

6.1 Planning A2 investigations

Name: _____ Class: _____ Date: _____

Total: 31 marks

KEY WORDS linearisation • range • control variables • ammeter
• voltmeter • data logger

Objective

Practise the WPH16 planning skills: turn a predicted relationship into a method whose data feeds a chosen graph, control what actually changes, place meters correctly and justify improvements. These are original training tasks grounded in the specification and reviewed assessment demand.

1 Key knowledge and worked examples

■ Choose the graph before the method

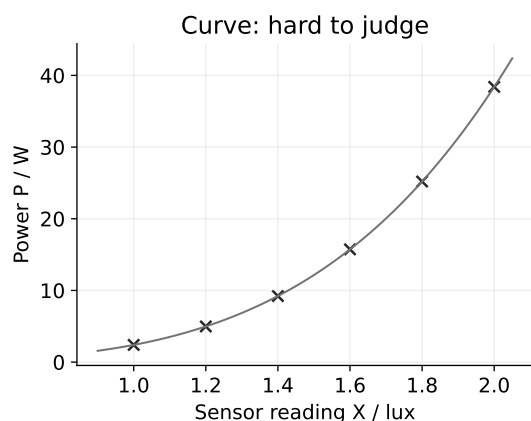
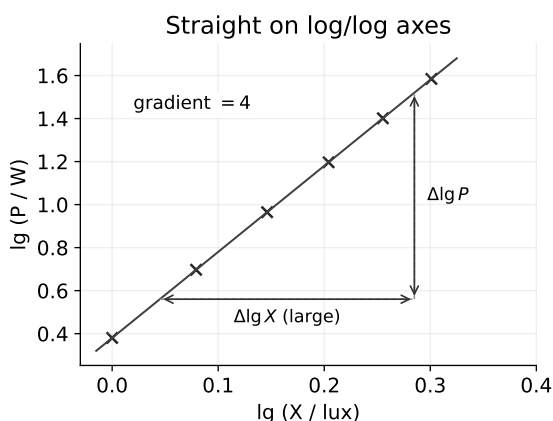
Decide how the data will be processed **before** writing the method. **Linearisation** turns a model into the straight-line form $y = mx + c$:

Model	Plot	Read off
$V = V_0 e^{-t/RC}$	$\ln V$ against t	gradient $-1/RC$, intercept $\ln V_0$
$P = kX^n$	$\lg P$ against $\lg X$	gradient n , intercept $\lg k$
$p = c/V$	p against $1/V$	straight through origin, gradient c
$T^2 = (4\pi^2/k)m$	T^2 against m	gradient $4\pi^2/k$, intercept 0

A method that never names its graph is unfinished. State what proves the model: the expected gradient, or a straight line through the origin.

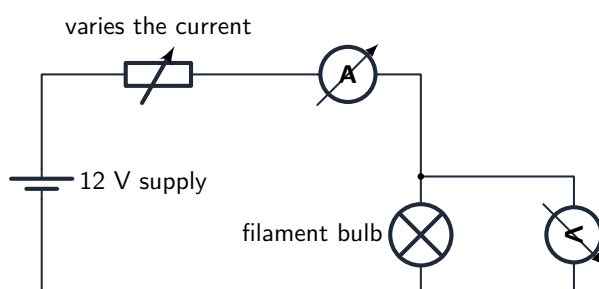
■ The method skeleton

- named apparatus with measuring **range** and **resolution** ;
- the quantity you change, set to at least five well-spread values;
- **control variables** with the physical reason each one matters;
- repeats that test stability, and new settings rather than repeats when mapping a relationship;
- realistic hazards with a specific action for each;
- the calculation or graph that answers the question.



■ Meters belong where the measurement is

An **ammeter** is in series with the component under test; a **voltmeter** is in parallel with that component **only**. A variable resistor in series changes the current through it. If a voltmeter straddles two components, its reading belongs to neither.



■ Worked planning example: the spring constant from oscillations

A loaded spring oscillates with $T = 2\pi\sqrt{m/k}$. Plan an investigation to determine k .

