

Paper 7 Notes – Physics

Common techniques

- Check instruments for zero error
- Repeat measurements (at different places if appropriate)
- Difference methods (eg for extension of a spring)
- Eye level to avoid parallax error
- Use of marker at centre of oscillations to aid timing
- Use of set square for checking vertical or horizontal arrangements
- Interpolation of analogue scales
- Trigonometric methods for measuring angles
- Liquids should be stirred before taking a temperature with a thermometer
- Repeat readings should be taken and averaged
- For cooling curves, for example, take readings more frequently
- Thermometer readings should be recorded to 0.05 °C or less
- All readings should be recorded to the same precision

Criticism of results

- There should be at least 6 results
- Repeat readings should be taken and averaged
 - Helps identify anomalies
 - Allows an average to be taken
 - Reduces random errors
- There shouldn't be a large gap between values of independent variables → Could have more values in between
- Distance should be measured in cm rather than in m → more precise
- There must be a consistency in precision
- Range must not be too small
- Degrees should be given to nearest 0.5°
- Units given for values?

Precision of instruments

- mm scale (e.g: ruler or measuring tape) 0.50 mm
- Vernier 0.10 mm
- Micrometer 0.01 mm
- Stopwatch 0.01s → reaction time in stopping and starting stopwatch
- Angles 0.5°



Improving accuracy



- Repeating readings and calculating average
- Taking reading at eye level to avoid parallax error

- Hold apparatus vertically
- Release from rest (If it involves releasing something)
- Check for zero error
- Exclude anomalous values

Calculating uncertainty

- Obvious anomalies should be ignored in both mean and uncertainty
- Range/2
- Highest value-mean

Prefixes

Giga	$\times 10^9$	Nano	$\times 10^{-9}$
Mega	$\times 10^6$	Micro	$\times 10^{-6}$
Kilo	$\times 10^3$	Milli	$\times 10^{-3}$
		Centi	$\times 10^{-2}$
		Deci	$\times 10^{-1}$

% Loss

$$\% \text{ Loss in } x = (\% \text{ loss in } x / \text{initial } x) * 100$$

Graphs

- Scales on graphs should be appropriate
- Axes should be labeled with the quantity being plotted and its units
- Line of best fit → Straight line or a smooth curve
- Proportional relationship → Line must go through the origin, if it is expected to go through the origin but it doesn't, there could've been a systematic error
 - E.g: Extension against force should go through origin
- When finding area → Use more than half of graph, large triangle
- Advantages of graphs:
 - Enables an average result to be taken via the line of best fit
 - Graph shows anomalies
 - Allows trend to be identified
 - Allows equation to be derived
 - Systematic errors can be detected
 - Allows extrapolation
 - Gradient/intercept/area can be taken
- Straight line
 - As y increases, so does x
 - Mention any constants

Experiments

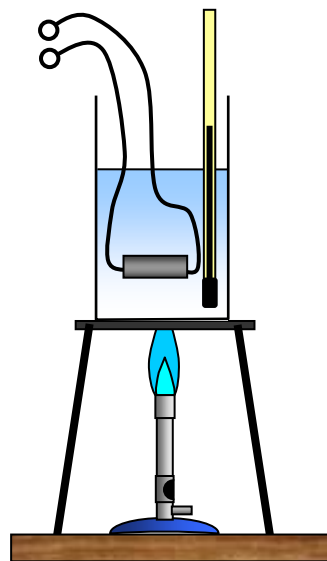
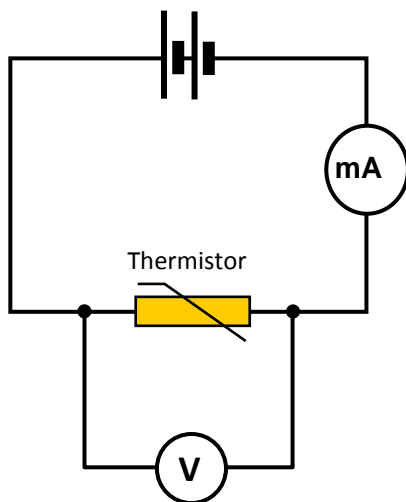
Which oil is more viscous?

