Mark Scheme (Results)

October 2021

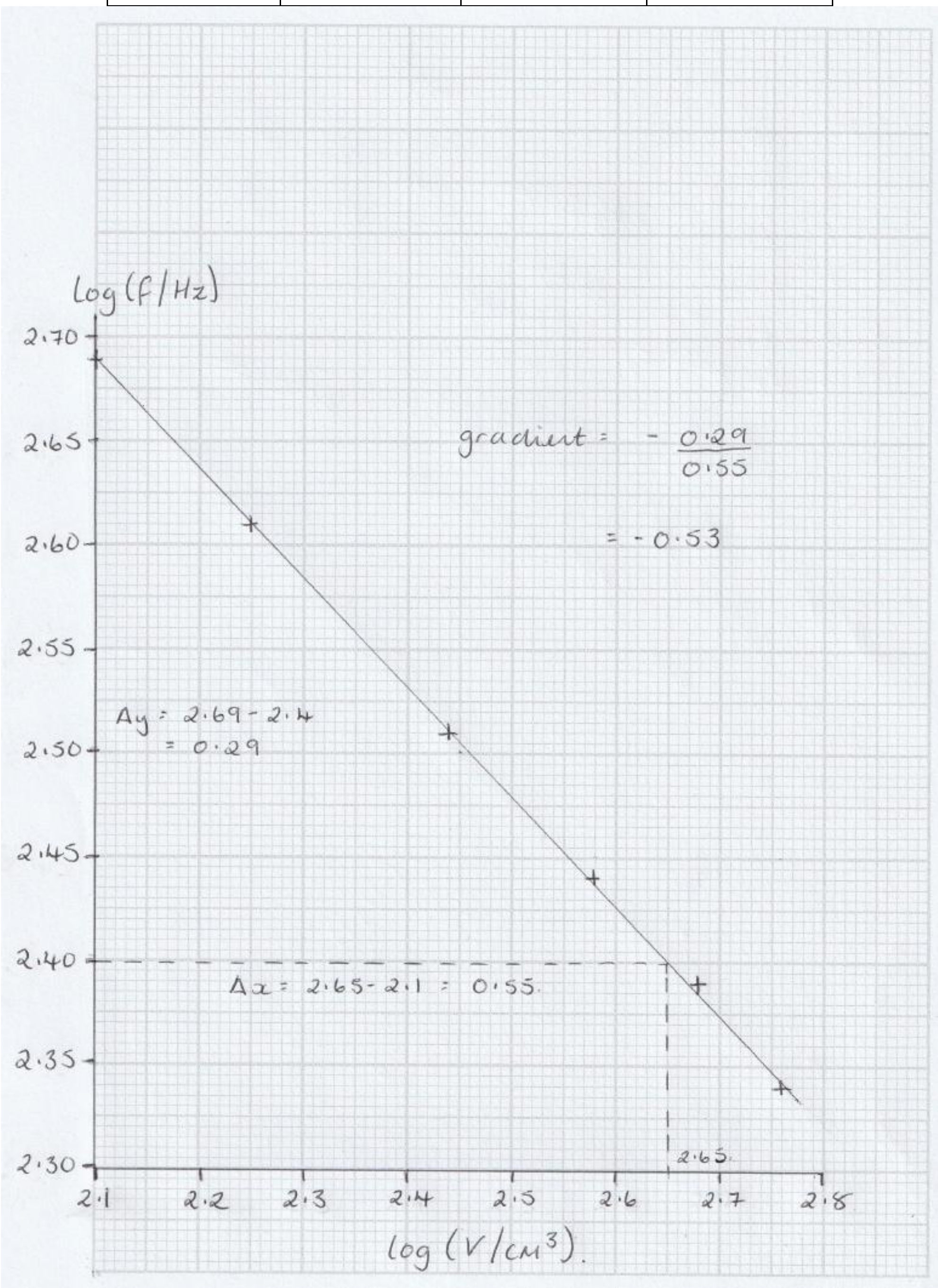
Pearson Edexcel International Advanced Level in Physics (WPH16) Paper 01
Practical Skills in Physics II

Question Number	Answer	Mark
1 (a)(i)	Mass **Or** volume (of water) (1) Time **Or** distance between resistor and thermometer (1) Ignore room temperature, temperature of the surroundings, size of the beaker or insulation, potential difference	2
1 (a)(ii)	Significant figures are inconsistent (1) Not enough sets of readings taken **Or** no repeats shown (1) No units given for $\Delta\theta$ **Or** initial and final values of θ not recorded (1)	3
1 (b)	Any **PAIR** from: Insulate the beaker **Or** cover the beaker (1) To reduce the amount of energy transfer to the environment (1) Stir the water **Or** ensure thermometer is close to the resistor (1) To ensure the water is at the same temperature as the resistor (1) MP2 dependent on MP1	2
	Total for question	**7**

