Practical Summary Sheet

General Rules for Practical

Collection of Data

1. Record raw data to correct d.p.
2. Record calculated data based on d.p./s.f. rule
3. Collect at least 6 sets of data, maximising range of possible data
4. Label column headers and axes with units, e.g. L / m

Graph Plotting

1. Scales must be chosen so that the plotted points occupy at least half the graph grid in both x and y directions
2. Axes need not start from zero.
3. Line of best-fit with a fair scatter of points on either side of the line
4. If anomalous point exists, circle and label

Analysis of Data

1. Gradient triangle must be > half the length of best-fit line.
2. Show every step for gradient calculation
3. Unit for gradient = $\frac{\text{unit of y-axis}}{\text{unit of x-axis}}$
4. Y-intercept either: read from y-axis if x-axis starts from zero *or* substitute values from gradient triangle into y = mx + c
5. Unit for y-intercept = unit of y-axis
6. Do not leave answers in fraction form

- f.s.d.: full-scale deflection

Recording of Raw Data

instrument	smallest graduation	uncertainty and d.p. for a measurement
metre rule	0.1 cm	±0.1 cm, 1 d.p.
vernier calipers	0.01 cm	±0.02 cm, 2 d.p.
micrometer screw gauge	0.01 mm	±0.01 mm, 2 d.p.
Thermo-meter	0.5 °C	±0.5°C, 1 d.p.
digital stop watch	0.01s	±0.2 s, 1 d.p. (human reaction time)
analogue ammeter	depends on f.s.d.	If ½ the smallest graduation = ±0.01 A, 2 d.p.
analogue voltmeter	depends on f.s.d.	If ½ the smallest graduation ±0.05 V, 2 d.p.
multimeter	depends on range	Record what is seen on screen

Example:
length of a string = 0.100 m (3 d.p),
timing of 15 oscillations = 16.7 s (1 d.p.)

Recording of Calculated Data

$Y = 2a + \pi b - c$, follows least d.p. of a, b and c.

$Y = \frac{\sqrt{a} \times b^2}{5c}$, follows least s.f. of a, b and c.

$Y = \cos\theta$, follows s.f. of θ.

Practise "Drawing" Best-fit Line

https://ggbm.at/vqzpxa2x

Possible Sources of Experimental Error

Type of Experiment	Source of Error	Suggestions for Improvement
Oscillation timing	Difficulty in determining start and stop time when using a stopwatch	Place a fiducial marker behind the centre of the oscillation to serve as a reference for the start and stop time
Angles/length between two strings	The string is thick, making the angle/length measurement less precise	Use a thinner string
Reading length/angle of a suspended object	Difficulty in reading length/angle when holding ruler/protractor by hand	Clamp the ruler/protractor close to and behind the object
An object suspended horizontally	Difficulty in ensuring the object is horizontal	Place a spirit level on the object to check if it is horizontal
Measuring diameters	Object may not be perfectly round	Measure the diameter in several orientations and take average
An object clamped vertically	Difficulty in ensuring the object is horizontal	Place a plumbline next to the object to check if it is vertical
Measuring terminal velocity	Difficulty in ensuring that terminal velocity is reached	1. Ensure distance travelled is far enough 2. Verify terminal velocity by comparing time interval between photogates that are equally spaced
Extension of spring	Spring may have exceeded the elastic limit	Repeat the experiment by loading and unloading the masses to ensure no permanent deformation of spring
Heating/ Cooling	1. Heat exchange with the surroundings 2. Temperature of a liquid undergoing heat exchange may be uneven	1. Insulate the setup 2. Stir the liquid periodically
Electric current	Resistance changes due to joule heating	1. Switch off the circuit when not taking measurements and allow to cool 2. Use a fan to cool down the circuit
Resistance of wire on ruler	Wire is not straight	1. Tighten wire with pliers 2. Use a wire that is less flexible
Sound	1. Difficult to observe changes in freq/amplitude of sound 2. Background noise affects readings	1. Use a sound sensor attached to a datalogger to measure frequency/ amplitude; 2. Perform the experiment in a soundproof room
Light	Difficult to observe changes in brightness of light	1. Use a light sensor attached to a datalogger to measure intensity; 2. Perform the experiment in a dark room

Outline for Planning Question

Control of Variables

1. Identify independent and dependent variables
2. State two or three key variables to be kept constant

Diagram

1. Label all equipment
2. If using sensor, make sure to add datalogger or CRO

Procedure

1. Describe method to vary independent variable
2. Describe how independent and dependent variables are measured, stating instrument used
3. If any calculation is needed, state the equation to be used
4. Repeat experiment for one data set and take average
5. Repeat experiment to obtain 6 different sets of data
6. Plot a graph of dependent variable against independent variable to investigate relationship.

Additional Details (can be included in procedure)

1. At least one safety precaution
2. Any further details to improve accuracy of results, e.g.
   a. Conduct pre-experiment to obtain suitable range of independent variable
   b. (Refer to "Suggestions for Improvement" for good precautions)