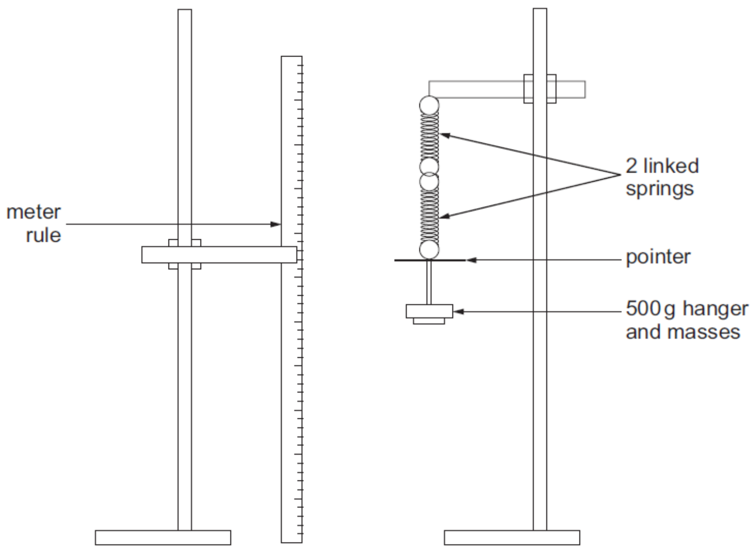
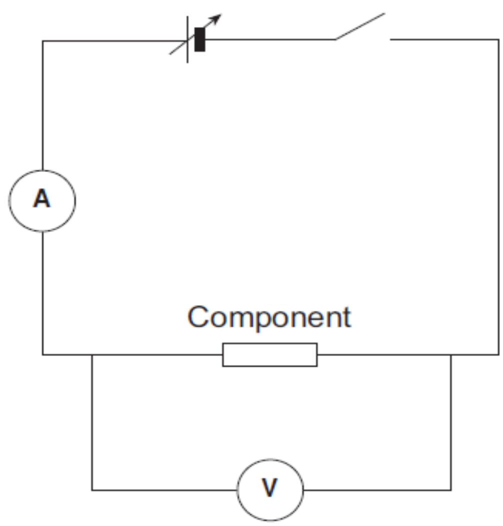
WJEC Physics Unit 5
Condense Guide
IGC HK Exam





Methods of data collection and analysis

You should be able to:

- take repeat readings where appropriate;

Safety considerations

Hazard	Risk	Control measure

Hazard - an object or chemical and the nature of the hazard

Risk - an 'action' in the method that can create a risk for a body part

Control measure - must be practicable in the context of the practical

Recording readings and significant figures

- Any data processed (calculated) from the raw data should be to the same number of significant figures (or a maximum of one extra) as the raw data.

- The number of significant figures should be consistent within a column of data.

To simplify things a general rule is that:

Processed data should be given to the same number of significant figures as raw data and raw data should always be quoted to the resolution of the instrument used to measure it

- Use the correct number of significant figures for calculated quantities. For example, if values of pd and current are measured to 2 and 4 significant figures then the corresponding resistance should be given to 2 or 3 significant figures.

Reading	**T / s**	**T^2 / s^2**
1	Down 2 sf Across	Same sf 2 sf
2	Same 2 sf	2 sf
3	sf 2 sf	2 sf

Estimating uncertainties

Estimate uncertainties using the spread of readings

Estimated Uncertainty (Resolution): i.e. $u = \frac{x_{max} - x_{min}}{2}$

Percentage uncertainties

The percentage uncertainty, p, is calculated from:

$$p = \frac{\text{estimated uncertainty (Resolution)}}{\text{mean value}} \text{ x}100\%$$

Uncertainties in calculated quantities

1. multiplying and/or dividing

e.g. If λ is calculated using $\lambda = \frac{ay}{D}$, the percentage uncertainty in λ is:

$$p_\lambda = p_a + p_y + p_D$$

2. If a quantity is **raised to a power**, e.g. x^2, x^3 or $\sqrt{x}$, the percentage uncertainty is **multiplied** by the same power.

Example: The energy, E, stored in a stretched spring is given by E= 1/2 kx^2.

