Precision

- Ammeter — 0.01A
- Voltmeter — 0.05V
- Thermometer — 0.5C
- Metre ruler — 0.1cm or 0.001m
- Protractor — 1 deg
- Measuring cylinder — 0.5cm3
- Spring balance —0.1N(for 0-10N), 0.01N(for 0.10N)
- Stopwatch — 0.1s
- Mass — 0.1g

When asked to obtain average value, must draw out table of at least 3 different values and calculate average (follow dp)

When asked to find period, find average of time taken for 20 oscillations, then divide by 20 again

Graph

- axis, scale, points, best fit, trend, range
    - Plot at least 5 readings for straight line and 8 readings for curve
- Readings interpreted from graph should be read to half of the smallest square
- MUST ALWAYS HAVE ORIGIN

Table

- Headings
- Processed data follow sf of raw data
- Dp of raw data follow instrument (must be same throughout the column)
- Range must be more than 50% of instrument, eg metre ruler range must be more than 50cm

Relationship between x and y

- X is linearly related to y, with negative/positive gradient
- Directly proportional
- As x increases, b decreases at at a decreasing rate

Precautions

- [measurements] eye must be placed vertically above the scale when reading the ruler/protractor to avoid parallax error
- [measurements] take reading over a few points and find average value
- [pendulum] take 2 sets of readings per interval for 20 oscillations and find the average by dividing by 20
- [pendulum] the time for the first few swings should not be taken and only start timer when oscillations are steady

- [measuring volume of irregular solid] make sure solid is dry before lowering into liquid and ensure no liquid spillage or splashes when lowering the liquid
- [circuits] circuit must be switched off when not in use so that heat is not produced in the resistance wire and also to conserve the emf of the batteries

Source of error

- [mechanics] the time taken for the oscillation is too short, causing inaccuracy in the timing due to human reaction time to be significant
- [mechanics] difficulty to read the markings on the ruler as the strings with the loads are swaying
- [mechanics] difficult to judge the exact position of where the metre rule is clamped
- [mechanics] the difficulty to judge the position of the loop to be just above the ruler
- [moments] the diameter of the pivot is large and errors will arise when drawing the lines to join the center to the pivot, making the centre of gravity located inaccurate
- [moments] the string used to make the plumbline is too thick, when 2 points are marked on the lamina, its centre is difficult to locate to draw the line through
- [moments] the card is light and keeps oscillating with the slightest movement of air, making it difficult to mark the 2 points on the card. This affects the accuracy of the line drawn and thus the centre of gravity located
- [heat] there is heat loss to/gain from the surroundings hence leading to inaccurate values of
- [light] the holes created by the pins are too large as the pin is too thick, this makes the centre of the pin hard to locate and makes drawing the line inaccurate and affect reading. Use a thinner pin such that the holes created are smaller so that locating the center of the holes to draw line through the center of the 2 relevant points are easier
- [light] (for determining sharp image)there is a range of values of v in which the image of the object for a particular value of u, appears sharp. This will affect the accuracy of the v value and hence affect the accuracy of 1/v. Therefore, the focal length obtained from the graph will be inaccurate
- [light] when the board is shifted, the mirror tends to be off aligned from the drawn line, this will cause the pins aligned to be off. Hence the line drawn through the hole will be inaccurate thereby affecting the value of
- [light] Pins are placed at least 5 cm apart, to reduce uncertainty when aligning the pins, and determine a more accurate path travelled by the incident ray. This will give a more accurate r value
- [light] Place my eyes level with the glass block and when performing alignment of the pins, to avoid parallax error and to obtain a more accurate r value
- [circuits] as current increase when rheostat is adjusted, temperature of resistor might increase, causing resistance of resistor to change and thus affecting the value of the current and potential difference recorded
- [circuits] when the circuit is closed for too long, the heating effect of the current on the resistance wire will increase, this will affect the total resistance of the circuit and hence affecting the readings on the ammeter and voltmeter

- [circuits] the point of contact between the wire and the jockey is not consistent due to different amounts of pressure applied. This will affect the ammeter reading as the ammeter needle keeps fluctuating when the pressure applied on the wire by the jockey varies
- [circuits] the cross sectional area of the resistance wire may not be uniform, so the resistance of the wire involved may not be proportional to its length, this will affect the accuracy of the current obtained when L is varied
- [circuits] there may be kinks on the resistance wire, this will affect the length of the wire recorded as the presence of kinks on the wire will cause the actual length to be longer than what is recorded
- [circuits] the emf of the battery might have changed after first student has done the experiment
- [circuits] both wires cannot be straightened, causing the value of r recorded to be inaccurate
- [circuits] the clips at the ends of both wires may not be exactly at the edge of the tape, causing reading of r recorded to be inaccurate
- Perception of motor turning slowly is subjective so might end up with different speed of rotation

