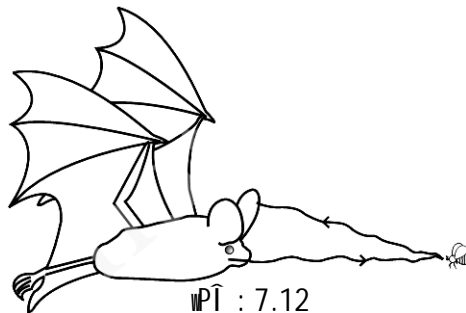
$$\text{ev } h = v \times t/2 |$$

Ktci cwbcbjõi Mfxi Zv 16.6 wgvŕi i Kg ntj, cãZaŕvb wfwEK GB cixŕwU Kiv mæe nte bv|

GKBfŕte f-MŕfP LubR c`v\_P mÜvb jvtf G cæwZi e`envi nt`Q|

ev`ŕi i c\_Pjv :

ktãi cãZaŕvb i mrvn`th`B ev`j c\_Ptj | ev`j tPŕtL t`tL bv| ev`j ktãvEi Kæuvŕt¼i kã `Zwi Kitz cvŕi Avei i`btZi cvŕi | GB kã Avgiv i`btZi cvB bv| ev`j ktãvEi Kæuvŕt¼i kã `Zwi Kti mvgtb Qwotq t`q | H kã tKvŕbv cãZeÜtK evav tctq Avei ev`ŕi i KvqQ Ptj Avtm|wdti Avmv kã i`tb eŕtZ cvŕi th mvgtb tKvŕbv e`- AvtQ wKbv| ev`j Gfŕte Zvi wKvii l atj | hw` evav tctq kã



wdti bv Avtm Zte eŕtZ cvŕi th dvKv RvqMv AvtQ, tmB c\_eivei tm Dto Ptj | AtbK mgq `e`jZK Zvŕi i mŕVK Ae`vb wbyq Kitz e`\_ŕntj mgsZivj `B Zvŕi i ga` w`tq Dto Pjvi mgq thB gvŕ abvZK I FYvZK Zvŕi (ev mŕµq I wbitcŕŕ Zvŕi) ev`ŕi i kixŕi i gva`tg msthvM tctq hvq tmB ev`ŕi i kixŕi i ga` w`tq we`ŕr cæwnZ nq Avi tm gviv hvq | gvtSgta` `e`jZK Zvŕi Sj ŕZ giv ev`j t`Lv hvq |

ev`j cãq 1,00000 nŕR`KæuvŕtKi kã `Zwi Kitz I i`btZi cvŕi |

## 7.8 ktãi tetMi cwieZŕ

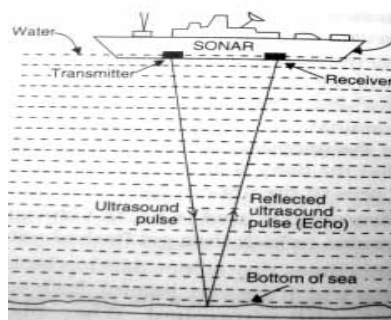
### Variation of velocity of sound

kã Drm t`tK Avgvŕ`i Kvŕb kã AvmtZ wKQlv mgq tbq | cãZ tmktKtÜ kã hZUv c\_ AmZµg Kti ZvŕK ktãi telM etj | ktãi telM KtqKwU wetqi Dci wbfP Kti |

gva`tgi cKwZ : weŕfbægva`tg ktãi telM weŕfbæ D`vniY `ie evqy cwlb Ges tjvrvŕZ ktãi telM wfbæ wfbæ 20°C Zvcgvŕvq evqŕZ ktãi telM 344 ms<sup>-1</sup>, cwlbZ 1450 ms<sup>-1</sup>, Avi tjvrvq 5130 ms<sup>-1</sup> | mŕaviYfŕte ejv hvq evqŕZ ktãi telM Kg,Zitj Zvi tPŕtq tewk Avi Kwvb c`v\_ŕmetPŕtq tewk |







wPÎ -7.14

AvtQ|cwbï gta` GB hšŁi mrvñh` ktävËi Káúti¼i kã Drcbæ Kti tcŦY Kiv nq Ges GB kã mgf`i Zjt`tk evav tctq Avevi Dcti DtV Avmtj MânK hšŁi mrvñh` MâY Kiv nq| kã tcŦY I MâtiYi mgq tiKWKti wetqm Ki tj ktâi fgYKvj ðei Kiv nq| aiv hvK GB mgq t Ges mgf`i

Mfxi Zv d hñ` cwbtiZ ktâi teM v nq Zte,

$$2d = vt$$

$$\text{or, } d = \frac{vt}{2}$$

(7.3)

kã hvlqv I Avmv wgtj  $d + d = 2d$  c\_ AwZµg Kti | GLb ktâi teM tRtb Dcti mgxKi tiYi mrvñh` mgf`i Mfxi Zv wbYq Kiv hvq|

Kvctoi gqjv cwi`<vi Kiv: AvRKvj AvaybK I qmks tµkb ðei ntqtQ hvi Ŧviv mñtR Kvco cwi`<vi Kiv hvq| cwbï gta` mvevb ev Ŧtov mvevb wµkZ Kti Kvco wfmRtq ti tL tmB cwbï gta` ktävËi Káúti kã tcŦY Kiv nq| GB kã Kvctoi gqjvK evBti ðei Kti Avtb Ges Kvco cwi`<vi ntq hvq|

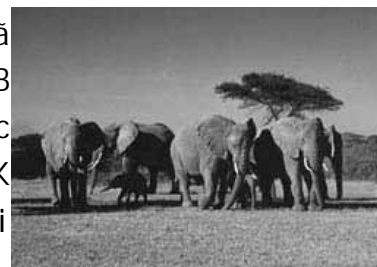
tiM wbYq : gvbti i tñi Af`šixY Qwe G- -ti Ŧviv thgb tZjv hvq tZgb ktävËi Káúti ktâi mrvñh` Qwe Ztj tiM wbYq Kiv hvq| GB cµqi big AveñtbtvMâd (Ultrasonography)| GB kã tñi Af`šti tcŦY Kiv nq Ges cŦZdij Z kãtK AvtjvK kw³tZ ievSZi Kti tUwj wfkbi c`q tdjv nq| dtj tKvbtv tiM\_vKti aiv cto|

wPwKrmvt¶tÎ : `wtZi t`<wj s ev cv\_i tZjvi Rb` ktävËi Káúti kã e`eüZ nq| wKWmbi tQvU cv\_i tft0 Ŧov Kti Zv AcmtiYi KvRI GB kã e`eüZ nq|

Ab`vb` KvR: avZe wÊ ev cvtZ m²Zg dvUj AbñÜvbm² Btj KUwbK hšŁi cwiZ cwi`<vi Kivi KvR, ¶wZKi tiMRxevYayštmi KvRI ktävËi Káúti kã e`eüZ nq|

ktâZi Káúti¼i ktâi e`envi :

ktâZi Káúti mµv nt`Q 1 Hz t\_tK 20 Hz. | GB Káúti kã gvb| i btiZ cvqbv Zte tKvbtv tKvbtv Rxe-Rš` i btiZ cvq| nmwZ GB Káúti kã Ŧviv wñtRti gta` thvñthvM i ¶v Kti Ptj | tKvbtv c weKwZ Qvov GB kã eü` i chš-thtZ cvti | fgKáú Ges cvigvñek wñtiYi mgq GB ktâZi Káúti mµo nq Ges cßj SvKmbi gra`tg aÿsm hÁ Pjvq|



wPÎ 7.15

MwYwZK D`niY 7.3 : b`xi GK cto `mo tq GK e`w<sup>3</sup> nvZZwj w`j | IB kã b`xi Aci cvo t`tK wdtti  
Gtm 1.5 s ci cãZa`nb tkubv tmj | IB mgq evqfZ ktãi teM 340 ms<sup>-1</sup> ntj b`xUi cã`ÍZv KZ ?  
mgvavb : aiv hvK b`xi cã`ÍZv d | mZivs Argiv cvB,

$$\begin{aligned} 2d &= v \cdot t \\ \text{AZGe } d &= \frac{vt}{2} \\ &= \frac{340 \text{ ms}^{-1} \times 1.5 \text{ s}}{2} \\ &= 255 \text{ m} \end{aligned}$$

mZivs b`xi cã`ÍZv 255 m

GLvfb,  
teM  $v = 340 \text{ ms}^{-1}$   
mgq  $t = 1.5 \text{ s}$ ,  
cã`ÍZv  $d = ?$

## 7.10 mjhyß kã I Zvi `enkó`

### Musical sound and its characteristics

Argiv cãZw`b eü iKg kã i`btZ cvB | iv`Zv w`tq hvbevnb PjvPtji kã, nvUevRv`i i kã, el`Kv`ij ewó  
covi kã, we`fbæv`h`ts`i kã BZ`w` Argiv cãZw`b i`tb \_wK | GmKj ktãi wKQy wKQy i`btZ kãZgaj  
jv`M Avi wKQz wKQz i`btZ kãZKUz jv`M | Ab`f`w`Zi w`K w`tq wePvi Ki`ij kãZgaj kã nt`Q mjhyß kã |  
gjZ kã Dr`mi w`bqgZ I ch`E K`útbi dtj th kã Drcb`nq Ges hv Argv`i Kv`b kãZgaj etj gtb  
nq Zv`K mjhyß kã etj | wUvi, tenjv, ev`ki ewk c`f`w`Z ev`h`ts`i kã mjhyß kã |

mjhyß ktãi `enkó`:

mjhyß ktãi wZbw`U `enkó` Av`Q- i) cãej` ev ZxeZv (Loudness or Intensity) ii) Zx`q`Zv (Pitch) Ges  
iii) \_Y ev RmZ (Quality or Timbre)

cãej` ev ZxeZv: cãej` ev ZxeZv ejtZ kã KZUv tRv`i nt`Q Zv e`svq | kã we`Zv`i i Aw`fgtL j`^f`vte  
iv`Lv GKK t`q`Í dtj ga` w`tq cãZ tm`Kt`U th cw`igY kãk`w`<sup>3</sup> cãwnZ nq Zv`K ktãi ZxeZv etj | SI  
c`w`ZtZ ktãi ZxeZvi GKK Wm<sup>-2</sup> |

Zx`q`Zv: mjhyß ktãi th `enkó` w`tq GKB cãej` i Lv`i mj Ges Pov m`i i gta` cv`R` e`sv hvq Zv`K  
Zx`q`Zv ev cxP etj | Zx`q`Zv Dr`mi K`út<sup>1</sup>/<sub>4</sub> i Dci w`b`P Kti | K`út<sup>1</sup>/<sub>4</sub> hZ tewk nq, mj ZZ Pov nq Ges  
Zx`q`Zv ev cxP ZtZv tewk nq |

\_Y ev RmZ: mjhyß ktãi th `enkó` i Rb` we`fbæDr`m t`tK Drcb`GKB cãej` I Zx`q`Zv`hyß ktãi gta`  
cv`R` e`sv hvq Zv`K \_Y ev RmZ etj |

cj`j` i Mjvi `^i tgvUv wKŠ` bvix I w`ki i Mjvi `^i Zx`q`etKb?

gvb`ti i Mjvi `^i h`ts` \_ytUv c`P Av`Q Gt` i`tK etj `^i ZS`x ev Vocal Chord | GB t`fvKvj Kt`W`P K`út<sup>1</sup>/<sub>4</sub>  
dtj Mjv t`tK kã w`M`Z nq Ges gvbl K\_v etj | eq`< cj`j` i t`fvKvj KW`eqtmi m`<sup>1</sup>/<sub>2</sub> m`<sup>1</sup>/<sub>2</sub> `p ntq  
cto | wKŠ` w`ki ev bvix` i t`fvKvj KW`<sup>®</sup> p \_v`K bv, dtj eq`< cj`j` i Mjvi `^i i K`út<sup>1</sup>/<sub>4</sub> Kg Ges bvix  
ev w`kkt` i `^i i K`út<sup>1</sup>/<sub>4</sub> tewk nq | ZvB cj`j` i Mjvi `^i tgvUv wKŠ` w`ki ev bvix` i KÚ`^i Zx`q`

## 7.11 kã`tY

**Noise pollution**

cvi`úwi K thvMthvM I fve Av`vb-cŕvŕbi Rb` kã cŕqRb| wKŠ' AcŕqvRbxq kã I tKjvntjv Amn`  
jvŕM| wewfbaDrm t\_tK DrcbaŕRvŕtjv Ges AcŕqvRbxq kã hLb gvbŕI i mnbkxj Zvi gvŕv Qmoŕq weiw<sup>3</sup>  
NUvq Ges `vŕ`'i ŕwZmvab Kti ZLb ZvŕK kã`tY etj |

gvBŕKi Aera e`envi, tXvŕj i kã, tevgewR, cUKv tdvUŕbvi Avl qvR, Kj KviLvbi kã, Mmoi ntŕP  
Avl qvR, D`P fjŕg Pwj Z tUc ti KWŕ I tUwj wfkŕbi kã, cjŕbv Mmoi BwÄŕbi kã, DŕovRvR I R½x  
wegvŕbi Zxe<sup>3</sup>kã cŕwZ kã`tYi cãvb KviY |

Aweig Zxe<sup>3</sup>kã gvbwmK DŕĖRbv ewoq I tgRvR wLUwLŕU Kti | kã`tY ewg ewg fie, ŕŕav g`v, i<sup>3</sup>Pic ewŕ,  
ü`ucĖ I gwZŕ<i RŕUj tiwM, Awb`ŕRwbZ Amy`Zv, KwšZ I Aemv`Mŕ` ntq cov, KgŕŕgZv nm, ŕŕZkw<sup>3</sup> nm,  
gv\_v tNiv cŕwZ ŕwZKvi K cŕve mwó Kti | nVr Zxe<sup>3</sup>kã gvbŕI i kŕYkw<sup>3</sup> bó KiŕZ cŕti |

eZŕvŕb kã`tY gviwZK mgm`vi mwó KiŕQ | Gi Ketj cŕo cŕqB Amy` tiwM Ges cixŕv\_xŕv ŕwZMŕ`  
nt`Q | kã`tYi nvZ t\_tK ewŕi Dcvq ntjv kã Kgvŕbv | Gcŕt½ Avgiv wKŕc`ŕŕc MŕY KiŕZ cwi |  
th tKŕbv Drme ew Abŕvŕb D`P`ti gvBK ewRvŕbv t\_tK weiZ\_vKŕZ ntŕ | Drmŕe cUKv, ewR dvUŕbv  
cŕwZ wbuŕŕ KiŕZ ntŕ | Mmoi nb`Ah\_v ewRvŕbv ew tRŕti ewRvŕbv cwinvi Kiv DŕPZ | Kg kã  
Drcv`bKvi BwÄb ew hš\_cwZ `Zwi Ges tjvKj q t\_tK `ŕi Kj KviLvbi I wegvb ew`i `vcb Kti I Avgiv  
kã`tYi nvZ t\_tK tiniB tctZ cwi | knŕi i gvŕS gvŕS Dbŕ<sup>3</sup> RvqMv ivLv Ges iv`Zvi avŕi kã tkvYKvi x  
MŕQcvjv jwŕvŕbv DŕPZ | Kj KviLvŕq kã tkvY hš\_c i e`envi PjyKti Ges RbmŕPZbZv ewŕ Kti kã  
`tY wŕqš\_c Y Kiv mŕŕ |

**Abkxj bx**

K.eũbeŕbx cŕkŕ:

mŕVK DĖiŕUi cŕtk wUK (✓) wPŕ`v |

1 | kã tKv&aiŕbi Zi½?

K. wZhŕ Zi½

L. ZwoZŕPš`Kxq Zi½

M. Abŕ% N`Zi½

N. teZvi Zi½

2 | ktãi teM tKv&gvaŕg meŕPŕq tewk |

K. KwVb

L. Zij

M. M`vmxq

N. cŕŕgv

3 | `e`jwZK jvBŕb gZ ew`j Sŕj\_vKŕZ t`Lv hvq tKb ?

i. `e`jwZK Zvi\_tjvi Ae`vb Ges ga`eZŕ` tZi mŕúŕK`ZvŕŕwYKfŕte mŕúó avi Yv bv\_vKvq |

ii. mvgŕbi w`ŕKi ktãvĖi Ziŕ½i cŕZaŕw i bŕZ bv cvl qvq |

iii. ew`j GKw Zŕti Sŕj Aci Zviw ŕúK`Kivq |

নিচের কোনো উত্তরটি সঠিক

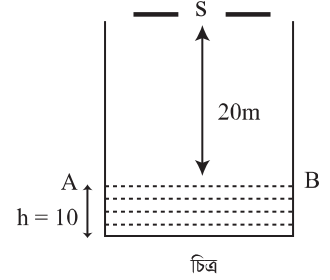
ক. i ও ii

খ. i ও iii

গ. ii ও iii

ঘ. i, ii ও iii

চিত্রে S একটি শব্দ উৎস এবং AB পানির পৃষ্ঠতল। শব্দের বেগ  $332 \text{ ms}^{-1}$  ধরে নিয়ে এবং পার্শ্বের তথ্য ও চিত্রের ভিত্তিতে ৫ ও ৬ নং প্রশ্নের উত্তর দাও।



৪. পানির উচ্চতা h সর্বোচ্চ কত পর্যন্ত প্রতিধ্বনি শোনা যাবে ?

ক. 13.40 cm

খ. 13.40 m

গ. 3.4 m

ঘ. 3.4 cm

৫. প্রদত্ত চিত্রের ক্ষেত্রে প্রতিধ্বনি শুনতে কত সময় প্রয়োজন হবে ?

ক. 0.10 s

খ. 0.12 s

গ. 0.14 s

ঘ. 0.18 s

খ. সৃজনশীল প্রশ্ন

১। রাফসান দশম শ্রেণীর নির্বাচনী পরীক্ষা দিচ্ছে। পরের দিন তার পদার্থবিজ্ঞান পরীক্ষা। পাশের বাড়িতে বিয়ের অনুষ্ঠান। সেখানে রাত দুটো পর্যন্ত জোরে জোরে গান বাজলো। উচ্চ শব্দের জন্য তার পড়াশুনার দারুণ ব্যাঘাত ঘটলো। তার বাবা উচ্চরক্তচাপের রোগী। তাঁরও অসুবিধা হলো।

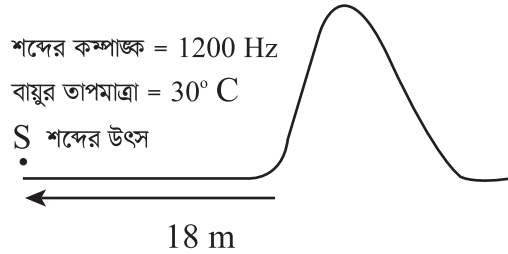
ক. শব্দদূষণ কী ?

খ. শব্দদূষণের কারণ ব্যাখ্যা কর।

গ. রাফসানের বাবার কী অসুবিধা হতে পারে এবং এ প্রসঙ্গে জনস্বাস্থ্যে শব্দ দূষণের প্রভাব লিখ।

ঘ. রাফসানের এলাকায় শব্দদূষণ প্রতিরোধে কী কী ব্যবস্থা নেওয়া যেতে পারে ?

২।



ক) পর্যাবৃত্ত গতি কাকে বলে?

খ) পানির ঢেউ অনুপ্রস্থ তরঙ্গ কেন? ব্যাখ্যা কর

গ) শব্দের তরঙ্গ দৈর্ঘ্য নির্ণয় কর।

ঘ) S অবস্থান থেকে প্রতিধ্বনি শোনা সম্ভব কী? গাণিতিক যুক্তিসহ যাচাই কর।

# Aóg Aa`vq

## Avtjvi cŕZdj b

### REFLECTION OF LIGHT



[ Avgiv Avgvŕ`i Pricŕtk bŕbvi Kg e`' ŕ`LŕZ cvB| hLb ŕKvŕbv AvtjvK Drm ŕ\_ŕK Avtjv miŕmŕi Avgvŕ`i ŕPvŕL Avŕm ZLb Avgiv DrmŕU ŕ`LŕZ cvB| Aveŕi AvtjvK Drm ŕ\_ŕK ŕbMŕZ Avtjv ŕKvŕbv e`' i cŕ ŕ\_ŕK cŕZdjZ nŕq hLb Avgvŕ`i ŕPvŕL Avŕm ZLb| Avgiv e`' ŕU ŕ`LŕZ cvB| Avtjv nŕ`Q GK cKvi kŕ³ ev emŕ`K KviY hv Avgvŕ`i ŕ`LŕZ mŕnŕh` Kŕi ev `kŕbi AbŕŕZ mŕŕó Kŕi| G Aa`vq Avgiv Avtjvi cKŕZ, `cŕ, Avtjvi cŕZdjŕbi mŕŕejx, `cŕYi cKviŕf`, `cŕY Kŕfŕe cŕZŕeŕ^ mŕŕó nq, `cŕYi e`envi l cŕZŕeŕ^i ŕeeab mŕŕŕKAvtjvPbv Kie|]

GB Aa`vq cvŕ tkŕl Avgivŕŕ

1. Avtjvi cKŕZ e`vL`v KiŕZ cŕie|
2. Avtjvi cŕZdjŕbi mŕ e`vL`v KiŕZ cŕie|
3. `cŕ e`vL`v KiŕZ cŕie|
4. cŕZŕeŕ^ e`vL`v KiŕZ cŕie|
5. AvtjvK iŕkŕi ŕŕŕŕŕŕiLv A¼b Kŕi `cŕY Avtjvi cŕZŕeŕ^ e`vL`v KiŕZ cŕie|
6. mgZj l ŕŕjxq `cŕY cŕZŕeŕ^ mŕŕó i ŕKŕmŕaviY NUbŕ e`vL`v KiŕZ cŕie|
7. `cŕYi e`envi e`vL`v KiŕZ cŕie|
8. ŕeeab e`vL`v KiŕZ cŕie|
9. cŕZŕeŕ^ mŕŕó cŕkŕ KiŕZ cŕie|
10. Avgvŕ`i Rŕeŕb ŕewŕŕbAvtjvKxq NUbŕi cŕŕe Ges Gŕ`i Ae`vb Dcŕŕä KiŕZ cŕie Ges cŕksmŕ KiŕZ cŕie|

## 8.1 Avtjvi cKwZ

### Nature of light

Avgiv Rwb, Avtjv ntjv GK cKvi kw<sup>3</sup> hvi gva'tg Avgiv tKvtrv e<sup>-</sup> t`LtZ cvB| Avgiv hLb Kvtrv e<sup>-</sup> t`wL, ZLb e<sup>-</sup> t`tK Avtjv Avgv`i tPvL Avtm| tPvL cŋeó Avtjv tPvLi tiwUvq e<sup>-</sup> wUi cŋZwe<sup>α</sup> mŋó Kti Ges RwUj cŋuqvi gva'tg Avgv`i gw`Ít<sup>®</sup> e<sup>-</sup> wUi Abyc GKwU e<sup>-</sup> i AbywZ mŋó Kti| cŋPxbKvj ntZ gvb| Avtjvi cKwZ m<sup>α</sup>útk<sup>®</sup>Ávb jvtfi tPóv Kti AvmtQ| GK mgq aviYv Kiv ntZv Avgv`i tPvL ntZ Avtjv tKvtrv e<sup>-</sup> i Dci cto, ZvB Avgiv tmB e<sup>-</sup> t`LtZ cvB| Avmtj hLb tKvtrv e<sup>-</sup> t`tK Avtjv Avgv`i tPvL Avtm, ZLb tKej Avgiv tmB e<sup>-</sup> t`LtZ cvB|

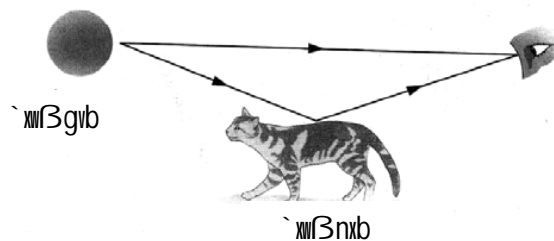
Avtjvi cÁvb cÁvb ag<sup>®</sup>tjv wbg<sup>®</sup>c:

1. tKvtrv <sup>~</sup>Q mgmZi gva'tg Avtjv mij ct\_Ptj |
2. tKvtrv wbw`ŋ gva'tg Avtjv GKwU wbw`ŋ teŋM Ptj | kb<sup>~</sup>vtrb GB teŋMi gvb,  $c = 3 \times 10^8 \text{ ms}^{-1}$  |
3. Avtjvi cŋZdj b, cŋZmi Y, e<sup>-</sup>wZPvi, AceZŋ, we<sup>®</sup>Qi Y Ges mgeZŋ NtU |
4. Avtjv GK cKvi kw<sup>3</sup> |
5. Avtjv GK ai tbi ZwoZtPŋ<sup>α</sup>K Zi ½ |
6. tKvtrv tKvtrv NUBvq Avtjv Zi t½i b`vq, Avevi KLttrv KLttrv Avtjv KYvi b`vq AvPiY Kti |

## 8.2 Avtjvi cŋZdj b

### Laws of reflection of light

Avgiv Avgv`i PricvK AŋbK iKg e<sup>-</sup> t`tL \_wK| Gt`i tKvtrwU PricvK Avtjv Qovq Avevi tKvtrwU Avtjv Qovq bv| th mKj e<sup>-</sup> thgb-mh<sup>®</sup>Zviv, Rj ŋ-tgvgewZ, bŋÍ BZ`w` wotr t`tK Avtjv wotmiY Kti Zv`i tK ejv nq`xwBgvb e<sup>-</sup> | Avevi th mKj e<sup>-</sup> thgb- gvb|, MvQcvjv, tUvej, t`qvj, Qwe, PK tev<sup>®</sup> BZ`w`i wotr Avtjv tB ev wotr Avtjv wotmiY Kitz cvti bv Zv`i tK ejv nq`xwBnxb e<sup>-</sup> | hLb `xwBgvb e<sup>-</sup> t`tK Avtjv Avgv`i tPvL Avtm ZLb Avgiv tmB e<sup>-</sup> wU t`LtZ cvB| Avgv`i PricvK th mKj maviY e<sup>-</sup> t`LtZ cvB tm<sub>3</sub>tjv `xwBgvb e<sup>-</sup> bq, Zey Avgiv tm<sub>3</sub>tjv t`LtZ cvB| Gi KviY nt`Q Avtjvi cŋZdj b| 8.1 wPÍ tZvgiv t`LtZ cvt`Qv Kxfvte Avgiv GKwU `xwBgvb e<sup>-</sup> (mh)<sup>®</sup> Ges GKwU `xwBnxb e<sup>-</sup> tK (weovj) t`LtZ cw`Q| tPvL `xwBgvb e<sup>-</sup> wU tK t`LtZ cvq tKbbv GwU t`tK Avtjv miwmi tPvL cŋek Kti| ŋxwBgvb e<sup>-</sup> t`tK Avmv Avtjv weovj t`tK cŋZdwj Z ntq Avgv`i tPvL cŋek Kti etj weovj wU Avgiv t`LtZ cvB|



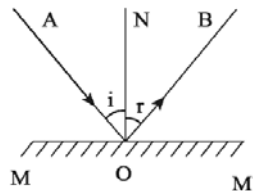
wPÍ 8.1

GK<sub>W</sub> ˆ~Q I mgmĒi gvaˆtg (thgb-KvP) AvtjvKi<sub>W</sub>ˆ mij cĭ Mgb Kti Ges GKB teŕM Ptj | ˆKŠ' AvtjvKi<sub>W</sub>ˆ hLb GK gvaˆg ˆ ˆq PjĭZ PjĭZ Abˆ GK gvaˆgi tKvŕbv Ztj Avc<sub>W</sub>ZZ nq ZLb ˆß gvaˆgi ˆeŕfˆ Zj nĭZ ˆKQzcwi gvY Avtjv Avevi cĭg gvaˆtg ˆdĭi Avŕm | G NUbvŕK Avtjvi cĭZdj b etj | ˆh cĕ nĭZ AvtjvKi<sub>W</sub>ˆ cĭZdjw Z nĭq ˆdĭi Avŕm ZvŕK cĭZdj K cĕ etj |

cĭZdj ˆbi mŕ:

Avc<sub>W</sub>ZZ i<sub>W</sub>ˆ Ges cĭZdjw Z i<sub>W</sub>ˆ ˆU mnR mŕ tgŕb Ptj -

1. cĭg mŕ: Avc<sub>W</sub>ZZ i<sub>W</sub>ˆ, cĭZdjw Z i<sub>W</sub>ˆ Ges AvcZb ˆeˆ ˆZ cĭZdj ˆKi Dci A<sub>W</sub>¼Z A<sub>W</sub>fj ˆ^ GKB mgZĭj Aeˆˆvb Kti |
2. ˆQZxq mŕ: cĭZdj b ˆKvY AvcZb ˆKvŕYi mgvb nq |



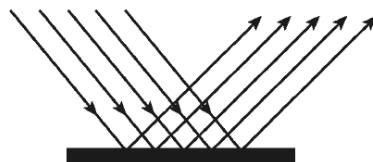
ˆPĭ 8.2: Avtjvi cĭZdj b

hLb Avtjv tKvŕbv cĕ ˆĭK cĭZdjw Z nq ZLb Zv AekˆB cĭZdj ˆbi mŕ tgŕb Ptj | tKvŕbv cĕ ˆĭK Kxfvŕe Avtjv cĭZdjw Z nĕ Zv ˆbfˆ Kti cĭZdj ˆKi cĕi cK<sub>W</sub>Zi Dci | cĭZdj K cĕi cK<sub>W</sub>Zi Dci ˆbfˆ Kti cĭZdj b ˆK ˆß fŕŕM fŕM Kiv hvq | h\_v-

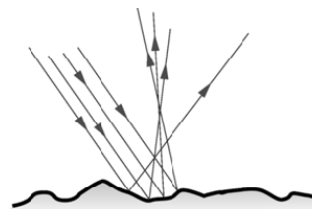
1. ˆbqwgZ ev mŕg cĭZdj b
2. eˆvŕ3 ev AˆbqwgZ cĭZdj b

1. ˆbqwgZ cĭZdj b :

hˆ GK<sub>ˆ</sub>Q mgvŕˆvj AvtjvKi<sub>W</sub>ˆ tKvŕbv gmY Ztj Avc<sub>W</sub>ZZ nĭq cĭZdj ˆbi ci mgvŕˆvj i<sub>W</sub>ˆ, Q ev Aˆfŕmvi x ev Acmvi x i<sub>W</sub>ˆ, ˆQ cwiYZ nq Zŕe G aiŕYi cĭZdj b ˆK Avtjvi ˆbqwgZ cĭZdj b etj | DˆvniY ˆntŕte ejv hvq- hˆ GK<sub>ˆ</sub>Q mgvŕˆvj AvtjvKi<sub>W</sub>ˆ tKvŕbv mgZj ˆcŕY ev Lŕ fŕŕjvŕŕe cwiŕk Kiv tKvŕbv avZe cĕi Avc<sub>W</sub>ZZ nq, Zŕe cĭZdj ˆbi cĕi i<sub>W</sub>ˆ, Q mgvŕˆvj ˆvŕK | G ˆŕŕŕ i<sub>W</sub>ˆ, ˆQ cĭZˆK<sub>W</sub> AvtjvKi<sub>W</sub>ˆ AvcZb ˆKvŕYi gvb mgvb Ges ˆbqwgZ cĭZdj ˆbi dĭj cĭZˆK<sub>W</sub> i<sub>W</sub>ˆ cĭZdj b ˆKvŕYi gvb mgvb nq [ ˆPĭ 8.3] |



ˆPĭ 8.3: ˆbqwgZ cĭZdj b



ˆPĭ 8.4 : eˆvŕ3 cĭZdj b

## 2. e`vŋ3 cŏZdj b

hw` GK„Q mgrš+vj AvtjvKiwkŋtKvŋbv Ztj AvcmZZ ntq cŏZdj tbi ci Avi mgrš+vj bv \_vtK ev Aurfmvix ev Acmvix iwkŋ„tQ cwiYZ bv nq Zte G aiŋYi cŏZdj bŋK Avtjvi e`vŋ3 ev AmbqwgZ cŏZdj b etj |

8.4 wPtŋ t`Lv hvŋQ th, GK„Q mgrš+vj AvtjvKiwkŋ GKw AgmY Ztj AvcmZZ ntQ | Gtŋŋŋ iwkŋ„tjv AgmY Ztj i wewfbœAvcZb weŋ ŋZ wewfbœAvcZb tKvŋY AvcmZZ nq, dtj GmKj iwkŋŋ Avbŋ w½K cŏZdj b tKvY„tjv i wewfbœnq | hvi dtj cŏZdj Z iwkŋ„tjv Avi mgrš+vj \_vtK bv | Avgvŋ`i Pvi cvŋk th mKj e`ŋY t`LŋZ cvB, Zvŋ`i AmaKvŋtKi cŏ gmY bq | dj kŋZŋZ Avgvŋ`i tPvŋL th mKj cŏZdj Z iwkŋ cŋek Kŋi Zviv e`vŋ3 cKwZi | hvi dtj e`„tjv Avgvŋ`i wBKU D¾4j bv ntq Abŋ¾4j t`Lvq | Lwŋj tPvŋL t`Lv AmaKvŋk cŏ AvcvZ`wŋŋZ gmY gŋb ntj | cKZcŋŋ G mKj cŏ gmY bq | hLb AbŋŋŋY hš„ ŋviv G mKj cŏ t`Lv nq ZLb Zv tevSv hvq |

## 8.3 `cŋ

**Mirror**

`cŋ ntjv Ggb GKw gmY Zj thLvŋb Avtjvi wŋqwgZ cŏZdj b NŋU | `cŋY Avtjvi cŏZdj tbi dtj `cŋYi mwŋŋb `wŋcZ e` i GKw ŋŋŋ cŏZwŋŋ MvZ nq |

GKw gmY Ztj cŏZdj K AvŋŋiY wŋŋ `cŋ cŋ` Z Kiv nq | mvaviYZ KvŋPi GK cŋŋ avZi cŋj c jwMŋŋ `cŋ`Zwi Kiv nq | KvŋPi Dci cvi` ev ŋcvi cŋj c jwMŋŋbv GB cŋŋqŋK Ōcvi v jwMŋŋbv ev wŋj fwiŋ ejv nq | avZi cŋj c jwMŋŋbv cŋŋi wecixZ cŋw Gtŋŋŋ cŏZdj K cŏ wŋŋŋŋ KvR Kŋi | GŌvovl w`i cwb cŏ, gmY eid BZ`w` I `cŋYi b`vq KvR Kŋi \_vtK |

`cŋ cŋvbZ `ŋ cKvi | h\_v-

## 1. mgZj `cŋ

## 2. tMvj xq `cŋ

mgZj `cŋ

cŏZdj K cŋw hw` gmY I mgZj nq Ges ZvŋZ Avtjvi wŋqwgZ cŏZdj b NŋU, Zte tm cŋŋK mgZj `cŋ etj | Avgiv mPivPi th `cŋ ev Avqbv e`envi Kŋi \_wK | tmw ntjv mgZj `cŋ |

tMvj xq `cŋ

cŏZdj K cŋw hw` gmY Ges tMvj xq nq A\_ŋ cŏZdj K cŋw hw` tKvŋbv tMvj tKi Askwŋŋl nq Ges ZvŋZ Avtjvi wŋqwgZ cŏZdj b NŋU Zte ZvŋK tMvj xq `cŋ etj | 8.5 I 8.6 wPtŋ tMvj Kxq `cŋ t`Lvŋbv ntqŋQ | GKw KvŋPi drcv tMvj tKi LwbKw Ask tKŋU wŋŋ hw` Zvi GK cŋŋ cviv jwMŋŋbv nq, Zte tMvj xq `cŋ`Zwi nq | tMvj xq `cŋ Avei `ŋ cKvi | h\_v-

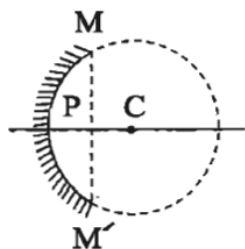
## 1. AeZj `cŋ

## 2. DĖj `cŋ

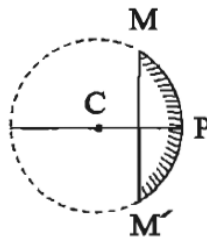
AeZj `cŋ: tKvŋbv tMvj tKi AeZj cŏ hw` cŏZdj Kiŋc KvR Kŋi A\_ŋ Avtjvi wŋqwgZ cŏZdj b hw` tMvj xq `cŋYi AeZj cŏ ntZ msNwUZ nq Zte tm `cŋŋK AeZj `cŋ etj | Gtŋŋŋ tMvj tKi tKŋU tŋqv Astki DĖj cŋŋ cviv jwMŋŋ AeZj `cŋ`Zwi Kiv nq [wPtŋ 8.5] | AeZj `cŋ GKw Aurfmvix `cŋ tKbbv



mgvš+vj AvtjvKiwkŕ AeZj `cŕY AvcwZZ nI qvi ci cŕZdj Z ntq GKwU we`ŕZ AwfmvixZ nq ev GKtŕ wgvj Z nq|



ŕPŕ 8.5: AeZj `cŕ



ŕPŕ 8.6: DĖj `cŕ

DĖj `cŕ: tKvŕbv tMj tKi DĖj cŕ hw` cŕZdj Ki tC KvR Ktŕi A\_ŕ Avtjvi wbcwgZ cŕZdj b hw` tMj xq `cŕYi DĖj cŕ ntZ msNwUZ nq, Zte tm `cŕtK DĖj `cŕ etj | Gtŕŕŕŕ tMj tKi tKtU tbi qv Astki AeZj cŕŕ A\_ŕ wFZtŕi w tK cviv j wMtq DĖj `cŕ`Zwi Kiv nq [ŕPŕ 8.6]|

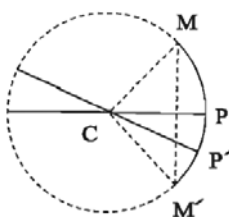
DĖj `cŕ GKwU Acmvix `cŕ, KviY mgvš+vj AvtjvKiwkŕ DĖj `cŕY AvcwZZ ntq cŕZdj Z nevi ci Acmvix iwkŕŕQ cwiYZ nq A\_ŕ Qwŕtq cŕŕ Ges KLbB GKwU we`ŕZ wgvj Z nq bv|

tMj xq `cŕ mspvš-KtqKwU msÁv

tgiy(Pole): tMj xq `cŕYi cŕZdj K cŕŕi ga`we`ŕK `cŕYi tgiyetj | 8.7 ŕPŕŕ P `cŕYi tgiy| AeZj `cŕYi tŕŕŕŕ cŕZdj K cŕŕi meŕPŕtq wbpzwe`y Ges DĖj `cŕYi tŕŕŕŕ cŕZdj K cŕŕi meŕPŕtq DPzwe`ŕ `cŕYi tgiy|

eμZvi tKŕ`ŕ: tMj xq `cŕ th tMj tKi AskwŕtKl, tmB tMj tKi tKŕ`ŕK H `cŕYi eμZvi tKŕ`ŕ etj | 8.7 ŕPŕŕ c we`y `cŕYi eμZvi tKŕ`ŕ|

eμZvi e`vmaŕ: tMj xq `cŕ th tMj tKi Ask, tmB tMj tKi e`vmaŕK H `cŕYi eμZvi e`vmaŕ etj | 8.7 ŕPŕŕ PC ev MC ntjv tMj xq `cŕYi eμZvi e`vmaŕ eμZvi e`vmaŕK r ŕviv cŕvK Kiv nq|



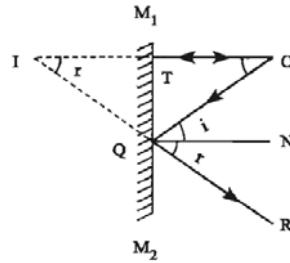
ŕPŕ 8.7: tMj xq `cŕ

cÁvb Aŕŕ: tMj xq `cŕYi tgiy| eμZvi tKŕ`ŕ ga` w tŕ AwZμgKvix mij tŕi LvŕK `cŕYi cÁvb Aŕŕ etj | 8.7 ŕPŕŕ PC mij tŕi Lv ntjv `cŕYi cÁvb Aŕŕ|

tMSY Aŕŕ: tgiywe`ye`wZZ `cŕYi cŕZdj K cŕŕi Dci` th tKvŕbv we`y| eμZvi tKŕ`ŕ ga` w tŕ AwZμgKvix mij tŕi LvŕK tMSY Aŕŕ etj | 8.7 ŕPŕŕ P'C mij tŕi Lv `cŕYi tMSY Aŕŕ|



ŕPŕŕ 8.10-G AeZj `cŕYi mŕŕL O GKŕU we`yj ŕŕe` | O ntZ cŕvb Aŕŕŕi mgvŕ+j iŕkŕ OM `cŕY AvcŕZZ ntq cŕvb tŕvKŕm ŕŕŕ MFI cŕ\_ cŕZdj Z nq | OP iŕkŕ `cŕYi tgi`we`yP-tZ AvcŕZZ ntq cŕZdjŕbi ci PI cŕ\_ hvq | cŕZdj Z iŕkŕ`ŕU I we`ŕZ tŕ` Kŕi | GB I we`ŕ ntjv O we`j cŕZweŕ^ |



ŕPŕ 8.11: cŕZdjŕbi Rb` Aer`ŕe cŕZweŕ^ |

ŕPŕŕ 8.11-G O mgZj `cŕYi mgŕb Aer`Z GKŕU we`yj ŕŕe` | O ntZ OT iŕkŕ Aŕfj ŕ^fŕe `cŕY AvcŕZZ nq Ges TO cŕ\_ cŕZdj Z nq | OQ iŕkŕ Zŕŕŕfŕe `cŕY AvcŕZZ nq Ges QR cŕ\_ cŕZdj Z nq | G iŕkŕ`ŕU Acŕvix nŕqv iŕkŕ,tjvŕK ŕcŕŕbi ŕŕŕ ewŕ Kŕtj G,tjv I we`ŕZ ŕgvj Z nq | A\_ŕ cŕZdj Z iŕkŕ,tjv `cŕYi ŕcŕŕb I we`yt\_ŕK Acŕmŕi Z nt`Q etj gŕb nq | GB I we`ŕ ntjv O we`j cŕZweŕ^ |

tKŕŕbv we`yntZ ŕbMŕ AvŕjvK iŕkŕ,"Q tKŕŕbv Ztj cŕZdj Z ev cŕZmŕi Z nevi ci ŕŕZxq tKŕŕbv we`ŕZ ŕgvj Z nq ev ŕŕZxq tKŕŕbv we`yntZ Acŕmŕi Z nt`Q etj gŕb nq, ZLb H ŕŕZxq we`ŕŕŕK cŕg we`j cŕZweŕ^ etj | GKŕU e` ntjv AŕsL` we`j mgŕŕ | dtj we`j b`vq e` iŕ cŕZweŕ^ MŕVZ nq | cŕZweŕ^i cŕŕiŕf`

Zŕg hLb Aŕqbŕq tZŕgvi ŕPŕiv ŕ`L, ZLb Aŕqbŕi ŕcŕŕb tZŕgvi cŕZweŕ^ ŕ`LŕZ cvl | Avŕjvi cŕZdjŕbi Rb` GgbŕU NŕU | Aŕqbŕq ŕ`Lŕ tZŕgvi Gŕc cŕZweŕ^ mŕZ`Kvi Aŕ\_ŕAvŕjv ŕgvj Z nq bv | G aŕŕbi cŕZweŕ^ŕK etj Aer`ŕe cŕZweŕ^ | Avi th mKj cŕZweŕ^ Avŕjv mŕZ`Kvi Aŕ\_ŕgvj Z nq (thgb- ŕŕŕbgvi c`ŕq tŕjv tKŕŕbv `k`) tm,tjvŕK ejv nq ev`ŕe cŕZweŕ^ | ŕŕŕŕUŕj K`ŕŕgivi c`ŕq tŕŕm I Vŕ Qŕe ntjv ev`ŕe cŕZweŕ^ | ev`ŕe cŕZweŕ^ c`ŕq tŕjv hvq ŕKŕ` Aer`ŕe cŕZweŕ^ c`ŕq tŕjv hvq bv | cŕZweŕ^ ŕ cŕŕŕi i nq-

(K) ev`ŕe cŕZweŕ^

(L) Aer`ŕe cŕZweŕ^

(K) ev`ŕe cŕZweŕ^: tKŕŕbv we`yntZ ŕbŕmZ AvŕjvK iŕkŕMŕQ tKŕŕbv Ztj cŕZdj Z ev cŕZmŕi Z nevi ci hŕ ŕŕZxq tKŕŕbv we`ŕZ cŕKZcŕŕ ŕgvj Z nq Zŕntj H ŕŕZxq we`ŕŕŕK cŕg we`j ev`ŕe cŕZweŕ^ etj |

ŕPŕ : 8.10 G I ntjv cŕZdjŕbi Rb` ev`ŕe cŕZweŕ^ |

(L) Aer`ŕe cŕZweŕ^: tKŕŕbv we`yntZ ŕbŕmZ AvŕjvK iŕkŕ,"Q tKŕŕbv Ztj cŕZdj Z ev cŕZmŕi Z nevi ci hŕ ŕŕZxq tKŕŕbv we`yt\_ŕK Acŕmŕi Z nt`Q etj gŕb nq, Zŕe H ŕŕZxq we`ŕŕŕK cŕg we`j Aer`ŕe cŕZweŕ^ etj | ŕPŕ 8.11 G I ntjv cŕZdjŕbi Rb` mŕŕ Aer`ŕe cŕZweŕ^ |

## 8.5 `cŕY e` i cŕZweŕ^

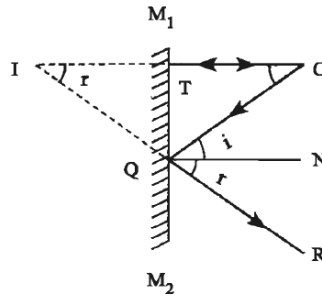
### Image in Mirror

Aŕgiv Rŕb `cŕ ŕ cŕŕi | (K) mgZj `cŕ Ges (L) tMŕxq `cŕ | mgZj Ges tMŕxq `cŕY Kŕfŕe cŕZweŕ^ mŕŕ nq Zŕ Aŕgiv AvŕjvPbv Kŕe |

mgZj `cŕY mŕ cŕZŕeŕ^ :

(K) ŕe`yj ŕŕe`

ŕPÎ 8.12 G M mgZj `cŕYi mvgŕb O GKŕŕ ŕe`yj ŕŕe` | O ŕŕK OT iŕkŕ Áŕfj ŕ^ŕŕe `cŕY ÁŕŕZZ nq Ges TO cŕŕ ŕŕi Áŕŕm | OQ iŕkŕ `cŕY Zŕhŕŕŕe ÁŕŕZZ nq Ges QR cŕŕ cŕZdŕj Z nq | cŕZdŕj Z iŕkŕ QR Ges TO ŕcQŕb eŕaŕ Kiŕj Giv I ŕe`ŕZ ŕgŕj Z nq | Áŕŕ cŕZdŕj Z iŕkŕ ŕŕ thb `cŕYi ŕcQŕb Áeŕ`Z I ŕe`ŕŕŕK ÁŕŕŕQ | AZGe, GB I ŕe`ŕŕŕj O ŕe`ŕj Áeŕŕe cŕZŕeŕ^ |