So: $p_E = p_k + 2p_x$

Example of good practice

The following results were obtained when the resistance of a coil of wire was measured at different temperatures. The resistance was measured when both heating and cooling the wire so giving two sets of readings. The mean resistance was calculated using:

$$\text{mean resistance} = \frac{R_{\text{max}} + R_{\text{min}}}{2}$$

and the absolute uncertainty calculated using:

$$\text{absolute uncertainty (resolution)} = \frac{R_{\text{max}} - R_{\text{min}}}{2}$$

Systematic presentation

Consistent sig figs within each column

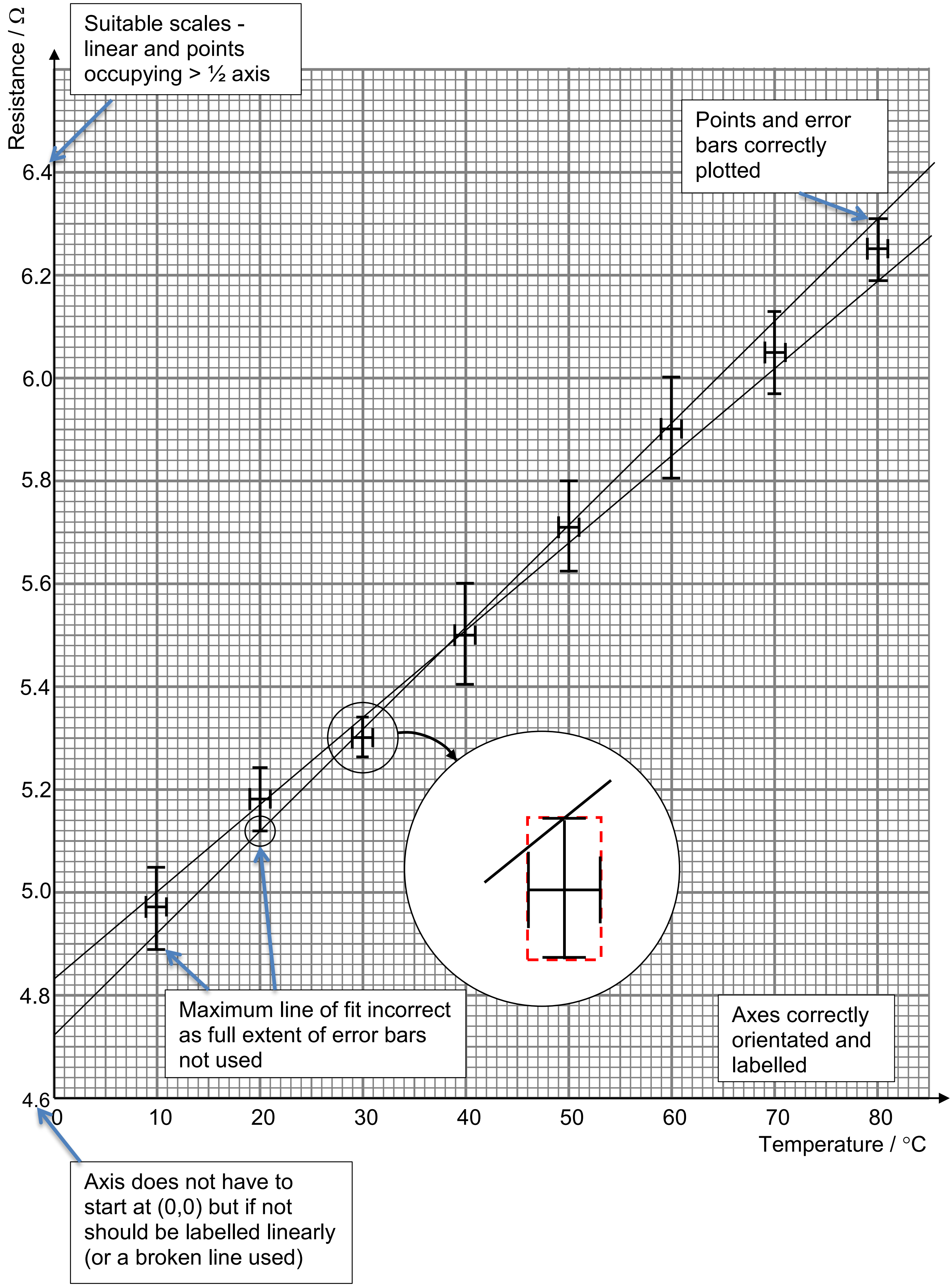
Headings given with units

Temperature $\pm$ 1 / °C	Resistance heating / Ω	Resistance cooling / Ω	Mean resistance / Ω	Absolute uncertainty / Ω
10	4.89	5.05	4.97	0.08
20	5.12	5.24	5.18	0.06
30	5.26	5.34	5.30	0.04
40	5.40	5.60	5.50	0.10
50	5.62	5.80	5.71	0.09
60	5.80	6.00	5.90	0.10
70	5.97	6.13	6.05	0.08
80	6.19	6.31	6.25	0.06

