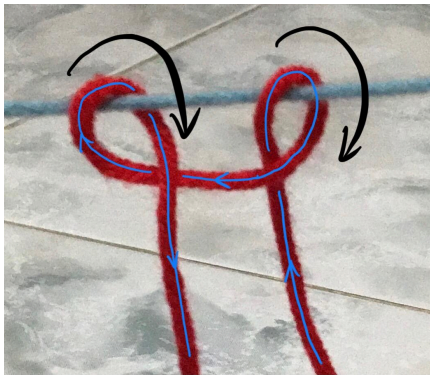
H2 Physics Practical

Preparation

- Bring curve ruler

Setting up

- Experiments involving string
    - Tying knots
    - Step 1 is always to make too thin string thicker, so 2 ply it.
    - If u want string to be movable, 1 knot will do
    - If u want string to be unmovable, do not tie a dead knot. Method 1: 1 knot by hanging string around taut string, followed by 1 knot by taut string around hanging string.
    - Alternatively, clove hitch: suitable for both movable and unmovable purposes. 2 clockwise loops.



- Retort stand
    - Note perspective as drawn in diagram
    - See if ur supposed to hang stuff from the boss or from the clamp
    - Boss is the small thing that is attached to the retort stand neck directly
    - Clamp is the additional thing kiaped onto the boss, has a rod and has pincers

- Circuits
    - Multimeters used as ammeters are set up together with circuit cuz it is part of the circuit

    - Multimeters used as voltmeters are set up at the very end cuz it is a lone wolf
    - Multimeters used as resistor: start with lowest resistance setting. “1.” means setting is too low. Turn it up.

Measurements

- Length
    - May not always be vernier caliper. Is the object small enough? Ruler.
    - Vernier caliper
        - Zero error = 0.00 cm (2dp)
- Repeat if:
    - Recording time
    - Using vernier caliper/micrometer screw gauge
    - Large possible error
        - Eg flimsy object
        - Eg non uni-dimensional, different parts of object have different dimensions
    - 2 marks
- No need to repeat if:
    - 1 mark
    - Small small possible error
        - Eg length of smt
        - Electrical experiments
- Remember to write your units
- **Record** =/= measure. Record means take the value that qn tells you.

Apparatus

- Multimeter
    - Know how to problem-solve this devil
    - If used to measure resistance, it should be connected to resistor without current flow. (cuz multimeter measures resistance by injecting current. Won’t work properly if there is already current!)
    - H means hold. Press button.
    - Battery means low battery.
    - 1 means big value, setup wrong.

    - 0 means change multimeter.
    - Settings are correctly set for u in A levels. Don't change.
- Micrometer screw gauge
    - Don't over-tighten it. Turn thimble → make contact with object → turn ratchet → 3 clicks enough.
- Vernier caliper
    - Thing sticking out is called "depth probe".

Calculations and common errors by yours truly

- Uncertainty
    - Absolute uncertainty
        - Precision of instrument multiplied by 3-5 due to expt error
            - If max-min method/mathematical method gives bigger abs uc, use it instead.
        - This multiplication is not shown eg $\frac{\Delta t}{t} = \frac{3}{whatever} x\ 100\%$
        - Remember x100%
        - 1sf
        - For time: absolute uc just write 3
        - Length: 0.1cm x 3 = 0.3cm
        - No need x3 for measurements of diameter. No human error.
    - Percentage uncertainty
        - left to 2sf
        - Written as __%, not as a decimal
    - Choose a value of (variable) to use in following experiments
        - Concept tested: uncertainty
        - "Absolute uncertainty is large. To reduce percentage uncertainty, value is chosen to give largest value"

- Calculating constants
    - Follow sf and dp rules
    - Other than looking at substituted values to find the smallest sf, see if the expression for constant only has gradient & y-intercept → smallest sf is 3sf

    - Need units
    - Applies to proportionality constant

- Calculate gradient/y-intercept
    - 3sf
    - No units
    - "Calculate gradient G of the tangent" ← question wants **gradient**, not a constant. G is a placeholder to signify gradient.

- Justify your sf given to constant
    1. Constant has the same significant figures as the least significant figure of the values substituted
    2. (variable) has the least sf of ()
    3. Hence constant has () sf.

- Calculate % difference
    - Use average value in denominator
    - 2sf, like % uncertainty
    - % diff > % uncertainty then results do not support suggested relationship

- Table
    - Headings: look at what you are plotting. Follow it.
    - 22.0 is 3sf, not 2sf. The zero after the decimal place takes up 1 sf.
    - Range is 80% of maximum → means: if the whole thing is 100cm, ur range should be 80cm, eg 20 - 100 cm

- Graph
    - Labeling of axis: if there are 2 variables, add a bracket. ✔️ $(m_2\text{-}m_1)/g$
    - Use graph to find a specific value: don't create y=mx+c equation. Instead, do the gradient method. 1) Draw gradient triangle to find gradient. 2) $\frac{Y1-Y2}{X1-X2} = gradient$. Sub in coordinates from a point and value that you know.

