

CIE A-Level Physics 9702 Paper 5 Practice

Paper (Planning, Analysis and Evaluation) -

ANSWERS

Total: 30 marks · 1 h 15 min · 2 questions · 11 parts

Q	Part	Answer	Mark points	marks
1	(a)	Independent variable: the tension T , provided by weights of weight mg hung on the end of the wire. Dependent variable: the frequency f . Control variables: the vibrating length l , the linear density μ (same wire) and the mode of vibration (fundamental in every run).	1 mark: T independent, f dependent 1 mark: two controls (length l , linear density μ / same wire, fundamental mode)	2
1	(b)	Pass the wire over a pulley at the edge of the bench and hang a weight holder on the end. Add slotted masses in steps (for example 100 g at a time), measure the total mass m on a top-pan balance and use $T = mg$ with $g = 9.81 \text{ N/kg}$. Take seven settings from 2.0 N to 8.0 N (2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0 N) and let the wire settle before each measurement.	1 mark: pulley and hanging weights provide the tension 1 mark: mass measured on a balance, $T = mg$ used 1 mark: at least six settings between 2.0 N and 8.0 N	3
1	(c)	Drive an electromagnet placed near one end of the wire from a signal generator and raise the frequency slowly while watching the amplitude at the centre of the wire; resonance is when the amplitude is greatest and a small paper rider at the centre is thrown off. Read the frequency on a frequency meter as f . For better precision, time 50 oscillations ($f = 50/t$) and average three repeats.	1 mark: signal generator driving an electromagnet 1 mark: resonance judged by maximum amplitude (paper rider thrown off) 1 mark: frequency meter reading, or n oscillations timed and $f = n/t$ 1 mark: three repeats averaged / reading uncertainty mentioned	4

1	(d)	Plot f on the y-axis against $\sqrt{T}$ on the x-axis; the graph should be a straight line through the origin with gradient $1/(2l \times \sqrt{\mu})$. The gradient gives the linear density, $\mu = 1/(4 l^2 \times \text{gradient}^2)$, which is then compared with the maker value. Clear curvature would show that the relationship does not hold or that there is a systematic error.	1 mark: f against $\sqrt{T}$, axes labelled 1 mark: expected straight line through the origin 1 mark: gradient = $1/(2l \sqrt{\mu})$, μ obtained from the gradient	3
1	(e)	(i) Measure the vibrating length l with a metre rule to plus or minus 1 mm, taking the length between the two bridges to avoid end effects. (ii) Wait until the wire is at rest after each change of mass before measuring the frequency. (iii) Take three readings at each tension and average them, scanning in 0.1 Hz steps near resonance. Safety: the masses can fall, so place a soft pad under the bench, and never load the wire beyond its elastic limit in case it snaps.	1 mark: length measured carefully / end effects reduced 1 mark: readings taken at rest / three repeats averaged 1 mark: safety risk (falling masses or snapping wire) with a precaution	3
2	(a)	The values of $\ln(V/V_0)$ are 1.79, 1.29, 0.79, 0.29, -0.21 and -0.71; because V is divided by V_0 the quantity is dimensionless.	1 mark: three rows correct 1 mark: all six rows correct (allow plus or minus 0.02)	2
2	(b)	The points lie on a straight line of negative gradient, showing that V decays exponentially with t . Both axes must be labelled (the vertical axis is dimensionless but still labelled $\ln(V/V_0)$), each point marked with a cross, and the best-fit line need not pass through every point.	1 mark: axes labelled ($\ln(V/V_0)$ and t/s) with suitable scales 1 mark: six points plotted correctly 1 mark: best-fit straight line (not forced through every point)	3
2	(c)	Using two points on the line, for example (0, 1.79) and (50, -0.71): $\text{gradient} = (-0.71 - 1.79) / (50 - 0) = -2.50 / 50 = -0.050$, with unit s^{-1} .	1 mark: method (Δy over Δx from two points on the line) 1 mark: value -0.050 s^{-1} (allow -0.045 to -0.055)	2
2	(d)	The magnitude of the gradient is $1/(RC)$, so $C = 1 / (R \times 0.050) = 1 / (2.20 \times 10^4 \times 0.050) = 1 / 1.10 \times 10^4 = 9.1 \times 10^{-5} \text{ F}$, that is 91 microfarad.	1 mark: correct use of $C = 1/(R \times \text{gradient})$	2

			1 mark: 9.1×10^{-5} F (91 microfarad)	
2	(e)	C is found from the product of R and the gradient, so the percentage uncertainties add: $5\% + 3\% = 8\%$. Hence the absolute uncertainty is $91 \times 0.08 = 7$ microfarad and $C = (91 \text{ plus or minus } 7) \text{ microfarad}$.	1 mark: percentages added to give 8% 1 mark: absolute uncertainty about 7 microfarad, written (91 plus or minus 7) microfarad	2
2	(f)	(i) The voltmeter does not have infinite resistance, so part of the discharge current flows through it; the real time constant is shorter than RC and C comes out low. Improvement: use a data logger or electrometer of very high input resistance and record V against t automatically. (ii) Manual timing and reading give a systematic lag, worst in the first seconds when V changes fastest. Improvement: sample every 0.5 s with a data logger and take V_0 from the same record. It is also acceptable to note that the percentage error in V is largest at low V, so only data above about 0.5 V should be plotted.	2 marks: two sources identified (voltmeter resistance / manual timing lag) 2 marks: matching improvements (high-impedance logger / automatic sampling, V_0 from the same record)	4