ŕPÎ : 8.12

Q ŕe`ŕZ QN Áŕfj ŕ^ ÁŕKŕ nŕjŕ |

ŕPÎ TO Ges QN mvgŕŕj | OQ ŕŕ K |

$$\therefore \angle TOQ = \angle OQN = i$$

(8.1)

Áeŕi, OI Ges QN mvgŕŕj, RQI miŕŕi Lŕ Gŕ`i ŕŕ K |

$$\therefore \angle TIQ = \angle NQR = r$$

(8.2)

Ágŕŕ Rŕb,  $i = r$

$\therefore$  (8.1) | (8.2) mgyKiY nŕZ cŕB,

$$\angle TOQ = \angle TIQ$$

GLb,  $\Delta QOT$  Ges  $\Delta QIT$ -Gi gŕa`,

$$\angle TOQ = \angle TIQ, TQ \text{ mŕŕi Y evŕ},$$

$$\text{Ges } \angle QTO = \angle QTI = 90^\circ$$

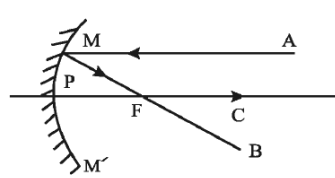
mŕZiŕs, ŕŕ ŕŕŕŕq meŕg |

$$\text{mŕZiŕs, } TO = TI$$

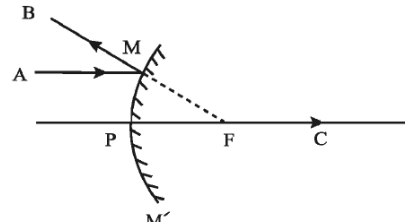
Áŕŕ, j ŕŕe` O `cŕYi hZ mvgŕb Áeŕ`Z, cŕZŕeŕ^ I `cŕYi ŕK ZZUŕ ŕcQŕb MŕWZ nq |



2. AeZj `cŋYi cǎvb Atŋi mǵvš+vtj ÁvcuZZ iŋkʹcǎZdj tbi ci cǎvb tǎvKvm w`tq hvq; [wPĤ 8.15 K] DĖj `cŋYi cǎvb Atŋi mǵvš+vtj ÁvcuZZ iŋkʹcǎZdj tbi ci cǎvb tǎvKvm ntZ ÁvmŋQ etj gtb nq [wPĤ 8.15 L]



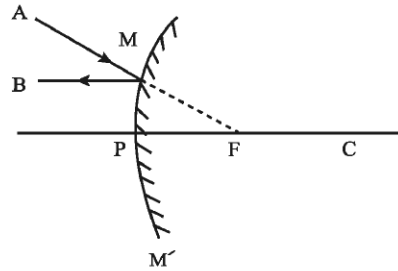
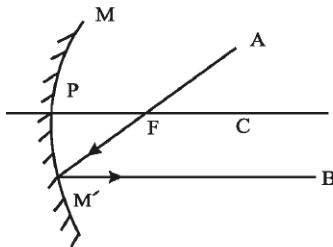
(K)



(L)

wPĤ : 8.15

3. AeZj `cŋYi cǎvb tǎvKvŋmi ga`w`tq ÁvcuZZ iŋkʹcǎvb Atŋi mǵvš+vtj cǎZdwj Z nq; DĖj `cŋYi cǎvb tǎvKvm ÁwfgtL ÁvcuZZ iŋkʹcǎZdj tbi ci cǎvb Atŋi mǵvš+vtj nq [wPĤ : 8.16]



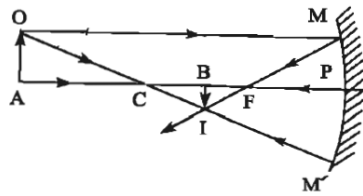
wPĤ : 8.16

AeZj `cŋY cǎZŋeα: tMvjxq `cŋY MvZ cǎZŋeαi Ae`vb, ÁvKvZ I cKvZ `cŋYi mǵtb Aew`Z jŋle`i Ae`vŋtbi Dci wbfP Kŋi | jŋle`i Ae`vŋtbi cwieZB ntj cǎZŋeαi Ae`vb, ÁvKvZ I cKvZiI cwieZB NŋU | aiv hvK MPM' GKv AeZj `cŋY P ntjv Gi tgiyGes F cǎvb tǎvKvm Ges C epZvi tK`ŋ | `cŋYi mǵtb cǎvb Atŋi Dci j`α fŋte Aew`Z jŋle`i AO |

jŋle`i tK Ámvg Ges cǎvb tǎvKvŋmi gŋa`cŋYi mǵtb thLvŋbB ivLv tŋvK bv tKb mǵ cǎZŋeα meŋv ev`ŋe I Dŋēv nŋe | Avei jŋle`i tK cǎvb tǎvKvm I tgi`i gŋa`vcb Kiv ntj MvZ cǎZŋeα nŋe Ae`ŋe Ges tŋvRv | wŋtαAeZj `cŋY mǵ ev`ŋe Ges Ae`ŋe cǎZŋeα eYBv Kiv ntjv:

ev`ŋe cǎZŋeα

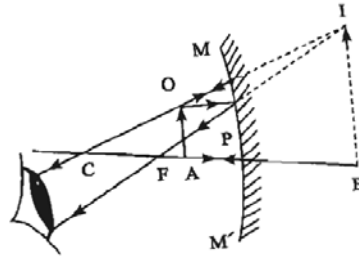
O wē`yt\_tK GKv iŋkʹOM cǎvb Atŋi mǵvš+vtj `cŋYi M wē`ŋZ ÁvcuZZ ntq cǎvb tǎvKvŋmi ga`w`tq MI ct\_ cǎZdwj Z nq | O ntZ Aci GKv iŋkʹOCM' epZvi tK`αC eivei `cŋY ÁvcuZZ ntq cǎZdj tbi ci tŋw GKB ct\_ wŋtŋ hvq | cǎZdj tbi ci iŋkʹ`ŋU I wē`ŋZ cKZctŋ wgvj Z nq | mŋZivs I ntjv O wē`j ev`ŋe cǎZŋeα | A t\_tK cǎvb Aŋ eivei ÁvcuZZ iŋkʹH ct\_B wŋtŋ hvq | dtj A -Gi cǎZŋeα H ŋiLv DciB nŋe | I t\_tK cǎvb Atŋi Dci IB j`α A½b Kv | BI -B ntjv jŋle`i OA -Gi ev`ŋe cǎZŋeα [wPĤ 8.17]



wPÎ : 8.17

côZweŕ^i cKwZ ntjv ev\_ŕe I Dŕev|

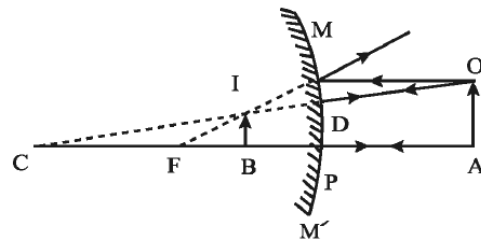
Aev\_ŕe côZweŕ^: wPÎ : 8.18-G j\_ŕe- cãvb tdivKvm Ges tgiy gta" Aew\_ŕZ| O we\_yt\_ŕK GKwU inkŕ cãvb At\_ŕi mgvŕitj AvcwZZ ntq cãvb tdivKvŕmi ga" w\_ŕtq côZdwjZ nq Ges Aci GKwU inkŕ epZvi e"vmaŕeivei `cŕY AvcwZZ ntq côZdjŕbi ci tŕmU GKB cŕ\_ŕdŕi hvq| côZdjŕbi dŕj inkŕ`yU ci\_ŕi Acmvix inkŕZ cwiYZ nq| inkŕ`yUŕK wQŕbi w\_ŕK evorŕj Giv I we\_yt\_ŕK AvmŕQ etj gŕb nq| A\_ŕ, I we\_ŕ ntjv O we\_y\_ŕ Aev\_ŕe côZweŕ^| I we\_yt\_ŕK cãvb At\_ŕi Dci Aw\_ŕZ IB j\_ŕ^ Uvbn ntjv| mŕZivs BI nj e- i Aev-e I tŕmRv côZweŕ^|



wPÎ : 8.18

mŕ côZweŕ^i Ae\_ŕvb ntjv `cŕYi wQŕb, cKwZ Aev\_ŕe Ges tŕmRv Ges AvKvŕi weewaZ A\_ŕ e- i tŕtq AvKvŕi eo|

(L) DĖj `cŕY côZweŕ^: Avgiv Rwb, AeZj `cŕY j\_ŕe-ŕj Ae\_ŕvŕbi Dci wŕfŕ Kŕi ev\_ŕe A\_ev Aev\_ŕe côZweŕ^ MwZ nq| wKŕ' DĖj `cŕY me\_ŕv e- i Aev\_ŕe côZweŕ^ MvB Kŕi| GB côZweŕ^ memgq tŕmRv Ges e- i tŕtq AvKvŕi tŕvU nq| wPÎ 8.19 G MPM'GKwU DĖj `cŕY| C Gi epZvi tK\_ŕ, F cãvb tdivKvm Ges P `cŕYi tgiy AO j\_ŕe- `cŕYi mgvŕb cãvb At\_ŕi Dci j\_ŕ^ŕvŕe Aew\_ŕZ| O we\_yt\_ŕK cãvb At\_ŕi mgvŕitj OM inkŕ`cŕY AvcwZZ nq| côZdjŕbi ci inkŕU `cŕYi cãvb tdivKvm F t\_ŕK AcMZ nt\_ŕQ etj gŕb nq| Aci GKwU inkŕ OD `cŕYi epZvi tK\_ŕeivei j\_ŕ^ŕvŕe AvcwZZ ntq GKB cŕ\_ŕdŕi nq| GLb GB Acmvix côZdwjZ inkŕ`yUŕK wQŕbi w\_ŕK ewotq w\_ŕj Giv I we\_ŕZ tŕQ Kŕi Ges I we\_yt\_ŕK AvmŕQ etj gŕb nq| mŕZivs, I we\_ŕ ntjv O we\_y\_ŕ Aev\_ŕe côZweŕ^| GLb I we\_yt\_ŕK cãvb At\_ŕi Dci IB j\_ŕ^ A\_ŕb Kiv ntjv| GB BI ntjv j\_ŕe- AO -Gi Aev\_ŕe côZweŕ^| côZweŕ^ `cŕYi wQŕb MwZ nq Ges Zv Aev\_ŕe, tŕmRv Ges



wPÎ : 8.19





4. cıvıwı iv`Ívi eıfK`Nŕbv GovtZ GıU e`envi Kiv nq|
5. wefFbŕAvtjvKıx hš¿cwıZ thgb- tUıjt`<vc, l fvi tıw cŕR±i, tj Rvi ^Zwi Ki tZ mgZj `cŕ e`envi Kiv nq|
6. bvUK, PjwPÎ BZ`w` i mıUs Gi mgq mgZj `cŕ w`ıq Avtjv cŕZdwjZ Kti tKıfbv`vıbi J¾ıj` eıfK Kiv nq|

#### AeZj `cŕ

1. mıeavRbK AvKıZi AeZj `cŕ e`envi Kti gıgÊtj i wewaZ Ges tıvRv cŕZwe^ ^Zwi Kiv nq, GtZ i ePPŕl`ıwı KıUıv mıeav nq|
2. `š-ıPıKrmKMY AeZj `cŕ e`envi Ktib|
3. cŕZdjK ıntıte AeZj `cŕ e`envi Kiv nq| thgb- UPŕvBU, w÷gvi ev j tÂi mıPŕvBtU AeZj `cŕ e`envi Kti MıZc\_ıbaŕY Kiv nq|
4. AeZj `cŕıv mıvıth` AvtjvKkı³, Zıckı³ BZ`w` tK>ıfZ Kti tKıfbv e` tK DÊB Ki tZ e`envi Kiv nq| Gŕovı GıU iWıvı Ges ıUıf mstKZ mSMŕn e`eüZ nq| thgb- ıWk GıUıv, tııPjı, tUıjt`<vc Ges iWıvı mSMŕnK BZ`w` |
5. AeZj `cŕıv mıvıth` AvtjvK ınkı, "ŖıK GıUı we`ıZ tK>ıfZ Kiv hıq etj Wı³vı iv tPıL, bvK, Kıv l Mjv cıxııv Kivı mgq G`cŕ e`envi Ktib|

#### DËj `cŕ

1. DËj `cŕ meıv Aev`İe, tıvRv Ges LıeZ cŕZwe^ MVb Kti weavq tıQıbi hıbeıvıv ev c\_Pııx t`Lvi Rb` MıwıZ Ges weıqı mgq ıfD ıgıı ıntıte G`cŕ e`envi Kiv nq|
2. DËj `cŕıv mıvıth` we`İZ GıvKıv t`LıZ cıvıv hıq etj t`vKıv ev kıcsgtj ıbıvcËıv KıfR DËj `cŕ e`envi Kiv nq|
3. cŕZdjK tUıjt`<vc ^Zwi tZ G`cŕ e`eüZ nq|
4. G`cŕ we`İZ GıvKıv AvtjvKııkıQıwıq t`q etj iv`Ívi ewıZıZ cŕZdj Kııtc e`eüZ nq|

### 8.8 ıbıvc` WıBıfı

#### Safe driving

ıbıvc` Mıwı, tıvıı mıBıKj BZ`w` hıbeıvıv Pıjııbıvı Rb` PıjKıK AıbK ıKŖıLıqı Ki tZ nq| cŕıgB ZıfK Mıwı mKj ewıZ Rıjııq Gıııv ıWK AvıQ ıKıvı Zıv cıxııv Kti ıbıZ nq| ıbııZ Ges ıbıvc` Mıwı PıjııZ tıj PıjKıK`ııııı Mıwı mıgııb Kı AvıQ Zıv t`LııB Pıjııv| eis Mıwı ıcŕııb Kı AvıQ G e`ıvııı mRıM\_ıvKıZ nq| Mıwı Rb` `cŕııv AZ`š-ıııııGı AcıııııA½| GRb` Mıwı PıjKıK MıwıZ Dıvı cıııB`cŕıııııı ıWKıZ Dcııııb Ki tZ nq|

### 8.9 cıvıvıv iv`Ívi A`k` eıfK

#### Blind turns on hilly roads

ıbıvc` MıwıPıjııv mKj MıwıPıjıııı Rb` Aek`B KZŕı| Gŕovı Lııvc Avenıııvıv thgb- eııııııı, Kıvıvı gıfS Mıwı Pıjııbıv Avıı Kııb KıRı weııııZ cıvıvıv iv`Íıvı Mıwı Pıjııbıv AZ`ıııı SııKcıııı tKııvı cıeZ` mıK thgb Avıııııı, tZıııı hı\_ŕ DPıııııııııı 8.23| cıvıvıv iv`Íıvı MıwıPıjııvıv Rb` AıbK mgq 90° tKıııı eıfK ıbıZ nq| GB eıfK tıııııııı mgq hı\_ŕ mıeavıvıv Aeıııııı Ki tZ nıe| A`k` eıfK weıııııı ıK

t\_†K Avm Mmoi Pvj K ci`úi†K †`L†Z cvb bv, GQovon eufKi Aci cv†k Kx Av†Q Zv Av†`Š Zviv Rv†bb bv|  
G mgm`v mgrav†bi Rb` wec¾bK eufK 45° †Kv†Y enr AvKwZi mgZj `cŕ emv†bv nq| Gi dtj  
MmoPvj KMY eufKi Av†kcv†k memKQz†`L†Z cvb Ges wbi v†` Mmo Pvjv†Z m¶g nb| g†b iv†L†Z n†e,  
civno iv`Ívi eufK KLB† †Rv†i Mmo Pvjv†bv wK bq| GQovon Ri¶i †Kv†bv KvR bv \_vK†j iv†Zi tejvq  
civno iv`Ívq Mmo Pvjv†bv DvPZ bq| †Kbbv Av†jvK `†i Zvi Rb` iv†Zi tejvq `wóMñ`Zv A†bK K†g hvq|



wP† : 8.21

## 8.10 weeaB

### Magnification

Avgiv hLb †Kv†bv `cŕ ev tj†Y mó cŕZwea^†`wL, ZLb †mU j ¶e` i Zj bvq eo, †QvU ev mgvb AvKv†i i  
n†Z cv† |

†Kv†bv `cŕ ev tj†Y MwZ cŕZwea^e` i ††q AvKv†i KZUKzeo ev †QvU weeaB Øviv Zv cwi gvc Kiv nq|  
Ab`fv†e ejv hvq cŕZwea^i `N°I j ¶e` i `†N¶ AbcvZ†K `i wLK weeaB ev m†¶†c weeaB etj |

hw / `†N¶ GKwU e` i Rb` †Kv†bv `cŕ ev tj†Y / `†N¶ GKwU cŕZwea^ MwZ nq Z†e H e` i  
weeaB n†e / / Gi Abcv†Zi mgvb |

$$A_{\text{ff}}, m = \frac{l'}{l} \quad (8.3)$$

weeaB m Gi gvb t\_†K Avgiv cŕZwea^ j ¶e` i Zj bvq KZ\_Y eo ev †QvU Zv Rv††Z cwi |

AbmÜvb : 8.1

AeZj `cŕ e`envi K†i cŕZwea^ m¶ó I cŕkB

D††k` : j`vetiUwi†Z AeZj `cŕ e`envi Ges ev`†e cŕZwea^ m¶ó Kiv|

hš¿cwZ : GKwU AeZj `cŕ|

Kv†Ri aviv :

1. GKwU AeZj `cŕ bvl |
2. `cŕU w†q †Zigvi j`vetiUwi i `i Rv A\_ev Rv†jvi wBKU `wovl |
3. Geri `cŕU†K ewnt†i i †Kv†bv `k` thgb-MwQcujv, `vjvb BZ`w` i w†K a†iv|
4. `cŕU†K W†b ev†g bovPov K†i †Zigvi Lp wBKUeZ¶gmY††qv†j H`†k`i cŕZwea^%Zwi Ki |
5. cŕZwea^U†K `úó Kivi Rb` `cŕU†K †qv†j n†Z mv†gb ev wQ†b mivl |
6. †Kv†bv GKwU wov`B`††ZjZig e` i `úó cŕZwea^†qv†j †L†Z cv†e|
7. Gfv†e `†i i e` i `úó cŕZwea^†qv†j cŕkB Kiv hvq|
8. cŕZwea^i cKwZ Av†jvPbv Ki |

## অনুশীলনী

### ক. বহুনির্বাচনী প্রশ্ন

সঠিক উত্তরের পার্শ্বে টিক (✓) চিহ্ন দাও।

১. উত্তল দর্পণ কোথায় ব্যবহার হয়?

ক. গাড়িতে

খ. টর্চ লাইটে

গ. সৌরচুল্লীতে

ঘ. রাডারে

২. প্রতিফলন কত প্রকার?

ক. ৪

খ. ৩

গ. ২

ঘ. ১

৩. সমতল দর্পনে সৃষ্ট প্রতিবিম্ব-

i. আকারে লক্ষ বস্তুর সমান

ii. পর্দায় গঠন করা যায়

iii. দর্পন থেকে বস্তুর দূরত্বের সমান দূরত্বে গঠিত হয়।

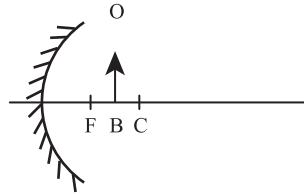
নিচের কোনটি সঠিক?

ক. i ও ii

খ. ii ও iii

গ. i ও iii

ঘ. i, ii ও iii



চিত্রের আলোকে ৪ ও ৫ নং প্রশ্নের উত্তর দাও।

৪. BO বস্তুর প্রতিবিম্বের আকৃতি কিরূপ হবে-

ক. বিবর্ধিত

খ. খর্বিত

গ. অত্যন্ত বিবর্ধিত

ঘ. অত্যন্ত খর্বিত

৫. BO বস্তুর প্রতিবিম্বের অবস্থান কোথায় হবে?

ক. ফোকাস ও মেরুর মাঝে

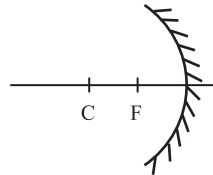
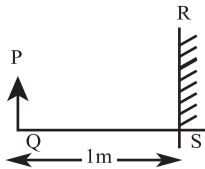
খ. প্রধান ফোকাসে

গ. বক্রতার কেন্দ্রে

ঘ. বক্রতার কেন্দ্র ও অসীমের মাঝে।

খ. সৃজনশীল প্রশ্ন :

১।



ক) সমতল দর্পণ কী?

খ) দর্পণের পিছনে ধাতুর প্রলেপ লাগানো হয় কেন?

গ) চিত্র ঐক্রে দর্পণ থেকে PQ বস্তুর প্রতিবিম্বের অবস্থান নির্ণয় কর।

ঘ) প্রতিবিম্ব গঠনের ক্ষেত্রে ১এবং ২নম্বর দর্পণের তুলনা কর।

২।

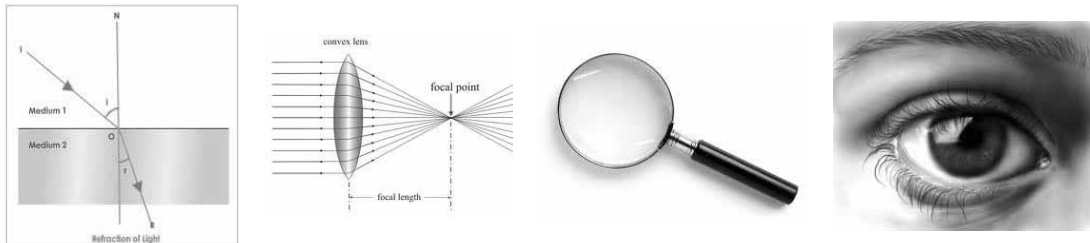


- ক) প্রতিবিম্ব কাকে বলে?
- খ) দর্পণে লম্বভাবে আপতিত রশ্মি একইপথে ফিরে আসে কেন?
- গ) চিত্রের আলোকে প্রতিফলন কোণের মান নির্ণয় কর
- ঘ) PQ দর্পণে গঠিত প্রতিবিম্ব অবাস্তব চিত্রসহ ব্যাখ্যা কর।

গ. সাধারণ প্রশ্ন

- ১। আলোর প্রতিফলন বলতে কী বুঝ ?
- ২। নিয়মিত প্রতিফলন ও ব্যাপ্ত প্রতিফলন বলতে কী বুঝ ?
- ৩। দর্পণ কাকে বলে ?
- ৪। প্রতিবিম্ব কাকে বলে? প্রতিবিম্ব কয় প্রকার ও কি কি ?
- ৫। অবতল দর্পণে কীভাবে বাস্তব প্রতিবিম্ব সৃষ্টি হয় তা রশ্মি চিত্রের সাহায্যে দেখাও।
- ৬। অবতল দর্পণে কীভাবে অবাস্তব প্রতিবিম্ব সৃষ্টি হয় তা চিত্রসহ বর্ণনা কর।

beg Aa`vq  
 Avtjvi cöZmiY  
**REFRACTION OF LIGHT**



[GKUv jwvK wZhRfite cmbi gta` Wpvtj euKv t`Lvq| RM fiv `~Q cmbi w`K Dci t`K ZvKvtj R#Mi Zjv Dcti DtvtQ etj gtb nq| Gme NUbv Avgiv `b`b Rxtb wböqB j`K KtiwQ| G NUbv,tjvi gtb itqtQ Avtjvi GKUv wtkl ag`hv nt`Q öcöZmiYö| cöZmiYi GKUv wtkl NUbv nt`Q cY`AF`šZixY cöZdjB| cY`AF`šZixY cöZdjB i Rb`B giFvgtZ giwPKvi m`ö nq, nxiKtK D¾j t`Lvq, AcwUK`vj dvBvti i mrvth` Z` mstKZ tcöY Kiv nq| Avgiv AtbtKB `wöi t`U `t Kivi Rb` Pkgv e`envi Kti `wK| GB Pkgvi KvP GKUv tjY| Avgiv GB Aa`vtq Gme wclq AvtjvPbv Kie|]

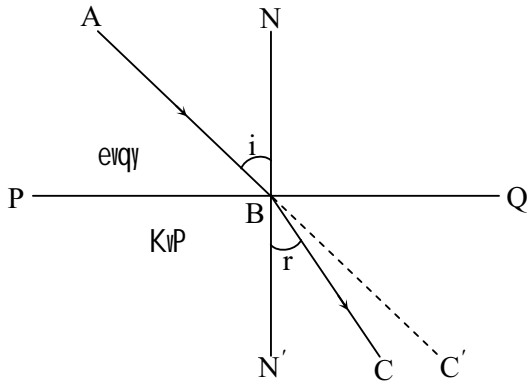
GB Aa`vq cW tktl Avgiv -

1. cöZmiYi m` e`vL`v KiZ cvie
2. cöZmiYv¼ e`vL`v KiZ cvie
3. cY`AF`šZixY cöZdjB e`vL`v KiZ cvie
4. AcwUK`vj dvBvti i e`envi e`vL`v KiZ cvie
5. tjY Ges Gi cKvtf` e`vL`v KiZ cvie
6. AvtjvKinkvi wµqvti Lv A¼b Kti tjY mspvšf wewfbaiwK eYöb KiZ cvie
7. tjY m` cöZw`^ AvtjvK inkvi wµqvti Lv A¼b Kti eYöb KiZ cvie
8. tjYi qgZv e`vL`v KiZ cvie
9. AvtjvK inkvi wµqvti Lv A¼b Kti tPvtLi wµqv e`vL`v KiZ cvie
10. t`ö`k`bi wbKUZg w`ye`vL`v KiZ cvie
11. `wöi t`U e`vL`v KiZ cvie
12. AvtjvK inkvi wµqvti Lv A¼b Kti `wöi t`U mstkvatb tjYi e`envi e`vL`v KiZ cvie
13. iwOb e` i AvtjvKxq Dcjwä e`vL`v KiZ cvie
14. `b`b Rxtb Avtjvi cöZmiYi e`envi e`vL`v KiZ cvie

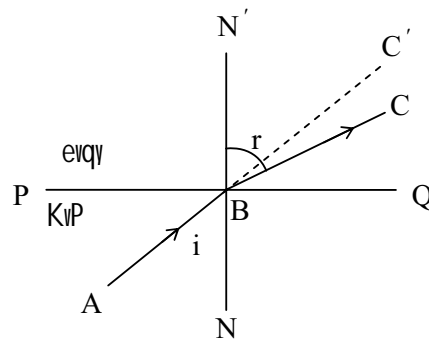
## 9.1 Avtjvi cŕZmiY

### Refraction of Light

ŕPŦ 9.1 j`ŕ Ki | GLŕb evqy Ges KvP `ŕJ gva`g t`Lvŕv ntŕtQ | AvtjvK iŕkŕ evqy gva`tg AB cŕ\_ Gŕm gva`gŕtqi ŕetf`Zj PQ Gi B ŕe`ŕZ ŕZhŕŕŕŕe ÁvcŕZZ ntjv | tŕvRv cŕ\_ tŕtj Avtjv KvŕPi gŕa` BC' cŕ\_ thŕZv ŕKŠ' Zv bv thŕq BC cŕ\_ tetK ŕŕtŕtQ | AvtjvK iŕkŕi GB tetK hŕevi NUBvB nt`Q cŕZmiY | mŕZivs AvtjvK iŕkŕ GK `~Q gva`gi tŕtK ŕŕbŕe`~Q gva`tg ŕZhŕŕŕŕe cŕek Ki tj `ŕ gva`gi ŕetf`Zj Gi ŕ K cŕiŕZZ nq | AvtjvK iŕkŕi GB ŕ K cŕiŕZŕbi NUBŕK Avtjvi cŕZmiY etj |



ŕPŦ : 9.1



ŕPŦ : 9.2

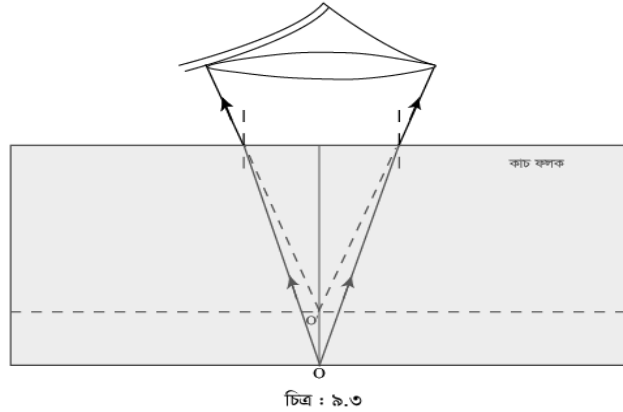
ŕPŦ 9.1-G AB ÁvcŕZZ iŕkŕ, BC cŕZmZ iŕkŕ Ges NBN', B ŕe`ŕZ PQ Gi Dci Áŕ¼Z Áŕfj ŕ^ |  $\angle ABN$  tK ÁvcZb tKŕY i Ges  $\angle N'BC$  tK cŕZmiY tKŕY r etj |

ŕŕŕbŕgva`tg Avtjvi teŕ ŕŕŕbŕZvB gva`g cŕiŕZŕbi mgq Avtjvi cŕZmiY NŕU | AvtjvK iŕkŕiŕ Kv gva`g (thgb evq) tŕtK Nb gva`tg (thgb KvP) cŕZmZ ntj cŕZmZ iŕkŕi Áŕfj ŕ^ i ŕ tK tetK hŕq A\_ŕ  $i > r$  | Áŕevi ŕecixZŕŕe Nb gva`g tŕtK AvtjvK iŕkŕiŕ Kv gva`tg cŕZmZ ntj (ŕPŦ 9.2) AvtjvK iŕkŕi Áŕfj ŕ^ tŕtK `ŕi tetK hŕte | A\_ŕ Gŕŕŕŕŕ  $r > i$  |

Kŕi t`L :

GKŕU mŕ`v KvŕŕRi Dci GKŕU Kwj i `ŕM `ŕl Ges Zvi Dci GKŕU `~Q KvŕPi djK iŕL | Kx t`L tj?

O ŕe`yO' ŕe`ŕZ DŕV GŕtŕQ | Avtjvi cŕZmiŕYi Rb` Giŕ NŕU | O ŕe`y tŕtK ÁŕMZ AvtjvK iŕkŕi Nb gva`g tŕtK Gŕm iŕkŕiŕ Kv gva`tg cŕZmZ nq (ŕPŦ 9.3) dtj Áŕfj ŕ^ tŕtK cŕZmZ iŕkŕiŕ, tjv `ŕi tetK hŕq | cŕZmZ iŕkŕiŕ, tjv tK ŕcŕŕbŕŕŕŕ Ki tj O' ŕe`y tŕtK ÁŕmŕQ etj gŕb nq | O' ŕe`y O ŕe`y Áŕŕŕŕŕ cŕZŕŕ^ | ZvB Dci tŕtK t`L tj O ŕe`yO' ŕe`ŕZ DŕV GŕtŕQ etj gŕb nq |



### Avtjvi cōZmiYi mġ

Avgiv BtZvgta" wPġ : 9.1 (GLvġb wPġ : 9.4) G jġ KtinQ AB AvcwZZ inkġ, BC cōZmZ inkġ Ges NBN', B weġġZ PQ Gi Dci Aw¼Z Awfj æ^  $\angle ABN$  tK AvCZb tKvY i Ges  $\angle N'BC$  tK cōZmiY tKvY r etj |

GLb hw` AvCZb tKvY eġġ Kiv nq Zġe cōZmiY tKvYI eġġ cvte | wKS' cōZmiY tKvY AvCZb tKvYi mgvYcwmZK nte bv, A\_ġ AvCZb tKvY i wġY Kiġj cōZmiY tKvY r wġY nte bv | tġ Lv tMġQ  $i_1, i_2, i_3, \dots$  AvCZb tKvYi Rb" cōZmiY tKvY h\_vġtg  $r_1, r_2, r_3, \dots$  BZ"wm ntj,  $\frac{\sin i_1}{\sin r_1} =$

$\frac{\sin i_2}{\sin r_2} = \frac{\sin i_3}{\sin r_3} = \dots = \text{aġK nte} |$  GB aġKuġi gvb wbfP Kiġe AvCZb I cōZmiY gvaġgi cġKuZ Ges AvcwZZ Avtjvi etYġ Dci | Avevi tġ Lv hvġ"Q AB, BC Ges Awfj æ^ NBN' wZbuġ ti LvB tZvgvi eBġi cġvi mgZġj AvġQ | Gi tġtK tġ Lv hvq Avtjvi cōZmiY wġtgæ" ġU mġ tgġb Pġj |

cġg mġ : AvcwZZ inkġ, cōZmZ inkġ Ges AvCZb weġġZ weġġ Zġi Dci Aw¼Z Awfj æ^ GKB mgZġj Ae"vb Kġi |

wġZxq mġ : GKġRvov wġv" e gvaġg Ges wġv" e etYġ AvtjvK inkġi tġtġ AvCZb tKvYi mvBb Ges cōZmiY tKvYi mvBb-Gi AbcġZ me"v aġK |

GB wġZxq mġ tK tġġi mġ I etj |

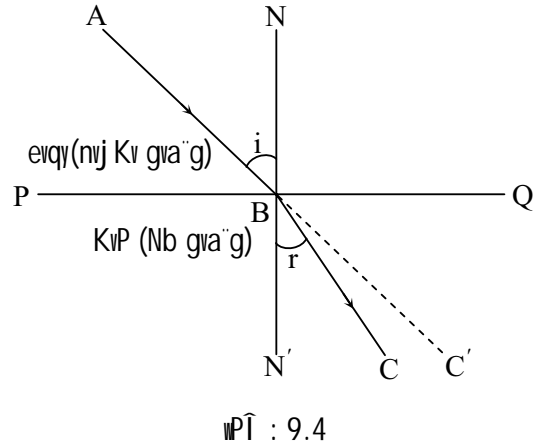
### 9.2 cōZmiYv¼

#### Refractive index

GKġRvov wġv" e gvaġg Ges tKvġbv GKġU wġv" e etYġ AvtjvK inkġi GK gvaġg tġtK Aci gvaġg cōZmZ ntj

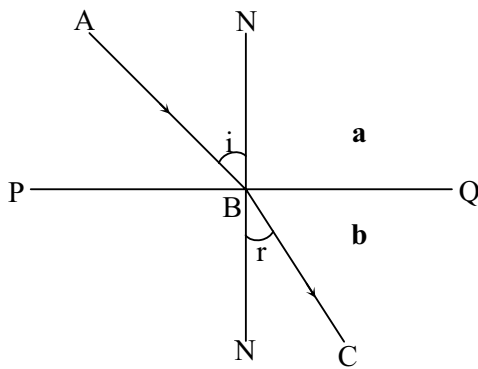
hw` AvCZb tKvY i Ges cōZmiY tKvY r nq Zvntj  $\frac{\sin i}{\sin r}$  th aġe msL"v nq ZvġK ej v nq H etYġ Avtj vi

Rb" cġg gvaġgi mġtġtġ wġZxq gvaġgi cōZmiYv¼ | GġK n wġtq cġKvK Kiv nq |

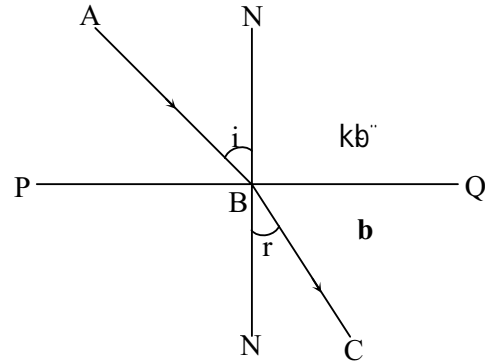


AvtjvKiwkŸ hw` a gva`g t\_ŸK b gva`g cŸek KŸi ZŸe, a gva`gi mŸtctŸŸ b gva`gi AvtŸŸŸK cŸZmiYv¼, (wŸŸ 9.5)

$${}_an_b = \frac{\sin i}{\sin r} \quad (9.1)$$



wŸŸ : 9.5



wŸŸ : 9.6

n Gi wŸŸP WwŸw` ŸKi AŸŸiŸw wŸŸ` R KŸi tKvb gva`gi cŸZmiYv¼ Ges evgw` ŸKi AŸŸiŸw wŸŸ` R KŸi tKvb gva`gi mŸtctŸŸŸ

Averi kb` `vb t\_ŸK hLb AvtjvK iwŸŸŸKŸtKŸtbr gva`g cŸek KŸi ZLb gva`gi th cŸZmiYv¼ nq ZŸŸK H etŸŸP Rb` H gva`gi cig cŸZmiYv¼ etj (wŸŸ 9.6) | hw` kb` `vb t\_ŸK b gva`g Avtjv cŸZmZ nq ZŸe, b gva`gi cig cŸZmiYv¼  $n_b = \frac{\sin i}{\sin r}$  | GŸŸŸŸŸ n Gi evgw` ŸK wŸKQzbr wjŸL tKej WwŸw` ŸK gva`g tjLv nq | thgb b gva`gi cig cŸZmiYv¼  $n_b$  |

Averi AvtjvKiwkŸ hw` b gva`g t\_ŸK a gva`g cŸek KŸi ZŸe tmŸŸŸŸŸ AvtjvKiwkŸi cŸ`veZŸŸi mŸvbŸŸŸŸi (9.6 wŸŸŸŸ) CB nŸe AvcŸZZ iwŸŸŸ, BA cŸZmZ iwŸŸŸ, A\_Ÿ AvcZb ŸKŸY = r | cŸZmiY ŸKŸY = i Ges b gva`gi mŸtctŸŸŸ a gva`gi AvtŸŸŸŸK cŸZmiYv¼ nŸe [mgxKiY 9.1 AbŸŸŸŸŸi]

$${}_bn_a = \frac{\sin r}{\sin i} = \frac{1}{\sin i / \sin r} = \frac{1}{{}_an_b} \quad (9.2)$$

mŸŸŸŸs gŸb ivLŸZ nŸe

$${}_bn_a = \frac{1}{{}_an_b} \text{ Ges } \text{wecixZŸŸŸg } {}_an_b = \frac{1}{{}_bn_a}$$

Averi ,

cŸZmiYv¼ŸK Avtjvi tetMi mŸŸŸŸŸŸŸ cŸŸŸK Kiv hwq,

$${}_an_b = \frac{\text{a gva`g Avtjvi teM}}{\text{b gva`g Avtjvi teM}} \text{ Ges}$$

$${}_on_b = \frac{\text{kb` gva`g Avtjvi teM}}{\text{b gva`g Avtjvi teM}} |$$



th gra`tgi cõZmiYv¼ teuk tmB gra`g teuk Nb Ges ZrtZ Avtjvi teM Kg| Avi th gra`tgi cõZmiYv¼ Kg tmB gra`g Kg Nb Ges ZrtZ Avtjvi teM teuk|

MwYvZK D`vniY 9.1 : evqyt\_+K cwb+Z cõZmi+Yi t`+t+ AvcZb tKvY 30° Ges cõZmiY tKvY 19° ntj , evqymv+ct+ cwb cõZmiYv¼ KZ ?

Avgi v Rwb,  $\frac{\sin i}{\sin r} = n$

$${}_w n_w = \frac{\sin i}{\sin r} = \frac{\sin 30}{\sin 19} = \frac{0.5}{0.325} = 1.538$$

DÊi : wbtYq cõZmiYv¼ 1.538

MwYvZK D`vniY 9.2 : evqj mv+ct+ cwb cõZmiYv¼ 1.33 ntj cwb mv+ct+ evqj cõZmiYv¼ KZ ?

Avgi v Rwb

$${}_w n_a = \frac{1}{{}_a n_w} = \frac{1}{1.33} = 0.75$$

D : 0.75

t` l qv AvtQ,  
AvcZb tKvY  $i = 30^\circ$   
cõZmiY tKvY  $r = 19^\circ$   
evqymv+ct+ cwb cõZmiYv¼  
 ${}_a n_w = ?$

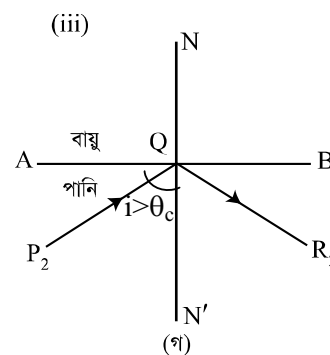
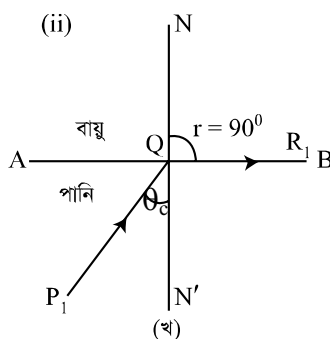
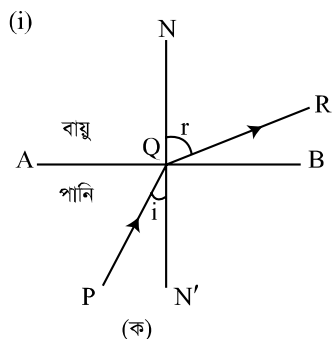
t` l qv AvtQ,  
evqj mv+ct+ cwb cõZmiYv¼,  ${}_a n_w = 1.33$   
cwb mv+ct+ evqj cõZmiYv¼,  ${}_w n_a = ?$

### 9.3 μmšZ tKvY l cY©Af`šZixY cõZdj b

#### Critical angle and total internal reflection

μmšZ tKvY : Nb gra`g t\_+K AvtjvK-iuk¥ hLb nvj Kv gra`tg cõZmZ nq, ZLb cõZmZ iukWU nvj Kv gra`tg Awfj s^ t\_+K Avi l `+i tetK hvq, dtj AvcZb tKvYi tPtq cõZmiY tKvY eo nq|

1. ami , AB ntjv KvP Ges evqygva`tgi wtf` Zj | KvP Nb gra`g Ges evqynvj Kv gra`g| KvPi gta` P we`yt\_+K PQ iuk¥ ¶jy` AvcZb tKvY AB wtf` Ztj i Q we`fZ AvcuZZ ntj evqygva`tg cõZmZ iuk¥ QR nte [wP+ : 9.7 K]| Gt¶+t+ AvcZb tKvY ( $\angle PQN'$ ) Gi tPtq cõZmiY tKvY ( $\angle NQR$ ) eo nte|



wP+ : 9.7

2. GLb Nb gva`tg ÁvcZb tKvY eŋŋ Ki t j , n j Kv gva`tg cŏZmiY tKvYI eŋŋ cŋte | GBfŋte ÁvcZb tKvY eŋŋ Ki t j t k t l GKŋU w e t k l ÁvcZb tKvY  $\angle P_1 Q N'$  c v l q v h ŋte (wŲŲ 9.7 L) h v i R b " cŏZmZ i ŋkŲ Q R \_ 1 g r a " g `ŲU i w e t f " Z j A B e i v e i P t j h ŋte A \_ Ų cŏZmiY tKvY  $\angle N Q R _ 1 = 90^0$  n t e | G B A e " ' v q N b g v a " t g i ÁvcZb tKvYŲtK ( $\angle P_1 Q N'$ ) n j K v g v a " t g i m Ųt c t Ų | N b g v a " t g i Ųw ŲšZ t K v Y e t j | 9.7 L b s wŲŲŲ  $\angle P_1 Q N' = \theta_c = \mu w ŲšZ t K v Y$  | G B Ųw Ųš - t K v Y i g v b l g v a " g Ųt q i c ŲK ŲZ G e s Á v t j v i e t Y Ų D c i w b f Ų K t i |

cYŲAf`šZixY cŏZd j b : N b g v a " t g ÁvcZb tKvYŲtK Ųw ŲšZ t K v Y i t P t q Á v i l G K Ųz e v o t j ( i > \theta\_c ) Á v t j v K i ŋkŲ m e U K B ` Ų g v a " t g i w e t f " - Z j m ŲŲYŲcŏZd w j Z n t q N b g v a " t g B w d t i Á v t m | G B A e " ' v q Á v i t K v t b v cŏZmZ i ŋkŲ c v l q v h v q b v | G B A e " ' v q g v a " g `ŲU i w e t f " - Z j ` c Ųb i g Z Á v P i Y K t i | G B N U b v t K c Y Ų A f ` š Z i x Y cŏZd j b e t j |

[wŲŲ 9.7 M] G N b g v a " t g ÁvcZb tKvY  $\angle P_2 Q N'$  g r a " g `ŲU i Ųw Ųš - t K v Y \theta\_c - G i t P t q e o | t m B R b " P \_ 2 Q i ŋkŲŲ ` Ų g v a " t g i w e t f " Z j A B - G i D c i Á v c Ų Z Z n t q cŏZd j t b i w b q g v b m Ųt i Q R \_ 2 c t \_ cŏZd w j Z n t q t Q |

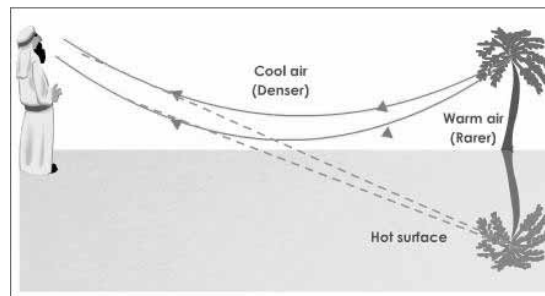
cYŲAf`šZixY cŏZd j t b i k Z " .

