Mark Scheme (Results)

January 2023

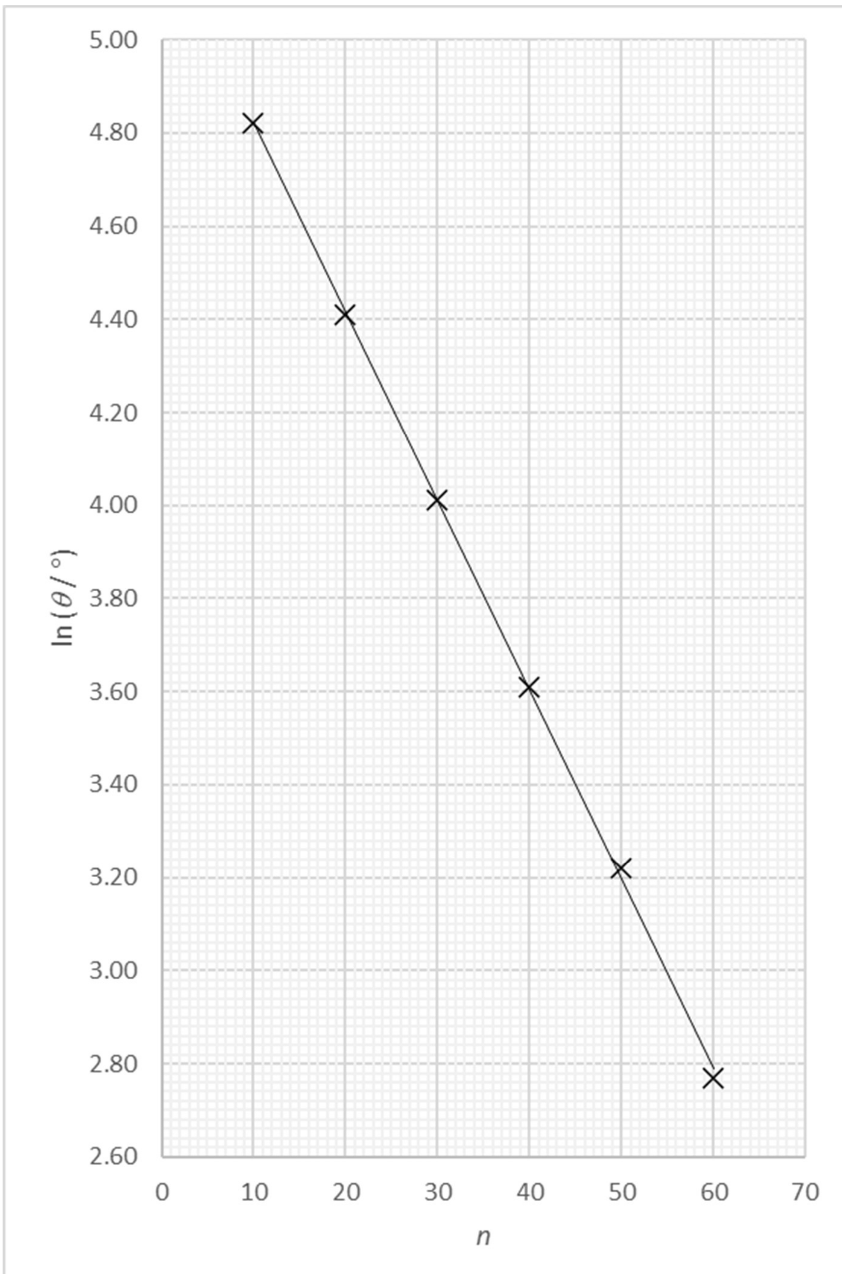
Pearson Edexcel International Advanced Level in Physics (WPH16)
Paper 01 Practical Skills in Physics II

Question Number	Answer	Mark
1(a)	The screw will get hot **Or** Risk of burns **(1)** (So) use tongs whilst heating **(1)**	**2**
1(b)(i)	Any **TWO** from: No repeats recorded **Or** Not enough sets of data Do not accept reference to range **(1)** Inconsistent number of significant figures **Or** Inconsistent number of decimal places **Or** Not all values recorded to resolution of instrument **(1)** No units for temperature (increase) **(1)** Actual temperatures (of water) not recorded **(1)**	**2**
1(b)(ii)	Any **ONE** from Time for heating the screw **(1)** Position of screw in flame **(1)** Flame setting **(1)** **Do not accept mass or volume**	**1**
1(b)(iii)	Use of $\Delta E = mc\Delta\theta$ using pair of values from table of results **(1)** Use of energy lost by screw in cooling down = energy gained by water in heating up **(1)** Correct value of $\Delta\theta$ to 3 sig figs **(1)** <u>Example of calculation</u> For water $\Delta E = mc\Delta\theta = 9.9 \times 10^{-3} \times 4180 \times 62 = 2570$ J For screw $\Delta\theta = \frac{\Delta E}{mc} = \frac{2570}{4.11\times10^{-3}\times420} = 1490$ (°C) 2nd data line: $\Delta\theta = 1510$ (°C) 3rd data line $\Delta\theta = 1500$ (°C) Reverse working can score 2 marks	**3**
	Total for question 1	**8**