All raw data to the resolution of the instruments used

Uncertainty to 1/2 sig figs **max**

Processed data to the same number of sig. figs as the raw data



Resistance / Ω
Suitable scales - linear and points occupying > ½ axis
Points and error bars correctly plotted
6.4
6.2
6.0
5.8
5.6
5.4
5.2
5.0
4.8
4.6
0
10
20
30
40
50
60
70
80
Temperature / °C
Maximum line of fit incorrect as full extent of error bars not used
Axes correctly orientated and labelled
Axis does not have to start at (0,0) but if not should be labelled linearly (or a broken line used)

A2 Prac Exam - Tips/Example answers

Plan

The relationship between *y* and *x* can be expressed by: $y = f(x)$
Write a plan of how you will obtain sufficient readings to test this relationship.

x = independent variable *y* = dependent variable

- ***Xxxxx(x)* will be varied over the range x_{min} to x_{max}**
- ***x* will be set by…** (*explain how*) **and measured using a ……….. by ……….**
  *(state equip & how used if applicable)***.**
- **5 (or 6) readings of *x* will be taken at values: x_1 x_2 x_3 x_4 x_5 x_6 .**
- **This range was checked by taking trial readings: …** *(record 2 readings at extremes)*

- **For each value of *x*, *Yyyyy*(*y*) will be measured.**
- **y will be measured using a ……. by ………..** (*state equip & how used if applicable*).
- **Repeat readings will be taken and the mean *y* value found.**
- **The value of Zzzzzz will be calculated, for each set of readings …** (*explain how, give equation).*

If time is the independent variable the Plan can be modified as below.

- **The initial value of Yyyy(y) will be set by**… *(explain how)*
- **y will be measured by**…. *(state equip & how used if applicable)*
- **y will be allowed to vary by …** *(explain how)* **and starting the timer.**

- **5 (or 6) readings of y will then be taken at times: t_1 t_2 t_3 t_4 t_5 t_6**
  (timed using the timer, ± 1s) by… *(explain how)*
- **This range was checked by taking trial readings:** … *(record 2 readings at extremes)*
  and is a suitable range because…

- **The experiment will be repeated and the mean y value found for each time, t.**
- **The value of Zzzzzz will be calculated, for each set of readings** … (*explain how, give equation).*

Think about accuracy of measurements and if applicable, include:

- **To ensure that measurements taken are accurate, …..**

Possible methods…
Distance x will be measured at eye level, to avoid parallax error.
A marker will be used (in experiments involving position of a moving object).
Stopwatch started when mass is at the top of a cycle and stopped when 10 full cycles completed.

Include a risk assessment.

- Risk assessment: **Hazard**: ….. **Risk**: ……. **Control measure**: …..
  This may relate to safety or avoiding damage to equipment.
  It must be specific to the experiment and something that could happen.
  If applicable: **No significant risks**.

Which Graph? (may need to be included under 'Plan')

The relationship between *y* and *x* can be expressed by: $y = k\,x^n$
Rearrange this equation into the form $y = mx + c$ and explain which graph you will draw to confirm this relationship and also determine the unknown constants *n* and *k*.

- Rearrange $y = k\,x^n$ to clearly show that $\log y = n \log x + \log k$ (log base 10 or *e* acceptable)

Comparing with $y= mx + c$ …
- Plot a graph of *log y* (*y*-axis) against *log x* (*x*-axis).
- *n* = gradient ; *log k* = *y*-intercept, so $k = 10^{y\text{-int}}$ (if base 10 log used)

The relationship between *y* and *x* can be expressed by: $y = k\,e^{-nx}$
Rearrange this equation into the form $y = mx + c$ and explain which graph you will draw to confirm this relationship and also determine the unknown constants *k* and *n*.