- Ball bearing dropped through measuring cylinder in each oil
- Time taken for the ball bearing to fall
- **Temperature must be kept constant**
- Calculating viscosity error
 - Might not have reached terminal velocity
 - Reaction time
 - Temperature not constant
 - Measurement of diameter
 - Micrometer zero error
 - Measure of distance fallen
 - Parallax error
- Safety
 - **Use safety goggles so oil doesn't go in eye**
 - **Low risk experiment**

Determine thickness of a coin

- Use micrometer to measure thickness of x coins
- Divide overall thickness into number of coins
- Check micrometer for zero error
- Measure thickness in more than one place

Thermistor resistance variation with temperature

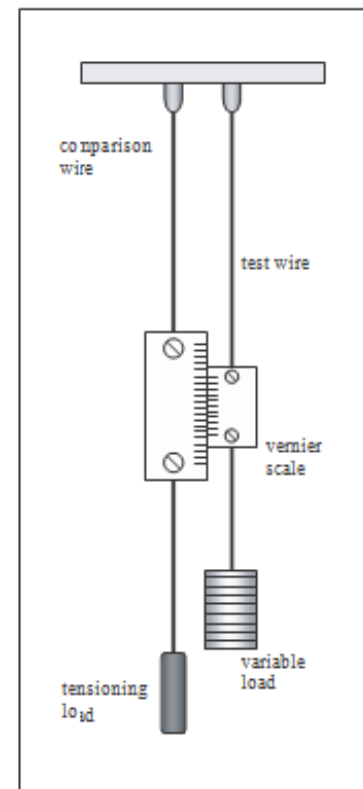


(Kettle could be used instead of Bunsen burner)

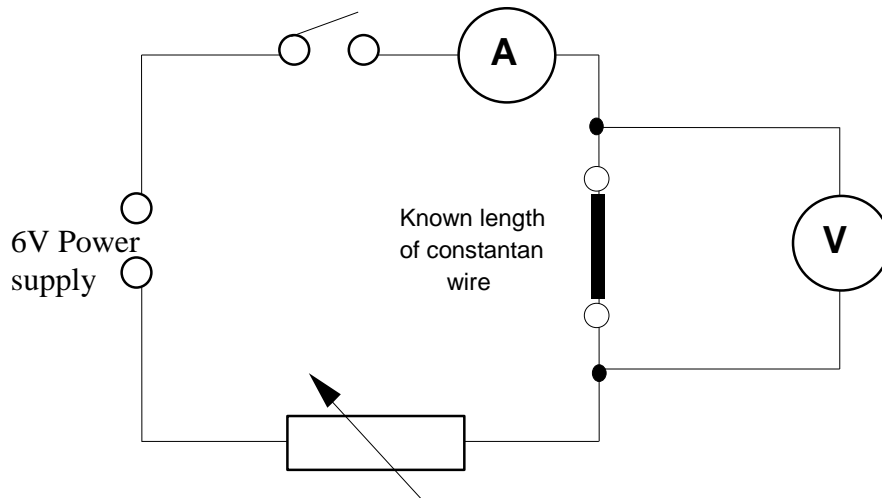
- Application → Temperature sensor
- V and I have to be measured so that R can be calculated, temperature needs to be measured too
 - R could be measured directly with an ohmmeter
 - Voltmeter and Ammeter should have correct range
- In diagram, a stirrer has also got to be drawn
- Safety
 - Don't spill the hot water
 - Don't place apparatus near edge of desk
 - Take care with Bunsen burner if used
 - Use of appropriate thermometer
- Errors
 - Simultaneous reading of both meters
 - Systematic error on thermometer
 - Parallax error
 - Zero error on meters

Young Modulus

- Micrometer needed to measure diameter of wire
- Original length, extension, diameter and force has to be measured
- = Gradient of Stress/Strain graph
- Applies to any sample of the material, whereas stiffness is to a given sample only
- Main sources of error
 - Diameter
 - Extension
- Safety
 - Goggles → Snapping wires
 - Falling masses on floor, feet