Miscellaneous

- If cambridge decides to show its true fucker nature and makes u repeat entire experiment for a new object for 2 marks or do something ridiculously demanding, whack it, just get 2 data sets, plot it and fuck off.
- Last qn may be a funky qn to draw diagram, suggest steps of procedure / how to use instrument to compare smth.
    - If it's the former → it's just a mini planning. Marks may be given for the reason why you measure Y instead of the variable in question. Eg the variable is tension, and qn restricts u to a spring. So u measure extension. Marks given for writing "tension proportional to extension".
    - If it's the latter → many marks: 1m for how the instrument is used, how to infer. Other marks are for additional details.

Planning

(a) the equipment you would use
(b) the procedure to be followed
(c) the control of variables
(d) how the data would be analysed
(e) any precautions that should be taken to improve the accuracy and safety of the experiment.

(a) Measure
(b) Vary
(c) Control

Methodology for planning

1. Circle important stuff in qn
    a. Eg you are tasked to produce ice cubes at 0^0C ← need to use temperature sensor connected to data logger
2. Linearize equation. Log both sides.
3. Identify independent, dep & 2-3 control var.
4. Think of equipment used to measure
5. Procedure to vary and control stuff
6. Scrutinize given diagram, think: What will Patrick Jane observe that I haven't yet noticed? → additional details

Present your wondrous experimentation

1. Header: Experiment 1: Vary x while keeping Y constant
2. “Set up as shown in diagram above.”
3. Create object for experiment
    a. Additional details (from step 6 above)
4. Insert preliminary readings
5. Measurement methods for dependent & independent variables
    a. Repeat measurements in different positions and take average
    b. Method to measure / calculate, if the variables cannot be obtained directly.
        i. Eg extension: measure 2 lengths, L0 and L1. Extension = L1-L0.
        ii. Eg number of oscillations: place a fiducial marker to mark out equilibrium position. Count oscillations every time object passes fiducial marker?
6. Procedure to vary indep var X
7. Procedure to keep Y constant
8. Procedure to keep constants constant
9. Analysis of data
    a. “Plot a graph of … If the relationship is valid, a straight line graph of gradient … will be obtained.” There is no need to write “Tabulate (variables)”
10. Additional details & safety precautions

Notes

- If you are stuck at the measuring part, put “xxx sensor connected to data logger”
- If you are running out of time / stuck, write down additional details and pray to god
- Draw ur table. No floating.
- Include calculations to obtain quantity if it cannot be measured. Eg radius. Measure diameter and divide 2.
- Remember to repeat procedure and collect 10 sets of data and repeat measurements for time, diameter etc

Procedures

- Move an object at constant speed: variable speed motor connected to power supply
- Drop an object with 0 initial v: use electromagnet. Iron core connected to electrical circuit. Once the switch is open, current stops flowing, and the iron core is easily demagnetized.
- Uniform B field: use helmholtz coils

- Heating source: electrical heating element

Additional details

- Preliminary readings
    - “Take preliminary readings for biggest and smallest (variable X), such that constant (variable Y) can be achieved for all ranges of (variable X) when varying (variable X).
- B field
    - Using a compass to measure angle of deflection: Ensure B field of object is perpendicular to B field of Earth. B field of Earth is used as a reference point.
    - Ensure there are no external B fields and ferromagnetic materials
    - Using magnetic field sensor connected to data logger/hall probe: adjust it in the magnetic field so that the largest reading is read. Keep the apparatus in this orientation and location.
- Thermal
    - To keep surrounding temperature constant, perform expt in air con room
    - To ensure constant heat supplied: electrical heating system with constant current and voltage
    - If thermometer is used: ensure bulb of thermometer is fully immersed in liquid and not touching side/bottom of container
- Oscillations
    - Record time taken for N oscillations such that NT>20s. Find period T by dividing by N.
    - Fiducial marker
    - Plumb line
    - Use windshield around experiment set-up to prevent wind from affecting oscillation
    - Set small oscillations to ensure object oscillates in the desired plane and does not wobble.
- Apparatus
    - If you find urself thinking “how do I know when the expt has ended”, use a sensor. Eg how to tell ice has completely melted → temperature sensor connected to data logger → timing stops once temperature stops decreasing. Eg how to tell wire has melted → current sensor connected to data logger → timing stops once no current is detected.
- Motion
    - Record experiment, playback in slow motion