- Rearrange $y = k\,e^{-nx}$ to clearly show that $\ln y = -n\,x + \ln k$ (log base *e* required)

Comparing with $y= mx + c$ …
- Plot a graph of *ln y* (*y*-axis) against *x* (*x*-axis).
- *n* = - gradient; *ln k* = *y*-intercept, so $k = e^{y\text{-int}}$

Example of a relationship that is not logarithmic:

The relationship between *y* and *t* can be expressed by: $y = at^2/2$
Explain which graph you will draw to confirm this relationship and determine *a*.

- Rearrange (if required). Comparing with $y= mx + c$ …
- Plot a graph of *y* (*y*-axis) against t^2 (*x*-axis).
- Gradient = *a*/2; no *y*-intercept expected / graph expected to cross through the origin.

Results Table
Using the apparatus, take sufficient measurements to complete this task.
Record your results below. State the resolution of all instruments used.

- Present **all** results (including repeat readings & mean) and calculations in a *single*, clear table.
- Include column headers with quantity and unit. (E.g. *length/cm*; *log T*- log values - no unit)
- Include equipment resolution in column headers – for measurement columns.

- Record measurements (including repeats if required) to the same number of decimal places – depending on the resolution of the equipment.
- Calculate mean values of measured quantities (*if repeats taken*) to same number of dps.

- Record all required calculated values to the same number of *sig fig* as the corresponding measurement(s). One more sig fig may be acceptable.
- *If required,* calculate absolute uncertainties for values to be plotted on graph as error bars. Include columns showing the absolute uncertainties, to 1 (or 2) sig figs, with units in header.

Graph

Draw a suitable graph.

- Label both axes with quantity and unit. (E.g. *length/cm*; *log T*- log values - no unit)
- Set out scales using sensible intervals so that plotted points occupy at least ½ of graph paper in both *x* and *y* directions. Graphs do *not* need to start from (0,0).
- Plot all points, using Xs, accurately, to nearest ± ½ small square.

Error bars are not required (this will be the case for log graphs)**.**

- Draw a single line of best fit though points.

Draw error bars if possible.

- Plot error bars in *x* and/or *y* directions, if uncertainties ± 1 small square or more.
  Add comment on graph if some/all error bars are too small to draw.
- If error bars in both *x* and *y* directions, draw error boxes.
- Draw max and min gradient lines through all error bars or error boxes, if possible.
  Note: lines need only cross corners of error boxes.

Gradient / y-intercept / calculations of constants

Find the mean gradient of your graph. Use your graph to determine a value for *n*.

- State: *n* = (-) gradient or gradient = some other constant (*non logarithmic relationship*)
- Clearly show on graph, the points used to find gradient, using extremes of line,
  - label (x_1, y_1) and (x_2, y_2)

- Calculate single gradient (or max & min gradients, if error bars used) using $m = \Delta y/\Delta x$.
  Read off values accurately (±½ small square), show calculation, give to 2/3 sig figs with units.

- If max & min gradients found,
  - Find mean gradient, using: $m_{mean} = (m_{max} + m_{min})/2$
  - Find absolute uncertainty of gradient using: $u = (m_{max} - m_{min})/2$; give units.
  - If required, find % uncertainty using: $p = u/m_{mean} \times 100$
  Give uncertainties to 1 (or 2) sig figs.

Find the *y*-intercept of your graph. Use your graph to determine values for *k*.

- State *k = ….(show how k relates to the y-intercept)*
- Read off (or calculate) *y*-intercept or max & min *y*-intercepts (if error bars used).
  Read off values accurately (±½ small square), show calculation and give units for *y*-intercept.

- If max & min y-intercept found,
  - Find mean y-intercept, using: $c_{mean} = (c_{max} + c_{min})/2$
  - Find absolute uncertainty of y-intercept using: $u = (c_{max} - c_{min})/2$; give units.
  - If required, find % uncertainty using: $p = u/c_{mean} \times 100$
  Give uncertainties to 1 (or 2) sig figs.

Explain whether your graph is consistent with the relationship given.

Yes / no, because…(*as applicable*)

- The graph was a straight line, with a positive/negative gradient
  A straight line with positive/negative gradient is expected from the equation.
- The value of the gradient was …(*state calculated value*)
  A gradient value of … is expected from the equation.

- The plotted points were very close to the line of best fit, with very little scatter (or not).

- The graph crosses the origin or has a positive/negative *y*-intercept.
  A zero/positive/negative *y*-intercept is expected from the equation.
- The value of the *y*-intercept was … (*state value from graph*)
  A *y*-intercept value of … is expected from the equation.