Within its limits of experimental error…

Qns

- Explain why measuring the time for 20 oscillations, rather than 1 oscillation gives a more accurate value of T
    - It reduces human reaction time error as when there are more oscillations, the human reaction time error can be divided with a larger multiple, thus each oscillation will have reduced human reaction time error
- Describe one precaution that you have taken to ensure that the readings are accurate (for spring extension practical)
    - Ensure that when the spring balance is held vertically, the reading on the spring balance is 0.0.N
- How to determine thickness of the wire of the spring used (for spring extension practical)
    - Using a 30cm ruler, measure the length of the spiral spring and record it down. Then count the number of coils of wire the spiral spring has. Divide the total length of the spiral spring by the number of coils to find the thickness of the wire
- Using the half metre rule provided, describe how you can check to ensure that the rule is horizontal (for principle of moments practical)
    - Place the shorter side of the ruler on the retort stand, and ensure that the half metre rule is perpendicular to the ruler and parallel to the markings on it
- Explain how you check that G is the centre of gravity of the lamina (for determining centre of gravity of irregular object)
    - Balance the card at the tip of the pen and check whether the card balances horizontally when the pen is at the point of intersection G

- What is a precaution to take when drawing a line on the lamina
  - Ensure that the lamina is stationary before the line is drawn. When the lamina is initially hung on the metal rod, the weight is not acting through the pivot, thus a moment is produced, causing the lamina to oscillate
- Describe how you would measure the mass of 1 steel bearing
  - Empty all 20 ball bearings from the plastic bottle. Place the empty plastic bottle on the scale and tare the value such that it is 0.0g. Without moving the position of the plastic bottle, place all 20 ball bearings in the plastic bottle still on the electronic balance. Take down the new reading on the reading scale. Divide the reading by 20.
- Why does water have to be stirred when the heated metal sample is submerged in it
  - this is to ensure that the heat is distributed evenly in order to obtain an accurate temperature of the water after the hot metal was submerged
- Why must resistance of the rheostat be at its maximum at the start of the experiment?
  - With the rheostat at its maximum, the current through the ammeter will be the least, this prevents the ammeter from being damaged by the higher than expected current.
- Describe the process and techniques used to ensure a focused image of the triangle forms on the screen
  - Arrange the torch, the lens combo and the screen such that they are formed in a straight line by adjusting the height of the torch. After fixing the torch and lens positions, move the screen until a relatively clear and sharp image is formed. Note this screen position. Continue moving the screen in the same direction until the image just becomes blurred and note the position of the screen. The midpoint of the above 2 screen positions will produce the most focused image.
- How to ensure circular loop of string is horizontal
  - Using the lab bench as a reference, measure both ends of the metre rule from the top of the bench. The height of both ends should be the same
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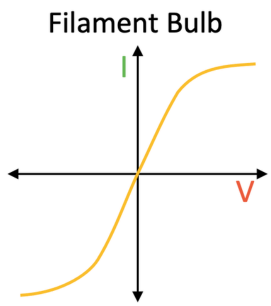
Planning

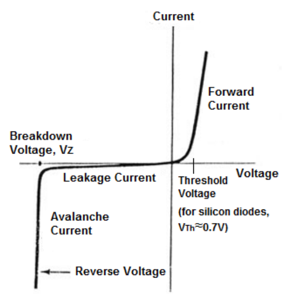
- When asked to investigate relationship between X and Y, MUST draw graph X against Y eg investigate relationship between R and I, graph must be R against I
- Marking points:
  - Identifying independent variable, dependent variable and control variables (give at least 2)
  - Describing precautions to obtain accurate and reliable readings
  - Describing how dependent variable is measured, and how independent variable is varied
  - Describing the graph plotted
- Format
  1. begin with identifying variables (control variables are factors that can affect the measurements directly)
  2. State precautions

3. Carrying out the actual experiment, must state clearly which steps are repeated, the change in the independent variable, the number of times to repeat
    - Eg repeat steps 3 to 8 with different distances between cross-wire and lens to obtain five further values of magnification m
4. Identify the graph plotted
    - Plot a graph of magnification m against image distance v