- Á v t j v K - i ŋkŲ K A e k " B N b g v a " g t \_ t K n j K v g v a " t g i Á w f g t L t h t Z n t e G e s ` Ų g v a " t g i w e t f " - Z j t j Á v c Ų Z Z n t Z n t e |
- N b g v a " t g ÁvcZb tKvY Ųw ŲšZ t K v Y i t P t q e o n t Z n t e |

## 9.4 giŋPKv

### Mirage

g i f ŋ g t Z Z Ų v Z " c Ų \_ K m g t q m g t q ` i e Z Ų M Ų t Q i D ě v t b v cŏZm e Ų ^ t ` t L g t b K t i b t m L v t b c w b Á v t Q | w k Ų ' M Ų t Q i K v t Q t m t j w Z w b Z v i f j e Ų t Z c Ų i b t h t m L v t b t K v t b v c w b b v B | Á v t j v i c Y Ų A f ` š Z i x Y cŏZd j t b i R b " B G i K g n q | G Ų v B g i ŋ P K v |



wŲŲ : 9.8

m Ų h Ų c Ų Ų Ě Z v t c g i f ŋ g i e w j D ě B n l q v i m t 1/2 m t 1/2 e w j m s j M a e v q Ų Z i \_ t j v l M i g n t q l t v | w b t P i e v q y D ě B l n j K v n q , Z t e D c t i i e v q y w b t P i e v q y - Z t i i Z j b v q V v Ų v \_ v K v q N b \_ v t K | G L b M w Q t \_ t K t h Á v t j v Á v t m Z v N b Z i g v a " g t \_ t K n j K v g v a " t g c Ų e k K i t Z \_ v t K | G i d t j cŏZmZ i ŋkŲ Á w f j Ų ^ t \_ t K

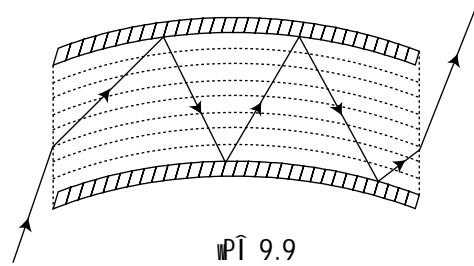
ত`ি মতি তহঁZ \_বঁK| GK mgq H AvtjvK-iৱkঋtKv৮v GKৱU evqj Zti ৮ৱশ-tKvYi tPtq eo tKvY AvৱZZ nq I Avtjvi cYAF`šZixY cŃZdj b NtU| H mgtqB M৮Qi Dëv৮v cŃZwe^ t`Lv hvq [ৱPÎ 9.8], hv৮K Avgiv giৱPKv ewj |

chêY: MৱKv৮j cŃi ti৮` ৱcP Xijv cŃ\_ nৱvi mgq ev hvbe৮t৮ hvvi mgq g৮S gta` nqZv t`tL \_vKte iv→v ৱPKৱPK Ki৮Q| g৮b nte thb iv`Zvq cৱb Rtg৮Q| GL৮bI gi৮gi giৱPKvi b`vq Nubv NtU৮Q|

## 9.5 AcৱUK`vj dvBevi ev AvtjvKxq Zš'

### Optical fiber

AcৱUK`vj dvBevi ^Zwi Kiv nq KvP ev cৱ÷tKi Lp miy `xN`bgbxq A\_P ৱbtiU dvBevi ev Zš' 0viv| GB dvBevii c`v৮\_P cŃZmiYv¼ 1.7| dvBevii Dci Atc¶KZ Kg cŃZmiYv¼i (1.5) c`v৮\_P GKৱU AveiY t`lqv nq| dvBevii GKcŃšZ ¶j` tKvY AvৱZZ AvtjvK iৱkঋ dvBevii ৱFZti evi evi cYAF`šixYfite cŃZdijZ nq tkI chšZ Ab` cŃšZ ৱ`tq tewi৮q Av৮m|



ৱPÎ 9.9

dvBeviU evKৱ ev cৱKv৮v Ae`vq \_vKtjI AvtjvK Gi ৱFZi ৱ`tq cŃq tKv৮v kৱ³¶q QovB cৱv৮v hvq (ৱPÎ 9.9)| GK`Q AcৱUK`vj dvBeviiK AvtjvK bj etj |

ত`v`t¶¶ Ges tUvj KৱDৱb৮Kk৮b AcৱUK`vj dvBevii e`envi:

tKv৮v tiৱmi cৱK`vj i ৱFZii t`qj cix¶v Ki৮Z ntj GKৱU AvtjvK bj৮K g৮Li ৱFZi ৱ`tq cৱK`vj tZ tXv৮v nq| GB AvtjvK btji GK tৱU AvtjvKxq Zš' ৱ`tq Avtjv cৱv৮q cৱK`vj i t`qtji mৱkŃ Ask৮K AvtjvKZ Kiv nq, Ab` tৱU ৱ`tq IB AvtjvKZ Ask৮K e৮ti t`tK t`Lv hvq| GB c`ৱZ GtŮv`<ৱc b৮g cৱi ৱPZ| Gfite AvtjvK bj XৱKtq i³evx agub ev ৱkivi eK ev ৱnctEi fij f`tjvi ৱৱqv t`Lv hvq|

GK `vb t`tK Ab` `v৮b `e`jvZK mstKZ Ar`vb-cŃv৮bi Rb` AcৱUK`vj dvBevi e`envi Kiv nq; Aek` Av৮M `e`jvZK mstKZtK cŃtg AvtjvK mstKtZ ৱcৱšZ Kti ৱbZ nq| cŃq 2000 tUvj tchb mstKZtK Gfite GKm½ GKৱU AcৱUK`vj dvBevii ga` ৱ`tq mÁvj b Kiv hvq| GtZ mstKZ`tjvi ZxeZvi cŃq tKv৮v cৱi eZ0 nq bv| AcৱUK`vj dvBevii e`envi eZ0t৮b thMthM e`vq Dtj t`thM` cৱi eZ0 Nৱtq৮Q|

## 9.6 tjÝ I Zvi cKvi৮f`

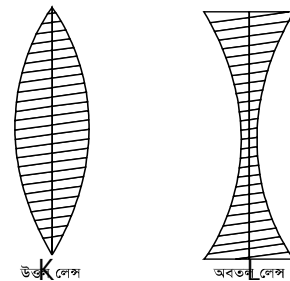
### Lenses and their classification

ৱU tMjxq cŃ 0viv mgiৱv tKv৮v `Q cŃZmi K gra`g৮K tjÝ etj |

tjÝ `B iKtgi nq : (i) Dëj tjÝ ev Aৱfৱvix tjÝ I (ii) AeZj tjÝ ev Acৱvix tjÝ

Dëj tjÝ : th tjÝi ga`fৱM cj` Ges cŃšZfৱM mi` Zv৮K Dëj tjÝ etj |

Dëj tjÝi Dci mgvšZiv iৱk`Q AvৱZZ ntj cŃZmi৮vi ci ৱbMZ nৱ qvi mgq Aৱfৱvix Kti etj Dëj tjÝtK Aৱfৱvix tjÝI etj [ৱPÎ 9.10 K]|



উত্তৰ লেন্স

অবতল লেন্স

ৱPÎ : 9.10

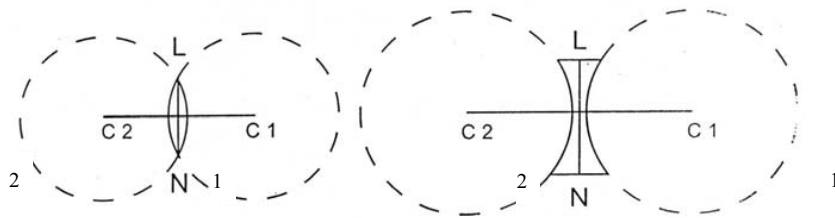
AeZj tjÝ : th tjÝi ga`fWM mi"Ges cõSZfWM µgk: cij" ZvK AeZj tjÝ etj | AeZj tjÝ mgvšZij iñkŷ\_Q AvcuZZ ntj cõZmiÝi ci wBMZ nl qvi mgq Acmvix nq etj AeZj tjÝK Acmvix tjÝI etj [wPÎ 9.10 L]

## 9.7 tjÝ msµvšZ KtqKw msÁv

### Few definitions

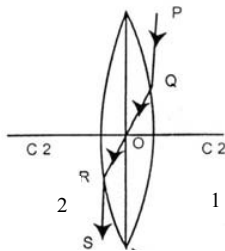
epZvi tK`^: tjÝi Dfq cõB GK GKw wbw`® tMjKi Ask | cõZ`K tMjKi tK`^K H cõi epZvi tK`^etj | 9.11 bs wPÎ C<sub>1</sub> Ges C<sub>2</sub>, LN tjÝi`® epZvi tK`^ | hw` tjÝi tKtbr GKw cõ tMjxq bv ntq mgZj nq Zte Zvi epZvi tK`^Amxg Aew`Z nte |

cãvb A¶ | tjÝi`® tMjxq cõ`vK | GB cõõti epZvi tK`^`® tMj thvM Ki tj th mij ti Lv cvl qv hvq ZvK H tjÝi`ãvb A¶ etj | 9.11bs wPÎ, C<sub>1</sub>C<sub>2</sub> mij ti LwU tjÝi`ãvb A¶ |



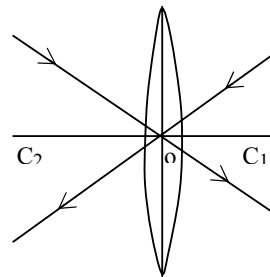
wPÎ t 9.11

AvtjvK tK`^: AvtjvK tK`^ntjv tjÝi` gta`ãvb A¶i Dci Aew`Z GKw wbw`® w`y hvi ga`w` tKtbr iñkŷAwZµg Ki tj cõZmiÝi ci tjÝi` Aci cõ t\_K wBMZ nl qvi mgq AvcuZZ iñkŷ mgvšZij fte wBMZ nq | 9.12 bs wPÎ tjÝi` GKcõ PQ iñkŷAvcuZZ ntq QR cõ cõZmZ ntqQ | GB iñkŷAci cõ t\_K RS cõ wBMZ ntqQ | wBMZ iñkŷ RS Ges AvcuZZ iñkŷ PQ ci`ui mgvšZij | GLb tjÝi` gta` cõZmZ iñkŷ QR cãvb A¶ C<sub>1</sub>C<sub>2</sub> tK O w`y Z tQ` Kti tQ, O w`y yntjv tjÝi` AvtjvK tK`^ |



cij tjÝ

wPÎ : 9.12



cvZjv tjÝ

tjÝw hw` cvZjv nq nte AvtjvK tK`^nt`Q tjÝi` gta` Aew`Z cãvb A¶i Dci`Ggb GKw w`y th w`y w` tK AvtjvK iñkŷAvcuZZ ntj w` K cwiEZB bv Kti cõZmZ nq |

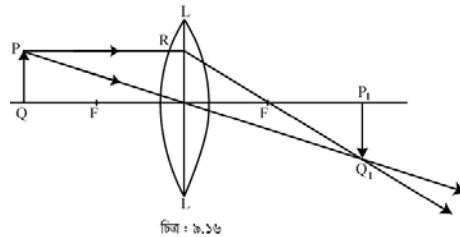
cãvb tcvKvm : tjÝi` cãvb A¶i mgvšZij Ges wBKUeZP iñkŷ\_Q cõZmiÝi ci cãvb A¶i Dci th w`y Z wgvj Z nq (Děj tjÝi` t¶t) A\_ev th w`y t\_K AcvZ nt`Q etj gtb nq (AeZj tjÝi` t¶t), tmB w`y K tjÝi` cãvb tcvKvm etj | 9.13 bs wPÎ tjÝi` cãvb tcvKvm F |



DĖj tjťÝ cĕZŕeŕ^ MVb :

LOL<sub>1</sub> GKŕU DĖj tjťÝ| FOF' cĕvb Aŕŕ, O AvťjvK ŦK>^, cĕvb F ŦdvKŕm GB tjťÝi cĕvb Aŕŕi Dci PQ GKŕU e^- ŦK tjťÝŕi ŦdvKŕm ŦťZi ŦŦq Ŧeŕk ŦKŦ' ŦŦY ŦdvKŕm ŦťZi Kg ŦŦi LvovŦŦe ivLv nťjv|

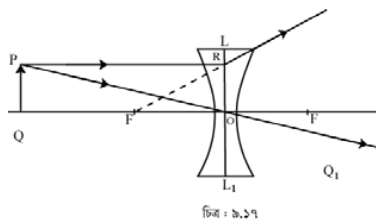
GLb P ŦťK AvMZ PR iŕkŦ cĕvb Aŕŕi mgvŦZiv ŦŦe GŦm tjťÝi ga" ŦŦq cĕZmZ nŦqvi ci cĕvb ŦdvKŕm F-Gi ga" ŦŦq RFP<sub>1</sub> cť\_ hvq| P ŦťK ŦbMZ Ab" GKŕU iŕkŦ PO cť\_ AvťjvK ŦK>^ O-ťZ AvcŕZZ nťq ŦŦvRŕmŦR OP<sub>1</sub> eivei cĕZmZ nťjv| RFP<sub>1</sub> Ges OP<sub>1</sub> iŕkŦ ŦŦU ci ŦŦi P<sub>1</sub> Ŧe>ŦZ ŦŦ KŦi | P<sub>1</sub> Ŧe>ŦťK Aŕŕi Dci P<sub>1</sub>Q<sub>1</sub> j ŦŦUvŦv nťjv| P<sub>1</sub>Q<sub>1</sub> nťjv PQ Gi eŦŦe cĕZŕeŕ^| GLŦŦb OQ e^- i ŦťZi Ges OQ<sub>1</sub> cĕZŕeŕ^i ŦťZi (ŦŦŦ 9.16)|



GB ŦŦŦŦ cĕZŕeŕ^ eŦ-e, DĖv I ŦeŦaZ nťqŦŦ| jŦŦe^- i ŦeŦŦbAe^-ŦŦbi Dci ŦbŦŦ KŦi cĕZŕeŕ^ eŦŦe, AeŦŦe; ŦŦvRv, DĖv; ŦeŦaZ, LŦeZ eŦ AvKŦi mgvb nťZ cŦi | jŦŦe^- DĖj tjťÝi cĕvb ŦdvKŦŦi ŦŦZi ŦŦKŦj cĕZŕeŕ^ AeŦ-e ŦŦvRv I ŦeŦaZ nťe|

AeZj tjťÝ cĕZŕeŕ^ MVb :

aiv hvK LOL<sub>1</sub> GKŕU AeZj tjťÝ| FOF' Gi cĕvb Aŕŕ, O AvťjvK ŦK>^, F cĕvb ŦdvKŕm| tjťÝi mgŦŦb PQ GKŕU jŦŦe^- cĕvb Aŕŕi Dci j ŦŦŦŦe AeŦ-Z (ŦŦŦ 9.17) PQ Gi cĕZŕeŕ^ AŦŦb KiťZ nťe|



P Ŧe>ŦťK ŦbŦmZ GKŕU AvťjvK iŕkŦ PR cĕvb Aŕŕi mgvŦŦjv nťq tjťÝ R Ŧe>ŦZ AvcŕZZ nťj cĕZmŦŦi ci RM cť\_ GgbŦŦe cĕZmŦi Z nq ŦŦb iŕkŦU cĕvb ŦdvKŕm F ŦťK AvŦŦQ eťj gŦb nq| P ŦťK Avi GKŕU iŕkŦ PO AvťjvK ŦK>^ ŦŦq tjťÝ AvcŕZZ nťq ŦŦvRŕmŦR PON cť\_ cĕZmZ nq| GB cĕZmZ iŕkŦ ŦŦU AcŦvŦx eťj ŦŦŦj Z nq bŦ| Gť iŦK ŦcŦb ŦŦK eŦŦŦq ŦŦj P<sub>1</sub> Ŧe>ŦťK AvŦŦQ eťj gŦb nq| ŦŦŦis P<sub>1</sub> Ŧe>Ŧ nťŦŦ P Ŧe>Ŧj AeŦ-e cĕZŕeŕ^| GLb P<sub>1</sub> ŦťK cĕvb Aŕŕi P<sub>1</sub>Q<sub>1</sub> j ŦŦUvŦj P<sub>1</sub>Q<sub>1</sub> nťe PQ jŦŦe^- i cĕZŕeŕ^| GB cĕZŕeŕ^ AeŦŦe, ŦŦvRv Ges AvKŦi jŦŦe^- i ŦŦq ŦŦŦU AeZj tjťÝ ŦeŦv AeŦŦe, ŦŦvRv Ges ŦŦŦU AvKŦi i cĕZŕeŕ^ MVb KŦi |

tjÝ tPbvi Dcvq : tjÝi Lp KvQvKwQ wKš' wQtb GKUv AvOj ai tj hw` GwUtk tmvRv Ges AvKvfi eo  
 † Lvq Zte tjÝWU DĖj | tmvRv Ges AvKvfi tQvU † Lvq tjÝWU AeZj | Gfvte tjÝ mbr<sup>3</sup> Kiv hvq |

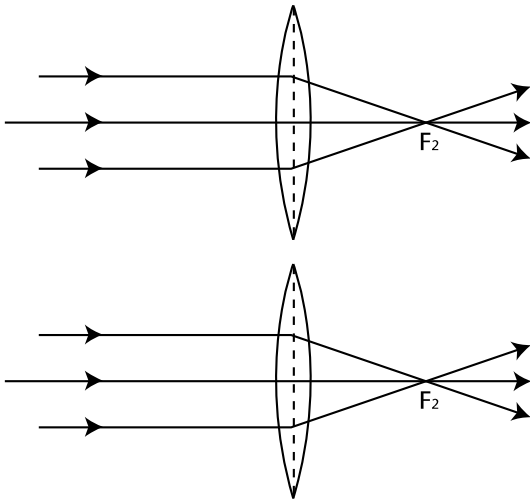
Kti † Lv : tZvgvi eB Gi tj Lvi KvQvKwQ GKwU DĖj tjÝ a†iv | tj Lv,tjv eo † LtZ cvt"Qv Kx ?  
 †Kb?

DĖj tjÝ KZK cāZmi†vi ci weewaZ cāZwe<sup>α</sup> tZvgvi tPvL ctotQ etj tj Lv,tjv eo † Lv"Q |

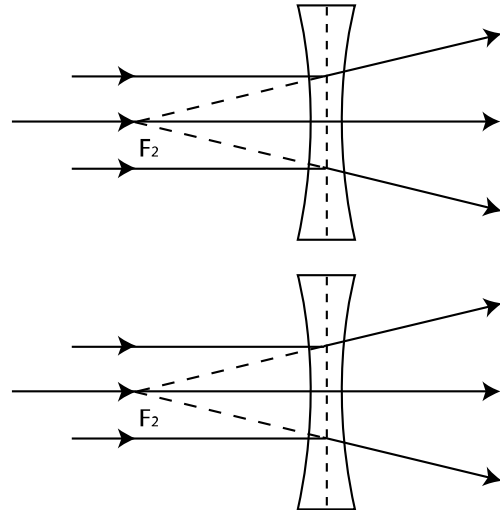
## 9.8 tjÝi ¶lgZv

### Power of a lens

gtb Ktiv`ŕWU DĖj tjÝ (wPĤ 9.18) | cāgwU tdvKv m`†Zj tenk Ges wāZxqWU tdvKv m`†Zj Kg | GLb  
 hw` GK,"Q mgvš†vj



wPĤ 9.18



wPĤ 9.19

inkŕ tjÝ`ŕWU cāvb At¶i mgvšZivj fvte Gtm AvcwZZ nq Zte Zviv tjÝ KZK cāZmZ ntq cāvb  
 tdvKvfm wgvj Z nte | cāg tjÝi t¶†Ĥ H tdvKv we`ytjÝi hZ`†i nte wāZxq tjÝi t¶†Ĥ Zv nte bv  
 eis Kg nte | DĖj tjÝi ¶lgZv ejtZ Avgiv ejS th H tjÝ mgvšZivj inkŕ,"Q†K KZ tenk KvQ wgv†Z  
 cvti ev Awfmvix Kitz cvti | Gt¶†Ĥ ejv hvq cāg tjÝi ¶lgZv Kg Avi wāZxq tjÝi ¶lgZv tenk | tjÝi  
 ¶lgZv Kg ntj tdvKv m`†Zj tenk Avi ¶lgZv tenk ntj tdvKv m`†Zj Kg |

9.19 bs wPĤ AeZj tjÝ mgvš†vj fvte AvMZ Av†jvK inkŕ,"Q†K cāZmiY † Lv†bv ntq†Q | Gt¶†Ĥ th tjÝ  
 mgvšZivj fvte AvMZ Av†jvK inkŕ,"Q†K cāZmi†vi ci hZ tenk Qnotq w†Z cvti ev Acmvix Kitz cvti  
 Zvi ¶lgZv ZZ tenk | Gt¶†Ĥ I tjÝi tdvKv m`†ZjhZ Kg, ¶lgZv ZZ tenk |

mZivs Avgiv mvaviYfvte ejtZ cwi tKv†bv tjÝi Awfmvix ev Acmvix Kivi mvg\_¶K Zvi ¶lgZv etj |

¶lgZv  $P$  Ges tdvKv m`†Zj†Gi g†a" GKwU m<sup>α</sup>úK<sup>α</sup>Av†Q | m<sup>α</sup>úKwU nt"Q,  $P = \frac{1}{f}$

GK wgvUvi tđvKvm `iZjēkō tKvťbv tjtŕYi ŦlgZđK 1 Wwqvŕvi etj | PŦlzeťklÁiv Pkgvi KvťPi th ŦlgZv wj tL \_vťKb Zv Wwqvŕvi GKđK wj tLb |

wŦđđ cŕv : mKj `iZi tjtŕYi AvťjvK tK`^t\_ťK cwi gvc KiťZ nte | mKj ev`ŕe `iZi abvZŦK, ev`ŕe `iZi ejťZ AvťjvKiwť cŦKctŦ th `iZi AwZug Kti tmB `iZđK eŖvq | mZivs mKj ev`ŕe jŦe` ,ev`ŕe cŕZwe^ ev ev`ŕe tđvKvťmi `iZđK abvZŦK aiv nq | mKj Aev`ŕe `iZi FYvZŦK | Aev`ŕe jŦe` ,Aev`ŕe cŕZwe^ I Aev`ŕe tđvKvťmi `iZđK Aev`ŕe `iZi aiv nq |

DĖj tjtŕYi tđvKvm `iZi abvZŦK Ges AeZj tjtŕYi tđvKvm `iZi Dfqb FYvZŦK |

MwvZK D`vniY 9.3 : tKvťbv tjtŕYi tđvKvm `iZi + 0.1 m ntj ŦlgZv KZ?

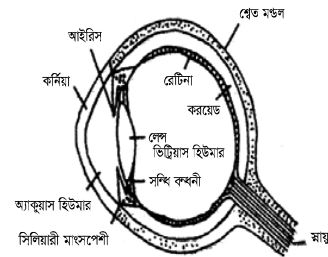
$$\text{Avgiv Rwb}, P = \frac{I}{f} = \frac{I}{+0.1 \text{ m}} = 10 \text{ D}$$

D: 10 D

t`lqv AvťQ,  
tđvKvm `iZi,  $f = +0.1 \text{ m}$   
ŦlgZv,  $P = ?$

## 9.9 tŦvťLi MVb

1. AwŦŦMvj K (**Eye-ball**) : tŦvťLi tKvťti gťa` Aew`Z Gi tŦvjvKvi AskđK AwŦŦMvj K etj | Gi mvgťb I wQđbi Ask LwbKvUv P`vŕv | GvU tŦvťLi tKvťti gťa` GKvUwbw Ŗ mvgvi PviwťK NjťZ cťi |
2. tkZgĖj (**Sclerotic**) : GvU k³, m`v, A`~Q Zš` wťq `Zwi AwŦŦMvjđKi evBđi AveiY (wŦ 9.20) | GvU tŦvťLi AvKwZ wVK iťL | evBđi bŕbv cŦKvi Awbó nťZ tŦvťLi iŦv Kti |
3. Kwbŕvi (**Cornea**) : GvU tkZgĖj mvgťbi Ask | tkZgĖj G Ask `~Q Ges evBđi wťK wKQvU DĖj |
4. KōgĖj (**Choroid**) : tkZgĖj wŦZđi Mvťq Kvťjv iđi GKvU Av`ŕiY \_vťK hvťK KōgĖj etj | GB Kvťjv Av`ZiťYi Rb` tŦvťLi wŦZđi AfšZixY cŕZdj b nq bv |
5. AvBwi m (**Iris**) : Kwbŕvi wVK wQđb Aew`Z GKvU A`~Q c`ŦK AvBwi m etj | AvBwiťmi is wewfŕetjvťKi wewfŕeikťgi nq | mvaviYZ Gi is Kvťjv, nvj Kv bxj ev Mvp ev`vgx nq | AvBwi m PŦlze tjtŕYi Dci AvcwZZ Avťjvi cwi gvy w bqšZ Y Kti |
6. tŦvťLi gvY I Zvivi Ū«(**Pupil**) : AvBwiťmi gvSLvťb GKvU tQvU wQ`^\_vťK | GťK tŦvťLi gvY ev Zvivi Ū«etj | ZviviťŪi ga` wťq Avťjv tŦvťLi wŦZđi cŦek Kti |
- 7 | PŦŦjŦŦ (**Eye Lens**) : tŦvťLi gvYi wVK wQđb Aew`Z GvU tŦvťLi metPťq iŦŦŦŦAsk | GvU `~Q `Re c`ťŦ `Zwi | tjtŕYi wQđbi wťKi epZv mvgťbi wťKi epZvi tťq wKQvU tenk | tjtŕYi AwŦŦMvjđKi mvť wmwj qwi gvsmťcwK I mvmtćYwi wj MvťgU Ŗiv AvUKvťbv \_vťK | GB gvsmťcwK I wj MvťgU tjtvi mťKvPb I cŦviťYi đťj PŦlze tjtŕYi epZv cwi ewZ nq đťj tjtŕYi tđvKvm `iťZi cwi eZŖ NťU | `đi i ev KvťQ i wŦwbm t`Lvi Rb` PŦlze tjtŕYi tđvKvm `iťZi cwi eZŖ Kivi cŦqvRb nq |



wŦ : 9.20



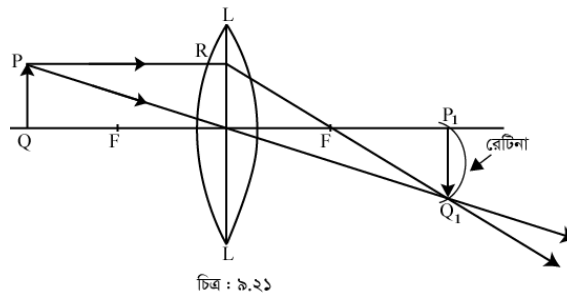


`ŋw tPvL \_vKvi myeav : `ŋw tPvL w`tq GKwU e` t`L tġ Argiv tKejgvġ GKwU e` B t`L tZ cvB | hw I cŋZ`KwU tPvL Avcb Avcb tiwUbvq cŋZwe` MVb Kti, wKš` gw`Ų< `yU wfbœcŋZwe`tK GKwU cŋZwe`t^ cwiYZ Kti | `yU tPvL \_vKvi Rb` `tZi wbfŲfvte cwigvc Kiv hvq | ZvB GKwU tPvL eÜ ti tL mŲtq mŲv civtZ LpB Amyeav nq | ZvQvov e` i Zj bvq `yU tPvLi wewfœAe`v tbi Rb` Wwb tPvL Wwb w`KUv tewk Ges evg tPvL evg w`KUv tewk t`L | `Ų tPvL w`tq e` t`L tġ `ŋw wfbœcŋZwe`t^i Dcwi cvZ NUte Ges e` tK fvtjvfvte t`Lv hvte |

## 9.10 tPvLi wuqv

### Function of an eye

cŋeB Argiv tRtbnQ th, Avgv` i tPvLi gwYi wK wQtb GKwU Kti DĖj tġ Y AvtQ hvi bvq PŲtġ Y | `ti i ev KvŲi wRwbm t`Lvi Rb` PŲtġ tġ Y tdvKvm `tZi cwieZB Kivi cŋqvRb nq |



wŲtġ PŲtġ Y t`Lvbnv ntqtQ | tPvLi mvgtb Z\_v tġ Y mvgtb PQ GKwU e` | e` wU P we`yt`K GKwU AvtjvKi wKŲ PR, cŋvb AtŲi mgyšZivtġ thtq tġ Y R we`ŲZ AvcwZZ ntġv | tġ Y cŋZmitYi ci Zv RFP<sub>1</sub> cŲ tMj | P t`tK Avi GKwU AvtjvKi wKŲ PO cŲ tġ Y AvtjvKtK`^ AvcwZZ ntq tmvRvmpR OP<sub>1</sub> eivei cŋZmZ ntġv | RP<sub>1</sub> Ges OP<sub>1</sub> cŋZmZ i wKŲ `yU P<sub>1</sub> we`ŲZ wgvj Z ntġv | Gevi cŋvb AtŲi Dci P<sub>1</sub>Q<sub>1</sub> jg!AwKtġ P<sub>1</sub>Q<sub>1</sub> nte PQ nte ev`Ųe I DjUv cŋZwe` |

cŋZwe`wU thLvfb MwZ ntġv Zv ntġv tPvLi tiwUbv | GwU iW I tKvY (rods and cones) bvŲg KZ\_tġv AvtjvK mŲe`bkxj tKvL Z\_v mŲqZš` Ōviv `Zwi | tiwUvbi Dci we` ev Avtjv cotġ Zv H mŲqZš` tZ GK cŲvi DĖRbv mŲŲ Kti dtġ gw`Zt`< `kŲbi AbyfwZ RvM Ges Argiv tmB e` t`L tZ cvB |

Dtġ t` th tiwUvbi Dci e` i DĖv cŋZwe` cŲ | GB AbyfwZ PŲly bvŲfŲ mrvth` gw`Zt`< Pġ hvq | tiwUbvq MwZ e` i cŋZwe` DĖv ntġ gw`Zt`< i we`kl cŋqvRb` Argiv e` tK tmvRv t`wL |

## 9.11 tPvLi ŲyU I Zvi cŋZKvi

### Defects of vision and their remedy

`vfwK tPvLi `wŲi cvjŲ 25cm t`tK Amxg chšZ we`ZZ A\_Ų, `vfwK tPvL 25cm t`tK Amxg `tZiġ gŲa` th tKvfbv e` `ŲŲ t`L tZ cvq | hw tKvfbv tPvL GB cvjŲi gŲa` tKvfbv e` tK `ŲŲ t`L tZ bv cvq Zvntġ tmB tPvL ŲwcyŲetġ aiv nq | tPvL cŋvbZ `Ų ai tbi ŲwU t`Lv hvq | h\_v-



cōZKvi : tPvLi tjŋi Awfmiw ƳgZv Ktg hvl qvi `i`b G ŋŋi D<sup>m</sup>e nq| ZvB G ŋŋi `i (wPŋ 9.23)  
 KiŋZ tPvLi tjŋi Awfmiw ƳgZv evovZ nq| G Rtb<sup>m</sup> mnvqK tjŋi wntmte DĖj tjŋi e<sup>m</sup>envi Kiv nq|  
 ZvOvov GKgvŋ DĖj tjŋi j Ƴe<sup>m</sup> i tPqI `i tmvRv Aev<sup>m</sup>ŋe cōZwe<sup>m</sup> MVb Kti | Gtŋŋi ZvB tPvLi  
 tjŋi mvgtb mnvqK tjŋi ev Pkgv wntmte Ggb ƳgZv Z<sub>v</sub> tdvKv <sup>m</sup>ŋZŋekó DĖj tjŋi e<sup>m</sup>envi KiŋZ nte  
 hv<sup>m</sup> ƳfweK tPvLi woku we<sup>m</sup>yN-G<sup>m</sup> wicZ j Ƴe<sup>m</sup> i we<sup>m</sup>ŋ ŋŋi ƳcYŋPvLi woku we<sup>m</sup>yO-tZ MVb Kti [wPŋ  
 9.23 (M)]|

## 9.12 iŋOb e<sup>m</sup> i AvtjvKxq Dcjwä

### Perceptions of coloured objects

Avgiv hLb tKv<sup>m</sup>bv e<sup>m</sup> t<sup>m</sup>L ZLb e<sup>m</sup> t<sub>ŋ</sub>K Avtjv Gtm Avgv<sup>m</sup> i tPvL cto| Pŋŋi tjŋi KZŋ D<sup>3</sup> Avtjv  
 cōZmwiZ ntq e<sup>m</sup> i GKw cōZwe<sup>m</sup> tiwUvq MVb Kti | tiwUvq eūmsL<sup>m</sup>K mŋy<sub>v</sub>ŋK hviv GB AbfwiZ  
 gw<sup>m</sup>ŋ<sup>m</sup> < tōY Kti | gw<sup>m</sup>ŋ<sup>m</sup> < wLŋZ we<sup>m</sup>ktkŋi ci Avgiv tmB e<sup>m</sup> t<sub>ŋ</sub>K t<sup>m</sup>LtZ cvB | tiwUv t<sub>ŋ</sub>K th bvf<sup>m</sup>ŋj  
 gw<sup>m</sup>ŋ<sup>m</sup> < wŋtqŋ t<sub>m</sub>ŋjvi bvg iW I tKvY (rods and cones) | Gt<sup>m</sup> i gta<sup>m</sup> tKvY<sub>v</sub>ŋj eY<sup>m</sup>mste<sup>m</sup> bKxj  
 (colour sensitive) | wZb aiŋi tKvY AvtQ bxj eY<sup>m</sup>mste<sup>m</sup> bKxj tKvY<sub>v</sub>ŋj eY<sup>m</sup>mste<sup>m</sup> bKxj tKvY Ges meR  
 eY<sup>m</sup>mste<sup>m</sup> bKxj tKvY | tKv<sup>m</sup>bv eY<sup>m</sup>hZB w<sup>m</sup>g<sup>m</sup>ev Rŋŋj tnvK bv tKb tPvL mKj eY<sup>m</sup>ŋK gvŋ GB wZbŋ eY<sup>m</sup>aviY  
 Kti | tiwUv tKvY<sub>v</sub>ŋj GB aviYKZ Z<sub>v</sub> gw<sup>m</sup>ŋ<sup>m</sup> < tōY Kti | gw<sup>m</sup>ŋ<sup>m</sup> < Avevi we<sup>m</sup>ktl cŋuqvi gva<sup>m</sup>tg mKj  
 eY<sup>m</sup>ŋK Avj<sup>m</sup>v Kti t<sup>m</sup>q | GfiteB Avgiv iŋOb e<sup>m</sup> i AvtjvKxq Dcjwä cvB |

## 9.13 ˆˆbŋˆˆb Rxeŋb Avtjvi cōZmiŋi e<sup>m</sup>envi

### Uses of refraction in our daily life

Avgv<sup>m</sup> i tPvL GKw DĖj tjŋi AvtQ | hLb Avgiv tKv<sup>m</sup>bv e<sup>m</sup> t<sup>m</sup>L ZLb Avtjv H e<sup>m</sup> t<sub>ŋ</sub>K Gtm tPvLi  
 tjŋi KZŋ cōZmZ ntq tiwUv Dci cto | tiwUvq H e<sup>m</sup> i GKw ev<sup>m</sup>Ze I DĖv cōZwe<sup>m</sup> MVb Kivi ci  
 Avgiv e<sup>m</sup> t<sub>ŋ</sub>K t<sup>m</sup>LtZ cvB | mZivs Avgv<sup>m</sup> i t<sub>ŋ</sub>K t<sup>m</sup>Lvi KvŋR mŋvŋ<sup>m</sup> KiŋQ Avtjvi cōZmiY |

AŋbŋKi tPvL ˆˆŋi ŋŋi AvtQ | tKD nqŋZv KvŋQi e<sup>m</sup> t<sup>m</sup>L bv tKD Avevi ˆˆi iUv t<sup>m</sup>L bv | Gme ŋŋi ˆˆi  
 Kivi Rb<sup>m</sup> Avgiv wŋˆˆ ƳgZvi tjŋi ŋviv ˆˆwi Pkgv e<sup>m</sup>envi Kwi | Pkgvi ga<sup>m</sup> w<sup>m</sup>ŋq AvMZ AvtjvK iŋkŋ  
 cōZmZ ntq tPvL cto Ges e<sup>m</sup> mŋWKfite t<sup>m</sup>LtZ mnvqZv Kti | mZivs ˆˆŋi ŋŋi ˆˆi KiŋZ Avtjvi  
 cōZmiY KvR Kti |

Avgiv K<sup>m</sup>vŋgiv w<sup>m</sup>ŋq ŋme Zŋj , gvBt<sup>m</sup>vŋ<sup>m</sup> <vc w<sup>m</sup>ŋq AvZŋŋi ˆˆwŋŋm eo Kti t<sup>m</sup>L , tŋŋi <vc w<sup>m</sup>ŋq ˆˆi i wŋŋm  
 KvŋQ t<sup>m</sup>L Gme hŋŋB Avtjvi cōZmiY agŋK e<sup>m</sup>envi Kiv nq |

ˆˆv<sup>m</sup>ŋŋi I tŋŋi KŋgDŋbŋKktb Avgiv th AcŋŋK<sup>m</sup>ŋj dŋBevi e<sup>m</sup>envi Kti ˆˆwK ZvI Avtjvi cōZmiY atgP Ae<sup>m</sup>vŋ |  
 Avgv<sup>m</sup> i AŋbŋKi Nti gvŋQi G<sup>m</sup>vKwi qvg AvtQ | GLvŋb wKŋiŋOb gvQ i vLŋj Zvŋ i gRvi MŋZwe<sup>m</sup> t<sup>m</sup>Lv hvq |  
 gvQ t<sub>ŋ</sub>K cŋŋ Avtjv cŋbi ga<sup>m</sup> w<sup>m</sup>ŋq Gtm KvŋPi ev<sup>m</sup> AvcwZZ nq | KvŋP cōZmiŋi ci Avgv<sup>m</sup> i tPvL  
 tmB ˆˆk<sup>m</sup> Avtm | mZivs GLvŋbI cōZmiŋi Ae<sup>m</sup>vŋ iŋtqŋ |



## Abkxj bx

K. eũbeŕPbx cłke

mVVK DĖti wJK (√) wPŕ`vl :

1| Nb gva`tgi wFZti i vLv tKvŕv e` tK nvj Kv gva`g t\_tK t` Ltj Gi cłZwe^ tKv\_vq nte?

K) Dcťi i w` tK DtV Avmťe

L) wŕtPi w` tK mťi hvťe

M) GKB RvqMvq \_vKťe|

N) cvťk mťi hvťe

cvťki wPĤ t\_tK 2 l 3 bs cłke DĖi `vl |

2| GLvťb cłZmiY tKvY KZ?

K) 0°

L) 90°

M) 180°

N) 45°

3| AvcZb tKvYw hw` μwšZ tKvYi tPtq eo nq Zvntj Kx NUťe ?

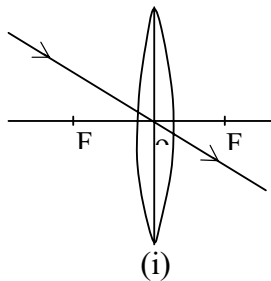
K) cY^Af`šZixY cłZmiY

L) cY^Af`šZixY cłZdjb

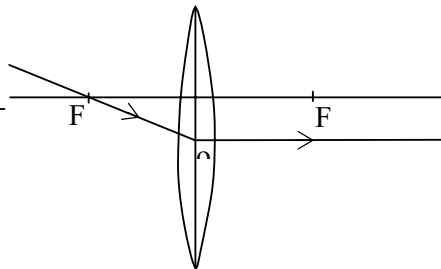
M) cłZmiY

N) cłZdjb

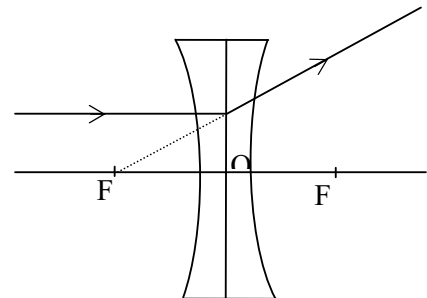
4| DĖj tjťY cłZwe^ A¼ťbi tŕťĤ mPivPi e`eüz i wKv wPĤ -



(i)



(ii)



(iii)

K. i

L. ii

M. i l ii

N. i, ii l iii

5| tjťYi ŕlgZvi GKK tKvťbwU ?

K) Wvqvŕvi

L) l qvU

M) AkĤ ŕlgZv

N) wKťj vl qvU - N>Uv

L. mRbkxj cłke

1| `kg tkiYi QvĤx wKDjx tkiY Kťŕ e`vK tevťWŕ tj Lv fvj fvťe t` LtZ cvq bv| dtj Wv³vťi i mi bvcbontj Wv³vi ZvťK -2D ŕlgZvm^úbetj Ý Pkgv wnmvťe e`envťi i ci vgkŕ tj b|

K) tj Ý KvťK etj ?

L) `úk^bv Kťi Kxfvťe GKwU tj Ý mbv³ Kiv hvq?

M) wKDj xi Pkgvi tclvKvm `ťZjwYŕ Ki |

N) wKDj xťK FYvZK (-) ŕlgZvi tj Ý e`envťi i ci vgkŕ`evi thšv³KZv wetkĤY Ki |

# STATICAL ELECTRICITY



[Avgiv Rmb cÖZ`K c`vṽ\_B tčÜb I Btj KÜb \_vřK| Züg wK Rvb th tZvgvi kixti 10<sup>28</sup> wÜ Gi tPřqI tēwK tčÜb Ges cÖq mgvb mSL`K Btj KÜb AvřQ| GB Btj KÜb I tčÜtbi GKwÜ tğšjij K ag`nřPQ Avarb (Charge)| tčÜtbi AvarbřK abřZřK I Btj KÜtbi AvarbřK FYvZřK aiv nq| AwnZ eš` ci`ütii Dci ej cÖqM Kti N hv Zwor ej břtg cwiwPZ| Zwor ej cKwZi GKwÜ tğšjij K I „i“Zcř`ej| GB Aa`vřq Avgiv ř Le Křřřte tKřřbv e` ř K AwnZ Kiv hvq| Avgiv Avřiv ř Le Křřřte Avarbři Aw`řZi tēvSř hvq, Křřřte Zř`i ga`Kvi ej wřtme KřřZ nq| GB Aa`vřq Avgř`i Avřj wPZ Avarb \_řjv GK`vřb w`i \_vřřte, GB Rb` Avgiv GB Aa`vřqřK w`i Zwor wřtřte AvL`wqZ KřřřQ| Avgiv mēřřř GB w`i Avarbři e`envi Ges Gi řřřřK wKQřwec` I řmB wec` řřřř Křřřte mřearb \_vřřř nřte Zřl Avřj vPbv Kie|]

GB Aa"vq cW tk†I Avgiv Ñ

1. cigvYMVtbi wfwEŁZ Avavb m̃wŁi tgŁj K KviY e'vL'v KiŁZ cvie|
2. NIY I AvŁek cŁuqvq Avavb m̃wŁ e'vL'v KiŁZ cvie|
3. ZworexŃY hŁŁzi m̃vŁh' Avavb mbrŁKiY KiŁZ cvie|
4. KjtŁ^i mŁ e'envi KŁi Zwor ej cwigvc KiŁZ cvie|
5. Zwor tŃŁ m̃wŁi KviY e'vL'v KiŁZ cvie|
6. Zwor ejŁi Lvi wŁ K Zwor tŃŁŁi wŁ KŁK wŁŁŁ R KŁi e'vL'v KiŁZ cvie|
7. Zwor wefe e'vL'v KiŁZ cvie|
8. Zwor kwŁ msi ŃŁŁY avitŁi KŁhŁg e'vL'v KiŁZ cvie|
9. w'Łi Zwor e'envi e'vL'v KiŁZ cvie|
10. w'Łi Zwor wecŁ RbK SŁŁŁ nŁZ i ŃŁŁi tŁŁŁj e'vL'v KiŁZ cvie|

## 10.1 Avavb

### Charge

GK kx̣Zi mKṿtj t̄m̄Si f̄ Zvi c̄w̄÷t̄Ki w̄Pi“b̄x̄U n̄v̄Z w̄bj Pj Av̄Pov̄t̄bvi Rb̄| w̄KŠ’ Pj Av̄Pov̄t̄bvi Av̄t̄M t̄m̄Si f̄ w̄Pi“b̄x̄U t̄K Zvi D̄t̄ji c̄j l̄ f̄v̄t̄i i m̄v̄t̄\_ w̄KQ̄ŋY N̄t̄l w̄bj | Gevi Pj Av̄Pov̄t̄Z t̄M̄t̄j t̄m̄ w̄ēt̄q̄i m̄v̄t̄\_ j̄ŋ Kij th H w̄Pi“b̄x̄ w̄t̄q̄ Pj Av̄Pov̄t̄bv̄ h̄v̄t̄“Q̄ bv̄, Pj\_ t̄jv̄ me L̄vov̄ n̄t̄q̄ t̄M̄t̄Q̄ th̄b̄ ci\_ ūi t̄K w̄eKl̄ŋ K̄t̄i `t̄i t̄v̄t̄j w̄t̄“Q̄| t̄m̄Si f̄ GLb̄ w̄Pi“b̄x̄U t̄K t̄Uw̄et̄ji K̄v̄t̄Q̄ Av̄b̄t̄ZB̄ t̄`L̄t̄Z t̄c̄j th̄, t̄Uw̄et̄ji D̄ci c̄to\_ v̄Kv̄ UK̄t̄iv̄ K̄M̄R\_ t̄jv̄t̄K w̄Pi“b̄x̄U Av̄Kl̄ŋ K̄i t̄Q̄| t̄m̄Si t̄fi ḡZ G i Kg Aw̄f̄ÁZv̄ n̄q̄t̄Zv̄ t̄Zv̄ḡv̄t̄`i Āt̄b̄t̄KiB̄ n̄t̄q̄t̄Q̄| Av̄ḡv̄t̄`i `b̄w̄`b̄ Rx̄et̄b̄ Av̄ḡiv̄ t̄`w̄L̄ th̄ Av̄ḡv̄t̄`i P̄ri c̄v̄t̄ki Āt̄b̄K w̄R̄w̄b̄M̄B̄ t̄m̄Si t̄fi w̄Pi“b̄xi ḡZ Av̄PiȲ K̄t̄i |

K̄t̄i t̄`L̄ : t̄Zv̄ḡvi c̄w̄÷t̄Ki t̄`c̄j w̄Ūt̄K t̄Zv̄ḡvi `i K̄t̄bv̄ P̄t̄ji m̄v̄t̄\_ w̄KQ̄ŋY N̄t̄l K̄Z\_ t̄jv̄ K̄M̄t̄Ri UK̄t̄ivi K̄v̄t̄Q̄ ai |

Av̄ḡiv̄ t̄`w̄L̄ th̄, t̄K̄v̄t̄bv̄ ē` w̄et̄kl̄ Aē`v̄q̄ Ab̄` ē` t̄K Av̄Kl̄ŋ K̄t̄i ev̄ Z̄w̄orM̄Ō` ev̄ Aw̄nZ̄ n̄q̄ A\_ŋ ē` t̄Z Z̄w̄ōt̄Zi D̄rc̄w̄Ē n̄q̄| GB̄ Z̄w̄or th̄L̄v̄t̄b̄ D̄rc̄b̄en̄q̄ t̄m̄L̄v̄t̄b̄B̄\_ v̄t̄K̄ et̄j Ḡt̄K̄ w̄`i Z̄w̄or ej̄v̄ n̄q̄| GLb̄ t̄`L̄v̄ h̄v̄K̄, Z̄w̄orM̄Ō` ev̄ Aw̄nZ̄ n̄l q̄v̄ ej̄t̄Z Av̄ḡiv̄ K̄x̄ ej̄S̄ ?