.. so the experiment result is *consistent* / *not consistent* with the relationship.

Explain whether your values of n/k is consistent with the relationship given.

Yes / no, because…(*as applicable*)

- The value of *n / k* found from the graph was …. (*give value*)/positive/negative.
  The value expected from the equation is.. (*give value*)/positive/negative.

.. so the experiment result is *consistent* / *not consistent* with the relationship.

Further calculations / questions

In later calculation you may be require to…

- Use the equation given, with constants you have found, to make a calculation or prediction.
- Calculate some other quantity, using constants or gradient/*y*-intercept values found.
- Calculate uncertainty values for some other quantity, by combining uncertainties of gradient/ *y*-intercept values.

Use your value of gradient in preference to values measured and recorded in table .
Show your method clearly and give units. Give uncertainties to 1 (or 2) sig figs.

In later questions you may be asked about:

- The limitations of your measurements or the results.
  - Think about the *equipment/methods* of measuring - could these be improved by using equipment with better resolution or a different method (automated method)?
  - Think about the *range* of readings taken – the experiment only confirms a relationship over the range included. The relationship may not be true outside this range.
- The *reliability* of your results - look at the scatter of points on your graph and comment (little scatter = reliable; a lot of scatter = unreliable).
- The cause of any systematic error in your results or reasons for a difference between expected values and experimental values (e.g. presence of air resistance/friction, additional mass of equipment etc).

Plan

- Rearrange to find linear relationship *eg: ln y = n ln x + ln k*
- State what to plot *eg: ln y against ln x*
- Determine value *slope = n, y intercept = ln k*
- Describe measurement taken, *eg: Time with stopwatch, Length with ruler, Voltage reading with voltmeter, Change pd by varying resistance, Use 10T of oscillation and small angle, Extension = Original – Final Length, Reduce parallax error*
- Range *eg:* X_{max} *= 10cm Y = 10s* X_{max} *= 100cm Y = 20s*
- List out values taken *eg: 10, 20, 30, 40, 50 cm taken (5 set)*
- Repeat each set of value and take mean

Final Reminder Notes

- In a table, write down what you measure eg Ruler measure 10cm, **don't** concert to m
- $\frac{4}{3}\pi r^3$ ← sphere volume
- πr^2 ← wire volume
- Remember to state range in plan x_{max}, x_{min}, y_{max}, y_{min}
- If answer ask changes, answer in terms of n, k
- Uncertainty = $\frac{ymax - ymin}{2}$
- If uncertainty is ≤0.1 eg: 0.00 ← then use resolution eg 0.1
- Gradient must state unit
- Absolute uncertainty & Percentage uncertainty 1–2sf
- Risk Assessment: Hazard + Risk + Control (eg G clamp)
- Calculate u^2 (uncertainty squared) → **uncertainty x 2 x mean**
- Zero error: Instrument that isn't reset zero
- Describe: Straight Line, Constant positive gradient, Positive y-intercept, Line straddle the origin, Line pass through all error bars (All points close to line of best fit)
- Reduce uncertainty → Use an improved resolution apparatus / Increase range of values measured
- When calculating gradient, look at axis of graph m → $\times 10^{-3}$
  u → $\times 10^{-6}$
- Same number of **significant figure** down + across [V→ln V] *(not dp)* But down the column, same dp, can go up by 1 sf max
- Damped oscillation: Avoid parallax error by bending down

Equations

Mean = $\frac{x1+x2}{2}$

Uncertainty / Resolution = $\frac{Xmax - Xmin}{2}$

Uncertainty = 2 x Uncertainty

Percentage Uncertainty = $\frac{Uncertainty\ /\ Resolution}{Mean} \times 100$

Absolute Uncertainty = $Mean \times \ Percentage\ Uncertainty$

WJEC 2026 Physics Practical

- 1.1 Basic physics
- 2.2 Resistance
- 3.2 Vibrations

Measurement of the Density of Solids

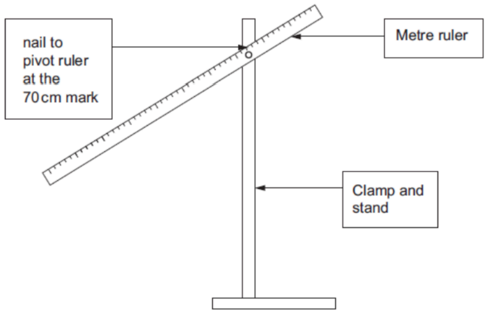
- Ruler (resolution ±0.1cm)
- Micrometer (resolution ±0.01mm)
- Balance (resolution ±0.1g)

