Determination of Young Modulus of a Metal in the Form of a Wire

Practical question — PH6 2012 Experimental task

Total	/25

EXPERIMENTAL TASK

Your task is to carry out an investigation to see how the amplitude, A, of vertical oscillation of a mass hanging from two springs in series varies with time, t.

Time allowed: You are **advised** to spend 15 minutes to answer parts (a) and (b) during which time you are allowed to set up and use the equipment for trial readings.

You are provided with the following equipment

- 500g hanger and masses 2 linked springs
- pointer
- split cork
- 2 clamps and stands G-clamps
- Metre rule Stopwatch
- Sticky tape

1. The relationship between the amplitude of an oscillation, A, and the time t, can be expressed by:

$$A = A_0 e^{-\lambda t}$$

where A_0 = initial amplitude

and λ = an unknown constant

Rearrange this equation in the form of $y = mx + c$ and explain which graph you will draw to confirm this relationship and also determine the unknown constant λ. [2]

If you are unsure what to do, ask your supervisor for information sheet 1.
You will be deducted 2 marks for this information.

2. Write a plan of how you will obtain sufficient readings to investigate this relationship. Include a labelled diagram with your plan, and justify all values chosen. [5]
[You are advised **not** to stop the timer as you record readings.]

If you are unsure what to do ask your supervisor for information sheet 2.
You will be deducted 2 marks for this information.

3. Obtain results and record them in a table. State the resolutions of all instruments used. [5]

4. Draw a suitable graph to determine λ. Error bars are **not** required. [4]

5. Does your graph confirm the relationship given in **1.**?
Explain your answer. [3]

6. (a) Use your graph to determine a value for λ. Remember to include units with your answer. [3]

(b) What does the intercept on the y-axis of your graph represent? [1]

(c) From the graph, determine the time taken for the initial amplitude of oscillation, A_o, to halve. Show your working clearly. [2]

MARK SCHEME

Question			Marks available
1.		$\ln A = -\lambda t + \ln A_0$ (1) Plot ln A (vertical axis) against t (horizontal axis) or equivalent stated — accept a sketch showing this. NB. No back-crediting from candidate's graph. (1) [Remember to indicate in the box whether the information sheet has been given and not to award the marks if it has been issued].	2
2.		Labelled diagram — springs shown approx vertical, securely attached vertical rule, weight shown on spring. (1) Method to avoid parallax [or shown on diagram]. (1) Suitable range of time intervals used which allows the amplitude to decrease by at least 50 % and at least 5 equally spaced readings. (1) Justification of the choice of range provided by a statement in the method not just implied from results. (1) e.g. I plan to take these readings because they will show the amplitude decaying by at least half. Suitable initial amplitude, A_0 — minimum 10 cm. (1) [Remember to indicate in the box whether the information sheet has been given and not to award the marks if it has been issued].	5
3.		Single clear main table: titles with units: including time, amplitude readings and $\ln A$ [ignore additional summary tables, e.g. a table with only $\ln A$ and t columns]. (1) Resolutions correct ruler 1 mm (accept 0.5 mm), stopwatch 1 s. (1) $\ln A$ values correct. (1) Repeat readings and correct means. (1) All readings and means to resolution of instrument and $\ln A$ to 2 or 3 s.f. (1)	5
4.		Axes labelled with units - correct orientation [e.c.f. from (a)](1) All points plotted correctly to within ½ small square division. (1) Good line of best fit consistent with the data. (1) Suitable scales (not involving awkward factors, e.g. 3 / over ½ each axis used). (1)	4
5.		NB There is no mark for yes / no only – the marks are for the explanation, straight line / not a straight line. (1) Negative gradient [no e.c.f. on incorrect data]. (1) Points close to line of best fit or not [as appropriate]. (1)	3

Question			Marks available
6.	(a)	Large triangle used (should be close to extremities of the line of best fit) [or 2 equivalent suitable points clearly indicated on the graph] and gradient calculated. (1) λ [identified as gradient] and given to 2 or 3 s.f. (1) 3 Units s^{-1} or min^{-1}. (1)	3
	(b)	$\ln$ (original amplitude) or $\ln A_0$ [not A_0 on its own]. (1)	1
	(c)	Calculation of $\ln(A_0/2)$ given or horizontal line at $\ln(A0/2)$ on graph shown. (1) Time calculated consistent with graph [NB No s.f. penalty]. (1) 2	2