Av̄ḡiv̄ R̄w̄b̄ c̄ŌZ`K̄ c̄`v\_ŋ̄i`ā ŋ̄i`ā KYv̄ Ō̄viv̄ M̄w̄V̄Z̄| Ḡt̄`i t̄K̄ ciḡv̄Ȳ et̄j| c̄ŌZ`K̄ c̄`v̄t̄\_ŋ̄ ciḡv̄Ȳ w̄b̄DK̄x̄q̄v̄t̄mi P̄riw̄`t̄K̄ N̄Ȳŋ̄ḡyb̄ B̄t̄j K̄Ūb̄ Ō̄viv̄ M̄w̄V̄Z̄| w̄b̄DK̄x̄q̄v̄t̄mi ḡt̄ā` `ŋ̄ aīt̄Yi KYv̄\_ v̄t̄K̄-t̄c̄Ōb̄ I w̄b̄D̄Ūb̄| c̄`v\_ŋ̄m̄ŌK̄v̄ix̄ t̄ḡŋ̄j̄K̄ KYv̄m̄ḡt̄ni (B̄t̄j ±b̄ I t̄c̄Ōb̄) t̄ḡŋ̄j̄K̄ I `en̄k̄Ō`ḡj̄K̄ aḡB̄ n̄t̄“Q̄ Avavb̄ ev̄ P̄v̄R̄ŋ̄ B̄t̄j K̄Ūt̄bi Avavb̄t̄K̄ F̄Ȳv̄Z̄K̄ Ges̄ t̄c̄Ōt̄bi Avavb̄t̄K̄ ab̄v̄Z̄K̄ aiv̄ n̄q̄| w̄b̄D̄Ūb̄ Z̄w̄or w̄bi t̄c̄ŋ̄ A\_ŋ Ḡt̄Z̄ t̄K̄v̄t̄bv̄ Avavb̄ t̄b̄B̄| ḠK̄w̄Ū t̄c̄Ōt̄b̄ Avavt̄bi c̄w̄iḡȲ B̄t̄j K̄Ūt̄bi Avavt̄bi m̄ḡyb̄| `v̄f̄w̄eK̄f̄v̄t̄ē ḠK̄w̄Ū ciḡv̄Ȳt̄Z̄ B̄t̄j K̄Ūt̄bi m̄sL̄`v̄ t̄c̄Ōt̄bi m̄sL̄`vi m̄ḡyb̄\_ v̄t̄K̄| d̄t̄j ḠK̄Ūv̄ t̄M̄Ūv̄ ciḡv̄Ȳt̄Z̄ t̄K̄v̄t̄bv̄ Z̄w̄or aḡ`c̄K̄v̄k̄ c̄iq̄ b̄v̄| w̄ērf̄b̄ac̄`v̄t̄\_ŋ̄ ciḡv̄Ȳt̄Z̄ t̄c̄Ōb̄ I B̄t̄j K̄Ūt̄bi m̄sL̄`v̄ w̄ērf̄b̄en̄q̄|

t̄K̄v̄t̄bv̄ ciḡv̄Ȳt̄Z̄ h̄Z̄ŋ̄Ȳ ch̄S̄-B̄t̄j K̄Ūb̄ I t̄c̄Ōt̄bi m̄sL̄`v̄ m̄ḡyb̄\_ v̄t̄K̄ Z̄Z̄ŋ̄Ȳ ch̄S̄-Z̄v̄ w̄b̄`f̄w̄or ev̄ Z̄w̄or w̄bi t̄c̄ŋ̄\_ v̄t̄K̄| w̄KŠ’ ciḡv̄Ȳt̄Z̄ Ḡt̄`i m̄sL̄`v̄ m̄ḡyb̄ b̄v̄ n̄t̄j ciḡv̄Ȳ Z̄w̄orM̄Ō` n̄q̄ A\_ŋ Aw̄nZ̄ n̄q̄| t̄K̄v̄t̄bv̄ ciḡv̄Ȳt̄Z̄ B̄t̄j K̄Ūt̄bi m̄sL̄`v̄ K̄t̄ḡ t̄M̄t̄j t̄c̄Ōt̄bi Aw̄aK̄` t̄`L̄v̄ t̄`q̄| Ḡ Aē`v̄t̄K̄ ej̄v̄ n̄q̄ ab̄v̄Z̄K̄ Avavt̄b̄ Aw̄nZ̄ n̄l q̄v̄| Avevi GB̄ w̄ēr̄Q̄b̄B̄t̄j K̄Ūb̄ Aci t̄K̄v̄t̄bv̄ ciḡv̄Ȳ m̄v̄t̄\_ h̄ȳŋ̄ n̄t̄j t̄m̄ ciḡv̄Ȳt̄Z̄ t̄c̄Ōt̄bi t̄P̄t̄q̄ B̄t̄j K̄Ūt̄bi m̄sL̄`v̄ t̄etō h̄v̄q̄, d̄t̄j F̄Ȳv̄Z̄K̄ Avavt̄b̄ Aw̄nZ̄ n̄q̄| ciḡv̄Ȳt̄Z̄ B̄t̄j K̄Ūt̄bi m̄sL̄`v̄ `v̄f̄w̄ēt̄Ki t̄P̄t̄q̄ Kḡ ev̄ t̄ew̄k̄ n̄l q̄v̄t̄K̄ Aw̄nZ̄ n̄l q̄v̄ et̄j |

th̄ m̄K̄j c̄`v̄t̄\_ŋ̄ gā` w̄t̄q̄ Z̄w̄or Z̄\_v̄ Avavb̄ m̄n̄t̄R̄ P̄jv̄P̄j K̄i t̄Z̄ c̄v̄t̄i Z̄v̄t̄`i t̄K̄ c̄w̄iēv̄n̄K̄ ev̄ c̄w̄iēv̄x̄ et̄j , th̄gb̄ av̄Zē c̄`v\_ŋ̄, ḡw̄Ū, ḡv̄b̄ēt̄`n̄ c̄f̄w̄Z̄| m̄v̄aviYZ̄ av̄Zē c̄`v\_ŋ̄ Z̄w̄or m̄p̄c̄w̄iēv̄n̄K̄ n̄q̄| Z̄v̄ḡv̄, Z̄v̄c̄v̄, Ā`v̄j̄ḡw̄b̄c̄q̄v̄ B̄Z̄`w̄` m̄p̄c̄w̄iēv̄n̄K̄| Aci c̄t̄ŋ̄ th̄ m̄K̄j c̄`v̄t̄\_ŋ̄ gā` w̄t̄q̄ Z̄w̄or Z̄\_v̄ Avavb̄ P̄jv̄P̄j K̄i t̄Z̄ c̄v̄t̄i b̄v̄ Z̄v̄t̄`i t̄K̄ Āš̄t̄K̄ ev̄ Ac̄w̄iēv̄n̄K̄ et̄j , th̄gb̄ K̄w̄, K̄M̄R̄, K̄v̄P̄ B̄Z̄`w̄` |

## 10.2 NIŋȲ Aw̄nZ̄KiȲ

### Electrification by friction

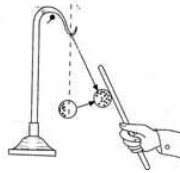
c̄ix̄ŋ̄Ȳ: ḠK̄w̄Ū nv̄j̄ K̄v̄ t̄k̄v̄j̄vi ej̄t̄K̄ ḠK̄w̄Ū m̄Z̄vi m̄v̄n̄v̄t̄h̄` t̄K̄v̄b̄ ÷`v̄Ū̄ ev̄ ūK̄ t̄`t̄K̄ S̄uj̄t̄q̄ `v̄l̄ | GLb̄ ḠK̄w̄Ū `i K̄t̄bv̄ w̄m̄t̄éi K̄v̄c̄toi UK̄iv̄ w̄t̄q̄ ḠK̄w̄Ū `i K̄t̄bv̄ K̄v̄P̄`t̄Ēi ḠK̄c̄ŌS̄Í f̄v̄t̄j̄v̄f̄v̄t̄ē N̄t̄iv̄| K̄v̄P̄`t̄Ē I t̄ik̄w̄ḡ K̄v̄c̄toi UK̄iv̄ m̄t̄h̄ŋ̄ w̄K̄i t̄Ȳ `i m̄K̄t̄q̄ Miḡ K̄t̄i w̄b̄t̄j̄ f̄v̄t̄j̄v̄ n̄q̄| GLb̄ K̄v̄P̄`t̄Ēi N̄iv̄ c̄ŌS̄Íw̄Ū ḡȳf̄v̄t̄ē S̄j̄v̄t̄bv̄ nv̄j̄ K̄v̄ t̄k̄v̄j̄vi et̄j̄ i K̄v̄t̄Q̄ Av̄t̄bv̄|



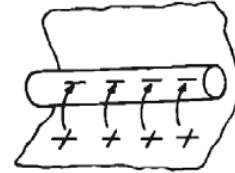
˘vfwek Ae˘˘vq c`v\_ŕ cigvYtZ Btj KUb I tçÜb mgcwi gvY \_vK| Zte cŕZ˘K cigvYj B cŕqRtbi AwZwi ³ Btj KU†bi cŕZ Avm³ \_vK| Btj KU†bi cŕZ GB Avm³ wewfbae



wPŦ : 10.1



wPŦ : 10.2



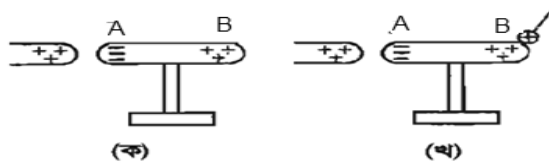
wPŦ : 10.3

e˘˘ tZ wewfbaei Kg| ZvB ˘wU e˘˘ tK hLb ci˘˘tii ms˘˘tk®Avbv nq ZLb th e˘˘ i Btj KUb Avm³ tewk tm e˘˘ Aci e˘˘ wU t˘tK Btj KUb msMh Kti FYvZK Avavb AwvZ nq| GKwU KvP˘ ÊtK wme Øviv Nltj Gi Kg NUbv NtU (wPŦ 10.1)| wmtéi Btj KUb Avm³ Kv†Pi tPtq tewk etj, Gt˘ i hLb ci˘˘tii mvt\_ Nlv nq, ZLb KvP t˘tK Btj KUb wmté Ptj hvq| Gi dtj wme FYvZK Avavb Ges KvP˘ Ê abvZK Aavb AwvZ nq| GRb˘ KvP˘ Ê tKvjvej†K AvKlY Kti (wPŦ 10.2)| Avevi dv†btji Kv†toi mvt\_ BtebvBU ev cujw\_b ˘Ê Nltj, cujw\_b ˘Ê FYvZK Avavb AwvZ Ges dv†btji Kv†co abvZK Avavb AwvZ nq| Kv†Y, cujw\_tbi Btj KUb Avm³ dv†btji tPtq tewk etj, ci˘˘tii mvt\_ NlYi dtj dv†btji Kv†co t˘tK Btj KUb BtebvBU ˘Ê Ptj Avtm (wPŦ 10.3)|

### 10.3 Zwor Avtek

#### Electric Induction

Avgiv t†LwQ th, ˘wU e˘˘ i cwi˘˘wi K NlYi dtj Avavb D™e nq| Avevi AwvZ e˘˘ tK AbwvZ e˘˘ i ms˘˘tk®Avbtj AbwvZ e˘˘ wU AwvZ nq| wKŠ˘ AbwvZ e˘˘ tK AwvZ e˘˘ i ms˘˘tk®bv Gt†b i˘ayKvQvKwQ w†tq Gt†I GwU AwvZ nq| Zwor Avtek†i Rb˘ Gi Kg nq| GKwU AwvZ e˘˘ i Kv†Q Gt†b ˘uk®bv Kti i˘agv† Gi Dcw˘˘wZ†t†K†bv AbwvZ e˘˘ tK AwvZ Kivi c˘wZ†K Zwor Avtek etj| w††Pi mnR cix¶vi mvr†h˘ Zwor Avtek e˘˘L˘v Kiv hvq|



wPŦ : 10.4

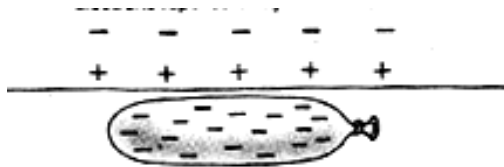
cix¶Y : ivet†i nvZj wenkó GKwU i†K†bv KvP˘ ÊtK tikg w†q fv†jv Kti Nt†I Gi GK cŕŠ-nv†Z

a†i Aci cŕŠ-GKwU AbwvZ cwievnK ˘Ê AB Gi A cŕŠ† w†K†U Av†j, cwievn†Ki g† Btj KUb t†jv KvP˘ Ê†i abvZK Avavb Øviv AvKó n†q A cŕŠ-m†i Avtm (wPŦ 10.4 K)| dtj B cŕŠ-Btj KUb NvUwZ m†w nq, A\_ŕ B cŕŠ-abvZK Avavb AwvZ nq Ges A cŕŠ-FYvZK Avavbh† nq| Avavb msMhK [GKwU Acwi evnx nvZ†i cŕŠ-j w††bv ¶†i ˘avZe cvZ ev ej] w†q B cŕŠ-t˘tK wKQzAvavb msMh Kti (wPŦ 10.4 L) Zworex¶Y h†Š˘i mvr†h˘ Gi cKwZ w†Y¶ K†j, Dcw†D³ e³te˘˘i mZ˘Zv cŕwY†Z n†e|

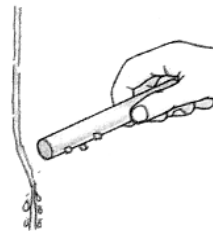
GL†b bZb tK†bv Avavb Drcb†ng bv| AwvZ KvP˘ Ê†i Dcw˘˘wZi Kv†Y mgcwi gvY wecixZ Rv†xq Avavb c˘K n†q cwievnxi ˘ß cŕŠ-m†i t††Q gv†| hZ¶Y KvP˘ ÊwU AB cwievnxi Kv†Q \_vKte ZZ¶Y wecixZ Avavb Gfv†te c˘K n†q cwievnxi ˘ß cŕŠ-Ae˘˘vb K†te| Dct†i cix¶vq KvP˘ Ê†i abvZK Avavb hv AB

cwi evnɔZ Aɪtek mɔ Kij ZɪK Aɪtekɪ Avavb eɟ | Aɪ AB cwi evnɔZ tɪ Avavɪbi mʌvi nɔ ZɪK  
Aɪeɔ Avavb eɟ |

m=úmwí Z KgRvÊ : GKwU dj vtbv tejþtK tZvgvi Rvgvi mv̄t\_Nl | Gi ci GwUtK Nti i  
t`l qvtj i mv̄t\_ GKUzLwb tPt̄c at̄i tQto`vl | wK t`Ltj ? tejþwU t`l qvtj AvUtK AvtQ |  
m=úmwí Z KgRvÊ : GKwU cw̄t̄t̄K i e` tK Rvgvi mv̄t\_Nl | Gi ci cw̄bi Kj t\_tK cov  
GKwU ¶xY cw̄bi avivi Kv̄tQ ai | cw̄bi aviv e` i w`tK t̄t̄K Av̄m̄t̄e |



WPI 10.5


$$w_{PI} : 10.6$$

tejtjb mǝ FYvZYK Avavb t̪ l qv̪tj Avtek m̪ǝ K̪ti | t̪ l qv̪tj Aweǝ abvZYK Avavb FYvZYK Avavb ien kǝ  
tejtjb̪t̪K AvK̪l̪b̪ K̪ti i v̪t̪L (w̪P̪ 10.5) | GKB Nubv N̪t̪u c̪w̪bi avivi t̪ q̪t̪̪ (w̪P̪ 10.6) |

## 10.4 Zworesch hš

## Electroscope

MVb : th hʃʒi mɪvɪh tKɪv e' tZ Avavɪbi AwɪZi | cKwz wɒbɒ Kiv hvq ZvɪK Zwɒrɛx ʔY hʃʒ  
etj | GB hʃʒ GKnU wCZj ev Ab' tKɪv avZe `Ê R Gi Dcɪ GKwU avZe PɪKwz ev tMɪj K AvUkɪv  
\_vɪK (wɪ 10.7) | `tÊi wɒɪPi cɒʃ-`wU nɪj Kv tɪvɪvɪ cvZ mʃɪɪ \_vɪK | cvZ `wU tɪvɪvɪ e'tj  
A'vɪɪvɪvɪvɪ ev Ab' tKɪv nɪj Kv avZi | nɪZ cvɪ | cvZmn `tÊi wɒɪPi Ask Acwɪvɪv c'`wU tɪɪ `Zwi  
wɪv C Gi ga' w' tɪ GKwU KvP cvɪɪ | gɪa' cɒk Kɪvɪv \_vɪK | hʃʒwU KvP cvɪɪ wɪZɪ \_vɪvɪvɪvɪv  
Gi ʔwZ KiɪZ cvɪ bv |

ZworexŋY hšŁK AwnZKiY : GKw KVP`ÊtK tikg w`tq Nltj KvP`tÊ  
abvZK Avartbi D<sup>m</sup>e nq| H AwnZ KvP`ÊtK ZworexŋYi PvkWZ ev  
tmvjtki Mrtq `uk©Kivtj `Ê ntZ LwbKUv Avarb PvkWztZ Ptj hvq| GB  
Avarb mpcwi evnx avZe `tÊi ga`w`tq tmvbvi cvZ0tq tctQ| dtj tmvbvi cvZ  
`yU GKB RvZxq Avarb tctq ci`ui tK weKIŸ Kti Ges ci`ui t\_tK`fi mti  
hvq ev wetCwvi Z nq| GB Ae`vq KvP`Ê mwitq vbtj hw`cvZ0tqi ga`eZ®  
dvk bv Ktg, Zvntj hšŁw abvZK Avartb AwnZ ntqtQ etj wmwvš-tblqv  
hvq|hšŁtK FYvZK Avartb AwnZ Kitz ntj GKw BtevbvBU`ÊtK dvtbj  
Øviv Ntl FYvZK Avarbhyß Kti DcwiD³ cūquqv PvkWZ `uk©Kiv nq| Gi  
dtj ^YevZ`yU FYvZK Avarb tctq ci`ui t\_tK`fi mti dvk ntq hvte Ges  
tmB Ae`vqb \_ykte| Avarb hZ tewk nte, avZe cvZ,tjvl ZZ tewk dvk ntq hvte|


$$w_{PI} : 10.7$$

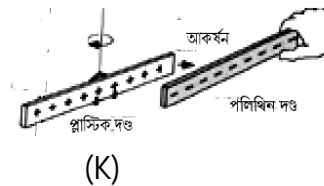
Avartbi Dcw`wZ wbyq : tKvbn e` tZ Avartbi Aw`Izi A\_ tKvbn e` tZ Avarb AvtQ wK bv wbyq Rb` e` wUtK GKwU AbwnZ ZworexY hsz i Pvkwi Zi KvQ AvbtZ nte| GtZ hw` cvZ `yU ci`ui t\_tK `fi mti hvq, Zvntj eStZ nte e` wUtZ Avartbi Aw`Izi AvtQ| wKs` hw` cvZ `yU ci`ui t\_tK `fi mti bv hvq, Zvntj eStZ nte e` wUtZ Avarb tbB|

Avartbi cKwZ wbyq : tKvbn ZworM0I e` tZ Kx aitYi Avarb AvtQ Zv RvbtZ ntj ZworexY hsz wUtK cUtq abvZK wKsev FYvZK Avartb AwnZ KitZ nte| aiv hvK, hsz wUtK abvZK Avartb AwnZ Kiv ntjv| H Ave`vq cvZ0tq abvZK Avarb vKivq Giv dvK ntq hvte| GLb cixYxq e` wUtK ZworexY hsz i Pvkwi Zi ms`utk`Avbtj hw` cvZ `yU dvK Ktg hvq, Zvntj eStZ nte H e` wU FYvZK Avartb AwnZ| cYvstfi cixYxq e` wUtK Pvkwi Zi ms`utk`Avbtj hw` dvK teto hvq, Zvntj eStZ nte e` wU abvZK Avartb AwnZ|

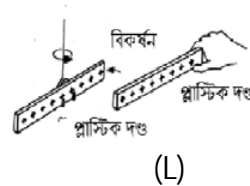
## 10.5 Zwor ej

### Electric force

etji cKwZ : GKwU abvZK Avartb AwnZ cW÷K `EtK bvBj tbi mZv w`tq Sij tq t`lqv ntjv (wP 10.8 K)| Gevi GKwU FYvZK Avartb AwnZ cWj\_w tbi `EtK Gi wKtU Avbv ntjv| wK t`Lv hvte? cW÷tKi `EuW cWj\_w tbi `Et i w`tK Nti hvte| G t\_tK eSv hvq, `yU wecixZ Avartb AwnZ e` ci`ui tK AvKIY Kti|



(K)



(L)

wP 10.8

Gevi GKwU abvZK Avartb AwnZ cW÷K `EtK Sij vb abvZK Avartb AwnZ cW÷tKi `Et i w`tK wbtq Gtj (wP 10.8 L) wK t`Lv hvte? Sij vb `EuW `Z `fi mti hvte| A\_ mgRvZxq Avarb ci`ui tK weKIY Kti|

Kj t`i m` : Avgiv t`Ljv, `yU wecixZ RvZxq Avarb ci`ui tK AvKIY Kti, `yU mgRvZxq Avarb ci`ui tK weKIY Kti| `yU Avartbi ga`eZP` tZi Dci|

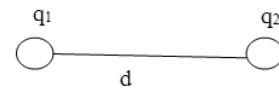
1. Avarb `yU cwigvYi Dci|
2. Avarb `yU ga`eZP` tZi Dci|
3. Avarb `yU th gva`tg Aew`Z Zvi cKwZi Dci|

`yU Avartbi ga`eZP AvKIY ev weKIY ej m`utK`weAvbx Kj t`i GKwU m` weZ Kti b| GtK Kj t`i m` etj|

m` : w`v` gva`tg `yU we`yAvartbi gta` w`qvkvxj AvKIY ev weKIY etji gvb Avarb0tqi Ydtji mgvbcwZK, ga`eZP` tZi etM` e`v`vbcwZK Ges GB ej Gt`i msthvRK mij t`Lv eivei w`qv Kti|

aiv hvK, `yU Avartbi cwigv h\_v`tg  $q_1$  l  $q_2$  Ges Gt`i ga`eZP

`tZi d (wP 10.9) Gt`i ga`eZP w`qvkvxj AvKIY ev weKIY ej  $F$  ntj, Kj t`i m` vbm`ti,



wP 10.9





4. `յԱ Amgvb abvZԻK Avartbi Rb` mթ Zvor tՊtի ejti Lv 1.11 (N) ԿPտի t` Lvտbv ntjv| GtՊtի ԿbiտՊ Կե`յN Պի Zi Avartbi ԿbKԼեZԹնե|

## 10.7 Zvor Կեֆե

### Electric potential

Zvor tՊtի thgb ZxeZv չտK, tZgvb Zvor tՊtի Կեֆե չտK| Կեֆե թviv ԿbաՊի Z nte Zvor tՊtի GKւԱ Avarb tKտbv ԿտK MvZkxj nte ev `յԱ ԿԿԵՆK mshթ Kիtj tKտb ԿԿԵՆK tտK tKտb ԿԿԵՆտK Avarb լեճՆZ nte| Zvor tՊtի mթKvix AwnZ e` ԿԱ Avarb abvZԻK ntj GKւԱ abvZԻK AvartbK e` i ԿտK AvտZ ԿեKԼԹ etji ԿեiտԻ KւR KիtZ nq| mZivs, Amxg tտK GKւԱ GKK abvZԻK AvartbK e` i hZ ԿbKԼեZԹtKտbv Կե`ջZ AvտZ nte ZZ տեւ KւR KիtZ nte| ZvB abvZԻKտե AwnZ GKւԱ e` i Zvor tՊtի gտ՝ GKւԱ Կե`յe` ԿԱ hZ ԿbKտU nte Zvi Կեֆե ZZ տեւ nte| abvZԻKտե AwnZ GKւԱ e` i Zvor tՊtի `ԿԿZ GKւԱ abvZԻK Avarb hԿ` gթտե PjտZ լտի, Zte tմԱ abvZԻKտե AwnZ e` tտK `ի mti hտե| mZivs ejv Pj abvZԻK Avarb DՊ Կեֆե tտK ԿԿԵՆտեի ԿտK Pj| AcitՊ FYvZԻK Avarb abvZԻK տե AwnZ e` i ԿտK Pj| mZivs, FYvZԻK Avarb ԿԿԵֆե tտK DՊ Կեֆեի ԿտK Pj| tՊtի mթKvix AwnZ e` ԿԱ FYvZԻKտե AwnZ ntj GKւԱ GKK abvZԻK AvartbK H e` i ԿտK AvտZ AvKԼԹ ej թviv KւR mթԵնե| FYvZԻKտե AwnZ e` i Zvor tՊtի Amxg tտK abvZԻK Avarb e` i ԿտK AvտZ ԿԿԵԼ KւR Kի| լtj AvartbU ԿԿ` nviq Ges Zvor tՊtի tKտbv Կե`յ ԿեֆեK FYvZԻK aiv nq|

Կեֆեի ԿԿԵՆ : Amxg չZtտK լժZ GKK abvZԻK AvartbK Zvor tՊtի tKտbv Կե`ջZ AvտZ th ԿԿԵՆ KւR mթԵնq ZտK H Կե`յ Zvor Կեֆե etj| Avevi, Amxg tտK լժZ GKK abvZԻK AvartbK ԿԿԵՆտK Lթ ԿbKտU AvտZ Zvor ej թviv ev Zvor etji ԿեiտԻ th ԿԿԵՆ KւR mթԵնq, ZտK H ԿԿԵՆտK Կեֆե etj|

Amxg tտK Պի`Avarb q tK Zvor tՊtի tKտbv Կե`ջZ ev ԿԿԵՆտK Lթ ԿbKտU AvտZ hԿ` mթԵնKտRi ԿԿԵՆ  $W$  nq, Zte H Կե`յ ev H ԿԿԵՆտK Կեֆե  $V$  nte  $V = \frac{W}{q}$  (10.3)

`յԱ AwnZ ԿԿԵՆտK ZvorMտե hթ Kիtj tKտb ԿտK Կտq Avarb լեճՆZ nte Zvor Կեֆե թviv Zv ԿbաՊի Z nq|

`յԱ AvartbԻ avZe tMj KտK GKւԱ ԿԿԵՆK Zvi թviv hթ Kիtj (ԿPտ 10.12) ԿԿԵԼ th tKտbv GKւԱ NUbv NUտZ լտի|

1. evg tMj K tտK ԿKQzAvarb Wvb tMj K thտZ լտի|
2. Wvb tMj K tտK ԿKQzAvarb evg tMj K thտZ լտի|
3. Avarb thgb լժj tZgbB չտZ լտի|

Avarb tKտb tMj K tտK tKտb tMj K hտե Zv ԿԿ՝ tMj Kթtqi Avartbi ԿԿԵՆYi Dci ԿԿԵ Kի bv| GւԱ ԿԿԵ Kի th ԿեԼԿԱ Dci ZտK Zvor Կեֆե ejv nq| th tMj K Կեֆե տեւ Zv tտK Kg Կեֆեի tMj K abvZԻK Avarb լեճՆZ nte| `յԱ tMj K Կեֆե mgvb Կv nԼ qv լժ՝Avartbi GB լեճ Pjte|

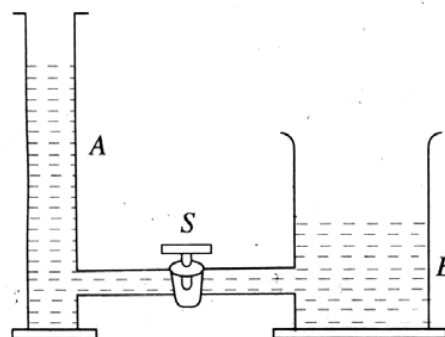


ԿPտ : 10.12

mZivs, wefe nt`Q AwnZ cwi evntKi Zvor Ae`v hv wbaŕY Kti H cwi evnKw Ab` tKvfbv cwi evntKi mvt\_ ZvorMZfvte hŕ Kiŕj Avarb t`te bv tbtel

Zvcgvŕv I Zitji gŕZtji mvt\_ wefŕei mv`k` : ZvcwÁvb I D`w`wZwe`vq h\_vŕtg Zvcgvŕv I Zitji gŕZj th fvgKv cvjb Kti \_vtK w`i Zvorwe`vq wefel tmb GKB fvgKv cvjb Kti \_vtK| Avgiv Rwb, `w e` tK Zvcxqvŕte mshŕ Kiŕj Zvt`i gŕa` Zvtci Av`vb cŕvb ntZ cvŕi | Zvtci cŕvn e` i fi Z\_v Zvtci cwi gvŕYi Dci wbfŕ Kti bv -Zvtci cŕvn wbfŕ Kti Zvcgvŕvi Dci | AZ`S-DEŔB GKw e` tK Zvi tPtq AŕbK\_y fvi x wKŠ` Kg Zvcgvŕv wekŕ Aci e` i mvt\_ mshŕ Kiŕj Zvc tQvU e` t`tK eo e` tZ cŕwnZ nte, hw I eo e` i Zvtci cwi gvY tQvU e` i ga` Zvtci cwi gvŕYi tPtq AŕbK tenk|

GKB AbfvgK Ztj `wcz `w cvŕ A I B GKw bj ŕviv ÷c-KK S Gi gva`tg hŕ AvtQ (wŕ 10.13)| ÷c-KK eÜ Kti A I B tZ cwb Xjv ntjv hvZ A I B Dfq btj cwbi D`PZv mgvb nq| B btji e`vm A btji e`vŕmi tPtq AŕbK eo nl qvq GKB D`PZv chS-cwb cYŕKiŕZ B btji Rb` AŕbK tenk cwbi cŕqvRb nte| GLb hw ÷c-KK Lŕj t`lqv nq Zte t`Lv hvte Zvt`i D`PZvi tKvfbv cwi eZŕ nq bv, A\_ŕ cwbi cŕvn NtU bv| `B btji gŕa` cwbi cwi gvY wfbŕenlqv mŕEj| D`PZv mgvb \_vKvi Rb` cwbi cŕvn nt`Q bv| GLb hw cŕivq



wŕ : 10.13

÷c-KK eÜ Kti A btj mgvb` cwi gvY cwb Xjv nq Zte A-tZ cwbi cwi gvY B Gi tPtq KgB \_vKte wKŠ` Gi D`PZv Af eŕ cŕte| Gici ÷c-KK Lŕj t`Lv hvq th A t`tK cwb B tZ cŕwnZ nq Ges cŕivq A I B -Gi cwbi t`tQ D`PZv mgvb nq| G t`tK eŕ hvq, cwbi cŕvn A\_ŕ Av`vb-cŕvb cwbi cwi gvŕYi Dci wbfŕ Kti bv D`PZvi Dci wbfŕ Kti |

aiv hvK, `w cwi evnK avZŕKfvte AwnZ| cŕg cwi evntKi Avarŕbi cwi gvY wZxq cwi evntKi Avarŕbi tPtq tenk, wKŠ` cŕg wU wefe wZxq wU tPtq Kg| GLb cwi evnK `w tK GKw cwi evnK Zvi w`tq mshŕ Kiŕj wZxq cwi evnK t`tK cŕg cwi evntK avZŕK Avarb cŕwnZ nte| Avarŕbi cwi gvY cŕg cwi evntK tenk nl qv mŕEj| wefe Kg nl qvq Gw Avarb MŕY Kti | Avarŕbi cŕvŕni dtj hLb cwi evnK `w wefe mgvb nte ZLb Avarŕbi cŕvn eÜ ntq hvte|

mZivs, ejv hvq, ZvcwÁvb Zvcgvŕvi fvgKv, D`w`wZwe`vq Zitji gŕZtji fvgKv Avi w`i Zvorwe`vq wefŕei fvgKv GKB|

cw\_ex ev fvgi wefe kb` : cw\_ex GKw Zvor cwi evnK| tKvfbv AwnZ e` tK cw\_exi mvt\_ hŕ Kiŕj e` wU wŕ-ŕwZ nq| avZŕKfvte AwnZ e` tK f-mshŕ Kiŕj cw\_ex t`tK BtjKUb Gŕm e` tK wŕ-ŕwZ Kti| Avi FYvZŕKfvte AwnZ e` tK cw\_exi mvt\_ mshŕ Kiŕj e` t`tK BtjKUb fvgŕZ cŕwnZ nq, dtj e` wU wŕ-ŕwZ nq| cw\_ex GZ weivU th, GŕZ Avarb thwM-weŕqM Kiŕj Gi wefŕei cwi eZŕ nq bv| thgb, mgy` t`tK cwb Ztj wŕtj ev mgy` cwb Xjv ntj Gi cwb Ztji tKvfbv cv`ŕ nq bv| cw\_ex wefŕbŕe` t`tK cŕZwbqZ Avarb MŕY Kti Avevi mvt\_ mvt\_ Ab` e` tK Avarb mieivl Kti, dtj cw\_extK Avarbnb gŕb Kiv nq| tKvfbv `vŕbi D`PZv wYŕqi mgq mgy` f Dcwi Ztji D`PZvK thgb kb` aiv nq tZgwb wefe wYŕqi mgq cw\_exi wefŕtKl kb` aiv nq|

kb", abvZ#K I FYvZ#K wefe : tKv#bv Avabnxb cwienv#Ki wefe#K kb" aiv nq| tKv#bv AwnZ cwienv#K#K c#\_exi m#\_ msh# Kij Zi wefel kb" nq| tKbbv, msh# Ae`'vq c#\_ex I cwienvK GK#I GK#U cwienv#K cwiYZ nq| abvZ#K Avatb AwnZ cwienv#Ki wefe abvZ#K Avi FYvZ#K Avatb AwnZ cwienv#Ki wefe FYvZ#K |

we#ei GKK t#v# : Amxg t\_#K c#Z Kj #^ (1C) abvZ#K Avab#K Zwor t#I#I i tKv#bv we`#Z Avb#Z hw` GK Rj (1J) K#R m#úbanq, Z#e H we`j wefe#K GK t#v# (1V) etj |

Zwor t#I#I i tKv#bv we`j wefe 20V ej#Z e#vq Amxg t\_#K c#Z Kj #^ abvZ#K Avab#K Zwor t#I#I i H we`#Z Avb#Z 20J K#R m#úbanq|

wefe c#\_R" : aiv hvK, Zwor t#I#I i g#a" Aew`Z A I B

`y# we`y hv# i wefe h\_v#tg  $V_A$  I  $V_B$  (w#I 10.14)|

Amxg t\_#K c#Z GKK abvZ#K Avab#K A we`#Z Avb#Z

K#Ri cwiqvY  $V_A$  Ges B we`#Z Avb#Z K#Ri cwiqvY

$V_B$ | AZGe c#Z GKK abvZ#K Avab#K B we`y t\_#K A

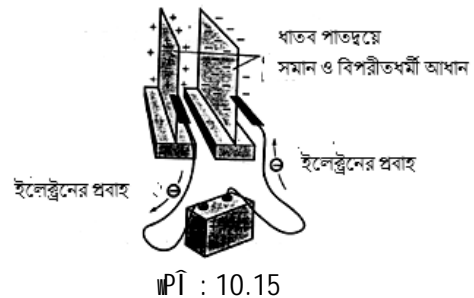
we`#Z Avb#Z K#Ri cwiqvY  $V_A - V_B$  A\_# GB `# we`j wefe c#\_R" |

c#Z GKK abvZ#K Avab#K Zwor t#I#I i GK we`y t\_#K Ab" we`#Z `v#s# K#Z m#úba K#Ri cwiqvY#K GB `# we`j wefe c#\_R" etj | wefe c#\_K" i GKK Aek"B t#v# |

## 10.8 Zwor avi K

### Electric capacitor

Zwor Avab#K c# m#Q Kivi mvg\_#K aviKZi ejv nq| aviKZi eRvq ivLvi Rb" D"weZ hws#K tK#Kj B avi K| tKv#bv Drm t\_#K thgb Zwor tKv t\_#K avi K c# m#Q K#i Zi c#vq e`envi Kiv nq| th tKv#bv AvK#i `y# cwienv#Ki ga`eZ#`v#b tKv#bv A#-iK c`v\_#hgb- evqy K#P, c#\_#K BZ`w# `vcb K#i avi K `Zwi Kiv nq| m#Zivs, KvQvKwQ `w#CZ `y# cwienv#Ki ga`eZ#`v#b A#K c`v\_#ti#L Zwor Avab#K c# m#Q K#i ivLvi hws#K tK#Kj#KB avi K etj |



GK#U mij avi K `Zwi Kiv nq `y# A#Z avZecvZ#K

ci`ui mgv#ij f#te ti#L| hLb GK#U e`vUwi#K Gi `y# cv#Zi m#\_ msh# Kiv nq (w#I 10.15), ZLb e`vUwi i FYvZ#K `E t\_#K B#j KUb GK#U cv#Z c#wnZ nq Ges G#U FYvZ#K Avatb AwnZ nq| avi#Ki Ab" cv#Z t\_#K B#j KUb e`vUwi i abvZ#K `#E c#wnZ nq, d#j H cv#Z abvZ#K f#te AwnZ nq| cv#Z\_#j#Z KZ Avab Rgv n#e Zi e`vUwi i t#v#e#Ri Dci w#f# K#i |

avi K ti#wI , tUw#wfk#b, ti KW#cqv# Ges Avb`vb" B#j KUb#K h#Z c#wZ m#`w#j Z eZ#x#Z e`vK f#te e`e#Z nq|



## 10.9 w`i ZwoþZi e`envi l wec`

### Uses and dangers of static electricity

1| w`i e`yZK is t`u` : Mmo, mvBþKj Avjgwi ev Ab`vb` wRlwm is Kivi Rb` B`wbs is Gi t`u`e`envi Kiv nq| GuU Kiv nq w`i Zwor e`envi Kti| t`u`Mvb Ggbfvte ^Zwi Kiv nq th GuU is Gi AwZ qjy`^qjy`^AwvZ KYv ^Zwi Kti| is t`u` Mvþbi mPvþjv cõšw GKw w`i Zwor tRbvtiUi Gi GK cõšt mvt\_ mshyþ Kiv nq| tRbvtiUi i Aci cõšw th avZe cuZw is KiþZ nte Zvi mvt\_ mshyþ Kiv nq hv Aek`B f-mshyþ \_vþK| GKw Mmo is Kivi t`qþt t`u`Mvb t`þK wbmZ AwvZ qjy`^qjy`^KYv Mmoi evBþi Kivvgtv Øviv AvKõ nq| dtj Mmoi emiveitYi Gi Dci is Gi GKw mlyg Av`iY cto| GQovl GB qjy`^KYv,tjv Zwor t`qþt i ej tiLv eivei Pþj Kivvgtv wPcivciv A\_@ Gi AcKvk`v`vþb tçtQ tmLvþb l is Kti|



wPÎ 10.16

2| B¼ tRU wõUvi : GuU nt`Q meþPþq mvaviY aitþi wõUvi hv KwõUDUvti mvt\_ mstþvM t`lqv \_vþK| GKw B¼-Mvb Zvi mPvþjv gyl w`tq AwZ qjy`^qjy`^Kwj i KYv wþt`q c Kti| GB qjy`^KYv,tjv avvZK (+) fite AwvZ| GB Kwj i KYv,tjv `yU cvþZi ga`j w`tq Pþj (wPÎ 10.17)| GB avvZK Kwj i KYv,tjvþK avvZK cuZ weKlY Kti Ges G,tjv FYvZK cþZ AvKõ nq|



wPÎ 10.17

GKw KwõUDUvi cuZ,tjv tfvþR Ggbfvte wloqšy Kti th cuZ,tjv KLþbv avvZK, KLþbv FYvZK Avvþb AwvZ nq Ges Kwj i KYv,tjv weqjB nq Pjgub KwþRi Dci wevfbv`vþb cto Ges cõqvRbgZ Aqj i ev Qwei AvKwZ Qvrc| iuOb Qrcvi Rb` Pvi i Kti i uOb Kwj e`envi Kiv nq|

3| dtUv Kucqvi : AvRKvj dtUv Kucqvi ev dtUv Kuc tgnkb LþB cõqvRbxq Ges Rbncõ GKw hšç| wkqj cõZõrb l weea Avdm Qrov mvaviY RbMY th tKvþb cõqvRbxq `wj ev KwMRcþt i GK ev GKwaK AwKj Kuci Rb` GB hšç e`envi Kti \_vþKb| GB htšç l w`i Zwor e`envi Kiv nq| dtUv Kucqvþi wFZþi AÜKvþi GKw NYqgub Wlg \_vþK| GB Wþgi Dci avvZK Avvþb t`u` Kiv nq| th cõv dtUvKuc KiþZ nte GKw D¾j Avþjv ZvþK AvþjwKZ Kti| cõvi m`v Ask Avþjv cõZdwj Z Kti, wKš' AÜKvi ev Qrcvþb Ask tKvþb Avþjv cõZdwj Z Kti bv| cõZdwj Z Avþjv Wþgi Dci tKw`fZ nq| Wþgi th `vbuU m`v KwMR Øviv cõZdwj Z Avþjv cto D¾j nq, tmB Ask t`þK Avvþb tei nq hvq| Wþgi tKej AÜKvi AskB avvZK Avvþb AwvZ \_vþK| FYvZKfite AwvZ Kveþbi cuDWi Kwj (tUvvi) Wþgi Dci t`u` Kiv nq| FYvZK fite AwvZ GB Kwj i KYv,tjv Wþgi avvZKfite AwvZ Astki mvt\_ Avþjv fite tjþM \_vþK| GK UKiv m`v KwMRþK avvZKfite AwvZ Kiv nq| GuUþK Wþgi mvt\_ tþc ivLv nq| GB KwMRw Wlg t`þK Kveþ cuDWi i c`vUY`Zvi Mtq Zþj Avþb| tUvvi (-) w KwMR (+) KZK AvKõ nte| KwMRlvb DEB tiþvti ga` w`tq Pþj bv Kiv nq| GþZ tUvvti i Kwj Mþj hvq Ges KwþRi mvt\_ wgtk hvq, dtj GKw `vqþ Kuc ^Zwi nq|

w`'i ZwoťZi wec`

AťbK tŋtŋ w`'i ZwoťZi Dcw`wZ AmjeavRbK Ges wec` tWťK AvbťZ cvťi |

wegvťb Rjywb fiv : AvKřk hLb wegvb Dťo ZLb evqj mť\_ NIŋYi dťj GwU ZwoZwnZ nťZ cvťi |  
wegvťbi Avarb evotZ \_vKťj wegvb l feťôi gťa` wefe cv\_R` evotZ \_vťK | GZ D`P wefe cv\_ŋK`i  
KviťY wegvťb hLb Rjywb fiv nq ZLb wKQz Avarb fvgťZ Pťj hvl qvi mgq Ůŋ ½ mřó nł qvi mřóebv  
\_vťK, hv weivU weťŮviťYi KviY nťZ cvťi | GB Rb` wegvťbi PvKv cwi evnK iveri Ůviv `Zwi Kiv \_vťK,  
hvťZ wegvb fvg Ůk`Kĩťj wegvťb Rgv nł qv Avarb wivcť` fvgťZ Pťj thťZ cvťi | GB mgm`vi mgvavb  
nť`Q wegvb fvgťZ AeZiťYi ci h\_v mře Zvorowmo Ges Rjywb fiv`i` Kivi AvťMB GKwU cwi evnK Ůviv  
fŇmshyť Kiv |

U`vsKřvi Rjywb fiv : th mKj U`vsKvi jix tťtŮťj, wWťRj BZ`w` Rjywb wbtq iv`Ův w`ťq GK `vb tťtK  
Ab` `vťb hvZvqřZ Kťi Zvť`i tejvqł Ůŋ ½ mřó l weťŮviY tťtK iŋlv cvł qvi Rb` Rjywb `vbrťŝi i  
AvťM fŇmshyť Kťi wbtZ nq |

tŮvj wřkb l Křw`úDUvťi gubUi : e`enviKřj tŮvj wřkťbi c`Ųl Křw`úDUvťi gubUi w`'i ZwoťZ AwnZ  
nq | GB Avarb \_ťjv AbwnZ KYv thgb aťjv ewj BZ`w` AvKlŲ Kťi, dťj G\_ťjv ZvorZmo gqjv nťq hvq |

Křco cřvťbv : Avgvť`i cwiťaq Křco tPřco AťbK mgq wbtRť`i ga`Kvi NIŋYi dťj AwnZ nťq thťZ cvťi |  
hLb Avgiv Křco e`jvB ZLb ZLb Avarb fvgťZ Pťj hvl qvi mgq Avgvť`i Aí kK&Lvl qvi GKUv mřóebv \_vťK

Acřťikb w\_ťqŮvi : thťnZi aťjvewj l RřevYyAwnZ e` Ůviv AvKó nq, KřřRB nřmcvZťji Acřťikb  
w\_ťqŮvi mveabZv Ae jř`b Kiv nq thb mřRŮ, mřkó e`wřeM`Ges wřwřmřmřvgřM` Avarbgyť \_vťK | G Rb`  
Zvť`i tK fŇmshyť ivLvi Rb` cwi evnK iverťi Rřv ciťZ nq Ges nťZ iverťi Mřřm e`envi KiťZ nq,  
hvťZ fvg tťtK mňťR Bťj KUb Amv hvl qv KiťZ cvťi |

tťtŮťjevnx ŮťťKi mť\_ avZe wKkj Sjvťbv \_vťK : tťtŮťj, wWťRj ev Ab` Zij Rjywbvnx U`vsKvi ev ŮťťKi  
mť\_ GKwU avZe wKkj jvMvťbv \_vťK hv ŮťK Pjvi mgq iv`Ův Ůťq Ůťq hvq | hLb iv`Ův w`ťq ŮťK Pťj ZLb  
tťtŮťj U`vsťKi Mvťq evievi av`v Lvq Ges Gw`K l w`K `jťZ \_vťK | U`vsťKi mť\_ tťtŮťji GB NIŋYi dťj  
Avarb mřĀZ nq | hw` U`vsťKi wKbviv tťtK GKUv Ůŋ ½ mřó nq Zvňťj ggřřřK `NŮbv NUťZ cvťi Ges  
tťtŮťj Av\_b aťi hvťe | KřřRB tťtŮťj Avavťbi Rb` wivcť` `vb bq | U`vsťKi tťtŮťb wKkj jvMvťq GB  
Zvor fvgťZ Pťj hvevi c\_ `Zwi Kiv nq | thťnZi avZi Lř fřťjv cwi evnx, ZvB Zvor aťi aťi avZe  
wKkj i ga` w`ťq gwŮťZ Pťj hvq |

we`řr jvBťbi mť\_ avZe LřŮi mřmři mřťhwM \_vťK bv : iv`Ůvq we`řr jvBťbi Zvi LvŮvevi mgq avZe LřŮi  
mť\_ mřmři mřhyť Kiv nq bv | avZi ZwoťZi mřcwi evnx | avZe LřŮi mť\_ mřmři mřťhwM Kiv nťj Zvťi i  
Zvor LřŮi ga` w`ťq gwŮťZ Pťj thZ | tKD H LřŮ Ůk`Kĩťj mť\_ mť\_ Zvor`úó nťZv Ges gřivZřK  
`NŮbv NUťZv | ZvB Acwi evnx tťvťmřťbi Křřci ga` w`ťq ZviťK LřŮi mť\_ mřťhwM t` l qv nq |

eRčvZ l eR` wbtřvaK : Avgiv Rwb evqřĚťj Rjxq evřú \_vťK | GB Rjxq evřú evqřĚťji AwnZ  
Avqb\_ťjvi Dci NbrřZ nťq cwb KYvi mřó Kťi Ges ZwoZwnZ nq | GB aiťYi cwb i KYv\_ťjv GKwŮZ  
nťjB tgťNi DrcwĚ nq | tgN abvZřK ev FYvZřK th tKřřbv řřťeB AwnZ nťZ cvťi | ZwoZwnZ `řŮ tgN  
KřvřKwQ Gťj Zvť`i gťa` ZvorŋiY nq, ZLb weivU AwMčřjťzi mřó nq | GťK we`řřPgK ejv nq |



## Abkxj bx

K. eŭ wbeŕbx cĕkæ

1| tKvb e`tZ Avavtbi Aw`ZjwbYŕqi hšjnj Ñ

(K) A`wŕgUvi

(L) tŕwëŕgUvi

(M) AYexŕŕY hšj

(N) ZworexŕŕY hšj

2| `ŭU Avavtbi ga`Kvi Zwor ej wbtPi tKvbŭUi Dci wbfŕ Kti bv ?

i. Avavb `ŭUi ga`eZŕ`tZj Dci |

ii Avavb `ŭU th gra`tg Aew`Z Zvi cĕkŭZi Dci |

iii Avavb `ŭUi fti i Dci |

tKvbŭU mŭVK

K) i l ii

L) i l iii

M) ii l iii

N) i, i l iii

3| Zwor ZxeZvi GKK ntŕ

(K) N

(L) N m

(M) N m<sup>-1</sup>(N) N C<sup>-1</sup>

4| tŕvë ŭKtmi GKK ?