No Significant Risk

Experimental Method

- Rectangle: V = l × w × h
- Sphere $V = 4/3\ \pi r^3$
- $$\rho = \frac{m}{V}$$
- Repeat for each set of data and take mean

Determination of Unknown Masses by Using the Principle of Moments



- Meter rule
- Clamp and stand
- Nail
- 200g mass and hanger
- 150g mass (unknown mass) and hanger
- Loops of thread

Hazard	Risk	Control measure
Nails have sharp ends	Nails can cause nasty cuts if they penetrate the skin.	Wear gloves and/or hold nail with pliers

moment = force x perpendicular distance from pivot

Method:
- Find the 70cm mark and nail the ruler to the clamp
- Place the looped 200g mass and adjust until the ruler is horizontal
- Measure the distance *l* from the pivot
- Replace the 200g mass by the unknown mass and adjust the ruler until it is horizontal
- Repeat for each set of data and take mean

Calculation:

$$0.20 \times \text{metre rule weight} = l \times 1.96$$

(distance from pivot to CoM of ruler × meter rule weight = distance of 200g mass to pivot × 200g / 0.2kg mass × 9.81)

In this first part, *l* is measured to determine meter rule weight

$$0.20 \times \text{metre rule weight} = d \times \text{unknown weight}$$

- Measure the distance d when it is horizontal with the unknown weight
- Recall the meter rule weight in part one to determine unknown weight
- Convert the weight into mass by dividing 9.81 → mass is in kg
- *You can check the mass on a top pan balance*

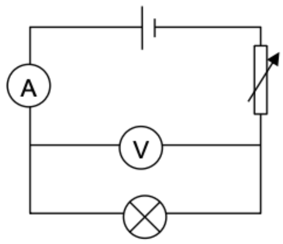
Investigation of the I–V Characteristics of a Filament Lamp and a Metal Wire at Constant Temperature

Theory:

- Ohm's law: *I* is directly potential to *V*
  Provided physical factors such as temperature and pressure remains constant
- Graph of *I* against *V*

Apparatus:

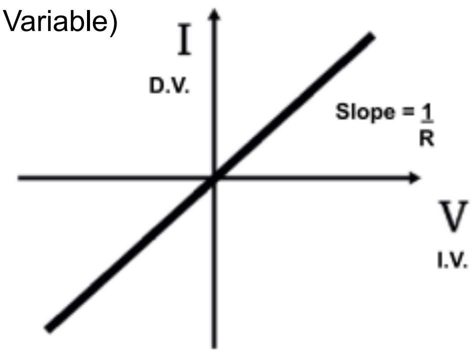
- D.C. Voltage Supply
- Ammeter
- Voltmeter
- Filament bulb 12V, 24W bulb or a metal wire 1m mounted on a wooden batten
- Variable Resistor



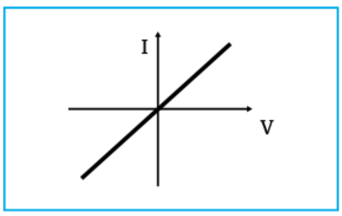
Hazard	Risk	Control measure
Hot resistor can burn	If the resistor is touched whilst taking measurements it will burn [skin]	Use the switch between taking measurements / let resistor cool before touching

Method:

- Adjust variable resistor to change resistor and record *V* and *I*
- Power = VI $\quad R = \frac{V}{I}$
- Repeat for 5 voltages and 3 times each take mean
- Voltage (independent variable) & Current (Dependent Variable)

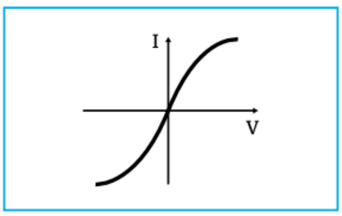


Resistor or wire
(At a constant temperature)



Constant resistance = obeys Ohms law

Filament lamp



Resistance increases at higher voltages

Doesn't obey Ohms law because the temperature of the lamp changes.