Measuring resistivity



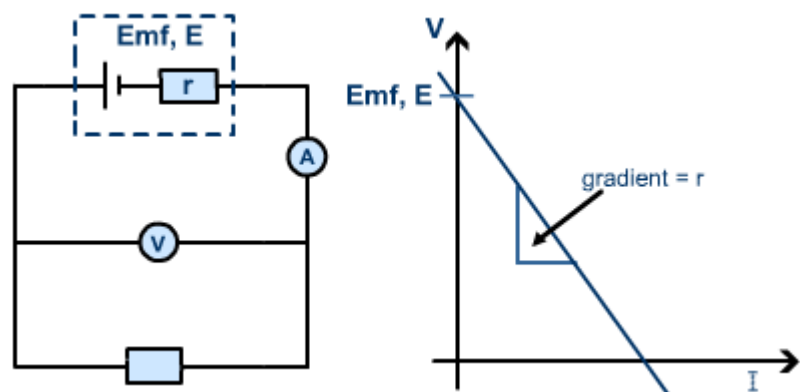
- (Contacts not required, doesn't have to be 6V necessarily)
- Measure current and voltage
- $R = V/I = \text{Gradient of graph}$
- Resistivity = RA/l
 - To find area, calculate diameter using a micrometer
 - $A = \frac{1}{4\pi d^2}$
- Sources of uncertainty
 - Diameter might have only been measured once
 - Zero error
 - Resistance of connecting wires
 - Accuracy of ohmmeter (or voltmeter + ammeter)

Finding spring constant

- Vertical length of wire with masses hung on its end
- Measure extension
 - = Final – initial length
- Safety
 - Goggles (Snapping wires)
 - Protection of feet/floor from falling masses

Internal resistance

- In addition to the circuit diagram, there should be a variable resistor
- Potential difference and current should be measured



- PD Could be measured with multimeter on voltage scale, range must be appropriate
- Graph \rightarrow V against I
 - Emf = Y-intercept
 - R = -gradient
- Error
 - Systematic/zero error on meter
 - Parallax error if analogue meter used
 - Accuracy of meters
 - Fluctuating reading on digital scale
- Safety
 - Voltage must be kept low

Datalogging vs stopwatch and thermometer

Idea	Datalogger		Liquid-in-glass + Stopwatch
Number of Readings	Advantage - large number of readings or small time interval between readings.	or	Disadvantage - small number of readings Or large time interval between readings
Graph	Advantage - drawn automatically		
Simultaneity	Advantage - simultaneous reading of temperature and time.	or	Disadvantage - reaction time (means readings are not simultaneous)
Conduction	Advantage - metal is a good conductor.	or	Disadvantage - glass is a poor conductor
Power supply	Disadvantage - power supply (or electricity) needed.	or	Advantage - no power supply required
Errors	Disadvantage - may be zero or systematic errors	or	Disadvantage - may be random, systematic or parallax errors
Transport			Advantage - easily transportable
Breakages			Disadvantage - easily broken
Cost	Disadvantage - expensive		Advantage - cheaper

Datalogging + lightgates vs stopwatch

Idea	Datalogger/light gates		Stopwatch
Comparison of errors	Advantage - fewer errors	or	Disadvantage - more errors e.g. random, systematic or parallax (not just human error)
Reaction time	No need to account for reaction time	or	Disadvantage - effect of reaction time
Precision	e.g. readings to nearest millisecond	or	e.g. insufficient precision for shortest times
Power supply	Disadvantage - power supply (or electricity) needed.	or	Advantage - no power supply required
Complexity	Needs 'training' setting up, alignment issues, time needed to set up	or	Simple to operate or to set up
Graph	Advantage - any graph could be drawn automatically	or	Any graph would have to be drawn manually
Availability, cost or transport	Not easily available Expensive Not easily transportable	or	Readily available Cheaper Easily transportable

Digital vs analogue meters

Idea	Analogue		Digital
Equipment /cost	two meters needed / may be more expensive	Or	only one meter needed / may be cheaper option
Ease of reading	two readings must be taken	Or	one reading only / fluctuates
Parallax	needs to be considered	Or	digital display / no parallax error
Systematic errors	zero errors contact resistance	Or	zero error contact resistance
Scales	fixed/ requires interpolation	Or	variable/can be changed / numeric reading
Sensitivity	limited by size of scale divisions	Or	two decimal places
Setting up	requires both series and parallel connections / additional apparatus	Or	only requires series connection / must set function switch / use correct terminals
Heating effect of current	heating may change resistance of wire	Or	unlikely to be much heating effect
Power supply	meters do not require individual batteries / but circuit needs a power supply	Or	internal battery required
Uncertainties	greater since two readings	Or	smaller since only one reading
Data	needs calculation from two readings	Or	no calculation required/direct reading
Graphical method	possible	Or	less simple for a fixed wire