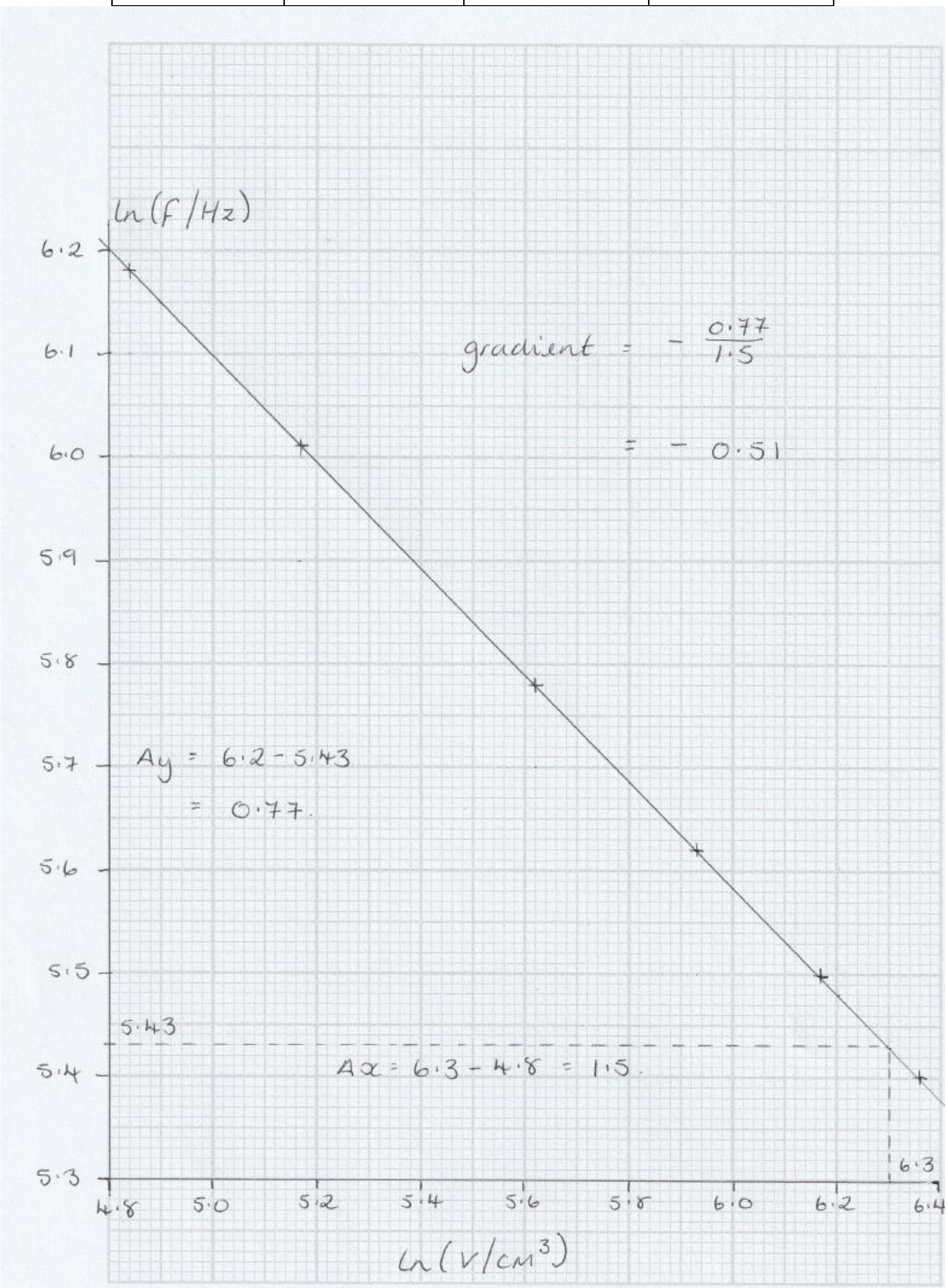
Question Number	Answer	Mark
2 (a)	Use of $T = 2\pi\sqrt{(l/g)}$ shown (1) Addition of (half) the time period for long and short pendulum shown (1) $T = 1.9$ s Accept 2 or 3 sig figs (1) Bald answer can score MP3 only <u>Example of calculation</u> Long pendulum $T_l = 2\pi\sqrt{(1.00\text{ m}/ 9.81\text{ m s}^{-2})} = 2.01$ s Short pendulum $T_s = 2\pi\sqrt{((1.00\text{ m} - 0.25\text{ m})/ 9.81\text{ m s}^{-2})} = 1.74$ s $T = 0.5(T_l + T_s) = 0.5(2.01 + 1.74\text{ s}) = 1.88\text{ s} = 1.9$ s	3
2 (b)	Measure the distance h using a metre rule (1) **Any THREE from**: Place a (timing) marker at the centre of the oscillation (1) Use a small initial angle (1) Time a number of oscillations and divide by the number (1) Repeat (measurement of time period) **and** calculate the mean (1) Start timing after several oscillations (1) Repeat the method for at least 5 values of h (1) Plot a graph of T^2 against h to check it is a straight line (1) Accept valid alternative graph	6
2 (c)	Using a light gate would eliminate reaction time (1) **Either** Light gates remove parallax error (1) As the light gate is in fixed position (1) **Or** There would be uncertainty in the time period from the light gate (1) As the light gate would time from edge of the bob rather than centre of mass (1)	3
	Total for question	**12**