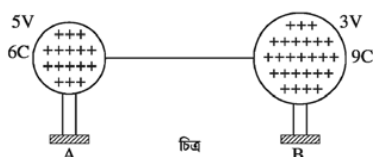
(K) Zwor tŕŕŕ

(L) Zwor wefe

(M) Zwor Avavb

(N) Zwor cëvn

5| wbtPi wŕtŕ



(i) A tMj K t`tK ŭKQz Avavb B tMj tK hvte

(ii) B tMj K t`tK ŭKQz Avavb A tMj tK hvte

(iii) Avavb cv`K` me`v mgvb `vtK |

wbtPi tKvbŭU mŭVK ?

(K) i

(L) ii

(M) iii

(N) i,ii l iii

## mRbkxj

1| wŕgv Pj AvPovtbi ci t`LtZ tcj Zvi wPi`bx tQvU tQvU KvMŕi UKivtK AvKIŕ KiŕQ | mxgv ej j

wPi`bxŭU aYvZŕK fŕte AwnZ ntqtŕ, hvi Rb` GUv NtŭtQ | wŕgvi e`e` wPi`YŭU FYvZŕK Avavtbi

AwnZ ntqtŕQ | welqvŭi mjvrvŭi Rb``ŕRb Zŕt` i c`v\_ŕeÁvb ŭKŕŕKŕ LŕŕtZ ŭŕtq ZŕtK c`v\_ŕeÁvb

MŕelYvMŕti tcj | ŭZŭb me`itb Zŕt`itK ZworexŕŕY hšj mŕvŕth` cixŕŕv Kti wPi`bxi Avavtbi

cĕkŭZ wbbŕ KiŕZ ej tj b |

(K) Avavb ej tZ ŭK eŕ ?

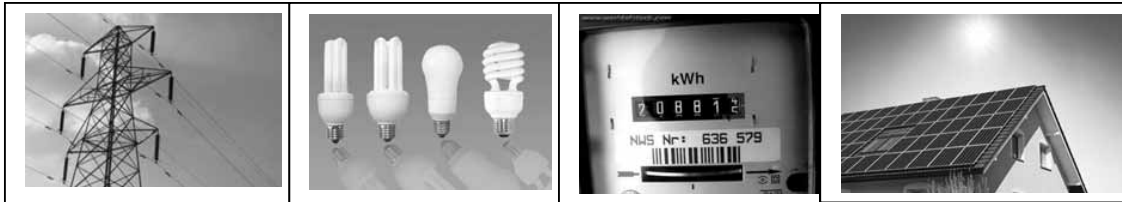
(L) NIŕY tKb e`'AwnZ nq eŕŕŕŕ`vl |

(M) wPi`wŭU AwnZ nŕ qvi KviY eYŕv Ki |

(N) hšjŭi mŕvŕth` ŭKfŕte wPi`wŭU Avavtbi cĕkŭZ wYŕ Kiv hvte e`vL`v Ki |



# GKv`k Aa`vq Pj Zvor CURRENT ELECTRICITY



[Avgv`i i`bwb Rxeibi wevfbeA`v`i Avgiv Zvor ev we`ytZi Dci wbfP Kti \_wK| AaybK hšcwmZ ev miAvtgi cđq meB ZvoťZi mnvth` Pti| Avgiv ZvoťZi Dci GZUvB wbfPkj th, ZvoZ Qrov Avgv`i Rxeb tKgb nte Zv KíbvI KiťZ cwi bv| ceZPAa`vq Avgiv w`i Zvor wbtq AvtjvPbv KtiwQ| G Aa`vq Avgiv Pj ZvoťZi wevfbe `e`juZK iwk thgbN`Zvor cēvngv`v, tiva, Zvo`PjK kw<sup>3</sup> Ges wefe cv\_ŕ` m`uťK`RvbtZ cve| GQrovI Zvor cēvtni w`K, cwievnx, Acwievnx Ges Aaēwievnx, Zvor eZBx, Intgi mť, w`i Ges cwieZBkxj tiva, tivtai wbfPkjZv, tivtai tkiY I mgvš+vj mgevq, Zvor ŕlgZvi wnmve, ZvoťZi wmt÷g jm Ges tjwtkwWs, ZvoťZi wbi vc` I KvRKi e`envi wbtq AvtjvPbv Kie|]

G Aa`vq cv tkťI AvgivN

1. w`i Zvor ntZ Pj Zvor m`o cđkB KiťZ cve|
2. Zvor cēvtni w`K Ges Bťj KUb cēvtni w`K e`vL`v KiťZ cve|
3. Zvor hšc I DckitYi cZxK e`envi Kti eZBx A¼b KiťZ cve|
4. cwievnx, Acwievnx Ges Aaēwievnx e`vL`v KiťZ cve|
5. tjLwPťi mnvth` Zvor cēv Ges wefe cv\_ŕ` GB`Bťqi gta` m`uťK`vcb KiťZ cve|
6. w`i tiva Ges cwieZBkxj tiva e`vL`v KiťZ cve|
7. Zvo`PjK kw<sup>3</sup> Ges wefe cv\_ŕ` e`vL`v KiťZ cve|
8. tivtai wbfPkjZv e`vL`v KiťZ cve|
9. tivaKZjI cwievKZje`vL`v KiťZ cve|
10. tkiY I mgvš+vj eZBx e`envi KiťZ cve|
11. eZBťZ Zj` tiva e`envi KiťZ cve|
12. Zvor ŕlgZvi wnmve KiťZ cve|
13. ZvoťZi wmt÷g jm Ges tjwtkwWs e`vL`v KiťZ cve|
14. ZvoťZi wbi vc` I KvRKi e`envi eYBv KiťZ cve|
15. emv ewoťZ e`envi DcťhvMx eZBxi bKkv cŕqb Kti Gi wevfbeAstk Gwm Drm-Gi e`envi cđkB KiťZ cve|
16. ZvoťZi wbi vc` I KvRKi e`envi i wltq mťPZbZv m`o KiťZ cve|
17. Zvor kw<sup>3</sup> AcPq tiva I msi ŕťY mťPZbZv m`o Rb` tcvóvi A¼b KiťZ cve|

## 11.1 | w`i Zwor nřZ Pj Zwor mřó

### Production of current electricity from static electricity

Zwor cěvn

`yU wřbæfēi e` tK hLb cwi evnX Zvi Øviv mshy<sup>3</sup> Kiv nq, ZLb wřæfēi e` t\_tK D`P wēfēi e` řZ Břj KUb cěvnZ nq| hZřY chS-e` Øřqi gřa` wēfēi cv\_R` kb` bv nq ZZřY chS-GB cěvn eRvq \_řřK| řKřbv cřuqvi gřa`řg hw` e` Øřqi gřa` wēfēi cv\_R` eRvq ivLv hvq ZLb GB Břj KUb cěvn wbi erQbēfēi Pj řZ \_řřK| Břj KUb GB wbi erQbēfēi nřjv Zwor cěvn|

řKřbv cwi evnxi řh řKřbv cř`řQ` i gřa` w` řq GKK mřřř řh cwi gřY Avavb cěvnZ nq ZřřK Zwor cěvn eřj |

řKřbv cwi evnxi řh řKřbv cř`řQ` i gřa` w` řq t mřřř hw` Q cwi gřY Avavb cěvnZ nq, Zřřř Zwor cěvn

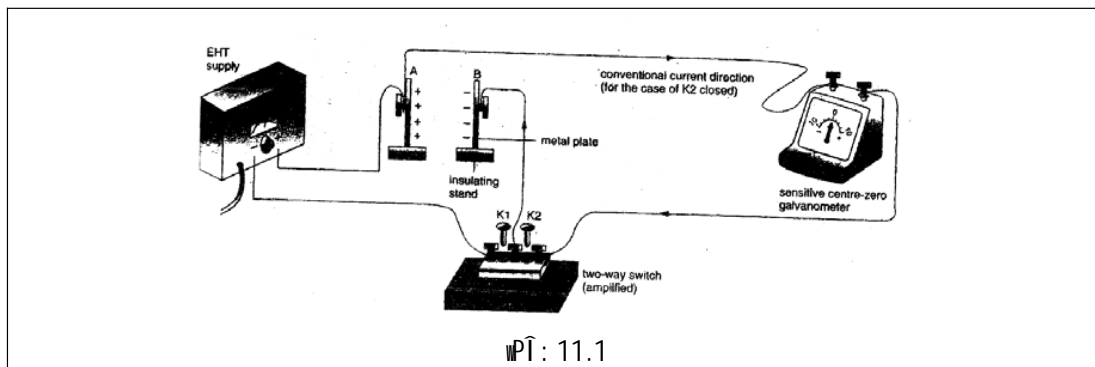
$$I \text{ nře, } I = \frac{Q}{t}$$

GKK : Zwor cěvni GKK nřjv A`wřuqvi |

řKřbv wēwQbē AwnZ cwi evnřZ Avavb Gi cřō Ae`řv Kři Ges PjřPj Ki řZ cřři bř| G ai řbi AvavřK eřj nq w`i Zwor Avavb| hw` GB Avavřbi Pjřřři Rb` cwi enb cř\_i e`e`řv Kiv nq ZLb GB Avavb cwi evnřZ Aveř bř ř\_tK cěvnZ řiyKři | hLb GgbřU NřU, ZLb Augiv ewj řh, Zwor cěvni mřó nřřřř|

GřK A Øviv mřřř Kiv nq| kb` gřa`řg řKřbv cwi evnxi řh řKřbv cř`řQ` i gřa` w` řq 1s -G 1 C Avavb cěvnZ nřj řh cwi gřY Zwor cěvni mřó nq ZřřK 1 A eřj |

$$\therefore I = \frac{1C}{1s} = 1Cs^{-1} = 1A$$



Mřřřř Avavb KZř Křřř Pj Zwor Drcbēnř Zv Dcři 11.1 wřřři eZřxi AvřřřK eYřv Kiv nřjv| ři řZB `yU cřM Pwe K1 Ges K2 Dřřřř řřřv nq Ges avZe cvZ A Ges B řK nřv `řkKři AbwnZ Kiv nq| Gevi Pwe K1 eř Kři w` řj D`P wēfēi Dřmř avZe cvZ `yU mřř mshy<sup>3</sup> nře|

Gici D`P wēfēi Dřřmi mřPř Ab&Kři avZe cvZ `yUřK mřcwi gřY avřřř Ges FYřřK Avavř AwnZ Kiv nq| Gevi Pwe K1 řřř řřř Ges K2 Pwe cřM cřēk Kivř avřřř Ges FYřřK Avavř AwnZ cvZ `yU Mřř řřřwřřři mřř mřřřř cřř GKrř AweřQbēwienY cř\_i mřó Ki ře| GLřb Mřř řřřwřřři nřjv Ggb GKř hřř hv Zwor cěvni Aweřřřř Ki řZ cřři | řLv hřř Mřř řřřwřřři Křwř řřřř Kři Rb` GKř řK wēwřř nřřřř Ges ci řřřř Zv cřē Ae`řv wřři Gřřřř|

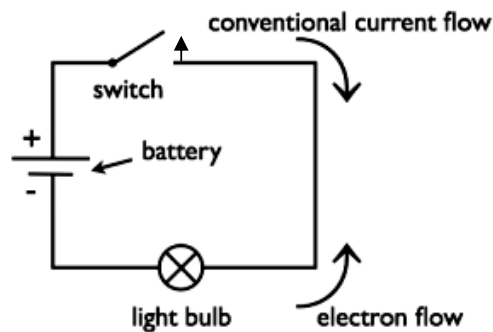
M'vj fvtbwgUvti i wet¶c wbt`R Kti th Zwor cēvni mʷó ntqtQ| GB Zwor cēvni Kxfvte mʷó ntjv? FYvZK Avavb AvnZ cvZ B t\_†K Btj Kub M'vj fvtbwgUvti i ga` w`tq cēvni ntq avvZK Avavb AvnZ cvZ A -G tcSvq Ges Gi dtj Zwor cēvni mʷó nq|

A cv†Zi avvZK Avavb, B cvZ t\_†K AvMZ FYvZK AvavbMŌ Btj Kub Ōviv wbr¶Eq nq| hvi dtj avZe cvZ `yLi Avavb ¶i†Yi gva`tg ¶Y`vqx cēvni mʷó nq, hv M'vj fvtbwgUvti i wet¶c Ōviv mbr³ Kiv hvq|

## 11.2| Zwor cēvni w`K Ges Btj Kub cēvni w`K

### Direction of electricity and direction of electron flow

cŭg hLb Pj Zwor Avw<Z nq, ZLb gtb Kiv ntZv th avvZK Avavbi cēvni dtj Zwor cēvni mʷó nq Ges GB avvZK Avavb D'PZi wefe t\_†K wbr¶Zi wef†ei w`†K cēvni nq| ZvB Zwor cēvni cPwj Z w`K aiv nq D'PZi wefe t\_†K wbr¶Zi wef†ei w`†K A\_ev Zwor tKv†i i avvZK cvZ t\_†K FYvZK cv†Zi w`†K| wKŠ' Avgiv Rwb th, cKZc†¶ Zwor cēvni ntjv FYvZK Avavb Z\_v Btj Kubi cēvni Rb`, dtj Zwor cēvni cKZ w`K ntjv wbr¶Zi wefe t\_†K D'PZi wef†ei w`†K A\_¶ Zwor tKv†i i FYvZK cvZ t\_†K avvZK cv†Zi w`†K| mZis Zwor cēvni cKZ w`K cPwj Z w`†Ki wecixZ| w†† cŌwKZ Zxi wP¶ Zwor cēvni cPwj Z w`K wbt`R Ki†Q|



w† 11.2

eZBx w† A¼b Kivi mgq Avgiv Zwor cēvni cPwj Z w`K†KB AbniY Kie|

## 11.3| Zwor cZxK

### Electric symbols

Zwor cēvni Pjvi mʷúYc\_†K Zwor eZBx etj| hLb tKv†v tKv†i i cvZ `yLi tKv†v tiva†Ki `ß cŌs-ev Zwor DcKi†Yi `ß cŌs† mvt\_ mshy³ Kiv nq, ZLb GKwJ Zwor eZBx `Zwi nq|

Pj Zwor cv†Vi mgq Avgv† i†K mnR Ges cwi<vi eZBx w† AuK†Z nq| wbtPi mvi w†Z wKŌz `e`jwZK DcKi†Yi cZxK t`Lv†v ntjv th\_tjv mvariYZ Zwor eZBx AuK†Z e`eüZ nq|



11.1: eZŔxi cŔxKmgñ

DcKiY	cŔxK
mßP	
tKvl	
e`vUwi	
w`i tiva	
cwi eZŔkj tiva	
wdDR	
A`wgUvi	
tfvëngUvi	
M`vj fvtbwgUvi	
fmsthvM	
AvovAwo Zvi	
msthvMwëxb Zvi	
evj	

wbßR Ki:

GKwU mßP, Zwor tKvl, w`i gvtbi tiva Ges A`wgUvi e`envi Kti GKwUtkŔY eZŔx A¼b Ki |  
Gevi GKwU tfvëngUvi tK w`i gvtbi ti vtai `ß cŔš-mgvsŕtj hß Ki |

#### 11.4 | cwi evnx, Acwi evnx Ges Aaëwi evnx

##### Conductor, insulator, semiconductor

Avgiv Rwb, Zwor cëvn ntjv tKvtbv c`v\_Ŕ ga` w`tq Avavtbi cëvn | GB Zwor cëvn tKvtbv tKvtbv c`v\_Ŕ ga` w`tq Lp mntßRB PjvPj KitZ cvti | Avevi Ggb wKQc`v\_ŔAvtQ th,tjvi ga` w`tq Zwor Avt`ß PjvPj KitZ cvti bv | Zwor cwi ewnZv atgŔ Dci wfvE Kti KwVb c`v\_ŔK wZb tkŔtZ fvM Kiv hvq | h\_v- (1) cwi evnx (2) Acwi evnx (3) Aaëwi evnx |

1. cwi evnx: th mKj c`v\_Ŕ ga` w`tq Lp mntßRB Zwor cëvn PjßZ cvti Zvt`i tK cwi evnx etj | GmKj c`v\_Ŕ ga` w`tq BtjKUb gßfvte PjvPj KitZ cvti | avZe Zvtii ga` w`tq Avavb BtjKUb Øviv cwi ewnZ nq | G KvittY avZe c`v\_Ŕtjv Zwor mpcwi evnx | Zvgv, iëv, A`vjgmbqvq BZ`w` mpcwi evnx c`v\_Ŕ th KvittY `e`jwZK msthvRtK avZe Zvi e`envi Kiv nq |

2. Acwi evnx: th mKj c`v\_Ŕ ga` w`tq Zwor cëvn PjßZ cvti bv Zvt`i tK Acwi evnx ev AštK c`v\_Ŕetj | A\_Ŕ th mKj c`v\_Ŕ ga` w`tq BtjKUb PjvPj KitZ cvti bv tm,tjv ntjv Acwi evnx c`v\_Ŕ thgb- cŔŔK, iëvi,

KW, KvP BZ'w | Acw evnx c`vt\_P gta` gP Btj KUb \_vtK bv| cwpOK RvZxq c`vt\_P ga` w`tq mntR Btj KUb  
c`wvNz ntZ cvti bv| hvi dtj cwpOK ntjv we`jtZi Rb` Acw evnx c`v\_P G Kv iYB `e`jvZK wgv`MY th mKj  
`EZWBfvi Ges cwpvi e`envi Kt`b Zt`i nVzj cwpOK RvZxq c`v\_P Qvi tvgvotbv \_vtK | G Qrov Argv`i `b b`b  
cQvRt`b th mKj Zvgvi `e`jvZK Zvi e`envi Kw tm,tjv cwpOK Qvi AveZ \_vtK |

3. Aa@wi evnx: th mKj c`v\_ P Zwor cwienb ¶lgZv mvariY Zicgr¶vq cwi evnx Ges Acwi evnx c`v\_ P  
gvSivgW\$, tm mKj c`v\_ PK Aa@wi evnx etj | thgb- Rvtg¶bvqv, wmwj Kb BZ`w | myeavgz Ac`e` wgnktq  
Aa@wi evnx c`v\_ P Zwor cwi evnKZ; eipx Kiv hvq |

11.5 | wefe cv\_ŕ Ges Zvor cētni gta" mꝰúK.© I ōtgi mġ

### Relationship between potential difference and electricity- Ohm's law

Argiv Rmb tKvbr cwi evnxi `ß cõtš+ gta" wefe cv\_R" \_vKtj Zvi ga" w`tq Zwor cëwnZ nq| GB Zwor cëvtni gvb wbfP Kti cwi evnxi `ß cõtš-Kx cwi gV wefe cv\_R" cõqm Kiv ntqtQ Zvi Dci, cwi evnX Ges Zvi Zvcgŭvi Dci | RR<sup>©</sup>mbGbg I õg tKvbr cwi evnX Zvti i ga" w`tq cëwnZ Zwor cëvngŭv Ges Gi `ß cõtš+ wefe cv\_R" i gta" th m<sup>au</sup>K<sup>g</sup> tqtQ tm wel tqt w<sup>au</sup>ewZ mŭ cõvb Kti b hv I õtgi mŭ bvtg cwi wPZ | I õtgi mŭ

Zɪcɡvɪv w' i ɪvKɪj tKɪɓv cwi evnxi ga" w' tɔ th Zwor cɛvn Pɪj Zv H cwi evnxi ʔ cɔʔSi wefe cv\_ɪK'i  
mgvɔcɪvZK| mgvɔcɪvZK ejɪZ eʃɔ hɪ" cwi evnxi ʔ cɔʔSi wefe cv\_ɪK' ɪY Kiv nq, Zte cwi evnxi ga"  
w' tɔ cɛvnZ Zwor cɛvn ɪY nte| Aveɪ, hɪ" cwi evnxi ʔ cɔʔSi wefe cv\_ɪK' GK-ZZxɪsk Kiv nq,  
Zte cwi evnxi ga" w' tɔ cɛvnZ Zwor cɛvn GK-ZZxɪsk nte|

gɔb Kwɪ, AB GKɪd cwi evx Zvi | Gi `β cɔtʃi wefe h\_ɣtɔ V\_A Ges V\_B [wɪ 11.3] | hw` V\_A > V\_B  
nɔ, Zvntʃi cwi evxi `β cɔtʃi wefe cɪ\_ʁ nte V = V\_A - V\_B

A horizontal line represents a resistor. At the left end, labeled 'A', there is a voltage  $V_A$ . At the right end, labeled 'B', there is a voltage  $V_B$ . An arrow labeled  $I$  points from A to B, indicating the direction of current flow.

$\hat{P}I: 11.3$

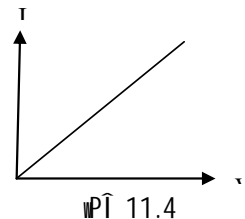
GLb w̃' i Zivcgṽiq cwi evnxi gã w̃ t̃q c̃ēvnZ Ziør c̃ēvn I nt̃j, l̃ōt̃gi m̃t̃ vbmṽt̃i,

$$I \propto V$$

$$\Rightarrow \frac{V}{I} = R = \frac{1}{\sigma} \frac{1}{K}$$

GB æK†K H ZvcgrÎvq H cwi evnxi tiva etj |

$$A_{ev} I = \frac{V}{R}$$



GKwU QK KwMfRi X A¶ eivei cwi evnxi `ß cõtš+ wefe cU\_R" V Ges Y A¶ eivei Zwor cõn I `vcb  
Kti tj LwP† A¼b Kti tj GwU gj we` Mvqx GKwU mi jti Lv nte [wP† 11.4 ]]

MwYvZK D`vniY 11.1 : GKwU tgvUi Mwoi tnWjvBtUi wdjvtgþUi ga`w`tq 4 A Zwor cêwnZ nt`Q | wdjvtgþUi cêstqi wefe cv\_R` 12 V ntj Gi tiva KZ?

Avgiv Rwb,

$$I = \frac{V}{R}$$

$$\text{er } R = \frac{V}{I}$$

$$= \frac{12V}{4A}$$

$$= 3 \Omega \quad \text{D: } 3 \Omega |$$

GLvþb,  
Zwor cêwn,  $I = 4 \text{ A}$   
wefe cv\_R`,  $V = 12 \text{ V}$   
tiva,  $R = ?$

11.6 | tiva: w`i Ges cwieZtiva

### Resistance : constant and variable

Avgiv Rwb, Zwor cêwn ntjv Btj KUþbi cêwn | Btj KUb tKvþv cwi evnxi ga`w`tq Pjvi mgq Gi Af`šþi i AYy-cigvYj mvþ`msNþl`qj B nq | dtj Gt`i MwZ evanMÖÍ nq Ges Zwor cêwn weNz nq | cwi evnxi GB agþK tiva etj | lÖtgi mþ tþK Avgiv cvB,

$$\text{wbw`Ö ZvcgvÎvq, tiva } R = \frac{V}{I}$$

$$= \frac{\text{Zvtii `þ cÖš-i wefe cv_R`}}{\text{Zvtii Zworcêwn}}$$

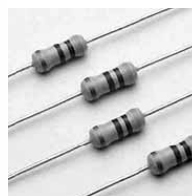
A\_þ, wbw`Ö ZvcgvÎvq tKvþv cwi evnxi `þ cÖš-i wefe cv\_R` Ges Zworcêwn I Gi AbpZ Öviv H ZvcgvÎvq H cwi evnxi tiva cwi gvc Kiv nq |

tivtai SI GKK ntjv lÖg | GtK eo niþdi lþgMv (Ω) Öviv cKvk Kiv nq | th cwi evnxi `þ cÖš-i wefe cv\_R` 1V ntj Zvi ga`w`tq 1A Zwor cêwn Pþj, Zvi tivaþK 1Ω etj |

tivaK: wbw`Ö gvtþi tivawekÖ th cwi evnxi Zvi tKvþv eZÖtZ e`envi Kiv nq ZvtK tivaK etj | tivaK e`envtii cÖwgK Dtík` ntjv eZÖtZ cêwnZ ZwtZi gvb wbqšY Kiv | eZÖtZ e`euZ tivaK `þ cKvi | h\_v-

1. w`i gvtþi tivaK
2. cwieZxþivaK

1. w`i gvtþi tivaK: th mKj tivaþKi tivtai gvb wbw`Ö Zvt`iþK w`i gvtþi tivaK etj | mvaviYZ j`vetiUwiþZ th mKj w`i gvtþi tivaK e`envi Kiv nq tm`tjv 11.5 bs wþÎ t`Lvþv ntjv:



wþÎ 11.5



wefe cv\_ℝ" Ges Zwo"Pyj K kw³i SI GKK Awfbo A\_ℙ tfrè (V) | `yU we`j wefe cv\_ℝ" 1 tfrè nte hw` 1 Kj^ abvZK Avav eZØxi H `ß we`j ga` w`tq cēwnZ nevi dtj 1 Rj Zworkw³ Ab` tKvfbv ai`yi kw³tZ qcvšwi Z nq |

cix¶Y :

tfrèwUvti i mnrth" GKwU Wßtmj i `ß cōš-i wefe cv\_ℝ" cwigvc Ki GwUB tKvfi i Zwo"Pyj K kw³ | Gevi tKvfwU w`tq UßPP evj | Rjvfbv Ae`vq tKvfi i `ß cōš-i wefe cv\_ℝ" cwigvc Ki |

cēvn PjvKvjxb tfrèwUvti i cvWB ntjv evtj i ev tivtai `ß cōš-i wefe cv\_ℝ" V | Gevi cwigvcKZ Zwo"Pyj Kkw³ Ges wefe cv\_ℝ" i gvtbi Zj bv Ki | Zvg t`LtZ cvte E -Gi gvb V -Gi gvtbi tPtq eo |

### 11.8 tivtai wbfPkj Zv

#### Dependence of resistance

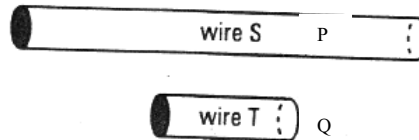
Avgi v Rwb, hLb Zvcgvv Ges Ab`vb` tfsZ Ae`v (thgb- ^N°, cō`t`Q`, Dcv`vb) AcwiewZ \_vtK ZLb cwi evxi tiva w`i \_vtK |

tKvfbv cwi evxi tiva wbtæ Pviw wltqi Dci wbfP Kti |

1. cwi evxi ^N°
2. cwi evxi cō`t`Q` i t¶¶dj
3. cwi evxi Dcv`vb Ges
4. cwi evxi Zvcgvv

Zvcgvv w`i \_vKtj tKvfbv cwi evxi tiva i agv Gi ^N°, cō`t`Q` i t¶¶dj Ges Dcv`vbi Dci wbfP Kti | tivtai GB wbfPkj Zv `ßw mti i mnrth" cKvk Kiv hq |

11.7 wP¶ GKB cō`t`Q` i t¶¶dj Ges GKB Dcv`vb Øviv ^Zwi `yU cwi evxi Zvi P Ges Q t`Lvfbv ntqtQ | P Zvti i ^N°Q Zvti i tPtq tewk | tewk nlqvq Zvi tival tewk |



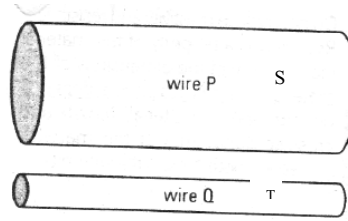
wP¶ 11.7

^N° mti : wbw Ø Zvcgvv vq wbw Ø Dcv`vbi cwi evxi cō`t`Q` i t¶¶dj w`i \_vKtj cwi evxi tiva Gi ^N° mgvbwZK |

cwi ewni ^N°L, cō`t`Q` i t¶¶dj A Ges tiva R ntj , GB mti vbmvti

$$R \propto L \quad \text{hLb Zvcgvv, Dcv`vb Ges A aß _vtK} \quad (11.1)$$

11.8 |P| GKB ^`N^ Ges GKB Dc`vb 0iv ^Zvi `yU cwi evnX Zvi S Ges T t`Lv`bv ntq`Q| S Zv`i i c0`t`Q` i t`q`T dj T Zv`i i c0`t`Q` i t`q`T dj A`c`q`v t`w`k| th Zv`i i c0`t`Q` i t`q`T dj t`w`k Zvi tiva Kg|



|P| 11.8

c0`t`Q` i m`f: w`b`w` 0 Zvcgv`v`q w`b`w` 0 Dc`v`v`bi cwi evnX ^`N`^ i \_v`K`j cwi evnX tiva Gi c0`t`Q` i t`q`T dj i e`v`v`b`c`v`Z`K|

$$A_{\text{P}} \quad R \propto \frac{1}{A} \quad hLb \quad Zvcgv`v` \quad , \quad Dc`v`vb \quad Ges \quad L \quad a`p` \quad _v`K \quad (11.2)$$

11.9 | Av`c`v`q`K tiva Ges cwi evnKZj

### Resitivity and conductivity

w`b`w` 0 Zvcgv`v`q w`b`w` 0 Dc`v`v`bi cwi evnX tiva Zvi ^`N`^ m`g`v`b`c`v`Z` Ges c0`t`Q` i t`q`T dj i e`v`v`b`c`v`Z` cwi evnZ` n`q`| m`Z`i`v`v` tiva i m`f` t`\_`K` c`v`B,

$$R \propto \frac{L}{A} \quad hLb \quad Zvcgv`v` \quad | \quad Dc`v`vb \quad a`p` \quad _v`K |$$

$$A_{\text{ev}} \quad R = \rho \frac{L}{A} \quad (11.3)$$

GLv`b` ρ GKwU a`p`K, hvi g`v`b` cwi evnX Dc`v`vb Ges Zvcgv`v`v` Dci w`b`f`p`k`j | G`K` H Zvcgv`v`q cwi evnX Dc`v`v`bi tivaKZj`ev` Av`c`v`q`K tiva e`j` |

(11.3) m`g`x`K`i`Y` L= 1 GKK Ges A= 1 GKK ntj , A = R nq|

A`\_`P` t`K`v`b`v` w`b`w` 0 Zvcgv`v`q GKK ^`N`^ | GKK c0`t`Q` i t`q`T dj w`e`w`k`0` t`K`v`b`v` cwi evnX tiva`K` H Zvcgv`v`q Gi Dc`v`v`bi Av`c`v`q`K tiva e`j` |

w`b`w` 0 Zvcgv`v`q t`K`v`b`v` cwi evnX tiva Gi t`f`S`Z` Ae`v`i (thgb` %N`^, c0`t`Q` BZ`w`v`) Dci w`b`f`P` K`i` | w`K`S`v` Gi Av`c`v`q`K tiva i`a`g`v`v` Gi Dc`v`v`bi Dci w`b`f`P`k`j |

Av`c`v`q`K tiva i GKK: (11.3) m`g`x`K`i`Y`K` m`w`R`t`q` t`j` Lv` hvq,

$$\rho = R \frac{A}{L} \quad (11.4)$$

m`g`x`K`i`Y`i` W`b`c`v`K`i` i`w`K`\_`t`j`v`i` GKK e`v`m`t`q` tivaKZj`p` -Gi GKK c`v`l`q`v` hvq|  $\frac{\Omega \, m^2}{m} = \Omega \, m$

Zvrch: 20 °C Zvcgvĭvq žūcvi tivaKZj  $1.6 \times 10^{-8} \Omega \text{ m}$  | A\_ℙ 20 °C Zvcgvĭvq  $1 \text{ m} \sim \text{N}^\circ \text{ l } 1 \text{ m}^2$   
 cŏ'ť"Qť`i tġĭĭdjwēkó žūcvi Zvťii tiva nťe  $1.6 \times 10^{-8} \Omega$  | Wwb cvťki mviwťZ wKQz maviY c`v\_ℙ  
 tivaKZjť Lvťbv nťqťQ |

mviwY 11.2: wēwfbač`vť\_ℙ tivaKZj

c`v_ℙ	tivaKZj ( $\Omega \text{ m}$ )
žūcv	$1.6 \times 10^{-8}$
Zvgv	$1.7 \times 10^{-8}$
Uvst÷b	$5.5 \times 10^{-8}$
bvBťμvg	$100 \times 10^{-8}$

Dcti i mviwY t\_ťK Avgiv t`LťZ cvB, th mKj c`vť\_ℙ tivaKZj Kg tм\_ťjv ZwotZi Rb` mpcwievN wntmťe  
 KvR Kťi | thgb, Zvgv bvBťμvťgi Zj bvq Zwor mpcwievnx | G KviťYB `e`jwZK eZBťZ mstћM Zvi  
 wntmťe Zvgvi e`vcK e`envi iťqťQ |

GQov th mKj c`vť\_ℙ tivaKťZj gvb Zj bvgj Kfťe tēk Zvť`i l eŭwa e`envi iťqťQ | D`vniY wntmťe  
 bvBťμvg Zvťii K\_vB aiv hvk | bvBťμvťgi tivaKZj Ges Mj bv¼ Zvgvi Zj bvq AťbK tēk | D`P tivaKťZj  
 KviťYB bvBťμvg Zvťii ga` w`ťq Zwor cēwN nťj cŏi Zvc Drčbēnq | bvBťμvťgi G aťgℙ KviťYB  
 `e`jwZK tKUjťZ cwb Lp`ž Mig nq | Avgiv ewotZ th mKj `e`jwZK evj l e`envi Kwi Zvť`i wdjvťgU  
 Uvst÷b ōviv `Zwi nq | Uvst÷ťbi D`P tivaKZj l Mj bvť¼i KviťY GwU `e`jwZK kwťK Lp mnťR  
 AvťjvKkwťZ žūcvšwi Z KiťZ cťi |

cwievN KZj

tivťai wēciX iwk nťjv cwiewNzv, tZgwb AvťcwġK tivťai wēciX iwkťK cwievN KZj etj | cwievN KZťK  
 $\sigma \text{ Aġi}$  ōviv cŏvk Kiv nq | Gi gvb cwievNxi Dcv`vb l Zvcgvĭvi Dci wbfPkj |

gťb Kwi, GKwU cwievNxi Dcv`vťbi AvťcwġK tiva =  $\rho$

mživs, H cwievNxi Dcv`vťbi cwievN KZj  $\sigma$  nťe-

$$\sigma = \frac{1}{\rho}$$

thťnZl  $\rho$  -Gi GKK  $\Omega \text{ m}$ , mživs  $\sigma$ -Gi GKK nťjv  $(\Omega \text{ m})^{-1}$  |

MwYwZK D`vniY 11.4 | GKwU `e`jwZK wUvťi e`ēüZ bvBťμvg Zvťii AvťcwġK tiva  $100 \times 10^{-8} \Omega \text{ m}$  |  
 $15 \text{ m j} \text{ } \alpha \text{ } \text{v}$  Ges  $2.0 \times 10^{-7} \text{ m}^2$  cŏ'ť"Qť`i tġĭĭdjwēkó Zvťii tiva KZ nťe ?

Avgiv Rwb,

$$\begin{aligned} R &= \rho \frac{L}{A} \\ &= \frac{(100 \times 10^{-8} \Omega \text{ m})(15 \text{ m})}{2.0 \times 10^{-7} \text{ m}^2} \\ &= 75 \Omega \end{aligned}$$

DĖi : tiva 75  $\Omega$  |

GLvťb,

AvťcwġK tiva,  $\rho = 100 \times 10^{-8} \Omega \text{ m}$

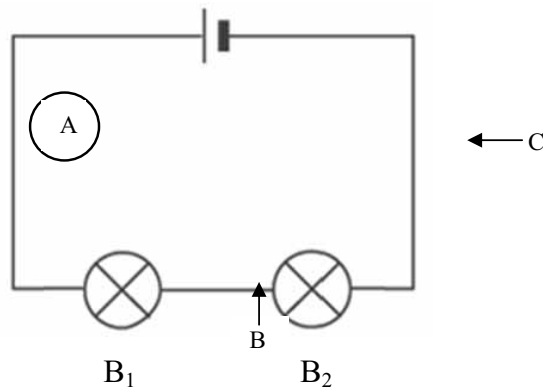
Zvťii cŏ'ť"Qť`i tġĭĭdj,  $A = 2.0 \times 10^{-7} \text{ m}^2$

Zvťii  $\sim \text{N}^\circ$ ,  $L = 15 \text{ m}$

ťiva,  $R = ?$

11.10| tköy Ges mgyšt'vj eZbX %Zwi l e'envi

## Making series and parallel circuits and their uses



$\hat{P}_I : 11.9$

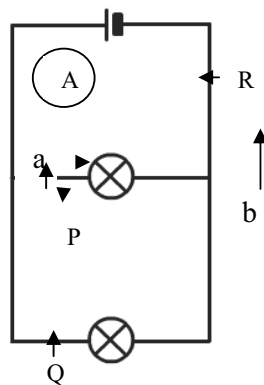
tköy eZBx

th eZDxZ Zwor DcKiY, tjv ci ci mVRtqv \_vK ZvK tkWY eZDx etj | 11.9 wP1 tKv E, yU evj | B1, B2 ci ci mVRtq tkWY eZDx ^Zwi Kiv ntqtQ | thnZzGB eZDxZ GKw gw1 c\_ i tqtQ, ZvB Gi meP GKB c0vn Pj te | GLb hw GKw A wgvUv tK A, B, ev C wv jZl msthW t l qv hvq Zvntj | Zwor c0vtni GKB gvb cvl qv hvte |

wetq emotZ ev wewfbaAbortbi ArtjvKm<sup>3</sup>/4vq th mKj tQvU tQvU ewlZ e'envi Kiv nq G<sub>tjv</sub>tkiYevfite  
mshy<sup>3</sup> Kiv nq| Avgiv UP<sup>9</sup>vBU GKwaK e'vUwi:k tkiYtZ mshy<sup>3</sup> Kti tfiter ejwv Kti \_wk| Zwor cēvn  
cwigutci Rb' A'wgluvi:k ezBxtZ tkiYtZ hy<sup>3</sup> Kiv nq|

mgvŠt-vj eZBx

th eZ<sub>Dx</sub>Z Zwor DcKiY<sub>1</sub>tjv Ggbfrte mVr<sub>1</sub>t<sub>1</sub>bv<sub>1</sub> v<sub>1</sub>K th cōZ<sub>1</sub>K<sub>1</sub>U<sub>1</sub> GK cōś<sub>1</sub> tjv GK<sub>1</sub>U<sub>1</sub> m<sub>1</sub>aviY<sub>1</sub> we<sub>1</sub> } Z  
Ges Acicōś<sub>1</sub> tjv Ab<sub>1</sub> GK<sub>1</sub>U<sub>1</sub> m<sub>1</sub>aviY<sub>1</sub> we<sub>1</sub> } Z mshy<sub>1</sub> v<sub>1</sub>K Zte Z<sub>1</sub>tK m<sub>1</sub>gvś<sub>1</sub>i<sub>1</sub>v eZ<sub>Dx</sub> etj | 11.10 wP<sub>1</sub>t<sub>1</sub>  
evj<sub>1</sub> B<sub>1</sub> | B<sub>2</sub> Gi GKcōś<sub>1</sub> a<sub>1</sub> we<sub>1</sub> } Z Ges Acicōś<sub>1</sub> b<sub>1</sub> we<sub>1</sub> } Z mshy<sub>1</sub> v<sub>1</sub>Kv<sub>1</sub> G<sub>1</sub> tjv GK<sub>1</sub>U<sub>1</sub> m<sub>1</sub>gvś<sub>1</sub>i<sub>1</sub>v  
eZ<sub>Dx</sub> ~Zwi K<sub>1</sub>t<sub>1</sub> | m<sub>1</sub>gvś<sub>1</sub>i<sub>1</sub>v eZ<sub>Dx</sub>Z GKwaK<sub>1</sub> c<sub>1</sub> v<sub>1</sub>Kv<sub>1</sub> cōZ<sub>1</sub>K<sub>1</sub> c<sub>1</sub> w<sub>1</sub> t<sub>1</sub>q Zwor cēv<sub>1</sub> P<sub>1</sub>t<sub>1</sub> |



11.13





$$\begin{aligned}
 &= IR_1 + IR_2 + IR_3 \\
 &= I(R_1 + R_2 + R_3)
 \end{aligned}
 \tag{11.5}$$

GLb  $R_1$ ,  $R_2$  l  $R_3$  gvtbi tiva wZbwU tiva  $R_s$  gvtbi Ggb GKwU tiva 0vív c0Z`vcb Kiv nq th, GtZ eZ0tZ GKB c0vñ I Ptj Ges tiva,tjvi `ß c0Š-i wefe cv\_ŕ V AcwiewZ \_vtK Zvntj  $R_s$  B nte GB mlobetki Zj` tiva |

$$\begin{aligned}
 &Zj` tiva tŕŕŕ V = IR_s \\
 &\text{mgiKiY Zj bv Kti cvB,}
 \end{aligned}
 \tag{11.6}$$

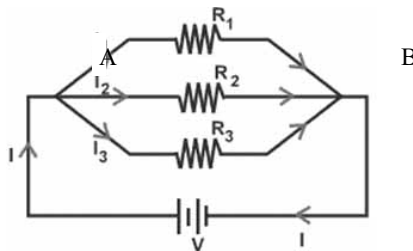
$$\begin{aligned}
 IR_s &= I(R_1 + R_2 + R_3) \\
 R_s &= R_1 + R_2 + R_3
 \end{aligned}$$

wZbwU tiva cwi etZ`h n mSL`K tiva tk0Y mlobetk hŕ \_vtK, Zv ntj Zj` tiva  $R_s$  nte

$$R_s = R_1 + R_2 + R_3 + \dots + R_n$$

A\_ŕ tk0Y mlobetk mshŕ tiva,tjvi Zj` tiva gvb mlobetk AŕF0 wefbr tiva gvtbi thMd tji mgvb | tk0Y mlobetk Zj` tiva gvb Avjv`v Avjv`v c0Z`KwU tiva gvtbi tPtq eo |

mgvŠ+vj mlobetk: KZK,tjv tiva hŕ Ggbfite mshŕ Kiv nq th, meKqU tiva GKc0Š-GKwU mvaviY we`yA-tZ Ges Aci c0Š-tjv Ab` GKwU mvaviY we`yB -tZ mshŕ \_vtK Ges c0Z`KwU tiva `ß c0Š-GKB wefe cv\_ŕ eRvq \_vtK, Zte tiva,tjvi GB mlobetk mgvŠ+vj mlobetk ejv nq |



wPŕ : 11.12

11.12 wPŕ wZbwU tiva  $R_1$ ,  $R_2$  Ges  $R_3$  mgvŠ+vj mlobetk mshŕ Kiv ntqtQ | Gtŕŕŕŕ wZbwU tiva `ß c0Š-GKB wefe cv\_ŕ V eRvq AvtQ | tiva gvtbi wefbrvi Rb` Zt`i c0Z`tki ga` w`tq Avjv`v gvtbi Zwor c0vñZ nt`Q | Gtŕŕŕŕ eZ0xi gj c0vñ I, A -msthvM we`ŕZ Gtm wZbwU fvŕM wef` nq Ges cŕivq B we`ŕZ Gtm wgvjZ nq | aiv hvK,  $R_1$ ,  $R_2$  Ges  $R_3$  tiva ga` w`tq c0vñZ Zwor c0vñi gvb h\_vuŕg  $I_1$ ,  $I_2$  Ges  $I_3$  | mŕZivs mgvŠ+vj c\_ŕtjvi c0vñ  $I_1$ ,  $I_2$  Ges  $I_3$  -Gi thMdj msthvM we`yA -Gi c0vñ I Gi mgvb | A\_ŕ

$$\therefore I = I_1 + I_2 + I_3
 \tag{11.7}$$

Gtŕŕŕŕ, c0Z`KwU tiva `ß c0Š-i wefe cv\_ŕ V nŕqvq l`tgi mŕ c0qM Kti Avgiv cvB,

$$I_1 = \frac{V}{R_1}, \quad I_2 = \frac{V}{R_2} \quad \text{Ges} \quad I_3 = \frac{V}{R_3}$$

(11.7) bs mgxKiY  $I_1, I_2$  Ges  $I_3$  -Gi gvb ewtq cvB,

$$I = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$= V \left( \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \right) \quad (11.8)$$

GLb  $R_1, R_2$  l  $R_3$  gvtbi tiva wZbwUtk hw`  $R_p$  gvtbi Ggb GKwU tiva Øviv cØZ`vcb Kiv nq th, GtZ eZØtZ GKB cØvn I Ptj Ges tiva,tjvi `ß cØtS-i wefe cv\_Ø` V AcwiewZØ \_vtK, Zvntj  $R_p$  B nte H mwteetki Zj` tiva |

$$\therefore I = \frac{V}{R_p} \quad (11.9)$$

(11.8) l (11.9) mgxKiY Zj bv Kti cvl qv hvq,

$$\frac{V}{R_p} = V \left( \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \right)$$

$$\frac{1}{R_p} = \left( \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \right)$$

wZbwU tivtai cwietZ`hw` n msL`K tiva mgvš+jj mwteetk hyß \_vtK, Zvntj Zj` tiva  $R_p$  tk wØv wLZ fite cØvk Kiv hvq |

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots + \frac{1}{R_n} \quad (11.10)$$

A\_Ø mgvš+jj mwteetk mshyß cØZ`KwU tivtai wecixZ iwki mgwó Zj` tivtai wecixZ iwki mgvb | MwYwZK D`vniY 11.6 : 5 Ω Ges 10 Ω gvtbi `wU tiva Avj`v fite tkØY Ges mgvš+jj mwteetk mshyß Kiti Dfq tØtT Zj` tivtai gvb wYØ Ki |

Avjiv Rwob,

$$R_s = R_1 + R_2$$

$$= 5 \Omega + 10 \Omega$$

$$= 15 \Omega$$

Averi ,

GLvtb,  
cØg tiva,  $R_1 = 5 \Omega$   
wØZxq tiva,  $R_2 = 10 \Omega$   
tkØY mgevq Zj` tiva,  $R_s = ?$   
mgvš+jj mgevq Zj` tiva,  $R_p = ?$

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{R_p} = \frac{1}{5\Omega} + \frac{1}{10\Omega}$$

$$= \frac{2+1}{10} \Omega^{-1}$$



$$\therefore P = \frac{W}{t} \quad (11.13)$$

mgxKiY (11.11) t\_ŕK W -Gi gvb ewmtq cvB,

$$P = VI \quad (11.14)$$

I ŕtgi mŕ cŕqM Kŕi P ŕK V, I Ges R -Gi mrvth` wŕt`e<sup>3</sup> fŕte cKvk Kiv hvq-

$$P = VI = I^2 R = \frac{V^2}{R} \quad (11.15)$$

Avgiv Rwb ŕlgZvi GKK nj IqvU (W) | Zwor kw<sup>3</sup> wntmŕei mgq maviYZ IqvUi cwi etZ<sup>3</sup>kW, MW BZ`w` e`envi Kiv nq | 1kW = 10<sup>3</sup>W Ges 1MW = 10<sup>6</sup>W |

Avgiv ewmewotZ th mKj `e`jwZK hšZcmwZ e`envi Kwi Zvi gŕa` KŕqKwUi ŕlgZv Dŕj ŕ Kiv ntjv | %e`jwZK evŕjŕi ŕlgZv 40, 60, 100 W ntq \_ŕK | `e`jwZK cvLvi ŕlgZv maviYZ 65-75 W nq | tUwj wfkŕbi ŕlgZv maviYZ 60-70 W | AvRKuj Avgiv th mKj GbwR<sup>3</sup>tmwfs evj | e`envi Kwi G<sub>s</sub>tjvi ŕlgZv maviYZ 11-30 W nq |

GQovl Avgiv ewmvq wdR, wUvi, Bw`Z, e`envi Kwi Gŕi ŕlgZv AŕbK tewk | ZvB wK Avl qŕti Gme hšZcmwZ e`envi bv Kiv fvŕjv |

Zworkw<sup>3</sup> e`ŕqi wmwve

Avgiv ewmv-ewmo, ŕvKvb, Kj -Kvi Lvbvq th Zwor kw<sup>3</sup> e`envi Kwi Zvi Rb` gj` cwiŕkva KiŕZ nq | Zwor kw<sup>3</sup> e`envi Kŕi Ggb cŕZ`K ewotZ GKwU `e`jwZK wUvi \_ŕK hv ewotZ e`wqZ Zwor kw<sup>3</sup>i wmwve ivŕL | wekŕvcx Zwor mieivn cŕZövb wKŕjvI qvU-NËv (kWh) GKKŕK e`wqZ Zworkw<sup>3</sup>i cwi gvY wbaŕY Kŕi | Avgiv GB wKŕjvI qvU-NvUv GKKŕK tew<sup>3</sup>Ae tUW BDwbU ev mŕŕŕŕc BDwbU etj \_wK | `e`jwZK wUvti `ß mgŕqi wmwS-Gi cv`R` t\_ŕK H mgŕqi e`eüZ Zwor-kw<sup>3</sup>i cwi gvY cvl qv hvq |

$$\text{thŕnZi ŕlgZv } P = \frac{KZ KvR}{mgq} = \frac{i \text{ cvš-wi Z kw}^3}{mgq}, \quad P = \frac{w}{t}$$

$$\therefore W = Ptw$$

hw` P=1 kW Ges t=1h nq, ZLb W=1 kW × 1h=1 kWh nq |

A\_ŕ GK wKŕjvI qvU ŕlgZvm`übaŕKvŕbv Zwor hšZ GK NËv aŕi KvR Kiŕj th cwi gvY Zworkw<sup>3</sup>ŕK Ab` kw<sup>3</sup>ŕZ ŕcvšŕ Kŕi ev e`q Kŕi ZvŕK GK wKŕjvI qvU-NËv ev GK BDwbU etj |

wŕŕR Ki : 1kWh ŕK Rŕj cKvk Ki |

$$1 \text{ kWh} = 3.6 \times 10^6 \text{ J}$$

ŕlgZvŕK IqvU Ges mgqŕK NËvq cKvk Kiŕj, e`wqZ Zworkw<sup>3</sup> W -ŕK tj Lv hvq-

$$W = Pt \quad \text{Wh}$$

GŕK 1000 w`ŕq fvM Kiŕj e`wqZ kw<sup>3</sup> kWh G cvl qv hvŕe |

wb†R Ki :

Zng th N†i eım K†iv, tmB N†i hw` ^e`jwZK msthvM \_v†K, Zvntj H N†i Kx Kx ^e`jwZK DcKiY Av†Q, Zvi GKwU Zwj Kv ^Zwi Ki | Gi t\_†K H N†i i Rb` GK gv†mi mæŕe` e`wqZ kw³i cwi gvY wbYŕ Ki |

MwYwZK D`vniY 11.7 : GKwU ev†jji Mtq 100 W- 220 V wj Lv Av†Q | Gi wdjv†gt†Ui tiva KZ ? Gi ga`w†q Kx cwi gvY Zwor cŕvnnZ n†e ?