Reference: 2018 1A, 2023 1A

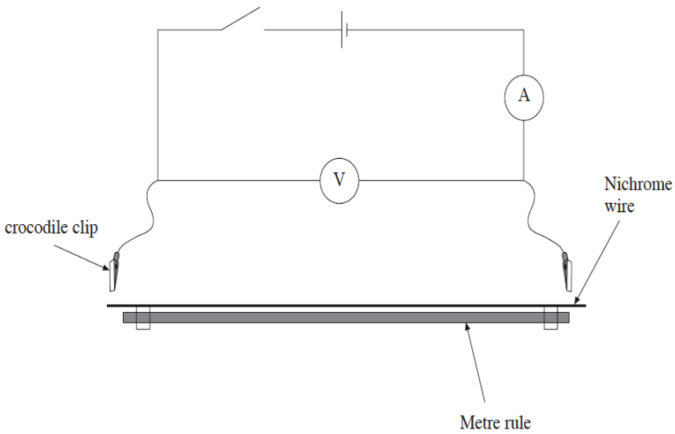
Determination of the Resistivity of a Metal Wire

$$R = \frac{\rho l}{A} \qquad A = \pi r^2 h$$

Theory:

- *R* (y axis) against *l* (x axis) where gradient is $\frac{\rho}{A}$

No Significant Risk



Method

- One crocodile clip fixed at one end of wire and the other one moved along at suitable intervals (10cm) to cover whole range of wire
- Reading of voltmeter and ammeter should be recorded for each length
- $R = \frac{V}{I}$. to determine resistance
- Area of wire could be found using a micrometer $A = \pi r^2$
- Plot a *R* (y axis) against *l* (x axis) graph where gradient is $\frac{\rho}{A}$

Reference: 2024 1A, 1B

Investigation of the Variation of Resistance with Temperature for a Metal Wire

Theory:

- Resistance increase with temperature for metal in a linear relationship

Hazard	Risk	Control measure
Hot water	Hot water can cause severe burns	Students should wear eye protection and should handle apparatus with tongs.

Experiment Method:

- Place a copper coil with ⅓ filled with oil and ensure the coil is completely immersed in the oil
- Connect an ammeter in series with coil
- Place the boiling tube in a water bath
- Place a thermometer in the beaker / water bath
- Fill the water bath with ice water (50% cold water + 50% ice)
- Record the resistance at interval of 10°C by heating it
- Repeat the record when water cools
- Repeat and take mean

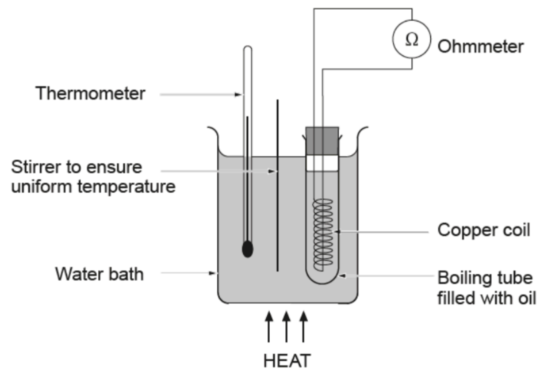
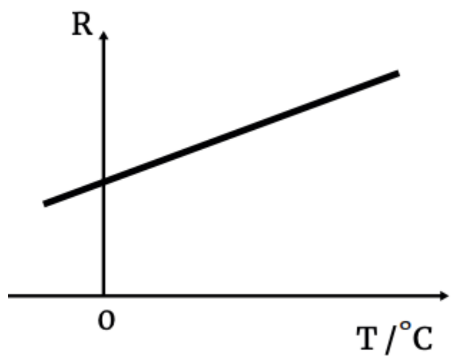


Table:

Temperature (°C) (Resolution ±0.1°C)	Resistance heating / Ω (±0.1Ω)	Resistance cooling / Ω (±0.1Ω)	Mean resistance / Ω

- Plot a graph of resistance against temperature → straight line



Measurement of g with a Pendulum

Theory:

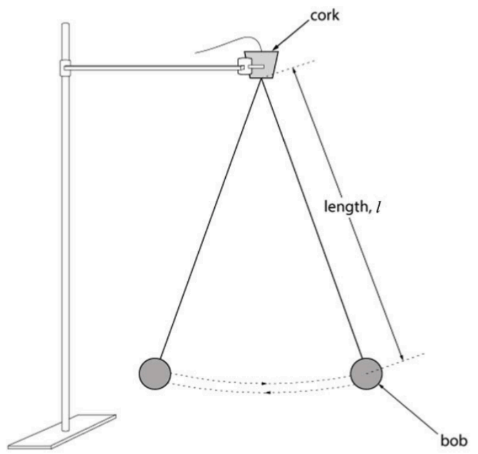
$$T = 2\pi\sqrt{\frac{l}{g}} \qquad T^2 = \frac{4\pi^2}{g}l$$

