

Exercise walk-through

6.1

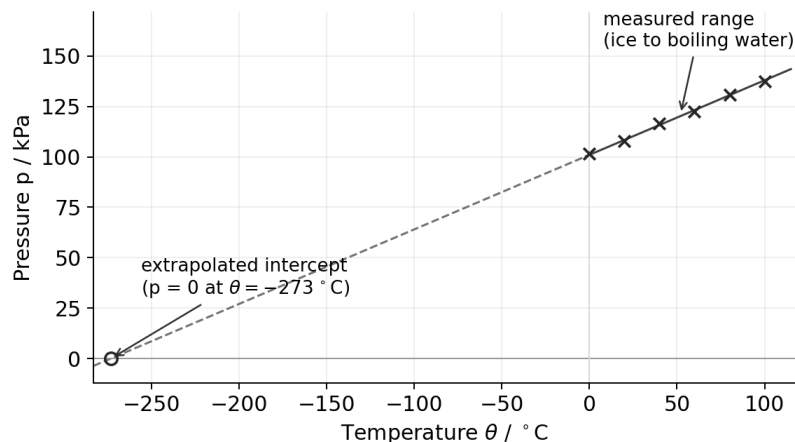
Planning A2 investigations

Pearson Edexcel · International A-Level · Physics

Four models and their straight-line plots

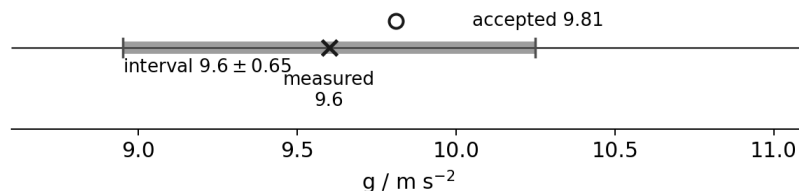
Model	Plot	Read off
$V = V_0 e^{-t/RC}$	$\ln V$ against t	gradient $-1/RC$, intercept $\ln V_0$
$P = kX^n$	$\lg P$ against $\lg X$	gradient n , intercept $\lg k$
$p = c/V$	p against $1/V$	through origin, gradient c
$T^2 = (4\pi^2/k)m$	T^2 against m	gradient $4\pi^2/k$

Plan an extrapolation to absolute zero



- 1 **Range** ice to boiling water bounds the measured temperatures
- 2 **Readings** at least five paired pressure and temperature values, stirred and perpendicular
- 3 **Graph** best-fit line extended to zero pressure; the intercept estimates -273 °C

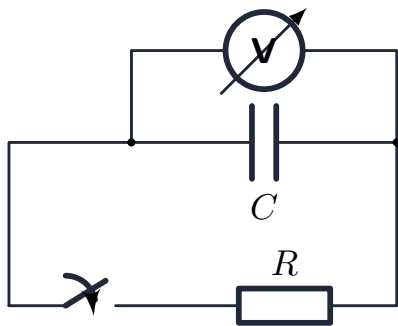
Turn the result into a conclusion



- 1 **Interval** $9.6 \times (1 \pm 0.068) = 8.9$ to 10.3 m s^{-2}
- 2 **Compare** accepted 9.81 lies inside, so the measurement is accurate
- 3 **Honest** consistency does not prove identity; other values also fall inside

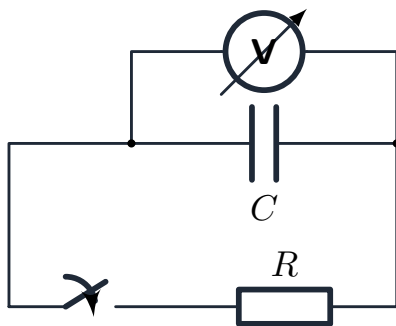
Exercise 2.1

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]



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2.1 Measure V (across the capacitor) at known times t after switching. Plot $\ln V$ against t . Gradient = $-1/RC$ and intercept = $\ln V_0$, so a straight line with negative gradient supports the exponential model.