Avgiv Rwb,

$$P = \frac{V^2}{R}$$

$$R = \frac{V^2}{P}$$

$$= \frac{220V \times 220 V}{100W}$$

$$= 484 \Omega$$

$$\text{Avevi, } P = VI$$

$$I = \frac{P}{V}$$

$$= \frac{100w}{220v}$$

$$= 0.455 A$$

GLv†b

wefe cL`ŕ, V = 220 V

¶lgZv, P = 100 W

tiva, R = ?

Zwor cŕvnn, I = ?

D: 484 Ω Ges 0.455 A

### 11.13 ZwotZi w†÷g j m Ges tjwW tkwWs

#### System loss and load shedding

Avgiv Rwb, t†ki wewfbæ`v†b Aew`Z we`jr cvl qvi cƿU,tjv†Z we`jr kw³ Drcw`Z nq | DrcbæGB we`jr†K cŕqvRb Abhvqx wewfbæ`v†b mÂvj b Ki†Z nq | we`jr mÂvj b e`e`vi gva†g Drcw`Z we`jr kw³†K we`jr tK`††K wewfbæ`v†b Aew`Z we`jr mve†÷k†b `v†v†Š† Kiv nq | Gi ci wewfbæmve†÷kb t\_†K cƿivq we`jr weZiY e`e`vi gva†g we`jr kw³†K M†nK ch†ŕq weZiY Kiv nq |

we`jr tK†`† we`jr kw³ wææ†fv†††R Drcv`b Kiv nq | c†i GB t†fv†††K t÷c Avc U†Ydgŕ -Gi m†v††h` D`P t†fv†††R ŕc†vŠ†† Z Kiv nq | we`jr mÂvj†bi Rb` th mKj cwi evnx Zvi e`envi Kiv nq Zv† i GKwU wbw` Œ cwi gvY tiva \_v†K | d†j GB tiva†K AwZ††gi Rb` Zworkw³i GKwU Ask Zv†c ŕc†vŠ†† Z nq | A\_ŕ kw³i j m ev ¶lq nq | GB j mB n†jv ZwotZi w†÷g j m | D`P t†fv†††R we`jr mÂvj†bi d†j we`jr w†w Z\_v cwi evnx†i t†v††i Kv††Y th j m nq Zv A†bK††k K†g hvq | GKwU wbw` Œ cwi gvY we`jrkw³i Rb`,

D`P tfv̄tēR wē`j̄r mĀvj tbi dtj Zwor cēv̄tni gvb Kg nq| Gi dtj tivaRwbZ j̄tmi cwigvYl Ktg hvq| D`v̄v̄iY w̄nmv̄te ejv hvq- hw̄ mĀvj b jvBb tfv̄tēR t̄K `k \_Y ejv̄ Kiv nq, ZLb Zwor cēv̄tni gvb GK `kgysk nq| hvi dtj wē`j̄r w̄M̄Wi f̄R j̄tmi cwigvY GKkZ f̄v̄Mi GK f̄v̄M nq| A\_v̄P mĀvj b jvBtbi tfv̄tēR t̄K ejv̄ Kti w̄m̄t ÷ g j̄m Kgv̄t̄v̄ t̄t̄Z cv̄ti |

tjw t̄k̄w̄s

c̄QZ`K̄w̄ wē`j̄r t̄K`^a ḠK̄w̄ w̄b̄w̄` Œ cwigvY wē`j̄r k̄w̄³ Drcv̄`b Kti | mē`t̄j̄v wē`j̄r t̄K`^a t̄t̄K Drcw̄` Z wē`j̄r RvZxq w̄M̄W th̄w̄ nq| w̄ērf̄b̄e Ḡj̄v̄K̄vi Pw̄n`v Ab̄hv̄q wē`j̄r Dc̄t̄K`^a RvZxq w̄M̄W t̄t̄K wē`j̄r m̄s̄M̄h̄ Kti | cieZ̄f̄Z wē`j̄r Dc̄t̄K`^a M̄h̄K ch̄f̄q G wē`j̄r t̄K t̄c̄t̄Q t̄`q ev̄ wēZiY Kti | t̄K̄v̄t̄v̄ w̄b̄w̄` Œ Ḡj̄v̄K̄vi wē`j̄t̄Zi Pw̄n`v Drcv̄`b ev̄ mieiv̄tni Z̄j̄bv̄q t̄ēnk̄ n̄tj ZLb wē`j̄r Dc̄t̄K`^a c̄t̄q̄ Pw̄n`v t̄ḡŪv̄t̄v̄ m̄ē n̄tq D̄t̄V̄ bv̄| ZLb ev̄a` n̄tq Dc̄t̄K`^a KZ̄Œ̄ wēZiY e`e`vi w̄b̄w̄` Œ w̄K̄Q̄z Ḡj̄v̄K̄v̄q w̄K̄Q̄z m̄ḡt̄q̄i Rb` wē`j̄r wēZiY eÜ Kti t̄`q ev̄ wē`j̄r m̄s̄t̄h̄w̄ w̄ēr̄Q̄b̄e Kti | Ḡt̄K̄ tjw t̄k̄w̄s ēt̄j̄ | Avevi Dc̄t̄K`^a h̄Lb c̄Q̄q̄v̄R̄bx̄q Pw̄n`v Ab̄hv̄q mieiv̄n̄ cv̄q ZLb c̄p̄iv̄q H Ḡj̄v̄K̄v̄q wē`j̄r mieiv̄n̄ Kti |

hw̄ tjw t̄k̄w̄s GK b̄v̄M̄t̄o K̄t̄q̄K N̄Ūv̄ `v̄q̄x nq ZLb M̄h̄K ch̄f̄q tjw t̄k̄w̄s t̄K̄ m̄nb̄x̄q Kīt̄Z KZ̄Œ̄ P̄v̄v̄K̄v̄t̄i w̄ērf̄b̄e Ḡj̄v̄K̄v̄q tjw t̄k̄w̄s Kti \_v̄t̄K̄ |

#### 11.14 Zwōt̄Zi w̄b̄iv̄c` I K̄v̄h̄Ŕi e`envi

##### Safe and effective use of electricity

Zwōt̄Zi w̄ēc̄¾bK w̄ K̄m̄ḡn̄: Zwor Avḡv̄t̄i `b̄w̄`b R̄x̄ēt̄b AZ`Š- \_iZ̄c̄Y`f̄ūḡK̄v̄ cv̄j̄b Kti | Zwor Avḡv̄t̄i th̄gb Āt̄bK D̄c̄K̄v̄t̄i Av̄t̄m̄ t̄Z̄ḡw̄b Gi Am̄ZK`e`envi AZ`Š-w̄ēc̄¾bK n̄t̄Z cv̄ti | `e`j̄w̄ZK h̄š̄c̄w̄Z Ges eZ̄Œ̄ t̄h̄ t̄K̄v̄t̄v̄ āit̄bi t̄j̄w̄ `e`j̄w̄ZK k̄K̄w̄ t̄Z cv̄ti Ges Am̄K̄v̄Ê NŪt̄Z cv̄ti | k̄ix̄t̄ii ga` w̄t̄q wē`j̄r cēv̄tni dtj ḡv̄b̄t̄li ḡZ̄j̄il S̄m̄K̄ īt̄q̄t̄Q̄| Z̄w̄ork̄w̄³i e`envi w̄b̄ēw̄ȲZ w̄Z̄b̄w̄ K̄v̄it̄Y w̄ēc̄¾bK n̄t̄Z cv̄ti |

1. Āš̄t̄t̄Ki Œ̄w̄Z̄m̄v̄ab;

2. K̄v̄ēt̄j̄i Am̄Z D̄Ê̄B̄ n̄l̄q̄v̄;

3. Av̄`Ae`v̄ |

1. Āš̄t̄t̄Ki Œ̄w̄Z̄m̄v̄ab : `e`j̄w̄ZK h̄š̄c̄w̄Z̄t̄K̄ K̄v̄R̄ Kīt̄Z n̄tj Z̄v̄t̄`īt̄K̄ tfv̄tēR D̄rm-Gi m̄v̄t̄\_`j̄w̄ c̄w̄i ev̄n̄x̄ Z̄vi Œ̄v̄iv̄ m̄sh̄j̄³ Kti eZ̄Œ̄ m̄ēŸ̄K̄īt̄Z nq| GB `j̄w̄ Z̄v̄it̄K̄ Avḡiv̄ ēw̄j̄ R̄x̄ēŠ-(Live) Ges w̄b̄it̄c̄Œ̄ (Neutral) Z̄vi | Ḡm̄K̄j̄ c̄w̄i ev̄n̄x̄ Z̄vi m̄v̄aviȲZ īvevi Œ̄v̄iv̄ Āš̄w̄i Z̄ Ae`v̄q \_v̄t̄K̄ | `j̄w̄ Z̄v̄it̄K̄ c̄t̄i ḠK̄w̄ t̄Z Ae`v̄q w̄c̄w̄f̄im̄ ev̄ īvevi Œ̄v̄iv̄ AveZ̄ Kti K̄v̄ej̄ `Z̄w̄i K̄iv̄ nq|

m̄ḡq Ges e`envi Gi m̄v̄t̄\_ m̄v̄t̄\_ Ḡm̄K̄j̄ Āš̄t̄K̄ c`v̄\_Œ̄w̄Z̄M̄Œ̄ nq| th̄gb Avḡiv̄ ew̄ōt̄Z̄ th̄ `e`j̄w̄ZK B̄w̄\_ e`envi K̄w̄i Gi K̄v̄ej̄ e`env̄t̄ii m̄ḡq t̄ēt̄K̄ hv̄q Ges t̄ḡv̄Po L̄v̄q| Ḡt̄Z̄ Kti Af̄`š̄t̄`v̄ Āš̄t̄K̄ e`e`v̄ t̄d̄t̄U Ges t̄f̄t̄o t̄t̄t̄Z cv̄ti | dtj c̄w̄i ev̄n̄x̄ Z̄vi D̄b̄j̄³ n̄tq hv̄q| GLb t̄K̄v̄t̄v̄f̄v̄te hw̄ R̄x̄ēŠ-Z̄vi k̄ix̄t̄ii m̄s̄`Ÿ̄t̄k̄® Av̄t̄m̄, ZLb ḡv̄iv̄ZK̄ `e`j̄w̄ZK̄ k̄K̄&Œ̄v̄iv̄ Av̄m̄Ÿ̄-n̄t̄Z nq| ḠQ̄v̄ov̄ Āš̄t̄K̄ e`e`v̄ Œ̄w̄Z̄M̄Œ̄ n̄l̄q̄i dtj R̄x̄ēŠ-Z̄vi Ges w̄b̄it̄c̄Œ̄ Z̄vi c̄i`Ÿ̄t̄ii m̄s̄`Ÿ̄t̄k̄® Av̄m̄t̄j̄ k̄Ūm̄w̄K̄Œ̄i m̄j̄ō n̄te Ges Am̄K̄v̄Ê NŪt̄Z cv̄ti |

2. K`vetji AmZ DĖB nI qv: hLb A`vfweKfite tenk cwigvY ZworcĖn `e`jwZK K`vej ev cwi evnx Zvi w`tq hvq ZLb GuU DĖB nq| thgb -hLb `e`jwZK cvLvi tgvUi AmZ DĖB nq Ges Mġ hvq, djKZtZ Rxeš-Zvi Ges wbičŋ Zvi GKwĪZ nġ hvq Ges A`vfweKfite D`Pgvtbi Zwor cĖwnZ nq| GQov AġbK mgq Avgiv mġKtU gwĖcŋM e`envi Kti AġbK,tjv `e`jwZK hš,cwZtK GKmġ½ msthM t`B| Gi dtj mġKtUi Af`št` cwi evnx Zvi tgBb jvBb t`tK th cwigvY Zwor MġY Kti Zv GB cwi evnx Zvi wbičt` th cwigvY Zwor cĖn MġY KtiZ cġti Zvi tPtq AġbK tenk nq| Gi dtj K`vej Zvi AZ`waK DĖB nġ I tV, AštK e`e`v Mġ hvq Ges AwMkVĖ NUvq|

3. Av`Ae`v: Av`Ae`vq AġbK `e`jwZK `Nġbv NtU \_vK| Avgiv Rwb, cwi ga` w`tq Zwor cĖwnZ nġZ cġti | G Kvi tY tKtġv `e`jwZK mi Ävtgi th mKj Ask Ašwi Z Ae`vq \_vK bv tm,tjv memgq i`< ivLġZ nte| Ab`vq `e`jwZK kUŋwKġ Ges kK&Ųiv Avpŋš-nI qvi SġK \_vKte| D`vniY wntmte ejv hvq, tKtġv tnqvi WġqitK tFRv wnt¼ tiġL t`I qv AZ`š-wec¾bK| hġ tnqvi Wġqitii Zvi Dbŋ \_vK wKsev Ztġi AštK e`e`v wPĪ 11.14: wec¾bK Ae`vq tnqvi Wġqiv  
 ¶wZMŲ nġ hvq, ZLb whb w¼ e`envi KitiQb wZwb `e`jwZK kK&Ųiv Avpŋš-nġZ cġti b| GQovI tFRv nvZ Ųiv tKtġv `e`jwZK mġP Abġev Ad&KivI wec¾bK|



ZwotZi wbič` e`envi

ceZP Abġ`Qt` tZvgiv Zwor e`envġi wec¾bK w`K m`utK`AeġnZ nġQ| eZġvb Abġ`Qt` Avgiv emotZ wKfite ZwotZi wbič` e`envi m`utK`Rvbe|

emotZ Zwor e`envġi mgq th mKj wbičĖvgjK e`e`v MġY Kiv cġqvRb G,tjv ntjv:

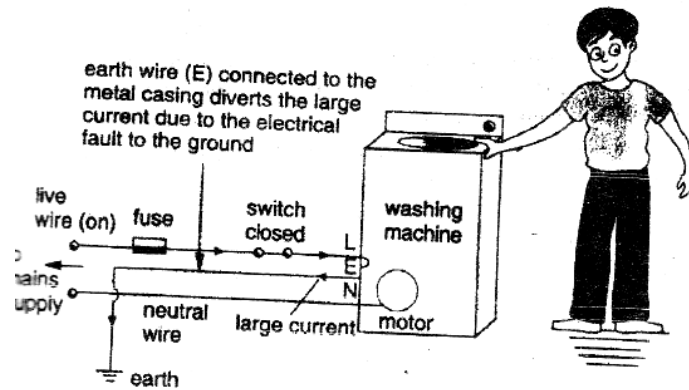
1. mwKġ teKvi
2. wDDR
3. mġtPi mwK msthM
4. f-msthM Zvi

1. mwKġ teKvi: wbičĖvgjK tKškj wnmte mwKġ teKvi e`envi Kiv nq| GuU maviYZ emoi mbyġ iRvi Avtkcġk `vcB Kiv nq| hLb tKtġv eZġtZ wbič gvtbi Awak Zwor cĖwnZ nq ZLb mwKġ teKvi eZġxi Zwor mieivn eÜ Kti t`q| mwKġ teKvi emoi tKtġv wbič Astki Zwor mieivn weŲQbe Kti| eZġtZ mwKġ teKvi bv \_vKtj AwZwi³ Zwor cĖvni Rb` emoi Zwor miÄvg webó nġ thġZ cġti, GgbwK AwMkVĖI NUġZ cġti |

2. wDDR: wDDR ntjv GKwU wbičĖvgjK tKškj | `e`jwZK eZġtZ Awak ZworcĖn cġZtġtai Rb` wDDR Ašfŋ Kiv nq| wDDRwġtK memgq `e`jwZK K`vetji Rxeš-Zvġi msthM t`I qv nq| GKwU `Ųi` tNŲ wPKb Zvi wDDR wntmte e`envi Kiv nq| wbič gvtbi ZworcĖn AtcŲv tenk Zwor cĖwnZ ntj wDDRwU DĖB nq Ges Mġ hvq| GġZ eZġx weŲQbenq Ges `e`jwZK hš,cwZ bó nI qvi nvZ t`tK iŲv cġq| wDġRi Mġq wbič gvtbi ZworcĖvni Dtj t`vK| tKtġv `e`jwZK hš ev miÄvg mtePP th







ŕPŦ 11.21 fmsťhvMmn l qŕks tgŕkb

G Qovl ÁvRKŕj ŕeŕfbænbťhvM hš;cwZťZ ŕ\_ŕcb cŕM e`envi Kiv nq| G\_ťjťZ ŕbi vcĖvgj K e`e`v  
ŕnťmťe ŕdDR mshŕ ŕ\_ťK| ŕdDRŕU Zŕor hš;ŕUťK ŕbi vc` iťL|

### AbŕmŬvb- 11.1

emv emv DcťhvMx Zŕor eZŕx bKkv cŕqŕ Ges e`envi cŕ kŕ|

Dťĩ k: ŕkŕŕv\_ŕŕv emv emvťZ e`envi DcťhvMx Zŕor eZŕxi bKkv cŕqŕ Kťi Gi ŕeŕfbæAstk Gŕm  
Drťmi e`envi cŕ kŕ KĩťZ cvi ŕe|

KŕťRi aviv :

1. KŕťRi ĩĩťZB e`ŕŕZK K`vetj i Rxeš-(L)Ges ŕbiťcŕŕ (N) Zvi Á½b Ki |
2. Gevi G`ŕU ZviťK cŕvb ŕdDR ev, e`ŕŕZK ŕgŕvi Ges ŕŕŕ÷ŕeDkb evť i mť½ cici mšťhvM  
`vI |
3. ŕŕŕ÷ŕeDkb evť tgBb mŕŕ Á½b Ki |
4. ŕŕŕ÷ŕeDkb evť `ŕŕU ŕdDR AsKb Ki | ŕdDR\_ťjťK Aek`B L Zťi mšťhvM ŕťZ nťe|
5. Gevi GKŕU ŕdDR-Gi mť½ `ŕŕU emvZ, GKŕU d`vb mgvšťvj fťŕe mšťhvM ŕťq eZŕx mŕuŕŕKi |  
cŕZ`K emvZ l d`ťŕbi Rb` LZťi Ávj v`v mŕŕ Á½b Ki |
6. Ab` ŕdDRŕU e`envi Kťi ŕŕŕj ŕfkb ŕmU, Bŕ`ZB`ŕŕ i Rb` Ávj v`v Ávj v`v cvi qvi mťKťU mšťhvM  
`vI |

ŕbťR Ki :

Zŕor kŕ³i AcPq ŕiva l msiŕŕťŕ mťPZbZŕ mŕŕi Rb` ŕcv÷vi Á½b |

1. ŕ`vKŕb ŕťK ŕcv÷vi ŕZŕi i Rb` ŕcv÷vi ŕccvi mŕMŕ Ki |
2. ŕeŕfbæiťŕi Kjg e`envi Kťi Zŕor kŕ³i AcPq ŕiva l msiŕŕťŕ Kx Kx e`e`v  
Mŕŕ Kiv Dŕŕ Zŕ ŕcv÷ťi ŕj L|
3. ŕkŕŕK ŕmiv ŕcv÷viŕU ŕbeŕŕb Kĩťeb Ges cj`ŕťi i e`e`v Kĩťeb|

## Abkxj bx

K. eũberPbx cŕkæ

mŕVK DĖtŕi i cŕtk ŕJK (√) ŕPŕ`vŕ |

1| th mKj c`vŕ\_P ga`ŕ`ŕq Lp mntRB Zŕor cĖvn Pj ŕZ cŕŕi Zvŕ` i ŕK Kx etj?

(K) Acŕi evnx

(L) Kcŕi evnx

(N) AaĖi evnx

(N) cŕi ewn

2| 2 Ω, 3 Ω l 4 Ω gvŕbi ŕZbŕU tiva tKŕY mgeŕŕqi mshŕ³ ŕvKŕj Zj` tiŕtai gvb nŕe-

(K) 8 Ω

(L) 7 Ω

(M) 9 Ω

(N) 20 Ω

3| tKŕŕbv cŕi evnx i `ŕ cŕŕŕŕ-i ŕefe cv\_ŕ` 100 V Ges Zŕor cĖvn gvŕŕv 10 A ntj Gi ŕiva KZ?

(K) 1000 Ω

(L) 0.1 Ω

(M) 10 Ω

(N) tKŕbŕUB bq

4| eZŕŕZ `e`ŕZK Ae`v cŕi gvŕŕi Rb` e`envi Kiv nq -

i. tŕvĖ ŕgUvi

ii. A`ŕgUvi

iii. tRbŕŕiUi

tKŕbŕU mŕVK

(K) i l ii

(L) i l iii

(M) ii l iii

(N) i, ii l iii

L. mRbkxj cŕkæ

1| GKŕU `e`ŕjZK ŕnUŕi e`eüZ bŕBŕŕvg Zŕŕi i `N°l cŕŕ`ŕQŕ` i tŕŕŕdj h\_vŕŕg 30 m Ges  $2 \times 10^{-7} \text{ m}^2$  | bŕBŕŕŕgi AŕŕcŕŕŕK tiva  $100 \times 10^{-8} \Omega \text{ m}$  | bŕBŕŕvg Zŕi ŕŕŕK GKB `ŕŕNŕ Ges cŕŕ`ŕQŕ` i tŕŕŕdj ŕeŕkó Zŕgvi Zŕi ŕvŕv cŕZ`vcb Kiv ntjŕ | Zŕgvi Zŕŕi i AŕŕcŕŕŕK tiva  $1.7 \times 10^{-8} \Omega \text{ m}$  |

(K) tiva KŕŕK etj?

(L) Zŕcgvŕŕv evovŕj cŕi evnx i tiva eŕŕx cvq tKb?

(M) Zŕgvi Zŕŕi i tiva ŕbYŕ Ki |

(N) Zŕgvi Zŕi e`envŕŕi i tŕŕŕKZv ŕeŕkŕŕ Ki |

2| covi mgq Avjŕŕf 220V–100 W Gi GKŕU ewŕZ `ŕŕbK 3 NĖv Kŕŕi Ab`ŕ`ŕK Zŕi ŕŕvB Awj d 220V – 40 W GKŕU tUeŕj j`vŕú `ŕŕbK 4 NĖv Kŕŕi e`envi Kŕŕi | cŕZ BDŕbU ŕe`ŕŕ kŕŕŕi gj` 3.5 ŕvKŕ |

K. l ŕŕŕgi mŕŕU ŕj L |

L. ŕbŕŕŕ Zŕcgvŕŕv, Dcŕvŕ l cŕŕ`ŕQŕ` i cŕi evntKi `N°5 ŕeo Kiŕj tiŕtai Kx cŕi eZŕ nŕe e`ŕL`v Ki |

M. Awj ŕŕŕi ewŕZ cĖngvŕŕv ŕbYŕ Ki |

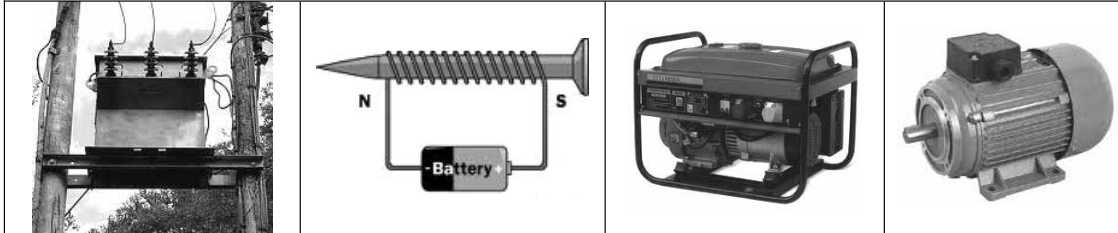
N. Awŕ\_ŕ ŕ`K ŕeŕePbvq Avjŕŕf l Awj ŕŕŕi gŕa` tK ŕgZe`ŕŕ? MŕŕŕŕZK hŕŕ³mn ŕeŕkŕŕ Ki |

M. mvavi Y cĕke

- 1| Zwor cĕvni KvĕK etj?
- 2| Zwor cĕvni cPvj Z w`K Ges Btj Kub cĕvni w`K tKvbwU?
- 3| cwi evnx, Acwi ewn Ges AaCwi evnx c`v\_ŕKvĕK etj?
- 4| I Őtgi mĕwU weeZ Ki |
- 5| t`LvI th, V = IR |
- 6| GKwU QK KwMĕR I ebyg V tj LwPĪ A¼b Ki |
- 7| AvĕcwĕK tivitai msÁv`vl |
- 8| t`LvI th, tkŕY mgevĕq mshy³ tiva,tjvi Zj`titvai gvb mgevĕqi Aš–f,³ wevfĕtitvai gvĕbi thwM dĕj i mgvb |
- 9| Kx Kx KvĕtY Zworkw³ e`envi wec¾bK nĕZ cvi?
- 10| GKwU evĕmi tnW jvBĕUi wĕjvĕgĕUi 2.5 A Zwor cĕwnZ nq| wĕjvĕgĕUi cĕš–ŕtqi wefe cv\_ŕ` 12 V nĕj Gi tiva KZ?
- 11| GKwU i`®< tKvĕI i Zwo`Pvj K kw³ 1.5 V | 0.5 C AvavĕĕK mæüYĕZBx Nviĕq AvĕĕZ tKvĕI i e`wqZ kw³ i cwi gvY wbYĕ Ki |
- 12| w`i Ges cwi eZxĕiva KvĕK etj?
- 13| Zwo`Pvj K kw³ Ges wefe cv\_ŕ` ejĕZ Kx tevS?

## Øv`k Aa`vq Zwo†Zi †PŠ`^K μμqv

### MAGNETIC EFFECT OF CURRENT



Zwo†Zi †PŠ`^K cŕve thgb Av†Q †Zgwb PŠ`†Ki Zwor cŕve Av†Q| GB `ß cŕve†K Kv†R jwM†q A†bK Zwor hš¿cwZ `Zwi Kiv n†q†Q| GB me hš¿cwZ Avgv†`i A†bK mgm`vi mgvaib K††Q, Rxe†b A†bK Avigv Av†qm G†b w†q†Q, Avgv†`i Rxebgwb Dbž K††Q| GB Aa`v†q Avgiv ZwoZPŠ`^K, ZwoZ†PŠ`^K A†tek, Aweó Zworcœvn I Aweó Zwo`Pvj K kw³, Zwor tgvUi, †Rbv†iUi, U`vÝdgŕ BZ`w i Kvœŕwj I e`envi wb†q Av†jvPbv Kie|

GB Aa`vq cW †k†I Avgiv-

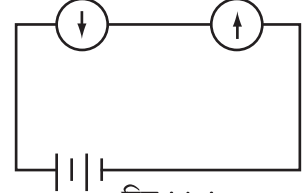
- 1| Zwor cœv†ni †PŠ`^K μμqv e`vL`v Ki†Z cvie|
- 2| ZwoZ†PŠ`^K A†tek e`vL`v Ki†Z cvie|
- 3| Aweó Zworcœvn I Aweó Zwo`Pvj K kw³ e`vL`v Ki†Z cvie|
- 4| gUi I †Rbv†iUi i gjbwZ e`vL`v Ki†Z cvie|
- 5| U`vÝdgŕ i gjbwZ e`vL`v Ki†Z cvie|
- 6| †÷c Avc I †÷c WvDb U`vÝdgŕ i Kvœŕwj e`vL`v Ki†Z cvie|
- 7| Avgv†`i Rxe†b Zwo†Zi bvbv†ci e`envi I Gi Ae`vb†K cksmv Ki†Z cvie|

### ১২.১। তড়িৎের চৌম্বক ক্রিয়া

#### Magnetic Effect of Current

ওয়েরস্টেডতড়িৎের চৌম্বক ক্রিয়া বা প্রভাব আবিষ্কার করেন।

**নিজে কর :** পাশের চিত্রের মতো করে একটি বর্তনী তৈরি কর। তারের নিচে একটি কম্পাসকে এমনভাবে রাখ যেন এর কাঁটা উত্তর-দক্ষিণে মুখ করে থাকে। এবার সুইচ অন কর। কম্পাস কাঁটার কী ঘটছে?



চিত্র ১২.১

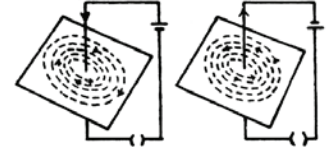
সুইচ অন করে বর্তনীতে প্রবাহ চালনা করার সাথে সাথে কম্পাস কাঁটাটি একদিকে সরে যাচ্ছে। তড়িৎপ্রবাহের দিক পরিবর্তন করলে কম্পাস কাঁটাটি উল্টা দিকে সরে যায়। এর থেকে বোঝা যায় তড়িৎপ্রবাহ চৌম্বকশলাকার উপর একটি প্রভাব সৃষ্টি করে। অর্থাৎ তড়িৎ চৌম্বকক্রিয়া আছে।

### ১২.২। পরিবাহীতে তড়িৎ প্রবাহের চৌম্বক প্রভাব

#### Magnetic effect of current carrying conductor

**পরীক্ষণ :** একটি শক্ত কাগজে একটি পরিবাহী তার ঢুকিয়ে এই তারসহ একটি তড়িৎ বর্তনী তৈরি কর। কাগজটি অনুভূমিক করে রেখে তারটির চারপাশে কিছু লোহার গুঁড়া ছড়িয়ে ছিটিয়ে দাও। এবার বর্তনী তথা পরিবাহী দিয়ে তড়িৎ চালনা কর। এবং শক্ত কাগজে আঙুল দিয়ে আস্তে আস্তে টোকা দিতে থাক।

দেখা যাবে লোহার গুঁড়াগুলো চিত্র ১২.২ এর মতো নিজেদেরকে সাজিয়ে নেবে। কোনো ছোট কম্পাসের সাহায্যে ডট ঐঁকে যোগ করলেও এরকম রেখা পাওয়া যাবে। প্রবাহের অভিমুখ বা দিক পরিবর্তন করলে কম্পাস কাঁটাটি বিপরীত দিক নির্দেশ করবে যা বিপরীত দিকে মুখ করে থাকবে। সুতরাং তড়িৎ প্রবাহ এর চারদিকে চৌম্বক প্রভাব ক্ষেত্র তথা চৌম্বক ক্ষেত্র তৈরি করে।

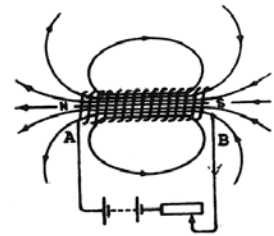


চিত্র ১২.২

### ১২.৩। সলিনয়েড

#### Solenoid

উপরে বর্ণিত তারটিকে পেঁচিয়ে কয়েল বা কুণ্ডলী তৈরি করে আমরা চৌম্বক ক্ষেত্রকে ঘনীভূত করতে পারি (চিত্র ১২.৩ দেখ)। পেঁচানো বা কুণ্ডলী পাকানো তার দিয়ে তড়িৎ প্রবাহ চালনা করা হলে অধিকাংশ বলরেখা কয়েলের কেন্দ্রে ঘনীভূত হবে। চৌম্বকক্ষেত্রটি দেখতে অনেকটা দণ্ড চুম্বকের ক্ষেত্রের মতো হবে। এরকম কুণ্ডলীকে বলা হয় সলিনয়েড। এর ভিতর যদি আমরা কোনো লোহার দণ্ড বা লোহার পেরেক ঢুকাই তাহলে লোহার দণ্ড বা পেরেকটি চুম্বকে পরিণত হবে। তড়িৎ প্রবাহ বন্ধ করে দিলে লোহার দণ্ডটি বা পেরেকটি আর চুম্বক থাকবে না। প্রবাহের দিক বিপরীত করা হলে, চুম্বকের মেরু বিপরীত হয়ে যাবে। এভাবে লোহার দণ্ডটি বা পেরেকটি যে চুম্বকে পরিণত হলো তাকে বলা হয় তড়িতচুম্বক।

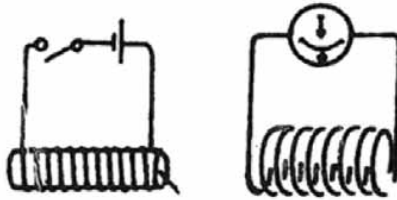


চিত্র ১২.৩

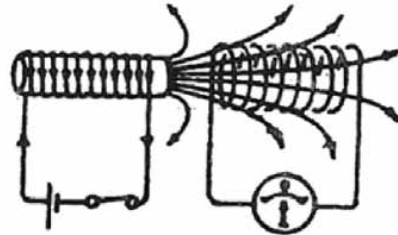


w`tk ntqWQj Pæ^KtK tei Kivtbi mgq wetŋc ntqt0 Zvi wecixZ w`tk| Pæ^KuUtK w`i ti tL Gevi hw` M'vj fvfbwglvimi KÊjxuUtK Pæ'tKi w`tk `Ź tbiqv nq ZvntjI M'vj fvfbwglviti ŋWYK wetŋc t`Lv hvte| KÊjxuUtK Pæ^K t\_tK `Źi mwi tq wbtj wetŋc wecixZ w`tk t`Lv hvte|

cixŋv-2 : GB cixŋvi Rb` AšixZ Zvgvi Zvtii `ŋu eÜ KÊjx wbtZ nte| cŋg KÊjxtZ i'ay GKwU M'vj fvfbwglvimi mshp` Kitz nte| wZxq KÊjxtZ GKwU Zwo`PvjK kw`i Drmŋtc GKwU e`vUwi , GKwU cwieZBkxj tiva I GKwU tUcv Pwe mshp` Kitz nte (wPÎ 12.5 K)| th KÊjxtZ GKwU Zwo`PvjK kw`i Drm mshp` ZvtK gŋ` KÊjx etj| Avi th KÊjxtZ M'vj fvfbwglvimi mshp` tmuU tMSY KÊjx| gŋ` KÊjxtZ Zwor cœvn Pvjrtj tMSY KÊjxi M'vj fvfbwglviti ŋWYK wetŋc t`Lv hvte wPÎ : 12.5 L| Avevi Zwor cœvn eÜ Kivi mgql M'vj fvfbwglviti wetŋc t`Lv hvte| Zte Gevi wetŋc wecixZ w`tk nq|



wPÎ : 12.5 K



wPÎ : 12.5 L

gŋ` KÊjxi Zworcœvn µgMZ cwieZB Kitz vKtj M'vj fvfbwglviti wetŋc t`Lv hvte| G tŋtÎ Zworcœvn eŋŋi mgq wetŋc thw`tk nte Zwor cœvn nŋtmi mgq wetŋc Zvi wecixZ w`tk nte| gŋ` KÊjxi Zworcœvn w`i ti tL hw` KÊjxtqi ga'eZP`iZi cwieZB Kiv nq ZvntjI M'vj fvfbwglviti ŋWYK wetŋc t`Lv hvte| iZi eŋŋi Kitz wetŋc thw`tk nte, iZi nŋm Kitz wetŋc Zvi wecixZ w`tk nte| wetŋcti nvi wbfP Kite KZ `Z KÊjxtqi iZi cwieZB Kiv nq|

15.6| Aweó Zwor cœvn I Aweó tftvèR ev wefe cv`R`

### Induced current and induced voltage

cixŋv `ŋu t\_tK M'vj fvfbwglviti wetŋc eZBxtZ tftvèR Z\_v Zwor cœvni Aw`ÍZij ŋ Kiv hvq| mZivs tKvfbv Zvi KÊjxi KvtQ Avgiv hw` tKvfbv Pæ^KtK bvovPvov Kwi , ev Avbv tbiqv Kwi ev tKvfbv Pæ'tKi woku tKvfbv Zvi KÊjxtK Avbv tbiqv Kwi Zvntj Zvi KÊjxtZ Zworcœvn Drcbenq| GtK ZwoZtPš`K Avtek etj| tKvfbv Zmorevnx Zvi ev eZBxi woku tKvfbv Zvi KÊjx Avbv tbiqv KitzI Zvi KÊjxtZ Zworcœvn Drcbenq| GtKI ZwoZtPš`K Avtek etj| mZivs Avgiv ejtZ cwi th, GKwU MuZkxj Pæ^K ev Zmorevnx eZBxi iZi ev Zworcœvni cwieZŋbi mŋvth` Ab` GKwU mseŋ eZBxtZ ŋY`vqx tftvèR I Zwor cœvn Drcbenq| qvi cŋwZtK ZwoZtPš`K Avtek etj| GB tftvèRtK Aweó tftvèR Ges cœvntK Aweó Zworcœvn etj|

Pæ^K I KÊjxi ga'eZP`AvtcŋŋK MuZ bv vKtj M'vj fvfbwglviti tKvfbv wetŋc t`Lv hvq bv| AvtcŋŋK MuZ hZ tenk nq wetŋcti cwigvYI ZZ eŋŋ cvq| mZivs ejv hvq, Pæ^K I KÊjxi ga'eZP`AvtcŋŋK MuZ hZŋY vKtK Aweó Zwor cœvnI ZZŋY `vqx nq| Pæ'tKi tgi` cwieZB Kitz Aweó Zwor cœvni w`KI cwi enZŋ nq| Aweó tftvèR ev Zworcœvn wbtv`ŋ fte eŋŋ Kiv hvqN



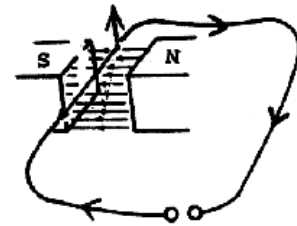
- $P\hat{a}^tKi$  tgi "k<sup>3</sup> eᎡᎡ Kti |
- $P\hat{a}^tKtK$  ev Zvi KĒj x<sup>3</sup>K `Z Avbv-tbl qv Kti |
- Zvi KĒj xi cvK ev tctPi msL<sup>3</sup>v eᎡᎡ Kti |

## 12.7 | Zwor cēvnx Zvtii Dci $P\hat{a}^tKi$ cēve

### Effect of magnet on current carrying wire

Avgiv Rwb th, Zwoevnx Zvi w<sup>3</sup>R<sup>3</sup> GKw tPš<sup>3</sup> Kt<sup>3</sup> t<sup>3</sup> i m<sup>3</sup> Kti | k<sup>3</sup> k<sup>3</sup> vjx  $P\hat{a}^tKi$  wecixZ tgi "0tqi gta" m<sup>3</sup> tPš<sup>3</sup> Kt<sup>3</sup> t<sup>3</sup> Ges Zwoevnx Zvtii tPš<sup>3</sup> Kt<sup>3</sup> t<sup>3</sup> i gta" w<sup>3</sup>qv-cōZw<sup>3</sup>qv NtU |

tZvgv<sup>3</sup> i w<sup>3</sup> K GB w<sup>3</sup>qv cōZw<sup>3</sup>qv tZvgv<sup>3</sup> i t<sup>3</sup> L<sup>3</sup> Z cvtib | tZvgiv w<sup>3</sup> tR ev w<sup>3</sup> Kti m<sup>3</sup> vqZvq GUv Kti t<sup>3</sup> L<sup>3</sup> Z cvi | w<sup>3</sup> t<sup>3</sup> i gZ Kti GKw k<sup>3</sup> k<sup>3</sup> vjx  $P\hat{a}^tKi$  `β cōš<sup>3</sup> gta" GKw Zwoevnx ZvtiK ivL | GB Zvtii ga" w<sup>3</sup> t<sup>3</sup> Zwor cēvnx Ki | t<sup>3</sup> L<sup>3</sup> te Gw Dctii w<sup>3</sup> t<sup>3</sup> K jwdtq DVte | Gi dtj tevSv hvq th, GKw ej Gi Dci KvR Kt<sup>3</sup> Q | GB ej tK<sup>3</sup> v t<sup>3</sup> K Gj?



w<sup>3</sup> t<sup>3</sup> : 12.6: w<sup>3</sup> g<sup>3</sup> f<sup>3</sup> v<sup>3</sup> t<sup>3</sup> R Zwor Drm

Zvg hw<sup>3</sup> w<sup>3</sup> t<sup>3</sup> : 12.7 (K) Gi w<sup>3</sup> t<sup>3</sup> K ZvKv Zvntj  $P\hat{a}^tKi$  tgi "0tqi ga" eZ<sup>3</sup> ejtiLv<sup>3</sup> t<sup>3</sup> L<sup>3</sup> Z cvte | Zwor cēvni `i<sup>3</sup> Y m<sup>3</sup> tPš<sup>3</sup> Kt<sup>3</sup> t<sup>3</sup> i t<sup>3</sup> L<sup>3</sup> v<sup>3</sup> ntq<sup>3</sup> Q | `βw<sup>3</sup> t<sup>3</sup> i mgš<sup>3</sup> t<sup>3</sup> m<sup>3</sup> ejtiLv<sup>3</sup> t<sup>3</sup> 12.7 (L)-t<sup>3</sup> L<sup>3</sup> v<sup>3</sup> ntq<sup>3</sup> Q | Zvtii w<sup>3</sup> t<sup>3</sup> P Zvtii Dctii t<sup>3</sup> t<sup>3</sup> q ejtiLv<sup>3</sup> t<sup>3</sup> w<sup>3</sup> | Gi KvY ntjv Df<sup>3</sup> q t<sup>3</sup> i GK<sup>3</sup> B Awf<sup>3</sup> g<sup>3</sup> L w<sup>3</sup> qv Ki<sup>3</sup> Q | [w<sup>3</sup> t<sup>3</sup> : 12.7 (K) Avei t<sup>3</sup> L] | Zvtii Dcti t<sup>3</sup> i t<sup>3</sup> q ci<sup>3</sup> ū<sup>3</sup> t<sup>3</sup> i w<sup>3</sup> tiw<sup>3</sup> aZv Ki<sup>3</sup> Q, Kt<sup>3</sup> qKw ejtiLv<sup>3</sup> Gt<sup>3</sup> K Acit<sup>3</sup> K ewZj Kti w<sup>3</sup> t<sup>3</sup> Q dtj tmL<sup>3</sup> v<sup>3</sup> tiLvi msL<sup>3</sup> v Kg | th<sup>3</sup> nZ<sup>3</sup> tiLv<sup>3</sup> t<sup>3</sup> i ci<sup>3</sup> ū<sup>3</sup> it<sup>3</sup> K Uvb Uvb ivL<sup>3</sup> Z P<sup>3</sup> vq (w<sup>3</sup> w<sup>3</sup> v<sup>3</sup> cK ievi e<sup>3</sup> v<sup>3</sup> ū<sup>3</sup> i gZ) Zviv Zvtii Dci Ea<sup>3</sup> g<sup>3</sup> L ej cōq<sup>3</sup> M Kti,



w<sup>3</sup> t<sup>3</sup> : 12.7 (K)



w<sup>3</sup> t<sup>3</sup> : 12.7 (L)

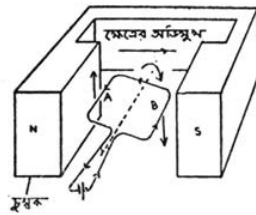
Zviv g<sup>3</sup> Ae<sup>3</sup> v<sup>3</sup> v<sup>3</sup> Ktj Dctii w<sup>3</sup> t<sup>3</sup> K jwdtq I t<sup>3</sup> v | Zwor cēvni Awf<sup>3</sup> g<sup>3</sup> L wecixZ Kiv ntj tm t<sup>3</sup> i t<sup>3</sup> Zviv w<sup>3</sup> t<sup>3</sup> Pi w<sup>3</sup> t<sup>3</sup> K hvte |