Hazard	Risk	Control measure
Clamp stand can topple	Injury from clamp stand toppling when in use	Securely clamp the stand

- Attach the pendulum bob to the string and clamp it between two small wooden blocks
- Measure length *l* from point of suspension to the center of mass of the pendulum bob
- Preform trial with min max length and period recorded
- For each length, take 10 period oscillation → divided by 10 to get time for 1 period
- Adjust the length of pendulum by drawing the thread through the cork
- The pendulum should oscillate in small amplitude (small angle approximation) and straight line
- Plot T^2 against *l* and gradient is $4\pi^2/g$ → determine g
- Repeat with different lengths and multiple reading for each to determine mean

Table:

***l* / cm ±0.1cm**	**10T / s ±0.1s**			**T / s**	**T^2 / s^2**
	R1	**R2**	**Mean**		

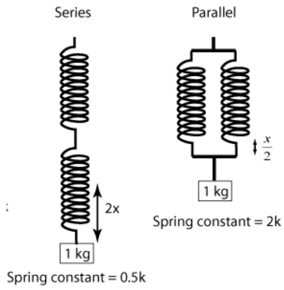


Investigation of the Damping of a Spring

Theory:

$$A = A_0 e^{-\lambda t}$$
$$\ln A = -\lambda t + \ln A_0$$
$$y = mx + c$$

$$T = 2\pi\sqrt{\frac{m}{k}}$$

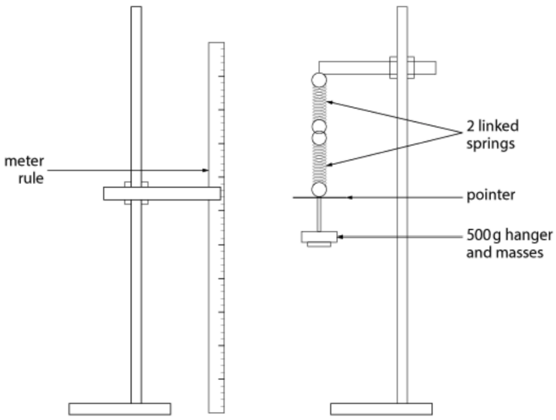


Hazard	Risk	Control measure
Clamp stand can topple	Injury from clamp stand toppling when in use	Securely clamp the stand

Method:
- Place the 500g mass on the spring system and attach a pointer so the value can be read on meter rule
- Displace the mass by 2.5cm and start stopwatch
- Record the amplitude for 8 minutes with 1 minute interval each
- Repeat two more times and find mean amplitude
- Plot a graph of ln A against time, slope of graph is -λ

Table:

t / s (±1s)	A / cm (±0.1cm)			ln (A / cm)
	R1	R2	Mean	



Reference: 2019 1A

Examiner only

Your task is to carry out an investigation to see how the amplitude, A, of vertical oscillation of a mass hanging from two springs in series varies with time, t.

You are provided with the following equipment

- 500g hanger and masses
- 2 linked springs
- pointer
- split cork
- 2 clamps and stands
- G-clamps
- Metre rule
- Stopwatch
- Sticky tape

Write a plan of how you will obtain sufficient readings to investigate this relationship.

Include a labelled diagram with your plan, and justify all values chosen. [You are advised not to stop the timer as you record readings.] [5]

Question		Marking details	Marks Available
(a)		Labelled diagram – springs shown approx vertical, securely attached vertical rule, weight shown on spring. (1) Method to avoid parallax [or shown on diagram]. (1) Suitable range of time intervals used which allows the amplitude to decrease by at least 50% and at least 5 equally spaced readings. (1) Justification of the choice of range provided by a statement in the method not just implied from results. (1) e.g. I plan to take these readings because they will show the amplitude decaying by at least half. Suitable initial amplitude, A_0 - minimum 10 cm. (1) [Remember to indicate in the box whether the information sheet has been given and not to award the marks if it has been issued].	5

IGC HK Exam - WJEC

GCE Physics Unit 5 Condense Notes

Though the resources are comprehensive, they may not cover every aspect of the specification and do not represent the depth of knowledge required for each unit of work.

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