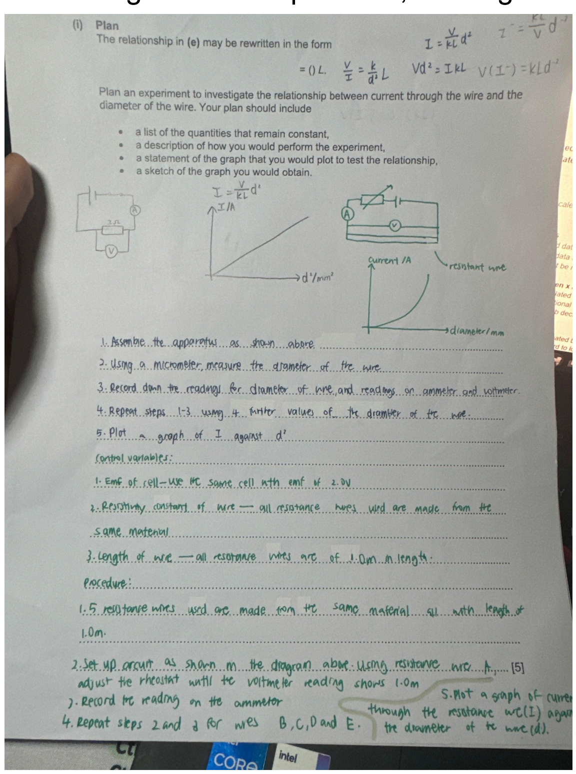
- [circuits] set up the circuit as shown in the diagram, using cell of emf of 2.0v
- [circuits] when keeping emf constant, use variable resistor: adjust the rheostat until the voltmeter reading shows 1.00v

Graph sketches





For R against I, graph increases at decreasing rate coz the higher the temperature, the larger the amount of thermal energy lost to the surrounding



(i) Plan
The relationship in (e) may be rewritten in the form

$I = \frac{V}{kL} d^2$ $I^{-} = \frac{kL}{V} d^{-2}$

$= () L.$ $\frac{V}{I} = \frac{k}{d^2} L$ $Vd^2 = IkL$ $V(I^{-}) = kLd^{-2}$

Plan an experiment to investigate the relationship between current through the wire and the diameter of the wire. Your plan should include

- a list of the quantities that remain constant,
- a description of how you would perform the experiment,
- a statement of the graph that you would plot to test the relationship,
- a sketch of the graph you would obtain.

$I = \frac{V}{kL} d^2$

I/A

d²/mm²

Current /A

resistant wire

diameter/mm

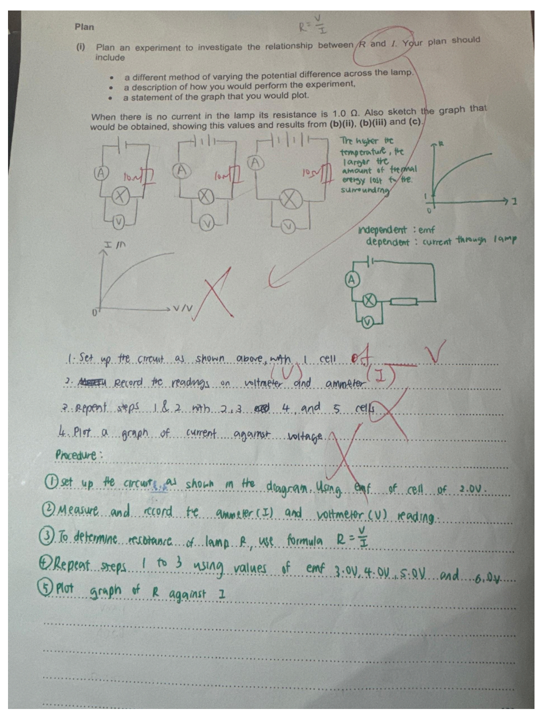
1. Assemble the apparatus as shown above
2. Using a micrometer, measure the diameter of the wire
3. Record down the readings for diameter of wire, and readings on ammeter and voltmeter.
4. Repeat steps 1-3 using 4 further values of the diameter of the wire.
5. Plot a graph of I against d²

Control variables:

1. Emf of cell – use the same cell with emf of 2.0V
2. Resistivity constant of wire — all resistance wires used are made from the same material
3. Length of wire — all resistance wires are of 1.0m in length.