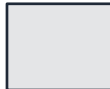
Exercise 2.2

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]

lamp



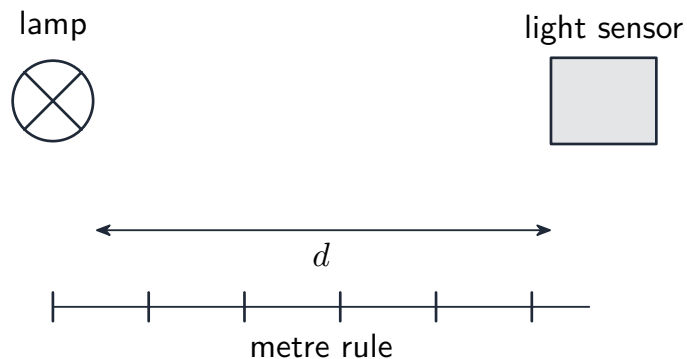
light sensor

 d 

metre rule

Exercise 2.2

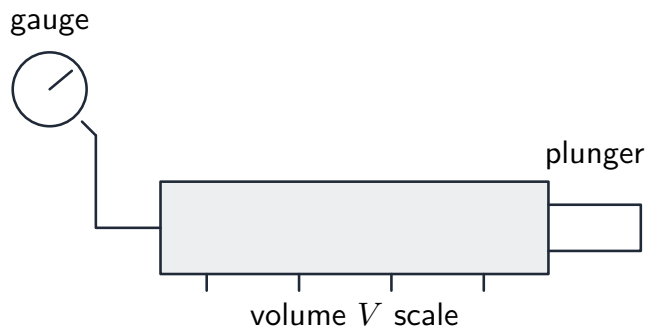
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2.2 Any two of: lamp current/supply voltage, since brightness and therefore X change with it; background illumination, since it adds to the sensor reading; alignment/angle of sensor to lamp, since the received fraction depends on it; same sensor and rule position. Physical reason required for each mark pair.

Exercise 2.3

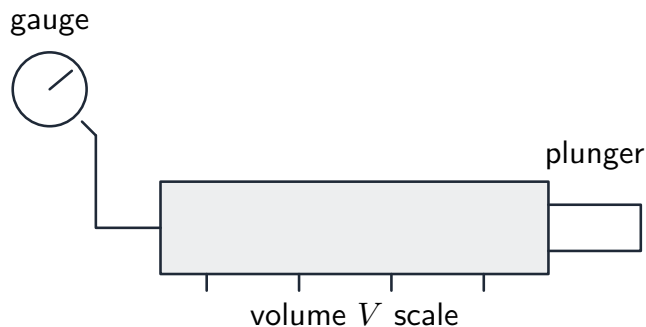
2.3 Air is compressed slowly in a sealed syringe at constant temperature. The model is $pV = \text{constant}$. State the graph you would plot to test this model and what a straight line through the origin would show. [3]



3 Exam-style questions

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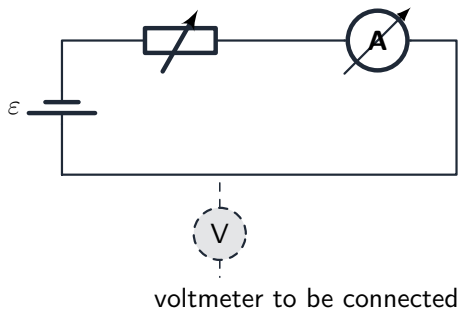
3 Exam-style questions

2.3 Record p from the gauge for a series of volumes V read from the syringe scale. Plot p against $1/V$. A straight line through the origin shows pV is constant, so the model holds over the range tested.

Exercise 3.1

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 $\varepsilon = V + Ir$.