Question Number	Answer		Mark
2(a)(i)	Substitution using $T = \frac{2\pi}{\omega}$	(1)	
	Clear algebra leading to relationship	(1)	2
	<u>Example of derivation</u> $T = \frac{2\pi}{\omega} \Rightarrow \omega = \frac{2\pi}{T} \Rightarrow \omega^2 = \frac{4\pi^2}{T^2}$ $Mg = mx\omega^2 = mx\frac{4\pi^2}{T^2}$ $\therefore T^2 = \frac{4\pi^2 mx}{Mg}$		
2(a)(ii)	1 Use a timing marker (to mark the start and end of a rotation)	(1)	
	2 Start timing after a few rotations	(1)	
	3 Time a number of rotations and divide by the number of rotations **Or** Repeat the measurement of T and calculate a mean	(1)	
	4 (Vary M to) obtain at least 5 sets of measurements	(1)	
	5 Keep x constant (for each value of M)	(1)	
	6 Plot a graph of T^2 against $\frac{1}{M}$ to check it is a straight line **Or** Plot a graph of T^2 against $\frac{1}{M}$ to check the gradient is constant	(1)	6
	Accept alternative graphs: T against $\sqrt{\frac{1}{M}}$ or log T against log M or variations with correct use of constants		
2(b)	Any **TWO** from		
	The video recording will help to judge when a rotation is complete	(1)	
	The video recording can be used to view the motion more slowly	(1)	
	The time for a rotation will be long so any improvement will be small	(1)	2
	Total for question 2		**10**

Question Number	Answer		Mark
3(a)	Any **PAIR** from		
	$\ln \theta = \ln \theta_0 - \lambda n$	(1)	
	Is in the form $y = c + mx$ where $-\lambda$ is the gradient	(1)	
	Or		
	$\ln \theta = -\lambda n + \ln \theta_0$	(1)	
	Is in the form $y = mx + c$ where $-\lambda$ is the gradient	(1)	2
	MP2 dependent on MP1		
3(b)(i)	Values of $\ln \theta$ correct to 2 d.p. Accept 3 d.p.	(1)	
	Axes labelled: y as $\ln (\theta / °)$ and x as n Accept degrees for °	(1)	
	Appropriate scales chosen	(1)	
	Values plotted accurately	(1)	
	Best fit line drawn	(1)	5
3(b)(ii)	Calculation of gradient using large triangle shown	(1)	
	Value of λ in range (–)0.038 to (–)0.042	(1)	
	Value of λ given to 2 or 3 s.f, positive, no unit	(1)	3
	Example of calculation		
	$-\lambda = (4.82 - 3.20) / (10 - -50) = -1.62 / 40 = -0.0405$		
	$-\lambda = -0.0405$		
	$\lambda = 0.041$		
3(b)(iii)	Correct value of $\ln \theta_0$ obtained using value of λ and data point from best fit line **Or** Correct value of $\ln \theta_0$ obtained using y-intercept	(1)	
	Conversion of $\ln \theta_0$ to θ_0	(1)	
	Valid conclusion based on calculated value of θ_0	(1)	3
	Example of calculation		
	$\ln \theta = \ln \theta_0 - \lambda n$		
	$\ln \theta_0 = \ln \theta + \lambda n = 3.2 + (0.041 \times 50) = 5.25$		
	$\theta_0 = e^{5.25} = 191°$		
	As this is greater than 180° the claim is correct		
	Total for question 3		**13**

n	θ / °	ln (θ / °)
10	124	4.82
20	82	4.41
30	55	4.01
40	37	3.61
50	25	3.22
60	16	2.77



Question Number	Answer		Mark
4(a)(i)	Any **PAIR** from: Repeat at different orientations and calculate a mean To reduce (the effect of) <u>random error</u> **Or** Check and correct for zero error Accept suitable method To eliminate <u>systematic error</u> MP2 dependent MP1	 **(1)** **(1)** **(1)** **(1)**	**2**
4(a)(ii)	Mean d = <u>8.54</u> (mm) Calculation using half range shown **Or** Calculation of furthest from mean Uncertainty in d = 0.02 (mm) d.p. consistent with mean <u>Example of calculation</u> Mean d = (8.53 + 8.56 + 8.55 + 8.53) / 4 = 34.17 / 4 = 8.54 (mm) Uncertainty = (8.56 – 8.53) / 2 = 0.03 / 2 = 0.015 = 0.02 (mm)	**(1)** **(1)** **(1)**	**3**
4(b)(i)	Use of 2 × %U in d shown **Or** Use of $2 \times \frac{\Delta d}{d}$ shown Calculation of U in d^2 shown U in d^2= 1.3 (mm^2) Accept 3 sig figs <u>Example of calculation</u> %U in $d^2 = 2 \times \frac{0.06}{10.70} \times 100 = 1.1$ % U in d^2= $(10.70)^2$ mm^2 × 1.1 % = 1.26 (mm^2) **Or** Uses uncertainty in d to calculate minimum or maximum d^2 Calculation of U in d^2 using half range shown U in d^2= 1.3 (mm^2) Accept 3 sig figs <u>Example of calculation</u> Maximum $d^2 = (10.70 + 0.06)^2 = 10.76^2 = 115.8$ (mm^2) Minimum $d^2 = (10.70 - 0.06)^2 = 10.64^2 = 113.2$ (mm^2) U in $d^2 = \frac{115.8-113.2}{2} = \frac{2.6}{2} = 1.3$ (mm^2)	 **(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**3**