Question Number	Answer			Mark
3 (a)	(Adjust the signal generator to find) trace with the maximum amplitude		(1)	
	Count the number of divisions between two (adjacent) peaks		(1)	
	Multiply by the time per division		(1)	
	Calculate frequency as $1/T$		(1)	**4**
3 (b)(i)	All log V values correct to 2 d.p.	Accept 3 d.p.	(1)	
	All log f values correct to 2 d.p.	Accept 3 d.p.	(1)	
	Axes labelled: y as $\log(f\,/\,\text{Hz})$ and x as $\log(V\,/\,\text{cm}^3)$		(1)	
	Correct scales for both axes		(1)	
	Plots accurate to ± 1mm		(1)	
	Best fit line with even spread of plots		(1)	**6**
	Accept equivalent ln-ln graph			
3 (b)(ii)	$\log f = \log k - \frac{1}{2}\log V$		(1)	
	is in the form $y = c + mx$ with a gradient of $-\frac{1}{2}$		(1)	
	Correct calculation of gradient using large triangle shown		(1)	
	Value of gradient in range –0.51 to –0.54 to 2 or 3 s.f., no unit		(1)	
	Valid conclusion including comparison of calculated gradient with the stated expected gradient of $-\frac{1}{2}$		(1)	**5**
	<u>Example of calculation</u> $gradient = (2.69 - 2.4)/(2.1 - 2.65) = -0.29/0.55 = -0.53$			
	Total for question			**15**

V / cm^3	f / Hz	log (V / cm^3)	log (f / Hz)
576	221	2.76	2.34
476	244	2.68	2.39
376	275	2.58	2.44
276	323	2.44	2.51
176	408	2.25	2.61
126	485	2.10	2.69



V / cm^3	f / Hz	ln (V / cm^3)	ln (f / Hz)
576	221	6.36	5.40
476	244	6.17	5.50
376	275	5.93	5.62
276	323	5.62	5.78
176	408	5.17	6.01
126	485	4.84	6.18



Question Number	Answer		Mark
4 (a)(i)	Any **TWO** from: Ensure the metre rule is vertical using a set square Accept alternative valid methods Ensure the end of the rod is close to the metre rule **Or** use a set square to read off the values Take readings perpendicular to the scale (to avoid parallax)	 (1) (1) (1)	2
4 (a)(ii)	The uncertainty of a single reading is half the resolution of the metre rule, (which is 0.5 mm) As the two readings are subtracted, the uncertainties are added	(1) (1)	2
4 (b)(i)	Micrometer screw gauge (with a resolution of 0.01mm) (Accept digital caliper) As this would produce an uncertainty of 0.25% which is small	(1) (1)	2
4 (b)(ii)	One **PAIR** from: Repeat at different orientations **and** calculate a mean To reduce the effect of <u>random errors</u> Check (and correct) for zero error To eliminate <u>systematic error</u>	 (1) (1) (1) (1)	2
4 (b)(iii)	Mean value of d = <u>2.35</u> (mm) Calculation from half range shown to give uncertainty of 0.02 (mm) <u>Example of calculation</u> Mean d = (2.35 + 2.37 + 2.34 + 2.34 + 2.33) mm / 5 = 11.74 mm / 5 = 2.348 mm = 2.35 mm Uncertainty = (2.37 – 2.33) mm /2 = 0.04 mm/2 = 0.02 mm	(1) (1)	2
4 (c)	Use of $G = (32mglx^2) / (\pi\, yd^4)$ shown Correct value of G given to 2 or 3 s.f. e.c.f. (b)(iii) Bald answer scores 0 Accept value of 1.5×10^{11} ($\mathrm{N\ m^{-2}}$) if d = 2 mm used <u>Example of calculation</u> $G = \dfrac{32 \times 0.1\,\mathrm{kg} \times 9.81\,\mathrm{N\,kg^{-1}} \times 0.589\,\mathrm{m} \times (0.103\,\mathrm{m})^2}{3.14159 \times 0.026\,\mathrm{m} \times (2.35 \times 10^{-3}\,\mathrm{m})^4}$ $= 0.196\ \mathrm{N\ m^3} / 2.49 \times 10^{-12}\ \mathrm{m^5}$ $= 7.87 \times 10^{10}$ ($\mathrm{N\ m^{-2}}$) $= 7.9 \times 10^{10}$ ($\mathrm{N\ m^{-2}}$)	(1) (1)	2