- Known: the period depends on the load. Why this route: $T^2 = (4\pi^2/k)m$, so a T^2 against m graph is straight through the origin and its gradient finds k without a stopwatch calibration.
- Hang mass increments on the same spring from a clamped stand. Record m from the labelled masses.
- Displace the mass a small distance, time 10 oscillations past a marker at the centre of the motion, and repeat. Divide by 10 for T , then square.
- Control the spring, the amplitude (small) and the environment. Keep feet clear of falling masses; use a clamp with a heavy base.
- Plot T^2 against m for at least five loads, draw the best-fit line and take its gradient g_T with a large triangle. Then $k = 4\pi^2/g_T$.

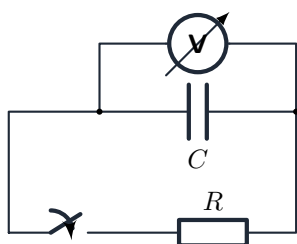
■ Improvements name their mechanism

A data logger with probes takes paired readings simultaneously, removes parallax and improves resolution; say which of these the investigation gains.

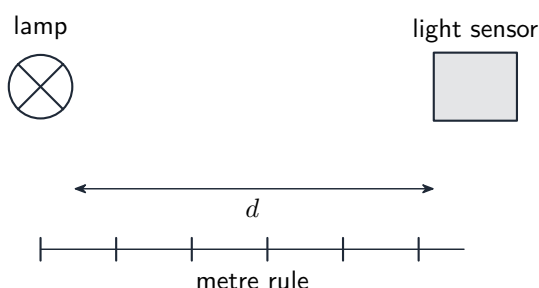
Safety answers name the hazard and the action: hot water burns, so move glass with tongs; a heater's leads can topple a beaker, so clamp it.

2 Practice

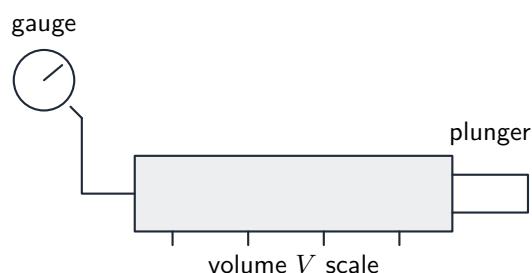
2.1 A charged capacitor discharges through a resistor. State the quantities you would measure, the graph you would plot to test $V = V_0 e^{-t/RC}$, and what its gradient and intercept would represent. [3]



2.2 A lamp shines onto a light sensor whose reading is X . Name two variables that must be controlled when investigating how X varies with the lamp-sensor distance d , and give the physical reason each one matters. [4]



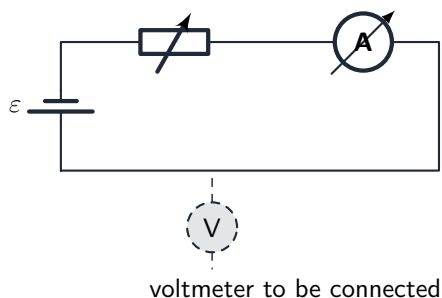
2.3 Air is compressed slowly in a sealed syringe at constant temperature. The model is $pV = \text{constant}$. State the graph you would plot to test this model and what a straight line through the origin would show. [3]



3 Exam-style questions

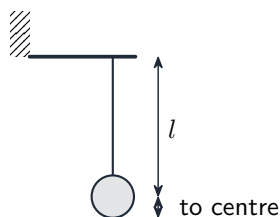
3.1 A student investigates a battery of e.m.f. ε and internal resistance r . The terminal potential difference V and current I follow $\varepsilon = V + Ir$.

Devise a method to determine ε and r using a suitable graph. Your answer should include the circuit with both meters, how the readings are varied, the graph axes, and what the gradient and intercept represent. [7]



3.2 A student times a pendulum for different lengths l , using $T = 2\pi\sqrt{l/g}$. The student measures l from the support to the **top** of the bob, but the effective pendulum length is $l + \delta l$, because the bob's centre of mass is a fixed distance δl below its top.

Show that a graph of T^2 against l still gives g from the gradient, explain what the intercept would reveal, and state one control variable and one timing technique. [6]



3.3 A gamma source is placed at different distances d from a Geiger–Müller tube. The corrected count rate R is predicted to follow an inverse-square law, $R = c/d^2$, where c is constant.

Devise a method to test this prediction with a suitable graph. Include the treatment of background radiation, the number and spread of distances, two safety points and what would confirm the prediction. [8]