## 12.8 | tgvUi ev Zwor tgvUi

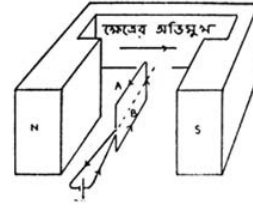
### Electric motor

aiv hvK  $P\hat{a}^tKi$  tgi "0tqi gta" GKw Uvb Uvb Zvi e<sup>3</sup> envi bv Kti w<sup>3</sup> t<sup>3</sup> : 12.8 (K) Gi gtZv Avgiv Zvtii GKw j<sup>3</sup> ev KĒj x e<sup>3</sup> envi Kiv ntjv | th<sup>3</sup> nZ<sup>3</sup> j<sup>3</sup> w<sup>3</sup> A t<sup>3</sup> K tetK B t<sup>3</sup> Z wecixZ Awf<sup>3</sup> g<sup>3</sup> L ntq w<sup>3</sup> dti Gt<sup>3</sup> m<sup>3</sup> Q, j<sup>3</sup> fci `β A<sup>3</sup> t<sup>3</sup> Kti gta" (hZ<sup>3</sup> t<sup>3</sup> Y ch<sup>3</sup> s- $P\hat{a}^tKi$  w<sup>3</sup> Av<sup>3</sup> Q) ci<sup>3</sup> ū<sup>3</sup> t<sup>3</sup> i wecixZ g<sup>3</sup> L Zwor cēvnx nte | m<sup>3</sup> Ziv A t<sup>3</sup> Zviv Dctii w<sup>3</sup> t<sup>3</sup> K DVte Ges B t<sup>3</sup> Z Zviv w<sup>3</sup> t<sup>3</sup> Pi w<sup>3</sup> t<sup>3</sup> K bvgte | Gi dtj Zviv w<sup>3</sup> i Yvet<sup>3</sup> Z<sup>3</sup> (N<sup>3</sup> woi KvUvi gtZv) Nj<sup>3</sup> te | w<sup>3</sup> t<sup>3</sup> : 12.8 (L)-Gi gZ Zviv hLb Luov Ae<sup>3</sup> v<sup>3</sup> v<sup>3</sup> Kte ZLb Gi Dci tK<sup>3</sup> v<sup>3</sup> v<sup>3</sup> ej w<sup>3</sup> qv Ki<sup>3</sup> te

bv| dtj GwU t\_tg hvte| jpcUtk NYŋqgvb ivLvi Rb` Avgiv Kg-tUU i bigK GKwU tKškj (Device) e`envi Kie| GwU mgvb `ß Astk wef<sup>3</sup> GKwU Zvgvi ejq ev AvsU (wPÎ 12.9 t`L)-Gi cŋZ`K AašK Ktqj i GKwU cŋšt mvt\_ mshy<sup>3</sup> \_vtK (h\_vptg A I B tZ)| wef<sup>3</sup> ejtqi evBti i cŋšU GKwU mÿp Kveŋ eŋki Øviv Zwor Drtmi mvt\_ ms`uk`-vcb Kti| wef<sup>3</sup> ejqU Ktqj i mvt\_ Nti Ges hLb Gi `ß AašKi ga`Kvi duK Kveŋ eŋki weciXZ \_vtK ZLb tKvbtv Zwor cŋwvZ nte bv| wKš` Zv mtZi| Gi NYŋ MwZi RoZvi KviY NYŋ Ae`vNZ \_vKte Ges cpiq eŋki ms`uk`Gtj NYŋbi Rb` bZpfvte ej jvf Kite| Gfvte NYŋ Awei Z Pj tZ \_vKte|



wPÎ 12.8 (K)



wPÎ 12.8 (L)

jYxq th, hw` I A I B Zvt` i `vb cwieZŋ Kti tQ KgjtUU i Kvti>Uw AvtMi gZB jŋci Wwb cŋš-w` tQ cŋek Kite Ges evg cŋš-w` tQ tmetq hvte| (wPÎ 12.9 t`L) Ges Ktqj wU `wYvteZB Nj tZ \_vKte| GwUB `e`jwZK tgvUti i KvŋŋwZ| `e`jwZK tgvUti Zwor kw<sup>3</sup> hws`K kw<sup>3</sup> tZ cwievZ nq| Gi `wZ I YlgZv eŋvi Rb` tPš`K tŋt i cŋej` evotZ nte|

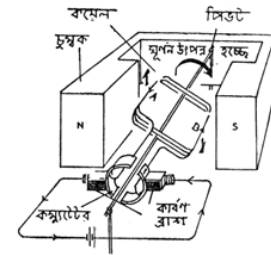
tPš`K tŋt i cŋej` wewfbvte evotbv thtZ citi| tm,tjv ntjvŋ

Ŋ Zworcŋv eŋvi Kti

Ŋ Ktqj jpc ev tŋPi msL`v eŋvi Kti

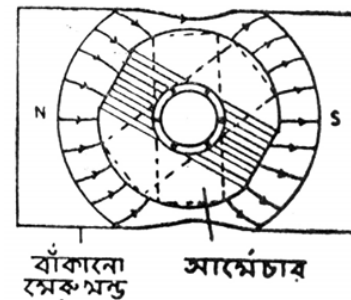
Ŋ AwaKZi kw<sup>3</sup>kvjx Pš`K ev AwaK msL`K tŋPwŋkŌ Zwor Pš`K e`envi Kti

Ŋ Ktqj i `N` I tea ewotq



wPÎ : 12.9

th `e`jwZK tgvUi Avgiv e`envi Kw i Zv GB bxwZtZ KvR Kti| wKš` Gt` i YlgZv I tNvivi gmYZv eŋvi Rb` GtZ AwZwi<sup>3</sup> Dcisk thwM KitiZ nq| GKgvŋ GKwU Ktqj ev GKwU jŋci cwieZ`AšbK,tjv Ktqj ev jpc `Zwi Kiv nq Ges tK>`ŋq Ašŋi Pviw`K Zvt` i tK eŋvKti mvrvtbv nq| Gt` i cŋZ`KwU tK Zvi wR wR KgjtUU i mvt\_ mshy<sup>3</sup> Kiv nq| GwU wbiev`Qbŋel gmYfvte Pj tZ mnvqZv cŋvb Kti|



বাঁকানো স্ক্রু মন্ড আর্মেচার

wPÎ : 12.10

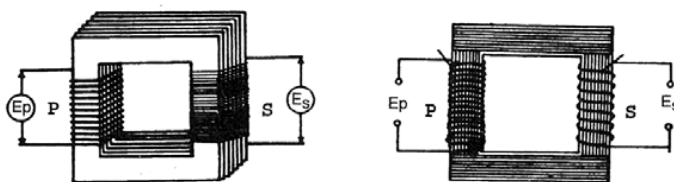
cŋZwU Ktqj big tjvvi UKivi (hv`K AvtgPvi ejv nq) Dci Zvti i kZ kZ tŋP w` tQ `Zwi| Gi dtj Zwor cŋwvZ nq qvi mgq AvtgPviwU Pš`KwqZ nq Ges tPš`K tŋt i cŋej` eŋvi Kti| wPÎ 12.10 tZ wZbwU



1. Ařivnx ev ř÷c Ávc UřÝdgř (Step up Transformer) : řh UřÝdgř Ář řefřei ÁwáK Zřor cěvřřK ÁwáK řefřei Ář Zřorcěvřř řűcřřř Z Křř ZřřK Ařivnx ev ř÷c Ávc UřÝdgř etj |

2. Aetivnx ev ř÷c WřDb UřÝdgř (Step down Transformer): řh UřÝdgř ÁwáK řefřei Ář ZřorcěvřřK Ář řefřei ÁwáK Zřor cěvřř řűcřřř Z Křř ZřřK Aetivnx ev ř÷c WřDb UřÝdgř etj |

UřÝdgřřř MVB : GKřU Křřř řjřvř ÁvřZřřKřř gřřv ev řKřř řbl qv řq | Gi ci řűi řecřřZ řB evřřZ Ářřřř Zřř řcřřřř UřÝdgřř řZřř Křř řq [řPř 12.12] | ÁřřZřřKřř gřřvř GK evřř KĚjřřZ cřřřřřř cěvřř ev řefřei cřřřř Křř řq, Gřř gřř KĚjř etj | Áci řh řecřřZ evřř KĚjřřZ cřřřřřř řefřei Áwěó řq ZřřK řMSY KĚjř etj | Ařivnx ev ř÷c Ávc UřÝdgřřř gřř KĚjřř řPřř řMSY KĚjřřZ Zřřřř cřřK řsLřř řewK řřřK | Aetivnx ev ř÷c WřDb UřÝdgřřř gřř KĚjřř řPřř řMSY KĚjřř Zřřřř cřřK řsLřř Kg řřřK |



řPř : 12.12 (K) Dřřřřř UřÝdgřř

řPř : 12.12 (L) řbgřřřř UřÝdgřř

Gřb Ki řKřřřř UřÝdgřřřř  $n_p$  řcř řewKó gřř KĚjřřZ  $E_p$  cřřřřř řefřei cřřřř Křřř řřj GB KĚjřřZ  $I_p$  cěvř cřř qv řřj | GB cěvř gřřřřřřř Přřřřř Křř řPřřřř ejřřřř řv řrcbřKřř řv gřř KĚjřřZ GKřU Áwěó řřřřř ev Zřřřřř K řűřř řrcbřKřř | řPřřřř ejřřřř řv řKřřř řřřř řv řq Zřřřř řMSY KĚjřřř cřř cřřKř GKb řsLřř ejřřřř řv řmřřř řř | řřj řMSY KĚjřřZ řřřřř ev Zřřřřř K řűřř Áwěó řř | řMSY KĚjřřř cřřK řsLřř  $n_s$  Ges řMSY KĚjřřZ Áwěó řřřřř ev Zřřřřř K řűřř  $E_s$  řřj gřř | řMSY KĚjřřř řřřřř ř Zřřřř cřřKřsLřřř řűřřřřř,

$$\frac{E_p}{E_s} = \frac{n_p}{n_s} \quad (12.1)$$

řLb  $n_s > n_p$ , ZLb UřÝdgřřřř Ařivnx ev ř÷c Ávc UřÝdgřřř Ges řLb  $n_s < n_p$ , ZLb UřÝdgřřřř Aetivnx ev ř÷c WřDb UřÝdgřřř | řKřřřř řřřřřřř Ácřřř řv řUřřř gřř KĚjřřř cřřř řKř řřřřř řMSY KĚjřřřř řřřřř řř | řZřřřř, gřř Křřřřř řřřřřřř  $\times$  gřř Křřřřřř Zřorcěvřř = řMSY Křřřřř řřřřřřř  $\times$  řMSY Křřřřřřř Zřorcěvřř

$$A_{řř} E_p I_p = E_s I_s$$

$$\frac{E_p}{E_s} = \frac{I_s}{I_p}$$

Gi ÁřGB řh, řKřřřř UřÝdgřřř řh řřř řřřřřřř Kgřř řK řm řřř Zřor cěvřř evřř Křř řřřř řřřřřř cřř gřř řgřř ev řř řřř | řZřřřř UřÝdgřřř řřřřřřř ř Zřor cěvřř řřřřřřř řűřřřř Křř |



## Abkxj bx

K. eũbeŋPbx cġæ

mũVK DĒt̄i i cġk wJK (✓) wPṣ `vl :

1 | tKv̄bv tPv̄0i Dci Aš+xZ Zvi tcv̄tq mwj b̄tqW `Zwi K̄ti Zv̄tZ Zworcēvn Pvj v̄tj tPṣ^K̄t̄ŋt̄i i Kx NUt̄e?

(K) NbrfZ I `p̄ n̄te

(L) NbrfZ I kw̄³kvj x n̄te

(M) Kg NbrfZ I `p̄ n̄te

(N) Kg NbrfZ wKš' kw̄³kvj x n̄te

2 | tKv̄bwl̄i Kv̄hēvj x̄tZ ZwoZt̄Pṣ^K Av̄tek̄tK e`envi Kiv nq ?

(K) Uv̄bwR ÷ i

(L) tgv̄Ūi

(M) A`vgw̄c̄p̄v̄q̄i

(N) Uv̄Ydḡŋ

3 | tKvb c̄q̄uq̄ ev Kv̄h̄vi vq Zwo`Pvj Kkw̄³ Drcb̄enq Ñ

(i) tKv̄bv Zvi KĒj xi w̄fZi tKv̄bv Pṣ^K w̄' i Ae`vq i vL̄t̄j

(ii) tKv̄bv tPṣ^K̄t̄ŋt̄i tKv̄bv Zvi KĒj x Njv̄tj

(iii) tKv̄bv w̄' i Zvi KĒj xi Pvi w̄ tK tKv̄bv Pṣ^K Njv̄tj

wb̄t̄Pi tKv̄bwl̄i m̄ũVK?

(K) i

(L) ii

(M) i I ii

(N) ii I iii

tKv̄bv Zvi KĒj xi w̄fZi GKw̄U `Ê Pṣ^K Av̄bv-̄tbl qv Kiv nt̄"Q | ḠtZ Zvi KĒj x̄tZ t̄fv̄t̄R Aweó nt̄"Q |  
Aweó t̄fv̄t̄R K̄t̄q̄Kw̄U w̄el̄t̄qi Dci w̄bf̄P̄ K̄ti | Gevi w̄b̄t̄Pi 4 I 5 b̄x̄'i c̄ġk̄e Reve `vl |

4 | ZwoZt̄Pṣ^K Av̄tēt̄ki tejvq Aweó t̄fv̄t̄R tKv̄bwl̄i Dci w̄bf̄P̄ K̄ti ?

(i) Zvi KĒj xi m̄v̄t̄\_ m̄s̄k̄ō tPṣ^K̄t̄ŋt̄i c̄ġej`

(ii) tPṣ^K̄t̄ŋt̄i Av̄bv-̄tbl qv Kiv Zvi KĒj xi t̄iva

(iii) tPṣ^K̄t̄ŋt̄i Av̄bv-̄tbl qv Kiv Zvi KĒj xi `w̄Z

wb̄t̄Pi tKv̄bwl̄i m̄ũVK?

(K) i

(L) ii

(M) i I ii

(N) ii I iii

5 | Zvi KĒj i c̄v̄t̄Ki m̄sL`v ev̄v̄t̄j Aweó Zworcēv̄ni Kx NUt̄e?

(K) Zworcēvn K̄t̄g h̄t̄e

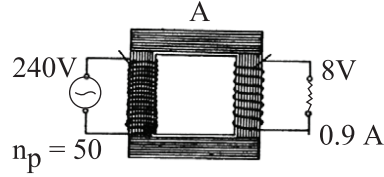
(L) Zworcēvn t̄ēto h̄t̄e

(M) Zworcēv̄ni ḡvb k̄b` n̄te

(N) Zworcēv̄ni ḡvb FYv̄Z̄K n̄te

## খ. সৃজনশীল প্রশ্ন

১। চিত্রটি দেখে নিচের প্রশ্নগুলোর উত্তর দাও।



- (ক) এই যন্ত্রে A চিহ্নিত বস্তুটির নাম কী?  
 (খ) যন্ত্রটি যে নীতি বা ঘটনার উপর তৈরি তা ব্যাখ্যা কর।  
 (গ) এই যন্ত্রের মুখ্য কুণ্ডলীতে তড়িৎ প্রবাহ মাত্রা নির্ণয় কর।  
 (ঘ) উপাত্তের আলোকে যন্ত্রটির ক্রিয়া গাণিতিকভাবে ব্যাখ্যা কর।

## গ. সাধারণ প্রশ্ন

- ১। তড়িৎপ্রবাহের চৌম্বক ক্রিয়া কী ?  
 ২। তাড়িতচুম্বক কাকে বলে? এই চুম্বক কী কী কাজে লাগে?  
 ৩। জেনারেটর কাকে বলে? জেনারেটর দিয়ে কী কাজ করা হয়?  
 ৪। জেনারেটর ও তড়িৎ মোটরের মধ্যে পার্থক্য কী ?  
 ৫। স্টেপআপ ও স্টেপডাউন ট্রান্সফর্মার দ্বারা কী কাজ করা হয় ?  
 ৬। তাড়িতচুম্বকের প্রাবল্য কীভাবে বৃদ্ধি করা যায় লিখ।  
 ৭। কোনো ট্রান্সফর্মার 240V এসি উৎসের সংযুক্ত আছে। এর মুখ্য ও গৌণকুণ্ডলীর পাক সংখ্যা যথাক্রমে 1000 ও 50। এর গৌণকুণ্ডলীর ভোল্টেজ কত?





## 13.1 | tZRw®EqZv

**Radioactivity**

divmx weÁvbx tnbix teKtjij (Henry Becquerel) 1896 mvtj t`LtZ cvb th, BDtiwbqvg avZi wBDKxqym t\_tK ^ZtùZvte wekl tf`bkw³ mæubæwKiY Aweiz wBMZ nq| teKtjij Avtiv j¶ Ktib, th tğšj t\_tK GB weuKiY wBMZ nq Zv GKwU mæuY®bZb tğšj žcvšw Z nq| GwU GKwU wBDKxq NUbv| NUbwU ^ZtùZv® Aweig NUbv Ges mæuYvte cKwZ wqwsZ| gvbe mō tKvibv eww^K cŕve thgb Pvc, Zvc, we`jr I tPšæ^K t¶¶ GB iukŕi wBMŕb eÜ KitZ ev nmejv NUVtZ cvti bv| cieZKvjtj gv`vg Kix (Madame Marie Curie, 1867-1934) I Zui ^vgx cxqvti Kix (Piree Curie, 1859-1906) GKB iKg NUbv j¶ Ktib| Zui t`LtZ cvb th, tiwvqvg, tcvtjwbqvg, t\_wi qvg, A`vKwUwbqvg, cŕvZ fvix tğšj i wBDKxqym t\_tK i GKB aitbi weuKiY wBMZ nq| GB weuKiY GLb tZRw®Eq iukŕ (Radioactive rays) bvtg cwiwPZ| tKvibv tğšj t\_tK tZRw®Eq KYv ev iukŕ wBMŕbi NUbv tK tZRw®EqZv (Radioactivity) etj| tZRw®Eq tğšj Avjdv, weUv I Mvgv bvtg wZb aitbi kw³kvjx iukŕ wBMŕb Kti| dtj Giv tftō Ab`vb` jNzi tğšj žcvšw Z nq| thgb tiwvqvg avZy tZRw®Eq fv½tbi dtj avtc avtc cwiwZŽ ntq mxmvq cwiYZ nq| tZRw®EqZv cwi gvtci Rb` th GKK e`envi Kiv nq Zvi bvg teKtjij |

## 13.2 | Avjdv KYv, weUv KYv I Mvgv iukŕi ^enkó`

**Properties of alpha, beta and gamma rays**

Avjdv KYv : AvjdvKYv ntjv GKwU wvjqvg wBDKxqym| Gi wBDKxqvfm itqtō `jU tčÜb I `jU wBDUb| AvjdvKYvi tf`b ¶lgZv Kg, 6 cm evZvm tf` Kti thtZ cvti bv| GB KYv tPšæ^K I Zwor t¶¶ Øviv cŕweZ nq| GB KYv Zxe³ Avqbvqb mō KiZ cvti Ges gvivZK ¶wZKi I wec`RbK| Gi fi nvBtWtRb cigvYj Pvi `Y Ges Avavb  $3.2 \times 10^{19} \text{C}$ | dtUwMndK wdjŕ, KvDW tPæ`vi, ^YevZ Zwor ex¶Y htšzi mrvtth` Gi Dcw`wZ wbyŕ Kiv hvq| GB KYv wR¼ mjdvwBW c`ŕ cŕZcŕv mō Kti| Gi tem Avtjvi teŕMi kZKiv 10 fW|

weUv KYv: GB KYv FYvZK Avavbhy³ Ges tPšæ^K I ZwoZ t¶¶ Øviv AtbK tenk wev¶ŕ nq| Gi `jZ Avtjvi `jZi kZKiv 50 fW Zte kZKiv 98 fW chš– ntZ cvti| Gi fi BtjKUti mgvb A\_ŕ  $9.11 \times 10^{-31} \text{ kg}$ | dtUwMndK wdjŕ I KvDW tPæ`vi w`tq Gi Dcw`wZ wbyŕ Kiv hvq| GB KYv cŕZcŕv mō KiZ cvti| Gi tf`b ¶lgZv Avjdv KYv tPtq tenk| Gi Mw 3 mm cjiyA`vjywbqvg cvZ Øviv \_wgtq t` I qv hvq| weUvKYv M`vfm ht\_ō Avqbvqb mō KiZ cvti |

Mvgv iukŕ: GB iukŕ Avavb wbič¶¶ GKwU ZwoZ tPšæ^K Zi ½| ^ŕ% N° Zi ½ weukó| Gi tKvibv fi tbB| GB iukŕ Zwor I tPšæ^K t¶¶ Øviv wePiZ nq bv| Gi `jZ Avtjvi mgvb A\_ŕ  $3 \times 10^8 \text{ ms}^{-1}$ | GB iukŕi tf`b ¶lgZv AtbK tenk| GwU tek KtqK tmwUgUvi cijmxmvi cvZ tf` Kti thtZ cvti| `ŕŕ Avqbvqb ¶lgZv mæubmjtj I GB iukŕ cŕZcŕv mō KiZ cvti| dtUwMndK wdjŕ, KvDW tPæ`vi I MvBwK gjvi KvDvvi w`tq Gi Dcw`wZ wbyŕ Kiv hvq|







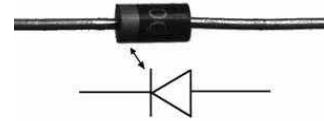
AwaK `tZj mstKZ tçtYi Rb` wWvRUvj mstKZ DËg| KviY `tZj tenk ntj GbvjM mstKtZi ¶lgZv axti axti KgñZ \_vñK| GñK ewPñq ivLñZ çpweaB KiñZ nq| wKš' GñZ bñqR tetò hvq dtj mstKtZi gvb nwm çvq ev mstKZ weKZ nq Ges GK mgq nwiñq| thñZ çvñi || wKš' wWvRUvj wñMb`vj thñZ thñZ weewaZ nq| dtj mstKZ GKB iKg \_vñK| AcñUK`vj dvBevi Øviv mstKZ tçtYi wWvRUvj mstKZ e`envi Kiv nq| KviY meñki mstKZñi I DËg \_YMZ gvb eRvq \_vñK| GQvov cñZ tmñKtñÙ AñbK tenk mstKZ tçtYi Kiv hvq| GbvjM wWfvBñmi tPñq wWvRUvj wWfvBm e`qeñj ntj I wWvRUvj mñwññmi tejvq meñtgZ e`q Kg| GbvjM wWfvBñm µm KvñbKkb ññZ çvñi, wWvRUñj Zv nq bv|

### 13.8| Aaewi evnx I mgñš^Z eZBx

#### Semiconductor and integrated circuit

Aaewi evnx: wKQz wKQz c`v\_° (thgb wñwj Kb I Rvñgñbqv) AvñQ thñjv mñwi evnx bq, AšñKI bq| Gñ`i ejv nq Aaewi evnx| weññ Aaewi evnx kñZj Ae`vq AšññKi gñZv KvR Kñi Ges `vñweK K¶ñZvcgñvq Lp mgvñb` cñi evnx| wKš' wKQz wñw`ó Ab` c`v\_°Gi mññ thñM Kñi Gi cñi ewñZv evovñbv hvq| tKvñbv c`v\_°thñM Kiv ññqñQ Zvi wñññññZ Aaewi evnxñK n- UvBc I p- UvBc wñmññe fñM Kiv nq| wñwj Kñbi mññ dmdivm thñM Kñi `Zwi Aaewi evnx ññjv n- UvBc Aaewi evnxñi GKñU D`vñiY| dmdivm cigvYj Dcñ`wZ GñZ FYvZñK Bñj KUñbi mñL`v ewññ Kñi hv c`v\_° gññ gññ fññe PjvPj KiñZ çvñi |

wñwj Kñbi mññ ñevib thñM Kñi `Zwi Aaewi evnx ññjv p- UvBc Aaewi evnxñi GKñU D`vñiY| ñevib cigvYj Bñj KUñb Kvññgñi gññ dvñK ev abvZñK ññvj `Zwi Kñi | Bñj KUñb GK ññvj tññK Ab` ññññ jwñññq jwñññq c`v\_° gññ PjvPj Kñi |

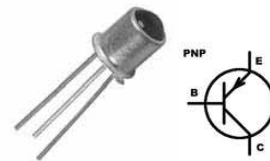


hñ` p- UvBc c`v\_° mññ n- UvBc Aaewi evnxñi tñvov jwñññbv nq Zvññj GKñU AñZ cñqvRbñq wWfvBm `Zwi nq hvñK p- n Rskb WññqW etj | GñU ti KñUdvñi ev GKgñL Kvi K wñmññe KvR Kñi |

¶Pñ 13.4: WññqW I Gi cñZñK wPñ

WññqW ZñvrcñvññK GKgñL Kñi A\_ñ WññqW w`K cñi eZñZñvrcñvññ (Gñm) tñK GKgñL Zñvrcñvññ (wñm) ññcñññ Z Kñi |

wññfññKvññR Zñvrcñvññ I tñññññ weeañbi cñqvRb nq| G KvññU th hññ Kñi Zvi bñv A`wñññdvñi | UñbñR ÷vi ññjv GKñU wWfvBm hv A`vññcñvñi I D`P `ññ mññP wñmññe KvR Kñi | `ñU n- UvBc Aaewi evnxñi gññS GKñU p- UvBc Aaewi evnx m`ññññPñi gññZv tñvov jwñññq UñbñR ÷vi `Zwi Kiv nq| Gi wZbñU `ññññ ejv nq mñMññK (collector), fñg (base) I wñtmñi K (emitter)| n- UvBc Añj ññjv UñbñR ÷vñi i mñMññK I wñtmñi K Ges mñ` p- UvBc Añj ññjv fñg|



¶Pñ 13.5: UñbñR ÷vi I Gi cñZñK wPñ



G ZmoZ AwWI mstKZtK weewaZ Kti tUwjtdvb jvBb ev tiwWI i gva`tg AtbK `fi cWtbn hvq| mZivs wUwf Ges tiwWI mæcPvi, tiKwS I tUwjtdvbi tŕŕt gvBtµvtdvb AZ`S, iZcy©FwgKv cjb Kti |

ŕuxKvi (Speaker) : ŕuxKvi gvBtµvtdvbi wK wecixZ KvRW Kti | ŕuxKvi gvBtµvtdvbi Zwor mstKZtK Abŕc kŕã ŕcviSŕi Z Kti |



wPŕ t 13.7 t ŕuxKvi i ewn`K ŕc

ŕuxKvi i Kvhpŕg t AwKvsk jvDWŕuxKvi ntjv Pj KÊjx jvDWŕuxKvi | GtZ \_vK

1. tejbvKwZi GKw ŕ`vqx Pæ^K hv GKw kw³kvj x tP\$æ^Ktŕŕt `Zwi Kti |
2. GKw tQv Ktqj ev Zvi KÊjx Sjvbn \_vK | GB Zvi KÊjx tP\$æ^Ktŕŕi gŕa` gŕfivte AMŕcŕv `jtZ cvti |
3. Zvi KÊjxi mvŕ\_ k¼AvKwZi KwMR (a paper cone) jvMvbn \_vK |

hLb kã t\_tK `Zwi cieZP Zworcŕv G Zvi KÊjx w`tq cŕwnZ nq, ZLb Zvi KÊjxw AMŕcŕv hvlqv Avmv Kti | GtZ KwMŕi k¼w KwúZ nq|dtj kŕã mŕo nq|

13.10|Z\_ I thvMvthvM cŕy³

Z\_ I thvMvthvM cŕy³ GLb LpB cwiwPZ I Rbwcŕ wŕq| Avgv`i `bw`b Rŕetbi maviY KvR t\_tK iiy Kti tckwZ Rŕetbi AtbK iZcy©KvR Z\_ cŕy³ e`envi Kti mntRB Kitz cwi | wesk kZK Ges GKwes kZtKi cŕi tægvbŕi KvhpŕgK metPŕq tewk cŕweZ Kti tQ thvMvthvM | Dbwes kZtK tUwjtdvb I tUwj Mŕdi weKv Dbŕŕb gvbtŕi thvMvthvM ŕgZv Avi I GKavc GwMŕq tMŕQ | wesk kZtK thvMvthvMi wecŕ GtŕQ tiwWI, tUwjwŕfb, tmjtdvb, d`v tŕwb|Gme e`e`vi ci thvMvthvMi tŕŕt metPŕq tewk Ae`vb ti tLŕQ KwúDUvi I BŕvibtU |

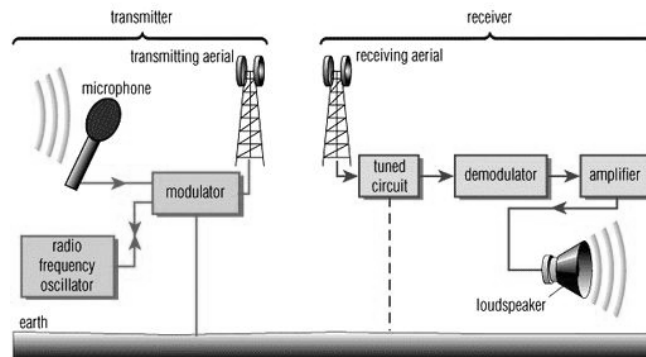
tiwWI t tiwWI wetb`b I thvMvthvMi GKw e`vcK I iZcy© gva`g|tiwWI tZ Avgiv Lei, Mvb evRbv, bvUK, AvtjvPbv weZK©Ges ctY`i weÁvcb i`btZ cvB | tmbvewnbx I cŕj kewnbxZ Z\_ Av`vb cŕvbi Rb` tiwWI e`envi Kiv nq | tŕevBj ev tmjjvi tUwjtdvb thvMvthvM tiwWI e`eüZ nq | tiwWI Awe<vŕi thme weÁvbx Ae`vb ti tLŕQb, Zviv ntjb BZwji iMwtqŕgv gvKŕ I evsjv`tki wepŕcŕi m`vi RM`xk P>`emy |



wPŕ 13.8: tiwWI

tiwWI tZ Avgiv kã i`btZ cvB | G kã Kxfvte tŕi Z nq Ges KxfvteB ev Avgiv i`btZ cvB? tKvbn teZvi mæcPvi t÷kŕbi ÷wWI tZ tKvbn e`w³ gvBtµvtdvbi mvgŕb K\_v etjb | gvBtµvtdvb H kãtK

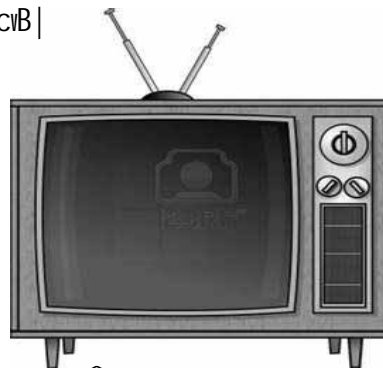
ZworZi½ ʒcŕšw Z Kti | G Zi½i bvg Awl mstKZ | G mstKZi Kúv¼ ev kw³ LpB Kg, 20 nVR® t\_½K 20000 nVR® G Zi½ tenk `i th½Z cvti bv | Z\_ enbKvix Kg Kúv¼i G Zi½K ZvB GK cKvi D"P Kúv¼ weikó ZwóZ½PŠ^K Zi½i mv\_ wgnkZ Kiv nq | D"P Kúv¼ weikó GB Zi½K evnK Zi½ etj | wgnkZ Zi½K ejv nq gWtj tUW ev ʒcŕiwcZ Zi½ | G `ß Zi½i wgtYi cŕuqvk ejv nq gWtj kb | ʒcŕiwcZ Zi½K teZvi Zi½i ejv nq | teZvi Zi½K A'vgncplvqti weenaZ Kti tčK hšZi GtUbvi mrvth" ZwóZ½PŠ^K Zi½ wmvte i'ib" (Space) tčY Kti | G teZvi Zi½ i'ib" Qwotq cto Ges fwg Zi½ (Ground wave) | AvKv Zi½ (Sky wave) bvtg `ß aitYi Zi½ fW nq | fwg Zi½ mivmwi MhK hšZi Gwtqtj tčQvq | Avgv`i Nti th tiwli tmUw v½K Zvtjv MhKhšZ | AvKv Zi½ AvgbgE½ cZdwj Z ntq cW\_extZ wdti Avtm Ges MhKhšZi Gwtqtj aiv cto | MhKhšZ teZvi Zi½K MhY Kti GtK Zworcŕtn ʒcŕšw Z Kti | Gici wv-gWtj kb ev weʒcŕiwcY cŕuqvk evnK Zi½ ntZ kã Avjv`v Kti tblqv nq | AZtci A'vgncplvqti mrvth" ZworcŕntK weenaZ Kti Ges jvDW`úKv tčY Kti | jvDW`úKv Zwor cŕntK cpivq ktã ʒcŕšw Z Kti | G kã Avgiv i'btZ cB |



wPŦ 13.9: tiwli mæcŕvi | MhY cŕuqv

myZivs, tiwli tZ tčK hšZ t\_½K kã tčY Kiv nq bv | kã Zi½K ZwóZ½PŠ^K Zi½ ʒcŕšw Z Kti cWv½bv nq, MhKhšZ teZvi Zi½ MhY Kti jvDW`úKv GtK ktã ʒcŕšw Z Kti |

tUwj wfkb: tUwj wfkb ntjv Ggb GKw hšZ hvi mrvth" Avgiv `ieZ½tKv½v `vb t\_½K kã tkvbi m½ e³vi Qwe tUwj wfkb i c`ŕq t`L½Z cB |

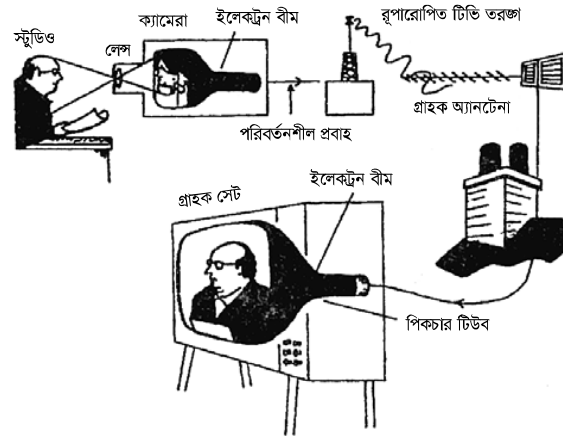


wPŦ 13.10 : tUwj wfkb



jwR teqW<sup>১৯২৬</sup> মত্জ tUwj wfkþb wPÎ tçðY mŕlg nb | tmw`bKvi wUwf wkíx wQj GKwU K\_v ejv cZj |

tUwj wfkþb Kx Kti Kiv Kti : Avgiv Rwb, tUwj wfkþb Qwe t`Lvi mŕ\_ mŕ\_ kâI tkbv hvq | tUwj wfkþb kâ I Qwe tçðYi Rb` tçðK t÷kþb \_vŕK c\_K c\_K tçðK hš, hvi mŕvth` ZwoZtPŠ`K Zi ½rûc kâ I Qwe tçðY Kiv nq |



wPÎ 13.10 : tUwj wfkþb mŕvPvi cŕuqv

GKwU tçðK hš, i mŕvth` Qwe tK Zwor mŕKtZ rûcšw Z Kti tçðY Kiv nq | Ab` GKwU tçðK hš, i mŕvth` Qwe tK ZwormŕKtZ rûcšw Z Kti Zi ZwoZtPŠ`K Zi ½ wntmte tçðY Kiv nq | cŕtg Qwe tçðY I MŕthYi K\_vB ejv hvK | th Qwe ev`k` tçðY KitiZ nte Zi tUwj wfkþb K`vŕgiv ZwoZ mŕKtZ rûcšw Z Kti | G mŕKtZ K gWtjkb cŕuqv D`P K`vŕt¼i evnK Zi t½i mŕ\_ wŕkZ Kiv nq | cti GtUvbi mŕvth` ZwoZtPŠ`K teZvi Zi ½ wntmte tçðY Kiv nq |

GtUvbi mŕvth` wUwf tmU Qwe i Rb` tçðZ ZwoZtPŠ`K evnK Zi ½ MŕthY Kti | ti KtUdvqi evnK Zi ½ t\_ŕK wŕwI Zwor mŕKtZ K c\_K Kti | weeaŕKi mŕvth` G Zwor mŕKtZ K weeaZ Kiv nq Ges Btj KUbMvþb Zi cŕvb Kiv nq | wUwfi wckPvi wUĐtei wQŕbi cŕš-Btj KUb Mvb mshŕ \_vŕK | wŕwI mŕKtZ MŕthYi ci Btj KUbMvb mŕtqi b`vq miy Btj KUb exg QŕtZ \_vŕK | wUwfi c`ŕ cŕZcŕ dmdti Btj KUb Mvb t\_ŕK hLb Btj KUb exg Gtm cŕo ZLb GtZ AvtjvK SjtKi mŕo nq | G D¾j I Ab¾j AvtjvK we`j mgš`qB wUwfi c`ŕ D¾j I Ab¾j AvtjvK we`yI SjtKi mŕo nq | G D¾j I Ab¾j AvtjvK we`j mgš`qB wUwfi c`ŕ dŕU DŕV K`vŕgiv t\_ŕK cvVtþv Qwe | tUwj wfkþbi c`ŕ Dci cŕZ tmŕKtE 25wU w`i wPÎ Mvþ Kti hv Avgŕ I tPvL Pjgwb Qwe wntmte t`L |

kâ tçðY I MŕthY

tUwj wfkþb th wPÎ tçðY Kiv nte Zi mŕ\_ mŕk kâKtI gvBtŕvŕtþbi mŕvth` ZwoZ mŕKtZ rûcšw Z Kiv nq | G Zwor Zi ½tK evnK Zi ½ bŕgK GK cKvi D`P K`vŕt¼i wŕkZ ZwoZtPŠ`K Zi t½i mŕ\_ wŕkZ Kiv nq Ges tçðK hš, i mŕvth` tçðY Kiv nq |

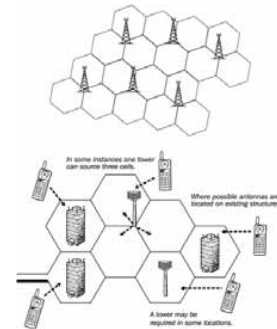
Avgiv ewotZ th tUwj wfkþb tmU e`envi Kwi ZŕZ kâ I Qwe mŕKtZ MŕthYi Rb` c\_K e`v \_vŕK | tçðK hš, KZŕ tçðZ ZwoZtPŠ`K Zi ½ Avgŕ`i wUwf tmŕUi GtUvq Avŕm Ges Zwor cŕtŕni mŕo Kti | G



bq, GB tđvđb tZvgiv tMBg tLj tZ cvi ,vgDwRK WDbtjw Ki tZ cvi , Mbo i btZ cvi , wmtbgv t`L tZ cvi Ges BđvibtU e`envi Ki tZ cvi | GQov G tđvđb K`vk tctgU, vej cwi tkva, Gqvi tcvU`PK-Bb I Ktj R ev wekte`vj tq fivZP` iLv`I Ki tZ cvi | G tđvđbi mnvđh` t`tki th tKvđbv cđš-t`K Aci th tKvđbv cđš-thvđhM Kiv hvq |

tgvevBtj Kj Kiv I Kj wimf Kiv

G tđvb wKš` cđvb Awdm ev Ab` tđvđbi mvt\_ Zvi w`tq mshjP` \_v`K bv | G ai tYi tđvb Zvtii cwi etZ`ti wvI ev teZvtii mnvđh` K\_vevZP`ev Z` tcđY I MđY Kti \_v`K | tgvevBj tđvđb tUwj tđvb tđvI qv`K mvt\_ msthvM NtU GK tgvevBj tmtUi KxtevW`\_t`K Ab` tgvevBtj Wqvj Kivi gva`tg | hLb Zvg tKvđbv tgvevBj t`\_t`K tđvb Ki Zvg thLvđbB \_v`K bv tKb Kj wU teZvi Zi ½ wmtmte tKvđbv tcđ KŇMđK UvI qvti hvq |



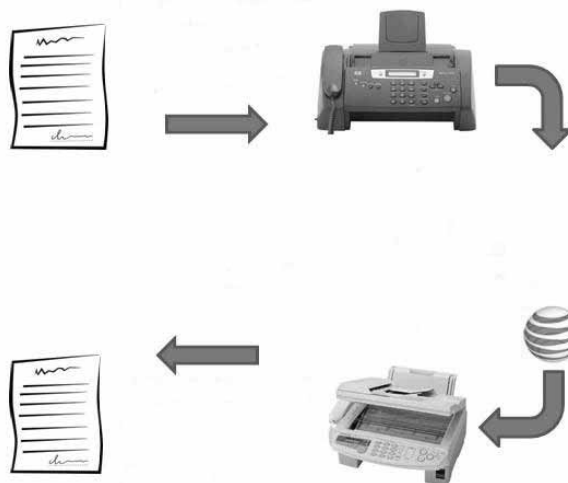
wPŦ 13.13: tgvevBj tđvI qv`K

Gici Kj wU Zvi ev gvBtđvI tqtfi gva`tg tgvevBj mBP t÷k`b hvq | G t÷kb Kj wU t`K`vbxq tUwj tđvb G` tPt`Á cvvq | tmlvđb GwU cđvj Z tđvb Kj ntq MđtKi woku tcđQvq | eZgvtb cđvj Z Awakvsk tgvevBj tđvb KvR Kti teZvi Zi ½ tcđY Ges cđvj Z tUwj tđvb mnvKđ mBvPs Gi mgš`tq |

d`v` : d`v` wj Gi msv`I bvg d`v` | tKvđbv WKtgu ũeu Kwc Kti cvv`Z d`v` e`envi Kiv nq |

d`v` Kx : d`v` ntjv Ggb GKwU Btj KUwbK e`e`v hvi gva`tg th tKvđbv Z`, Qwe, wPŦ, WqvMđg ev tj Lv ũeu Kwc Kti tcđY Kiv hvq | G htš`i mnvđh` th tKvđbv gj`wj ũeu cpi`rcv`b Kiv nq |

1842 mvtj d`v` tgvkb Awe`KZ ntjI tiwvI d`v` Gi hv`v kj` nq 1930 mvtj | weÁvbx Artj KRvŪvi teBb d`v` Awe`<vi Kti b |



wPŦ 13.14: d`v` tgvkb I Gi Kvđpg

d`v- Kxfvte KvR Kti : AvaybK d`v- tgvkb ntjv GKw AwZ DbZ cŋy³i Zwor AvtjvKxq tgvkb| GLvfb Btj KUŋbK Dcvtg gj WKtgUtk `<`wbs Kiv nq| Gici `<`vbKZ mstKZtK evBvix mstKtZ žcvšt Kiv nq| GB mstKZ ÷`vŮWŋtgvWg tKškj e`envi Kti tUwjtdvbi gva`tg tcŲY Kiv nq| MŋK d`v- tgvkb tcŲi Z Btj KUŋbK mstKZ MŋY Kti tgvWtgi mrvth` wWgWtjU Kti gj WKtgU cwiYZ Kti| GKw wŲŲvi GB gj WKtgUtk ūeu tŲtc tei Kti|

### KwŲDUvi (Computer)

G hŲ Z\_ I cŋy³i hŲ| Z\_ cŋy³ I thMvthMn RxeŲbi cŲZw tŲŲtŲ KwŲDUvii e`envi GZ tewk th G hŲtK KwŲDUvii hŲI ejv nq| Avgv`i ``bwb RxeŲbi KvRKtgŲ AŲbK wKQB KwŲDUvii e`envi Ųviv cŲfweZ ntŲQ| ŋeÁvb I cŋy³ ŋetq KwŲDUvi ntq DŲVtŲ AcwivthŲ KwŲDUvi MwywZK wnmve KiŲZ cvti, MwywZK hŲ³ w`ŲZ cvti| MwywZK wnmve Ųvovl KwŲDUvi tKvfbv wKŲzcŲ` Kiv ev wbeŲb Kiv, bKj Kiv, Zj bv Kiv, avivewKfve mrvfbv BZ`w` wvfbŲKvR KiŲZ cvti| e`env, ewYR`, cŲvmb, wKŲv, wKŲ, wŲKrmv, thMvthM, cŲZi Ųv, wvfbv b cŲwZ tŲŲtŲ KwŲDUvii cŲqM w`b w`b teŲ PŲtŲQ|

KwŲDUvi Kx

KwŲDUvi ktŲi A\_ŲMYK ev wnmveKvix| KwŲDUvi `iay GKw wnmveKvix hšZB bq, AvŲiv AŲbK wKŲ| KwŲDUvi ntjv GKw Btj KUŋbK wvfbv hv DcvE MŋY, cŲuqvKiY, žcvšt, msi ŲŲY I tcŲY Kti| th aiŲYi KwŲDUvi B tnvbv tKb, cŲZw KwŲDUvi tcŲŲgKZ wbt`R Ųviv wbvšZ nq, hv KwŲDUviiK etj t`q ZvŲK Kx KiŲZ nte ?



wŲŲ 13.16 : KwŲDUvi

KwŲDUvii Mv

KwŲDUvi GKw DbZ Btj KUŋbK e`e`v| KwŲDUvi Z\_ msMŋ Kti, mŲbw Ų wbt`R Abhvx Z\_ŲK cŲuqvRvZ Kti Ges cŲqvRbvbhvx djvdj Dc`vcb Kti| KwŲDUvi thLvfb Z\_ MŋY Kti ZvŲK ejv nq AšMŲx (Input) ev MŲYgt| GLvfb KwŲDUvii DcvE cŲvb Kiv nq| GRb` thme BbŲŲ wvfbv maviYZ e`envi Kiv nq Zvntjv Kx-ŲewŲ, gvDmUŲc`w, `<`vbi, wvRUj K`vgtv I gvBtŲvcb| thLvfb Z\_ cŲuqvRvZ Kti ZvŲK ejv nq wmcBD ev tK`Ųq cŲuqvKiY BDŲŲ (Central Processing Unit)| tK`Ųq cŲuqvKiY BDŲŲ ŲŲK `šZ BDŲŲ, wŲšZ YŲBDŲŲ I MwywZK hŲ³ BDŲŲ| th cŲš-ŲŲK djvdj cvl qv hvq ZvŲK ejv nq ewMŲx (Output) ev wMŲb gt| AvDUŲŲ wvfbv wnmte cŲvb Z\_ŲK gvŲŲi, `ŲKvi I wŲŲvi| Gt`i gva`tg cŲuqvKZ tWŲv ev DcvE Avgiv cvB| wbtP KwŲDUvii GKw tgvŲj K KvŲgv t`I qv ntjv :







Kv̄tRi d̄t̄K d̄t̄K w̄k̄t̄g bv w̄b̄t̄q `xN̄P̄ b I `xN̄P̄Y K̄w̄úDUv̄ti Kv̄R Kīt̄j t̄Pv̄t̄L bv̄bv̄b i Kg m̄gm̄vi m̄w̄÷  
nq, Ḡt̄K ej̄v nq K̄w̄úDUvi w̄fkb w̄mb̄t̄W̄t̄g | GB w̄mb̄t̄W̄t̄gi ḡt̄ā īt̄q̄t̄Q t̄Pv̄L R̄j̄v t̄c̄v̄ōv Kīv, t̄Pv̄L ī®<  
n̄t̄q h̄v̄l qv, t̄Pv̄L P̄j Kv̄t̄bv, t̄Pv̄L j̄v̄j n̄t̄q h̄v̄l qv Ges t̄Pv̄t̄Li c̄w̄b īw̄K̄t̄q h̄v̄l qv |

K̄w̄úDUv̄ti Kv̄R Kivi m̄gq m̄w̄K̄f̄v̄t̄e em̄t̄Z n̄t̄e Ges t̄m̄v̄R̄v m̄v̄ḡt̄b Z̄v̄K̄v̄t̄Z n̄t̄e | Uv̄Bc Kivi m̄gq n̄v̄Z t̄h̄b  
t̄K̄v̄t̄bv w̄K̄Q̄i D̄ci īv̄L̄v bv v̄t̄K Ges n̄v̄Z I Av̄Oj̄ t̄h̄b t̄m̄v̄R̄v v̄t̄K | K̄w̄úDUv̄ti ī w̄Ēb ev c`w̄U t̄h̄b Aek̄B  
t̄Pv̄L t̄t̄K 20 t̄t̄K 24 B̄w̄Ā (c̄l̄q 50N̄60 t̄m̄w̄g) `t̄i v̄t̄K | ḡv̄vi D̄ci ew̄Zi Av̄t̄j̄v Ges t̄Uw̄et̄j̄i ew̄Zi  
Av̄t̄j̄v Ḡgb̄f̄v̄t̄e K̄ūḡt̄q w̄t̄Z n̄t̄e Z̄v̄ t̄Z̄v̄ḡvi t̄Pv̄t̄L ev K̄w̄úDUv̄ti ī c`ŕ̄q t̄h̄b bv c̄t̄o |

t̄i w̄WI Ges t̄Uw̄j̄ w̄fkb t̄t̄K t̄h m̄gm̄v̄ t̄L̄v t̄q Z̄v c̄ā̄v̄b̄Z k̄ā`t̄YR̄w̄b̄Z `v̄v̄v̄ m̄gm̄v̄ | t̄Z̄v̄ḡiv Āt̄b̄t̄K L̄p̄  
n̄v̄B̄N̄f̄w̄j̄ q̄t̄g t̄i w̄WI I t̄Uw̄j̄ w̄fkb P̄j̄v̄l | Ḡt̄Z t̄Z̄v̄ḡvi K̄v̄t̄bi t̄h̄gb m̄gm̄v̄ m̄w̄ó n̄t̄Z c̄v̄t̄i, t̄Z̄ḡw̄b h̄v̄iv t̄Z̄v̄ḡvi  
Av̄t̄k̄c̄t̄ki ew̄ōt̄Z ew̄m̄ K̄t̄ib, Z̄v̄t̄i ḡt̄ā h̄w̄ D̄P̄ ī³P̄t̄c̄ Av̄v̄š– t̄i w̄M̄x Ges ǖt̄i w̄M̄x v̄t̄K̄b ev Ab̄ t̄h  
t̄K̄v̄t̄bv Am̄j̄ t̄i w̄M̄x v̄t̄K̄b k̄ā`t̄YR̄w̄b̄Z K̄vīt̄Y Z̄v̄iv Av̄i I t̄ēw̄k̄ Am̄j̄ Z̄v̄ I Aw̄v̄i Z̄v̄ t̄ēv̄a Kīt̄Z c̄v̄t̄ib | h̄v̄iv  
L̄p̄ t̄ēw̄k̄ k̄t̄ā t̄i w̄WI ev w̄Uw̄f̄ P̄j̄v̄b, Z̄v̄iv ḡv̄v̄ e`v̄, K̄v̄t̄b Kg t̄K̄v̄t̄bv, Aemb̄Z̄v̄ B̄Z̄w̄ `v̄v̄v̄v̄ m̄gm̄v̄q c̄ōt̄Z  
c̄v̄t̄ib | m̄j̄Z̄iv̄s t̄ēw̄k̄ t̄R̄v̄t̄i w̄Uw̄f̄ I t̄i w̄WI P̄j̄v̄t̄e bv |

Āt̄b̄t̄K t̄ḡv̄v̄B̄j̄ t̄d̄v̄b e`env̄i K̄t̄i ḡv̄b̄j̄t̄K w̄ei³ K̄t̄i | Ḡm̄e Kv̄R t̄t̄K Av̄ḡv̄t̄i w̄ei Z̄v̄K̄t̄Z n̄t̄e |

## Ab̄k̄x̄j̄ b̄x

K. ēū̄w̄bēP̄b̄x c̄k̄e

m̄w̄K̄ D̄Ēt̄i ī c̄v̄t̄k̄ w̄UK (✓) w̄P̄ŕ`v̄l |

1 | t̄ZR̄w̄Ēq t̄ḡš̄j̄ t̄t̄K w̄b̄M̄Z̄ Av̄j̄ d̄v̄ K̄Ȳv̄ K̄x̄?