Safety precautions:

- Electrical
    - Open switch in between readings to prevent overheating of wires, so that resistance and thus ammeter and voltmeter readings are not affected
    - Wear rubber gloves to prevent electrocution from high voltage/current
- Thermal
    - Wear rubber gloves to prevent burns
    - Use holders to pick up hot object to prevent burns
    - Turn off heat source between measurements to prevent burns
- Oscillation
    - Stand far away from oscillating path of object so that object will not hit you
    - Tie object securely to ___ using a rubber band so that object will not fall or fly off during oscillation
- Heavy objects used
    - Wear covered hard footwear so that your foot does not get hurt if the heavy object falls
    - If heavy object clamped to retort stand, add weight stabilizers to the bottom of retort stand so that the retort stand is less likely to fall
- Objects that can roll away
    - Add a plastic container/cardboard barricade to prevent object from rolling away, so that no one will trip over it

1. Set up
2. Preliminary readings
    a. Determine max/min value for independent variable, which can produce *appreciable* (dep var) over a *reasonable* period of time: “Perform preliminary experiments to determine a suitable range of X and Y such that variations in Z are observable”.
    b. Set up apparatus such that maximum dependent variable can be measured: “Perform preliminary experiments by varying distance and orientation of apparatus such that maximum readings of Z are obtained.” ***Follow this by using this as “constant”!!!*** “Keep the distance and orientation of the apparatus constant throughout all experiments.”
3. Apparatus to measure
    a. Repeat measurements
4. Vary indep var
5. Repeat experiment; 10 sets of data
6. Constant
    a. Distance between apparatus
    b. Physical dimensions of apparatus
    c. Others (topic dependent)
7. Graph
8. Precautions:
    a. Topic-specific
    b. Surroundings
    c. Vertical, horizontal
    d. Take large measurements to reduce percentage uncertainty
    e. Use G clamp/weighted mass to ensure retort stand doesn’t topple
9. Repeat steps
10. Apparatus
11. How to vary
12. Repeat for 10 sets of data
13. Constant
14. Graph

Experiment	Procedure	Apparatus	Variables	Precautions
Thermal		- Rate of heat transfer: thermometer, formula - Electronic hot plate - Wind speed: wind speed sensor/anemometer	Rate of heat transfer: temperature of objects: keep temp of semiconductor and heat sink constant using thermostatically controlled water bath	● Stir water; ensure uniform temp throughout water ● Ensure thermometer doesn't touch beaker; no measuring temp of beaker ● * Ensure better thermal contact by using thermal paste ● ** Allow heat sink to cool down after each experiment; reduce effect of residual heat on subsequent expts ● *** Account for heat gain from surroundings (background) by conducting expt without set-up, subtracting this from data collected
Circuits				● * Ensure better electrical contact by using conductive paste ● ** Open switch after collecting measurements; prevent overheating of wires to prevent change of resistance of wires
EM/EMI	- Dir of displacement of string such that there is change in flux. - Eddy current: use retort stands to hold electromagnet and plate separately	- B: use electromagnet, vary resistance	- String: speed depends on tension and mass per unit length - Plate: material, diameter, area	● (Preliminary reading) Apparatus: Adjust position of hall probe until max B is read ● Surroundings: ensure no ferromagnetic materials nearby, as it might change B field of magnet ● (Preliminary reading) Surroundings: Conduct expt without setup, to subtract B field reading due to Earth's B field.
Forces		- K (calculate using	- Rope: length,	● Falling objects: place counterweight on base of

		mg/x). Use electronic mass balance to measure m, no need to use a force sensor.	k, diameter	retort stand to prevent it from toppling. Wear covered footwear. Place smth to cushion fall. ● Ensure limit of proportionality is not exceeded by checking that elastic rope returns to unstretched natural length when mass is removed
Waves		- Measure frequency cathode ray oscilloscope (CRO) with microphone / **sound sensor connected to data logger.** <u>Period</u> = time base x length of 1 periodic waveform. **Freq = 1/period** - To form stationary wave: Using signal generator connected to loudspeaker, increase f from zero until the sound sensor w data logger records first maximum sound intensity. Then measure f using sound sensor data logger. - Stationary wave formed in tube. Measure **inner** diameter using **inner jaws** of vernier calipers.	- Temp of air affects speed of air. Conduct expt in an air-con room and keep temp constant using a thermostat.	● *** Perform expt in soundproof room to avoid interference (of stationary wave formed) by background noise ● Preliminary to determine appropriate intensity ● Confirm fundamental freq: ○ Find 2nd harmonics' freq ○ Or use formula f=v/2L