Procedure:

1. 5 resistance wires used are made from the same material all with length of 1.0m.
2. Set up circuit as shown in the diagram above. Using resistance wire A, adjust the rheostat until the voltmeter reading shows 1.0m [5]
3. Record the reading on the ammeter
4. Repeat steps 2 and 3 for wires B, C, D and E.
5. Plot a graph of current through the resistance wire (I) against the diameter of the wire (d).



Plan $R = \frac{V}{I}$

(i) Plan an experiment to investigate the relationship between R and I. Your plan should include

- a different method of varying the potential difference across the lamp.
- a description of how you would perform the experiment,
- a statement of the graph that you would plot.

When there is no current in the lamp its resistance is 1.0 Ω. Also sketch the graph that would be obtained, showing this values and results from **(b)(ii)**, **(b)(iii)** and **(c)**.

10Ω 10Ω 10Ω

The higher the temperature, the larger the amount of thermal energy lost to the surrounding

R

1

0

I

independent : emf
dependent : current through lamp

I /A

0

V/V

1. Set up the circuit as shown above, with 1 cell of
2. ~~Measu~~ Record the readings on voltmeter (V) and ammeter (I)
3. Repeat steps 1 & 2 with 2, 3 ~~and~~ 4, and 5 cells
4. Plot a graph of current against voltage

Procedure:

1. set up the circuit as shown in the diagram. Using emf of cell of 2.0V.
2. Measure and record the ammeter (I) and voltmeter (V) reading.
3. To determine resistance of lamp R, use formula $R = \frac{V}{I}$
4. Repeat steps 1 to 3 using values of emf 3.0V, 4.0V, 5.0V and 6.0V
5. Plot graph of R against I

$$T = \frac{Wx}{z} + \frac{W_R y}{z}.$$

Using the same apparatus as in Fig. 1.2, plan an experiment to investigate this relationship.

Your plan should include

- a list of the quantities that remain constant,
- a description of how you would perform the experiment,
- a statement of the graph that you would plot to test the relationship,
- an explanation of how W_R would be found from the graph.

Suggested solution:

$$T = \frac{W}{z}(x) + \frac{W_R y}{z}$$

Notice that this equation is derived from the one in **(c)**.

$$\Rightarrow y = mx + c$$

where: y = T (upward force exerted by spring)
x = x (distance between pivot and loop of string)
gradient, m = $\frac{W}{z}$
y-intercept, c = $\frac{W_R y}{z}$

List of quantities that remain constant [1]

1. W (weight of mass M)
2. y (distance between pivot and centre of mass of metre rule)
3. z (distance between pivot and S-hook)

Description of how to perform the experiment [2]

State brief, concise steps

- How to vary and measure x-axis variable:
  Shift the mass along the ruler and adjusting the position of the height of the boss on stand A so that the metre rule is horizontal.
  Record the value of x by reading off the metre rule.
- Measure y-axis variable:
  Record the corresponding value of L_1, and find the extension of the spring, e, by subtracting L from L_1.
  Find the corresponding value of T using $T = ke$, where k is the spring constant (= 0.25 N/cm).
- Take 5 sets of values (for straight lines), with a wide range of x.

Statement of the graph plotted to test relationship [1]

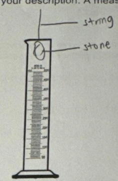
Plot T (y-axis) against x (x-axis).

Explanation of how W_R would be found from graph [1]

$$y\text{-intercept} = \frac{W_R y}{z} \Rightarrow W_R = \frac{(y\text{-intercept})(z)}{y}$$

(B) You are provided with a measuring cylinder, an irregular-shaped solid (solid that will sink and is small enough to go inside the measuring cylinder) and some thread.

Describe a simple experiment to show how you will determine the density of this solid. Use suitable diagrams to help in your description. A measuring cylinder has been drawn for you.



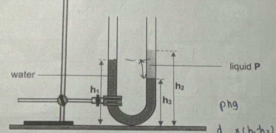
1. Add 50.00cm³ of water into the empty measuring cylinder.
2. Tie the thread around the rock.
3. Lower the stone into the measuring cylinder filled with water until the stone touches the bottom of the measuring cylinder.
4. Read the new reading of the measuring cylinder, make sure it is at eye level when reading.
4. Subtract 50.00cm³ from the new reading, that is the volume of the stone
5. Place the stone on an electronic balance with a 0.0 tared value to find the mass of the stone, record it as grams
6. By dividing the mass of the stone with the volume of the stone, the density can be found.