4 (d)	Use of 2× %U in x **Or** 4× %U in d shown Calculation of correct value of %U in G e.c.f. (b)(iii) Correct value of relevant limits from %U e.c.f. (c) Valid conclusion based on comparison of relevant limits with data <u>Example of calculation</u> %U $= (0.1 / 58.9) \times 100 + 2 \times (0.1 / 10.3) \times 100 + (1 / 26) \times 100 + 4 \times (0.02 / 2.35) \times 100$ $= 0.17\% + 2 \times 0.97\% + 3.85\% + 4 \times 0.85\%$ $= 0.17\% + 1.94\% + 3.85\% + 3.40\%$ $= 9.36\% = 9.4\%$ Upper limit $= 78.7 \times 10^9$ N m$^2 \times (1+0.094) = 86.1 \times 10^9$ N m^2 Lower limit $= 78.7 \times 10^9$ N m$^2 \times (1 - 0.094) = 71.3 \times 10^9$ N m^2 As both values fall within this range, the student cannot determine which type of steel the rod is made from. **Or** Use of uncertainties to calculate maximum or minimum shown Calculation of correct value of upper limit Calculation of correct value of lower limit Valid conclusion based on comparison of relevant limit with data <u>Example of calculation</u> Upper limit $G = \dfrac{32 \times 0.1\text{kg} \times 9.81\text{Nkg}^{-1} \times (0.589+0.001)\text{m} \times ((0.103+0.001)\text{m})^2}{3.14159 \times (0.026-0.01)\text{ m} \times ((2.35-0.02) \times 10^{-3}\text{ m})^4}$ $= 0.200$ N m^3 / 2.31×10^{-12} m^5 $= 8.68 \times 10^{10}$ (N m^{-2}) Lower limit $G = \dfrac{32 \times 0.1\text{kg} \times 9.81\text{Nkg}^{-1} \times (0.589-0.001)\text{m} \times ((0.103-0.001)\text{m})^2}{3.14159 \times (0.026+0.01)\text{ m} \times ((2.35+0.02) \times 10^{-3}\text{ m})^4}$ $= 0.192$ N m^3 / 2.68×10^{-12} m^5 $= 7.16 \times 10^{10}$ (N m^{-2}) As both values fall within this range, the student cannot determine which type of steel the rod is made from. **Or** Use of 2× %U in x **Or** 4× %U in d shown Calculation of correct value of %U in G e.c.f. (b)(iii) Correct calculation of relevant %D shown e.c.f. (c) Valid conclusion based on comparison of relevant %D with %U <u>Example of calculation</u> %U $= (0.1 / 58.9) \times 100 + 2 \times (0.1 / 10.3) \times 100 + (1 / 26) \times 100 + 4 \times (0.02 / 2.35) \times 100$	(1) (1) (1) (1) (1) (1) (1) (1) (1) (1) (1) (1)	4

	$= 0.17\% + 2 \times 0.97\% + 3.85\% + 4 \times 0.85\%$ $= 0.17\% + 1.94\% + 3.85\% + 3.40\%$ $= 9.36\% = 9.4\%$ %D for structural steel = $(78.7 - 79.3)/79.3 \times 100 = 0.76\ \%$ %D for carbon steel = $(78.7 - 77)/77 \times 100 = 2.3\%$ As % D for both structural and carbon steel are less than the %U, the student cannot determine which type of steel the rod is made from.	
	Total for question	**16**