Question	Answer		Mark
4(b)(ii)	Use of $A = \frac{\pi}{4}(s^2 - d^2)$ Addition of uncertainties in s^2 and d^2 e.c.f. 4(b)(i) Calculation of U in A using factor of $\frac{\pi}{4}$ shown %U in A = 0.43 % Accept 3 sig figs Accept use of U in d^2 of 1mm² to give 0.39% <u>Example of calculation</u> $A = \frac{\pi}{4}(s^2 - d^2) = \frac{\pi}{4}(881 - 114) = \frac{\pi}{4} \times 766 = 602$ mm² U in $A = \frac{\pi}{4}(2 + 1.3) = \frac{\pi}{4} \times 3.3 = 2.6$ mm² %U in $A = \frac{2.6}{602} \times 100 = 0.43$ % **Or** Use of $A = \frac{\pi}{4}(s^2 - d^2)$ Correct use of uncertainties to calculate maximum or minimum A e.c.f. 4(b)(i) Calculation of U in A from half range shown %U in A = 0.42 % Accept 3 sig figs <u>Example of calculation</u> $A = \frac{\pi}{4}(s^2 - d^2) = \frac{\pi}{4}(881 - 114) = \frac{\pi}{4} \times 767 = 602$ mm² Max $A = \frac{\pi}{4}(s^2 - d^2) = \frac{\pi}{4}((881 + 2) - (114 - 1)) = \frac{\pi}{4} \times 770 = 605$ mm² Min $A = \frac{\pi}{4}(s^2 - d^2) = \frac{\pi}{4}((881 - 2) - (114 + 1)) = \frac{\pi}{4} \times 763 = 600$ mm² U in $A = \frac{605-600}{2} = 2.5$ mm² %U in $A = \frac{2.5}{602} \times 100 = 0.42$ %	(1) (1) (1) (1) (1) (1) (1) (1)	4
4(c)	Both readings would have the same uncertainty (So) the percentage uncertainty (in the mass) is reduced **Or** %U for mass of 10 rings = 0.8% and %U for mass of one ring = 8%	(1) (1)	2
4(d)(i)	Use of $\rho = \frac{m}{xA}$ ρ = <u>7.46</u> (g cm^{-3}) <u>Example of calculation</u> $\rho = \frac{63}{1.403 \times 6.02} = 7.46$ (g cm^{-3})	(1) (1)	2

4(d)(ii)	%U in ρ = 1.5 % Accept 1, 2 or 3 sig figs **(1)** Correct calculation of relevant limit using %U shown e.c.f. (d)(i) **(1)** Conclusion based on comparison of limit and range **(1)** MP3 dependent MP2 <u>Example of calculation</u> %U in $\rho = \frac{0.5}{63} \times 100 + \frac{0.04}{14.03} \times 100 + 0.4$ = 0.8 % + 0.3 % + 0.4 % = 1.5 % Upper limit of ρ = 7.46 × (1 + 0.015) = 7.57 (g cm^{-3}) As the upper limit is higher than 7.48 g cm^{-3} then the ring could be made from stainless steel. **Or** %U in ρ = 1.5 % Accept 1, 2 or 3 sig figs **(1)** Correct calculation of relevant %D shown e.c.f. (d)(i) **(1)** Conclusion based on comparison of %D and %U **(1)** MP3 dependent MP2 <u>Example of calculation</u> %U in $\rho = \frac{0.5}{63} \times 100 + \frac{0.04}{14.03} \times 100 + 0.4$ = 0.8 % + 0.3 % + 0.4 % = 1.5 % %D = $\frac{7.48-7.46}{7.48} \times 100$ = 0.3 % As % D for the lower value is less than the %U then the ring could be made from stainless steel. **Or** Use of $\rho = \frac{m}{xA}$ and uncertainties to calculate maximum or minimum ρ **(1)** Correct calculation of relevant limit shown e.c.f. (d)(i) **(1)** Conclusion based on comparison of relevant limit and range **(1)** MP3 dependent MP2 <u>Example of calculation</u> Maximum $\rho = \frac{63+0.5}{(1.403-0.004)\times(6.02-0.4\%)} = \frac{63.5}{1.399\times6.00} = \frac{63.5}{8.39}$ = 7.56 (g cm^{-3}) As the maximum ρ is higher than 7.48 g cm^{-3} then the ring could be made from stainless steel. Note minimum ρ = 7.35 (g cm^{-3})		3
	Total for question 4		**19**