(K) ḠK̄w̄U n̄v̄B̄t̄W̄t̄R̄b̄ w̄b̄DK̄x̄q̄m̄

(L) ḠK̄w̄U w̄w̄j̄ q̄v̄ḡ w̄b̄DK̄x̄q̄m̄

(M) ḠK̄w̄U Z̄w̄or w̄b̄īt̄c̄ŕ̄ K̄Ȳv̄

(N) ḠK̄w̄U F̄Ȳv̄Z̄K̄ K̄Ȳv̄

2 | t̄ZR̄w̄Ēq ŕ̄t̄q̄i d̄t̄j̄ t̄h w̄ēŪv̄īw̄k̄t̄w̄b̄M̄Z̄ n̄q Z̄v̄ Av̄m̄t̄j̄ K̄x̄?

(K) F̄Ȳv̄Z̄K̄ B̄t̄j̄ K̄Ūt̄bī t̄m̄t̄Z̄

(L) ḠK̄w̄U Z̄w̄or w̄b̄īt̄c̄ŕ̄ K̄Ȳv̄

(M) ḠK̄w̄U ab̄v̄Z̄K̄ w̄b̄DK̄x̄q̄m̄

(N) ab̄v̄Z̄K̄ t̄c̄Ű̄t̄bī t̄t̄Z̄

3 | t̄K̄v̄b w̄w̄j̄ K̄b w̄P̄t̄c̄ j̄ ŕ̄j̄ j̄ ŕ̄j̄ ēZ̄B̄x̄ m̄s̄t̄h̄w̄R̄Z̄ n̄t̄j̄ Z̄v̄t̄K̄ K̄x̄ ēt̄j̄?

(K) m̄ḡv̄š–īv̄j̄ ēZ̄B̄x̄

(L) Aāēw̄ī ev̄n̄x̄ Ű̄t̄b̄w̄R̄÷ ī

(M) m̄ḡv̄š^Z̄ ēZ̄B̄x̄

(N) Aāēw̄ī ev̄n̄x̄ W̄t̄q̄w̄

4 | t̄Uw̄j̄ w̄fkb m̄w̄úP̄v̄t̄i K̄v̄t̄ḡiv̄i Kv̄R K̄x̄?

(K) Ōw̄et̄K̄ Z̄w̄orm̄s̄t̄K̄t̄Z̄ īev̄š̄f̄ī Kīv̄

(L) Ōw̄et̄K̄ k̄ā Zīt̄½ īev̄š̄f̄ī Kīv̄

(M) Z̄w̄orm̄t̄¼Z̄t̄K̄ Ōw̄et̄Z̄ īev̄š̄f̄ī Kīv̄

(N) k̄ā Zī½t̄K̄ Ōw̄et̄Z̄ īev̄š̄f̄ī Kīv̄

L. m̄R̄b̄k̄x̄j̄ c̄k̄e

1 | t̄Ōv̄U n̄t̄q Av̄m̄t̄Q c̄w̄\_ex, Av̄ḡiv̄ ew̄m̄ Kīw̄Q t̄M̄ēv̄j̄ w̄f̄t̄j̄t̄R̄ | Z̄\_ I t̄h̄w̄M̄t̄h̄w̄M̄ c̄h̄ȳ³ h̄t̄š̄; ī ḡv̄āt̄ḡ c̄w̄\_exi  
m̄K̄j̄ ḡv̄b̄j̄t̄K̄ K̄v̄h̄K̄i I `ŕ̄j̄Z̄vī m̄t̄\_ m̄sh̄ȳ³ K̄t̄īt̄Q | t̄h̄w̄M̄t̄h̄v̄t̄Mī c̄ā̄v̄b̄ ev̄n̄b̄, t̄j̄v̄ n̄t̄Q t̄Uw̄j̄ w̄fkb, t̄i w̄WI  
Ges t̄Uw̄j̄ t̄d̄v̄b̄ |



(K) thMthM hš¿ KvK etj?

(L) Kxfite tUwj tdivb KvR Kti e`vL`v Ki |

(M) Kxfite tiwVl t÷kb wbw` Ø K÷ut¼i mstKZ mÂj b Kti Ges Zv MñtKi wBKU tcdQvq, wPÎ mn e`vL`v Ki |

(N) thMthvMi hš¿ wnmvte tUwj wfk b I tiwVl i KvRwv Zv wetkK`Y I Zj bv Ki |

2| kôj ¼vi tçgv`v m v t÷wvqtg evsjt`k I fvi tZi gta` AbjôZ tLjwU f-DcMñi gva`tg weUwrf m÷úPvi Ki tQ| dtj Nti etmB tUwj wfk t b tLjwU DctfvM Kiv hv t`Q|

(K) Gbvj M m t¼Z KvK etj?

(L) wPÎ i m v n t h` GKwU wVwRUvj m t¼Z e`vL`v Ki |

(M) tUwj wfk t b tLjwUi m÷úPvi tKškj e`vL`v Ki |

(N) G ai tbi thMthM cby³ Rxbgvb tK Kxfite Dbz Ki tQ -Av t j vPbv Ki |

M. m v a i Y c k æ

1| tZRw`EqZv Kx e`vL`v Ki |

2| Avj dv I weUv KYvi cv`R` e`vL`v Ki |

3| mgwš^Z eZBx Kx?

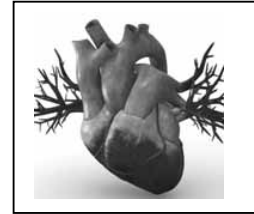
4| BvUvi t b U KvK etj? Gi Øvi v Kx Kx KvR Kiv hvq?

5| d`v· Kxfite KvR Kti eYBv Ki |

PZì Ŕ Aa`vq

# Rxeb evPvŕZ c`v\_ŕeÁvb

## PHYSICS TO SAVE LIFE



[c`v\_ŕeÁvb mŕ\_ RxeŕeÁvb mŕúK`'vcb Kŕi GKŭ bZb ŵetŕi ŵeKŭv NŕUŕQ Zvi bvg Rxec`v\_ŕeÁvb| tetP  
\_ŭKvi Rb` Avgŕ`i `iKvi mŕ', mej I ŵbŕiŵ t`n| mŕ' \_ŭKvi Rb` cŕqŕb mŕVK ŵPŭKrmŭ| ŵPŭKrmŭ ŵeÁvb tiŵM  
ŵbYŕ AZ`š-ŭiŕcŕŕŵelq| c`v\_ŕeÁvb ŵeŵfŕeZĖj I bŵiZi Dci ŵŵĖ Kŕi `Zwi ntŕŕQ bŕbŕ aiŕbi ŵPŭKrmŭ  
hšŕcŵiZ| GmKj hšŕcŵiZ c`v\_ŕeÁvb tKŕŕb bŵiZ ev ZĖŕK Kŕŕ jŵŵŕq KŕR Kŕi| Ggb ŵKQzhšŕcŵiZ mŕúŕK`  
G Aa`ŕq AvŕjŵPŕv Kiv nŕe|]

GB Aa`vq cŵ tŕŕI Avgiv-

1. Rxec`v\_ŕeÁvb ŵŵĖ e`vL`v KiŕZ cŕie|
2. Rxec`v\_ŕeÁvb RM`xkP`'emj Ae`vb e`vL`v KiŕZ cŕie|
3. gŕbeŕ`n c`v\_ŕeÁvb ŵbŕŕg cŵi Pŵj Z nŕ Zv e`vL`v KiŕZ cŕie|
4. ŵPŭKrmŭ ŵeÁvb tiŵM ŵbYŕ e`eüZ hšŕcŵiZ c`v\_ŕeÁvb aŕiŶv I ZŕĖj e`envi e`vL`v KiŕZ cŕie|
5. AvŕŕK cŕŕ<sup>3</sup> Ges hšŕcŵiZ e`envŕi dŕj mŕ `ŕ`' mŕm`v Ges cŕZŕŕŕai tKŕj e`vL`v KiŕZ cŕie|
6. mŕVK ŵPŭKrmŭ Rb` tiŵM ŵbYŕ cŕqŕRbŕqZv mŕúŕK`ŵŕR mŕPZb nŕev Ges Ab`ŕi mŕPZb KiŕZ cŕie|
7. tiŵM ŵbYŕ ŵeÁvb I cŕŕ<sup>3</sup> cŕksmŭ KiŕZ cŕie|

### 14.1 Rxec`v\_ŕeÁvb Gi ŵŵĖ

### Background of bio-physics

Rxec`v\_ŕeÁvb ntjv Ggb GK weÁvb hv weÁvtbi AþBK,tjv kvLvi Dci wfwĒ Kti cŕZwŕZ ntqtQ| Rxec`v\_ŕeÁvb RxeÁvtbi tKvtbv e`e`vK Aa`qþbi Rb` tŕSZweÁvtbi ZĒj I c`v\_ŕeÁvb e`envi Kiv nq| RxeÁvb ntjv RxeRMr Aa`qþbi weÁvb| Kxfvte Dw` I cŕx Lv` AmiY Kti, thMvthM i`qjv Kti, cvi tek m`útkDcjwä jvf Kti Ges eske` Kti Gwelq,tjv RxeÁvtb eYbv Kiv nq| Ab`w`þK cŕwZ th me MwYwZK wbgg tgbt Ptj tm,tjv ntjv c`v\_ŕeÁvtbi AvtjvP` welq| `xNŕ b GKwU aviYv weÁvbxiv tcvY Kti GtmtQb th RxeRMtZi wbgg I tŕSZRMtZi wbgg Avjv`v| wKS` tŕSZweÁvb I RxeÁvtbi AMŕwZi wFZi w`tq GB `þ AvciZ wfbok,Ljvi gta` Mfxi wgg cvlqv tMtQ| cŕtg c`v\_ŕeÁvb I RxeÁvb `yU wfbomelq wntte weKvk jvf Kti tQ| weÁvtbi AMŕwZi ga` w`tq GB `þ wel tqi gta` cvi`úwi K m`úK I mgs`q AþK ew` tctqtQ| AvtM gtb Kiv ntZv cŕYRMZ wfbok wbgg Ptj Ges Ro c`v\_ŕeÁvb t`qj t`ay tŕSZweÁvtbi wbgg,tjv cŕhvR`| wKS` Avgiv GLb Rwb cŕYt`ntK AþK w`K t`þK htš; i m½ Zj bv Kiv hvq Ges cŕYt`ni AþK AvPiYtK tŕSZ wbgg ŕviv e`vL`v Kiv m`e| e` Z c`v\_ŕeÁvtbi wbgg,tjv mveRbxb| dtj` iayRoRMZ bq, cŕYRMZtKI c`v\_ŕeÁvtbi wbgtg AþK t`qj t` e`vL`v Kiv m`e| GwUB Rxec`v\_ŕeÁvtbi wfwĒ|

Rxec`v\_ŕeÁvtbi P`vtjÄ ntjv Kxfvte Rxeþbi bvbv RuUj ZvþK c`v\_ŕeÁvtbi mnR wbggtgi wfwĒtZ e`vL`v Kiv hvq| MwY Ges c`v\_ŕeÁvb e`envi Kti Rxeþbi bvbwea inm` AbmÜvb I wewfbæNUbv wetkktYi gra`tg Gi Mfxi cŕek Kivi kw³kvjx gra`g ntjv Rxec`v\_ŕeÁvb| Rxec`v\_ŕeÁvb ntjv RxeÁvb Ges c`v\_ŕeÁvtbi gta` tmZeÜ`c|

### 14.2 RM`xkP>`emyj Ae`vb

#### Contributions of Jagadish Chandra Bose

AvPh`m`vi RM`xkP>`emyjQtj b GKvavti GKRB cŕvZ c`v\_ŕeÁvb, Ab`w`þK GKRB RxeÁvbx| Avgt` i Dcgnv`þK wZwb cŕg AvšRwZK mþKwZcŕB weÁvbx| emy cwi evti i Aw` wbev mQj XvKv tRjvi AšMŠ weµgcti i iwplvj bvgK Mŕtg| 1858 mvtj i 30 btf`vi RM`xkP>`emygggbwmsþn RbMŕY Ktib| wczv fMevbP>`emydwi`cj tRjvi GKRB tWcU g`wRt÷U wQtj b| cŕtg dmi`cti i MŕgxY we`vj tq gvZ.fvlvq tjLvov`iyKtib| cti tKvj KvZvi tnqvi`<j I tmU tRwfvqi`<j I KtjþR Zvi QvĒ Rxeb AwZewwZ nq| 1880 mvtj we.G cvk Kivi ci H eQiB wZwb D`P wKŕjvi Rb` Bsj`vĒ hvb| Bsj`vĒ Zvi wKŕjv Rxeb wQj 1880–1884 mvj chšt H mgtq wZwb K`w`R wekpe`vj q t`þK c`v\_ŕeÁvtb Avvmŕn we.G Ges jÜb wekpe`vj q t`þK we.Gmm. wWwMŕ ARB Ktib| 1885 mvtj wZwb tcmþWwY KtjþR c`v\_ŕeÁvb wel tq Aa`vcbv`iyKtib| tcmþWwY KtjþR Mtelyvi tZgb mþhM bv`vKv mtĒj| wZwb tmLvþb Mtelyvi KvR Pwjtq hvb| w`þbi tejvq mgq bv`vKvq tewki fM mgq ZvþK i vtZi tejvq Mtelyvi KvR KiþZ ntZv|



i<sup>3</sup> mÂvj b KițZ mŕlg| Aciw`țK, e<sup>o</sup> GKwJ wețkl Qwkb hšĳ hv gvbțli kixții bvBtUțRbhj<sup>3</sup> eR<sup>o</sup>  
 c`v\_ŕAcwviY Kti \_vțK| GiKg AmsL<sup>o</sup> tQvU tQvU hțšĳi KvțRi mgš`tqi dțj m<sup>o</sup>uY<sup>o</sup>gvbeț`n mPj \_vțK|  
 gvbbeț`n GKwJ `Rehšĳ ˆ`c| hšĳ Ŗviv KvR Kivi Rb<sup>o</sup> kw<sup>3</sup>i cŕqvRb| wevfbeBwĂtb Avgiv tctUțj ,  
 wWțRj, w.Gb.wR BZ<sup>o</sup>w<sup>o</sup> Rjywb e`envi Kti ivmivqwbK kw<sup>3</sup>țK hwsĳK kw<sup>3</sup>țZ žcivšwi Z Kw| wK  
 tZgwbvŕte, Lv<sup>o</sup> MŕY I kmb cŕqvvi gva`tg gvbbeț`nI ivmivqwbK kw<sup>3</sup>țK Zvckw<sup>3</sup> I hwsĳK kw<sup>3</sup>țZ žcivšwi Z  
 Kti| mZivs gvbbeț`n Avmțj GKwJ `RweK hțšĳi gțZv| wKš<sup>o</sup> AțbK w`K w`tq gvbbeț`n gvbem<sup>o</sup>  
 RuUj Zg hțšĳi tPtqI wekțKi| gvbbeț`n Ggb wKQz KvR KițZ cvti, hv tKvțbv hțšĳi cțŕ| Kiv m<sup>o</sup>e  
 bq| thgb- gvbțli i t`n GKwJ gvŕ tKvI t`țK DrcwĒ jvf Kti| mgțqi cwieZŕbi mvț\_ mvț\_ GB GKwJ  
 tKvIB cYŕ<sup>2</sup> gvbbeț`n cwYZ nq, hv j ŕ| tKwJ tKvI Ŗviv MwVZ| wKš<sup>o</sup> tKvțbv hțšĳB GgbwJ NtU bv|  
 KLțbv KLțbv kixții GKwJ gvŕ Ask weKj nțj mgMŕgvbeț`tni KgŕvĒ eÜ nțq hvq| thgb- ŭrwctĒi  
 wqvq t`tg tMțj kixții Ab`vb<sup>o</sup> mKj A<sup>1</sup>/<sub>2</sub> tji KgŕvĒ eÜ nțq hvq Ges Lp<sup>o</sup> `Z gwŕŕ<sup>o</sup> c<sup>o</sup>i wqvq t`tg  
 hvq|

#### 14.4 tiwM wbyŕq e`eüZ hšĳcwZ

##### Instruments used for diagnosis of diseases

GK mgq wPwKrmKMY tiwMxi ewn<sup>o</sup>K wevfbej ŕŕY t`țL tiwM wbyŕ KițZb Ges tm Abjhvx Jla I c<sup>o</sup>  
 w`țZb| tm mgq tiwM wbyŕqi Rb<sup>o</sup> AvaybK hšĳcwZ Awe<sup>o</sup><vi nqwb| dțj evBti t`țK wevfbeA<sup>1</sup>/<sub>2</sub> cĒ<sup>o</sup> t<sup>1</sup>/<sub>2</sub>i  
 mwVK Ae<sup>o</sup> vb tevSv thZ bv| GQvov tiwMxi tKvțbv wbw<sup>o</sup> Ŗ A<sup>1</sup>/<sub>2</sub> Kx gvŕvq tiwMwvš-nțqțQ, ZvI Rvrv m<sup>o</sup>e  
 wQj bv| weĂvțbi bvbv Awe<sup>o</sup><vi tK KvțR jwMțq tiwM wbyŕqi Rb<sup>o</sup> AțbK aițbi hšĳcwZ Awe<sup>o</sup><Z nțqțQ|  
 G hšĳcwZ tji mvrvth<sup>o</sup> mwVKfŕte tiwM wbi<sup>o</sup> cY Kiv m<sup>o</sup>e nțqțQ| mwVK hšĳcwZ Qvov wPwKrmțKi cțŕ|  
 mwVKfŕte tiwM wbi<sup>o</sup> cY Kiv m<sup>o</sup>e bq, thui mvrvth<sup>o</sup> H cŕqvRbxq cixŕŕwJ m<sup>o</sup>ubK ițZ nte| AvaybK wevfbe  
 hšĳ D<sup>o</sup>wēZ nlqvi dțj tiwMi KvY wbw<sup>o</sup> Ŗfŕte Rvrv m<sup>o</sup>e nțqțQ| GK mgq AĂZvi KvY gvb|  
 tiwMwvš-AțbK Kms<sup>o</sup> vti wekțm KițZv| AvaybK mgvR gZinvi AțbK Ktg tMțQ, Zvi cĀvb KvY tiwM  
 wbyŕ I wPwKrmvq wevfbețfšZ hšĳ e`eüZ nț<sup>o</sup>Q|

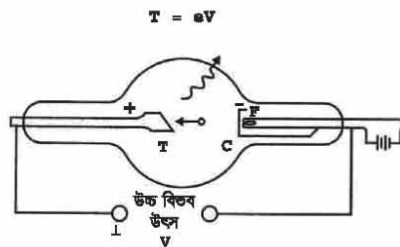
G Abț<sup>o</sup>Q<sup>o</sup> tiwM wbyŕqi Rb<sup>o</sup> mvaviYZ th me hšĳcwZ e`envi Kiv nq Gi KțqKwJ wbtq AvțjvPbv Kiv  
 nțjv|

G. ti

##### Xray

G. ti nțjv GK aițbi ZwōZțPš<sup>o</sup> K wevKiY| G. ti Zi<sup>1</sup>/<sub>2</sub> ˆ<sup>o</sup>N<sup>o</sup> mvaviY Avțjvi Zi<sup>1</sup>/<sub>2</sub>% tNŕ tPtq  
 AțbK Kg| GB iwKŕi Zi<sup>1</sup>/<sub>2</sub>% N<sup>o</sup> 10<sup>-10</sup> m Gi KvŕKwQ| 1895 mvtj Dnț tntjvg i>UțRb G. ti Awe<sup>o</sup><vi  
 Kti b| iĂbinkŕi AvtiK bvg G. ti| iĂbinkŕi cKwZ hLb Rvrv wQj bv ZLb ARvrv iwKŕ wntmte Gi  
 bvgKiY Kiv nq G. ti| Zi<sup>1</sup>/<sub>2</sub>% N<sup>o</sup> hZ tQvU nte G. ti tKvțbv c`v\_ŕf<sup>o</sup> Kivi ŕlgZv ZZ tewk nte|  
 mvaviY Avțjv `k`gvb Ges wevfbețfŕ<sup>o</sup> wef<sup>3</sup> wKš<sup>o</sup> G. ti `k`gvb bq| mvaviY Avțjvi cț\_ tKvțbv A<sup>o</sup>~Q

c`v\_©\_vKtj Zv t`f` Ki†Z cvti bv| Aciw`†K G· ti D`P t`f` b ¶lgZv m`ubø G· ti btj G· ti Drcbø nq| G· ti bj GKwU evqj`b` KvP bj| KvP btji `¶c†š-`yU ZworØvi ev Btj K†UW jvM†bv \_v†K| G†i GKwUi hvq K`v†\_wW Ges AciwU A`v†wW| K`v†\_v†W Uvst÷b avZi GKwU KÊjx \_v†K, G†K wdjv†gU etj| wdjv†g†Ui ga` w`†q cēwNZ ZworcēvN K`v†\_w†K DĒB K†i| dtj K`v†\_wW t\_†K BtjKUb gy³ nq Ges tei ntq Av†m| K`v†\_wW Ges A`v†v†Wi g†a` Lp D`P wefe cv\_Ŕ` cØqM Kiv ntj K`v†\_wW t\_†K BtjKUb\_tjv Lp `ZMwZ†Z Q†U hvq Ges j¶`e` A`v†w†K AvNvZ K†i| Gi dtj BtjKU†bi MwZ nVvr t\_†g hvq Ges G· ti Drcbø nq| BtjKU†bi MwZkw³ ZwoZ†Pš`K Zi½ž†c ievšw† Z nq| ¶i` Zi½†††N¶ GB wewKiYB ntjv G· ti| A\_v¶`ZMwZ m`ubøBtjKUb tK†bv avZ†K AvNvZ K†i† Zv t\_†K AwZ ¶i` Zi½%†N¶ Ges D`P t`f` b¶lgZv m`ubøARvbn cKwZi GK cKvi wewKiY Drcbø nq| G wewKiY†K G· ti ev G· iwk¶etj| wPĤ 14.1-G G· ti wD†ei cØqvRbxq Ask\_tjv t` Lv†bv ntqtQ|



wPĤ 14.1: G· ti wD†e



wPĤ 14.2: G· ti cix¶v

G· ti bvbv Kv†R e`envi Kiv hvq| tiwM wby¶qi Rb` wPwKrmv weAv†b Gi Ae`vb Acwi mxg|

1. `v†P†Z nvo, n†to dvUj, t††0 hvl qv nvo BZ`w` G· tii mvr†h` Lp mntRB kbv³ Kiv hvq|
2. g†gĒ†ji th tK†bv aitbi tiwM wby¶q G· tii e`envi A†bK thgb- `v†Zi tMvovq Nv Ges ¶iq wby¶q G· ti e`eüZ nq|
3. t††Ui G· tii mvr†h` A†šgi cØZeÜKZv (Intestinal Obstruction) kbv³ Kiv hvq|
4. G· tii mvr†h` wĒĒ \_w† I wKWwbi cv\_i†K kbv³ Kiv hvq|
5. e†Ki G· tii mvr†h` dmd†mi tiwM thgb- w†D†gwbqv, dmd†mi K`vYvi BZ`w` wby¶q Kiv hvq|
6. wPwKrmvi Kv†RI G· ti e`envi Kiv hvq| GwU K`vYvi tKv††K t††i t†j†Z cvti| tiwM t\_iw† cØqM K†i K`vY††i wPwKrmv Kiv hvq|

G· tii AcØqvRbxq wewKiYm`uvZ hv†Z tiwMxi ¶wZ Ki†Z bv cvti G e`vc††i cØqvRbxq mZKZv Ae†`b Ki†Z n†e| GRb` G· ti t†lqv mgq tiwM†K mxmv w†w†Z G†cØb Øviv h\_ym`e Av`Qw` Z Ki†Z n†e| AwZ Ri`ix bv ntj MfØZx gw†jv†i D`i Ges t†jw†K AĀ†ji G· ti Kiv DwPZ bq| Ab` tK†bv G· ti cix¶v cØqvRb ntj mxmv w†w†Z G†cØb Aek`B e`envi Ki†Z n†e|

## AvëtmþbMönd

### Ultrasonography

AvëtmþbMönd nþjv Ggb GKwU çµqv hv D"P KæúvstKi ktái cöZdjþbi Dci wbfPþkj | D"P KæúvstKi kã hLb kixþii Mfxþii tKvþbv A½ ev tçuk tþK cöZdwj Z nq ZLb cöZdwj Z Ziþ½i mnvþh" H Aþ½i Abgç GKwU cöZweæ^ gubUþii c`vq MVb Kiv nq |

þiVm wbyþqi Rb" th AvëtmþbMönd Kiv nq tmB ktái Kæúvsk 1-10 tgMvnuR nþq \_vþK | AvëtmþbMönd hþšç UþYwDmvi bvgK GKwU çwUKþK ãe`jwZKfvte DþEwRZ ev DþwçZ Kþi D"P KæúvstKi AvëtmþbK Zi½ DrcbæKiv nq | AvëtmþbMönd hþšç AvëtmþbK Zi½ þjvþK GKwU mi" exg-G cwiYZ Kiv nq | çþi GB exgUþK th Aþ½i cöZweæ^ tiKWþKiþZ nþe Zvi wþK tçöY Kiv nq | th Aþ½i wþK GwU wbf`R Kiv nq tmB Zþji çKwZ Abþvqx exgU cöZdwj Z, þkwL Z ev msewvZ nq | hLb exgU wewfbæNbþZþi tçuki (thgb- gvmþçuk, i³) wëfþ Zþj AvcuZZ nq ZLb Ziþ½i GKwU Ask cöZaYwb wnmvte çjþvq UþYwDmvi wdti Avþm | çþi GB cöZaYwb þjvþK Zwor mstKþZ çucvšwi Z Kiv nq | GB Zwor mstKZ þjv GKþÎ gubUþii c`vq çixþYxq e` ev tçuki GKwU cöZweæ^ MVb Kþi |

AvëtmþbMöndi meþPtq \_i"ZçYæ`envi çxtivM Ges çhæZweÁvþb jþK Kiv hvq | Gi mnvþh" áþYi AvKvi, cYþv, áþYi çrfweK ev A`rfweK Ae`vb Rvþv hvq | çhæZwe`vq GwU GKwU `Z, wþivc` Ges wbfPþhM" tKškj | AvëtmþbMöndi mnvþh" Rovqj wUDgvi Ges Ab`vb" tçjwFK gvtmi (Pelvic Mass) Dcw`wZI kbr³ Kiv hvq |

wewfbæiþbi Ww³vix çixþYv thgb- wçEcv\_i, ü hþšç i Tü Ges wUDgvi kbr³KiþY AvëtmþbMönd e`envi Kiv nq | üwçE çixþYv Kivi Rb" hLb AvëtmvDÜ e`envi Kiv nq ZLb G çixþYvþK BþKvKwWPMönd eþj |

G- þii Zjþvq AvëtmþbMönd AwaKZi wþivc` þiVm wbyþ çwçwZ | Zeyl AvëtmvDÜ Lþ mæwZ mgþqi Rb" e`envi KiþZ nþe | GQovv UþYwDmviþK memgq bovPovi gþa" ivLþZ nþe, thb GwU tKvþbv wþv`B `vþb w`i bv \_vþK |

wmwU`<`vb

### CT scan

wmwU`<`vb kãwU BstivR Computed Tomography Scan Gi msvþIß çç | wþwKrmweÁvþb GwU cöZweæ^ `Zwi i GKwU çµqv | th çµqvq tKvþbv wþgwþK e` i tKvþbv dwj (Slice) ev Astþi wþgwþK cöZweæ^ `Zwi Kiv nq tm çµqvþK UþgMönd eþj | wmwU`<`vb GKwU enr hþšç | G hþšç G- þi e`eüZ nq | G- þi thLþb kixþii Af`šþi i tKvþbv wþgwþK Aþ½i wþgwþK cöZweæ^ MVb Kþi, tmLþb wmwU`<`vb hþšç Øviv mþ cöZweæ^ wþgwþK |



wþÎ 14.3 :AvëtmþbMönd





GgAviAvB ntjv e`\_vnxb Ges wbi vc` tiwM wbyŕ c`v\_ŕeÁvb | GB htšŕ G. ti ev Ab` tKvfbv aitbi wewKiY e`envi Kiv nq bv | kixtii th Astki GgAviAvB `<vb Kiv nq tmLvb t\_ŕK cŕB mstKZŕK GKw KwaúDvŕii mrvŕh` cwi ewZŕ Kti tmB Astki AZ`š-`úo cŕZwe` MVb Kiv nq | cŕZ`Kw cŕZwe` kixtii tKvfbv `vŕbi GK GKw dwj ev `vBŕmi gtZv KvR Kti | Gfŕte AtbK,tjv cŕZwe` `Zwi Kiv nq, th,tjv kixtii H Astki mKj `ewkŕŕK duUŕq Zŕj |



ŕPŦ 14.5: GgAviAvB htšŕ

GgAviAvB Gi gva`tg cŕB cŕZwe`ŕK cvDi`wi GK GKw dwj i mŕ½ Zj bv Kiv hvq | hLb cvDi`wi t\_ŕK GK GKw dwj lVŕbv nq, ZLb dwj i mŕ\_ mŕ\_ cvDi`wi tŕZŕii meUKz t`Lv hvq | GKBfŕte GgAviAvB Gi gva`tg cŕB cŕZ`Kw cŕZwe` kixtii Af`šŕi mewKQzŕ LŕZ mrvŕh` Kti |

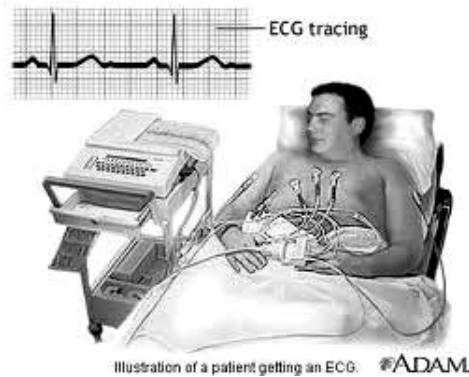
cvŕqi tMowj i gPKvfbv Ges wctVi e`\_vq GgAviAvB e`envi Kti RLŕgi ev AvNŕZi ZxeZv wbi`cY Kiv nq | teY Ges tgi` i ¾/4j (Spinal cord) we`ÍZ cŕZwe` `Zwi i Rb` GgAviAvB ntjv AZ`š-gj`evb cixŕŕv |

## BimwR

### ECG

BimwR ntjv BŕjKŕUŕKwŕŕMŕg (Electrocardiogram) kŕāi mŕŕŕB ŕŕc | BimwR Ggb GKw tiwM wbyŕ c`v\_ŕeÁvb hvi mrvŕh` wbyŕZŕŕte tKvfbv e`wŕi ŕrŕctŕi `e`jwZK Ges tŕkRŕbZ Kŕhŕjvc chŕŕŕY Kiv hvq | Avgiv Rŕb th, ewntii tKvfbv Dŕxcvŕ QvovB ŕrhšŕ ŕŕj`e`jwZK mstKZ DrcbŕKti | GB `e`jwZK mstKZ ŕrhšŕi tŕkŕi ga` w`ŕq Qwŕŕq cŕo, Gi dtj ŕrhšŕ msKŕPZ nq | BimwR htšŕi mrvŕh` Avgiv GB Zŕor mstKZmgŕŕK kbv³ Kw | BimwR Gi mrvŕh` Avgiv ŕrŕctŕi `w`ŕbi nvi Ges Q`gqZv cwi gvc KiŕZ cwi | Gw ŕrŕctŕi gŕa` i ¾cŕvŕni ctivŕŕ cŕvY t`q |

kixtii wewfbŕ`vŕb `wŕcZ Zŕorŕvi ev BŕjKŕUŕWmgŕ ŕrhšŕi wewfbŕ`K t\_ŕK AwMZ `e`jwZK mstKZ,tjŕŕK kbv³ Kti | ŕrŕctŕi GKw mŕúY`Qwe cŕevi Rb` `kw BŕjKŕUŕW e`envi Kti evŕiw ŕ`e`jwZK mstKZŕK kbv³ Kiv nq | cŕZ`Kw nŕZ Ges cvŕq GKw Kti tgvU Pŕiw Ges evKx QqU BŕjKŕUŕW ŕrŕctŕi cŕŕi eivei `vcb Kiv nq [ŕPŦ 14.6 ] | cŕZ`Kw BŕjKŕUŕW ŕviv msMŕxZ Zŕor mstKZŕK ti KW`Kiv nq | GB ti KW`mgŕni gŕ`Z ŕŕcB ntjv BŕjKŕUŕKwŕŕMŕg |



ŵPĪ 14.6: BimwR c`v\_ŋeÁvb

mŷ' gvbŋli Rb' cŌZ`K BtjKtUw t\_ŋK cŌB Zwor mstKtZi GKw ŋ`vfwK bKkv \_vŋK| hw' tKvŋbv e`w³i ūrhŋš; tKvŋbv aiŋbi A`vfwK Ae`v jŋ| Kiv hvq ZLb BtjKtUwmgŋ t\_ŋK cŌB bKkv ŋ`vfwK bKkv t\_ŋK wfbŋzi nŋe|

maviYZ tKvŋbv tivŋMi ewn`K jŋY thgb- eŋKi aocomb, AmbqgZ I `Z ūr`ŋ`b, eŋK e`v\_v BZ`w`i KviY wbyŋ Kivi Rb' BimwR cixŋv KiŋZ nq| GŌvovl wbyqgZ cixŋvi Ask wntmŋe thgb- Acvŋkŋbi cŋeBimwRi mrvh` tbi qv nq|

ūrvctŋi th mKj A`vfwK cKwZ BimwRi gva`tg kbv³ Kiv hvq G,tjv nŋjv-

1. ūrvctŋi A`vfwK ŋ`b thgb- ūrvctŋi ŋ`b tbi nvi tenk ev Kg ev AmbqgZ nŋj;
2. nŋU`A`vUvK hv m`ŋŋZ ev wKŌw` b cŋeŋsNwUZ nŋqtŌ;
3. m`ŋŋwiz ūrvctŋi A\_vŋ ūrvctŋi AvKvi eo nŋq hvl qv|

GŋŪvmŋKwc

## Endoscopy

GŋŪvmŋKwc ejtZ maviYfvŋe tKvŋbv wKŌi wFZti t`LvŋK eŋvq| wKš' GŋŪvmŋKwc ejtZ Avgiv eŋS wPwKrmvRwbZ KviŋY ev cŌqvRŋb t`ŋni Af`š`-` tKvŋbv A½ ev MnŋiŋK ewni t\_ŋK chŋeŋY| GŋŪvmŋKwc hŋš; gva`tg Avgiv kixŋi dndv A½mgŋni Af`š`fŋM cixŋv Kti \_wK|



ŵPĪ 14.7: GŋŪvmŋKwc hŋš;

GŋŪvmŋKwc hŋš; `wU bj \_vŋK, Gŋ' i GKwUi ga` w`ŋq evBti t\_ŋK tivMxi kixŋi wbw`Ō A½ Avtjv tcŌY Kiv nq| AvtjvK Zš' i wFZti t`qvŋj Avtjvi cY`Af`š`xY cŌZdjŋbi gva`tg D¾j Avtjv tivMxi t`n Mnŋi cŌek Kti| GB Avtjv tivMvŋš-ev ŋwZMŌĪ A½ŋK AvtjwKZ Kti| wŌZxq AvtjvK Zš' bŋj i







ŕPŦ 14.10: GbŕRI Mŕg

mŕaviYZ th mKj KviŦY ŕPŕKrmKMY GbŕRI Mŕg Kivi cigvKŕ`b, G\_Ŧjv nŦjv-

(K) ũrvcŦÊi ewnŦi agbxŦZ eŦKR nŦj ;

(L) agbx cŕŕwi Z nŦj ;

(M) ŕKWŕbi agbxi Ae`v eŖŕi Rb`;

(N) ŕkivi ŦKvŦbv mgm`v nŦj |

KLŦbv KLŦbv ŕPŕKrmKMY GbŕRI Mŕg Kivi mgq GKB mgŦq mŕRŕx QvovB i<sup>3</sup>bŕj i eŦKi ŕPŕKrmv KŦi  
\_ŦKb| th ŦKŖŦj ev cŕŕuqŕ GbŕRI Mŕg Kivi mgq agbxi eK gŖ Kiv nŕ ZŦK GbŕRI cŕŕo eŦj |

AvBŦmŦUvc Ges Gi e`envi

### Isotopes and its uses

AvBŦmŦUvc\_Ŧjv nŦjv GKŕŬ ŕbŕ`Ŧ tgŖŦj i ŖcŦf` | ŕewfŕœfimsL`v ŕewkó GKB tgŖŦj i cigvYŦK H tgŖŦj i  
AvBŦmŦUvc eŦj | A\_ŕP ŦKvŦbv tgŖŦj i AvBŦmŦUvcmgŦn ŦcŬŦbi msL`v mgvb \_ŦŦK, ŕKŖ` ŕbDUŦbi msL`v  
ŕewfŕœnŕ| ŦKvŦbv cigvYŦ ŕbDKŕqvŦm Aew`Z ŦcŬŦbi msL`v tgŖŦj ŕŬŦK Abb`ŖŦc kbv<sup>3</sup> KŦi | ŕKŖ`  
bŕŕZMZŦŕe GKŕŬ tgŖŦj i th ŦKvŦbv msL`K ŕbDUb \_vKŦZ cŕŦi | tgŖŦj i ŕbDKŕqvŦm Aew`Z ŦcŬb Ges  
ŕbDUŦbi msL`vB nŦjv Gi fimsL`v | G KviŦYB ŦKvŦbv tgŖŦj i cŕZ`KŕŬ AvBŦmŦUŦci fimsL`v ŕewfŕœnŕ|  
D`vniY ŕnŦŕŕe Kŕœbi K\_v ejv thŦZ cŕŦi | Kŕœbi ŕZbŕŬ AvBŦmŦUvc <sup>12</sup>C, <sup>13</sup>C Ges <sup>14</sup>C, hŕŦ`i  
fimsL`v h\_vŕŕg 12,13,14 | Kŕœbi cigvYŕeK msL`v 6, A\_ŕP cŕZ`KŕŬ Kŕœ cigvYŦZ QŕŕŬ ŦcŬb  
AvŦQ | hvi dŦj Kŕœbi AvBŦmŦUvc\_ŦjvŦZ h\_vŕŕg 6,7Ges 8 ŕŬ ŕbDUb iŦŦQ |

ŕPŕKrmŦŦŦŦ ŦcigvYŦ ŕPŕKrmŕqŦ ŦZRŕ`Œŕ AvBŦmŦUŦci e`vcK e`envi iŦŦQ | ŦZRŕ`Œŕ AvBŦmŦUŦci  
cŕŕbZ`ŦaiŦbi e`envi AvŦQ |

(K) tiŕŬ ŕbYŦŕi ŦŦŦŦ

(L) tiŕŬ ŕbŕgŦŕi ŦŦŦŦ

tivMxi kixti tKvfbv `vfb ev At½ ǂǂZKi K`vYvi wUDgvti Dcw`wZ tZRwEq AvBtmvUvci mrvth`  
 kbv³ Kiv hvq| tKveë-60 (<sup>60</sup>Co) AvBtmvUvc t\_tK wBMZ kw³kvjx Mvgv iwkY K`vYvi wPwKrmvq e`eüZ  
 nq| tKveë-60 t\_tK wBMZ Mvgv iwkY mrvth` Acvtiktbi hš¿cwZ tivM RxeYy g³KiY Kiv nq|  
 \_vBitqW Mš' ev MqÜi A`vfwK eǂǂ RwbZ tivMi wPwKrmvq AvtqwWb-131(<sup>131</sup>I) e`eüZ nq|  
 tUKwbkqvq- 99m tivM wbyqi Rb` cigvYy wPwKrmvq eüj e`eüZ GKwU tZRwEq AvBtmvUvc| GwU  
 mrvth` teY, wj fvi, cǂǂ Ges nvtoi BtgwRs ev `<wbs mǂübaKiv nq| it³i tkZ KwYKvi AZ`waK eǂǂ  
 dtj i³v Zv (Blood-Leucaemia) tivMi wPwKrmvq tZRwEq dmdim-32 (<sup>32</sup>P) Gi dmdU e`eüZ nq|  
 cigvYy wPwKrmvq tivM wbyqi Rb` wkiwi ga` w`tg BbRKktbi gva`tg tZRwEq AvBtmvUvc tivMxi t`tn  
 cǂek Kivbv nq| tivMxi tKvfbv At½i cixǂǂ Kiv nte Zvi Dci wbfP KtiB tZRwEq c`v\_ǂberPb Kiv  
 nq| GQovw Kw tǂǂ, Lv`msi ǂǂY, KxUcZ½ `gfb Ges wki tǂǂ tZRwEq AvBtmvUvci e`vcK e`envi  
 itqtQ|

## Abkxj bx

eübePwb cǂke

1| weÁvbx RMxP>`^emj mvf\_ tKvb wel quU msukó?

- i) emygw` i cǂZôv
- ii) tZRwEq tgstj i e`envi
- iii) tǂǂ Mǂd Awie®vi

wbǂPi tKvbwU mwVK?

- K) i
- L) i I ii
- M) i I iii
- N) i,ii I iii

2| X-ray wdtj ǂnvtoi Qwe `úó t` Lv hvl qvi Kvi YŇ

- K) nvo X-ray Øviv Atf`
- L) gysmtcuk X-ray Øviv Atf`
- M) Zi½ ``N©AtbK tenk
- N) Dp tf` bǂlgZvmǂüba

3| m² i³bwj Kvi eǂKR cixǂǂ Kivi cǂy³i bvg ntj vŇ

- K) GbwRI Mǂg
- L) GbwRI cǂw÷
- M) BwUwU
- N) BwUwR

4| n, `úǂ tbi nvi I Q>gqZv cw gvc Kiv nq Kx Dcvtq?

- K) Zwor msǂKZ mbv³ Kti
- L) X-ray Gi gva`tg
- M) wbdKxq tPšK Abǂvt` i gva`tg
- N) kǂ Zi½ e`envi Kti



webj PvpX gv nTz Ptj tQb| tPK Avtci Rb" wZnb wboqvgZ Ww<sup>3</sup>vtii Kv<sup>t</sup>Q hvb| tKvb GK gv<sup>t</sup>m Ww<sup>3</sup>vi  
 âfYi mW/K Ae<sup>-</sup>vb I AvKvi Rvbvi Rb" Zv<sup>t</sup>K GKwU cix¶v Kivi cavgk<sup>Q</sup> tjb| Avj U<sup>t</sup>m t<sup>t</sup>bvMândi  
 gva<sup>t</sup>g wZnb cix¶wU Kiv<sup>t</sup>jb Ges Gi gva<sup>t</sup>g Ww<sup>3</sup>vi âfY m<sup>â</sup>ú<sup>t</sup>K<sup>Q</sup> úo avibv jvf K<sup>t</sup>ib|

N) ɯgbvi Pɯpxi ci x<sup>1</sup> ɯɯ Ab<sup>2</sup> tKvb ɯPɯKrmv ch<sup>3</sup> i gva<sup>4</sup> tɔg Kiv hv<sup>5</sup> tɛ ɯK?-DĚti i <sup>-</sup> tɛ<sup>1</sup> ɯ<sup>3</sup> <sup>-</sup> ɯl |

18| AvB†mv†Uvc Kx? wPwKrmv†¶†Î GwU Kx Kv†R j v†M?



দারিদ্র্যমুক্ত বাংলাদেশ গড়তে হলে শিক্ষা গ্রহণ করতে হবে  
– মাননীয় প্রধানমন্ত্রী শেখ হাসিনা

সমুদয় কাজই সাহস ও সকলের  
ওপর নির্ভরশীল



২০১০ শিক্ষাবর্ষ থেকে সরকার কর্তৃক বিনামূল্যে বিতরণের জন্য

মুদ্রণে :