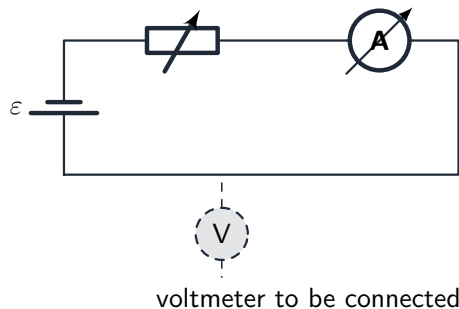
Devise a method to determine ε and r using a suitable graph. Your answer should include the circuit with both meters, how the readings are varied, the graph axes, and what the gradient and intercept represent. [7]



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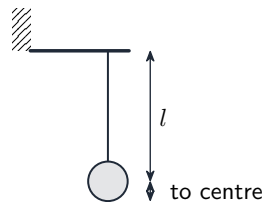


3.1 Circuit: battery in series with an ammeter and a variable resistor; voltmeter in parallel with the battery terminals only. Vary the resistance to obtain at least five well-spread current values; record paired I and V . Rearranged model: $V = \varepsilon - Ir$. Plot V vertically against I horizontally. Gradient = $-r$; intercept on the V axis = ε . Switch off between readings to avoid heating the cell.

Exercise 3.2

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.

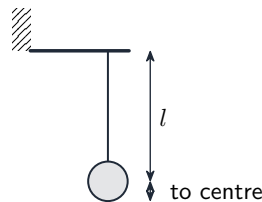
Show that a graph of T^2 against l still gives g from the gradient, explain what the intercept would reveal, and state one control variable and one timing technique. [6]



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3.2 With the effective length $l + \delta l$ and a constant δl :

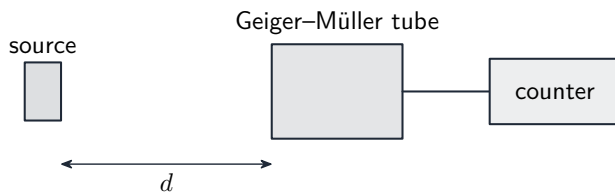
$$T^2 = \frac{4\pi^2}{g}(l + \delta l) = \frac{4\pi^2}{g}l + \frac{4\pi^2}{g}\delta l$$

This is the straight-line form $y = mx + c$: the plot of T^2 against l is straight with gradient $4\pi^2/g$, so $g = 4\pi^2/\text{gradient}$ whatever the length offset. The intercept on the T^2 axis is $(4\pi^2/g)\delta l$, so $\delta l = \text{intercept}/\text{gradient}$ – the graph reveals the systematic length error. Control: same bob and small amplitude. Technique: time many oscillations past a marker at the centre of the swing and divide by the count.

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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.

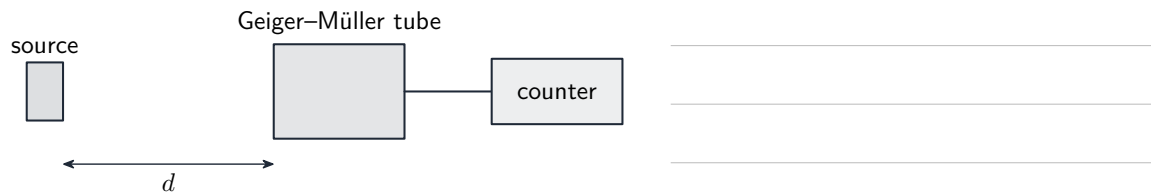
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3.3 Measure the background count rate with the source removed and repeat it. Subtract it from every gross rate to get R . Take readings at a series of at least five distances spread over a wide range, each counted for the same long time, repeating each count. Linearise: $R = c(1/d^2)$, so plot R against $1/d^2$ and expect a straight line through the origin, or plot $\lg R$ against $\lg d$ and expect gradient -2 . Confirmation: the line passes through the origin (or gradient -2) within scatter. Safety: hold the source in tongs/holder and point it away from people; minimise handling time and return it to its box immediately, keeping distance.