In this experiment, you will determine the density of an unknown liquid labelled P, using the principle of hydrostatic pressure.

You have been provided with a retort stand, U-tube, dropper, a 50-cm rule, Set-square, water, unknown liquid P.

(a) Clamp the U-tube in a stand and pour water into the tube until the water level is about half-way up each side.

(b) Liquid P floats on water. Using a dropper, carefully add some of liquid P to the right hand side of the U-tube until there is about 4.0 cm height of liquid P in the tube. The levels of water will now be different in each side of the U-tube, as shown in Fig. 1.1.



ρhg

$d_1 \times (h_1 - h_3) = d_2 \times (h_2 - h_3)$

Fig. 1.1

? (i) Draw on Fig. 1.2 to show how you check if the U tube is vertically positioned on the table before you clamped it to the retort stand. [1]

(ii) Draw on Fig. 1.2 to show how the value h_2 can be measured accurately from the apparatus provided. [1]

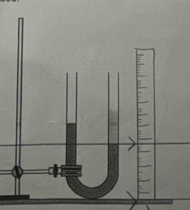


Fig. 1.2

flat on the surface

(c) Measure and record the heights h_1, h_2 and h_3.

h_1 = 9.0cm

h_2 = 10.0cm

h_3 = 6.0cm [1]

(d) Determine the difference in heights of the liquid, $h_1 - h_3$ and $h_2 - h_3$ respectively.

$h_1 - h_3$ = 3.0cm

$h_2 - h_3$ = 4.0cm [1]

(e) Using a dropper, repeat **(b)** and **(c)** for further heights of liquid P. You may add about 1.0 cm more of liquid each time.

Record your results for h_1, h_2, h_3, $(h_2 - h_3)$ and $(h_1 - h_3)$ in a table. [4]

Amount of liquid P added/cm	h_1/cm	h_2/cm	h_3/cm	(h_2-h_3)/cm	(h_1-h_3)/cm
4.0	9.0	10.0	6.0	4.0	3.0
5.0	9.5	10.5	5.5	5.0	4.0
6.0	9.9	11.0	5.0	6.0	4.9
7.0	10.0	11.5	4.5	7.0	5.5
8.0	10.6	12.0	4.0	8.0	6.6
9.0	11.0	12.5	3.5	9.0	7.5

(f) Plot a graph of $(h_1 - h_3)$ against $(h_2 - h_3)$ using a sheet of graph paper. Draw the best straight line through your plots. [3]

(i) Which variable is represented on the x-axis? $(h_2 - h_3)$

(ii) Which variable is represented on the y-axis? $(h_1 - h_3)$ [1]

(g) Determine the gradient of the line. You are to show relevant workings on the graph and report. The value calculated is the density of the unknown liquid P in g/cm³.

$$\text{gradient} = \frac{\text{rise}}{\text{run}} = \frac{7.5 - 3.0}{9.0 - 4.0} = 0.9$$

sf

Draw △ on graph.

☐ https://document.grail.moe/a2bef972f81e4254bd1609ebbd54da40.pdf

Plan an experiment to find out if current and length affects the angle of deflection

a. Relationship between angle and current

Controlled variable: diameter of the glass tube or diameter of the coil of wire and the gap distance between any 2 consecutive turns of the coil

Procedure:

1. Keep the length of coil L fixed at 7.0cm
2. Set up the circuit as shown in Fig2.2 with the fix resistor replaced by a variable resistor.
3. Place the protractor directly above the compass and align the zero degrees of the protractor with the compass needle
4. Close the switch and adjust the variable resistor to its maximum value. Record the ammeter reading, I
5. Measure and record the angle of reflection of the compass needle
6. Repeat steps 4 and 5 for four more currents by decreasing the resistance of the variable resistor
7. Plot the graph of tita against I

b. Relationship between length of coil and angle of deflection

Procedure:

1. Coil the wire on the 5 identical tubes such that the coil length, L is 4cm, 5cm, 6cm, 7cm and 8cm. Ensure that the gaps between any consecutive turns of each coil are of the same distance.
2. Using the coil length of 4cm, connect the circuit as shown in Fig2.2, replace the fix resistor with a variable resistor
3. Place the protractor directly above the compass and sign the zero degrees of the protractor with the compass needle
4. Close the switch and adjust the variable resistor until the ammeter reads 0.20A
5. Measure and record the angle of reflection of the compass needle
6. Repeat steps 2 to 5 using the other 4 coils of different lengths
7. Plot graph of tita against L

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