Pearson Edexcel

Mark Scheme (Results)

January 2023

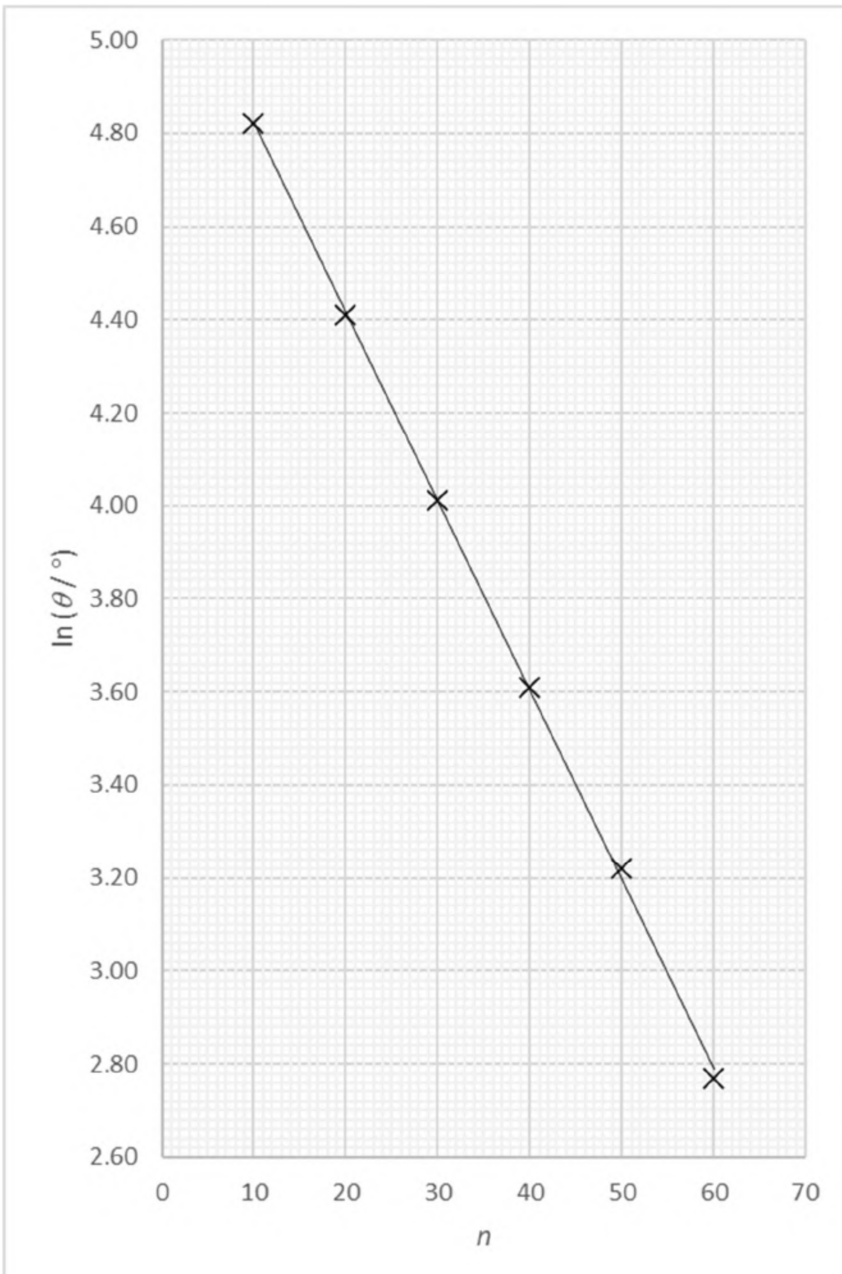
Pearson Edexcel International Advanced Level in Physics (WPH16)
Paper 01 Practical Skills in Physics II

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 $\Delta\theta = \frac{\Delta E}{mc} = \frac{2570}{4.11 \times 10^{-3} \times 420} = 1490$ (˚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 <u>gradient</u> **(1)** **Or** $\ln \theta = -\lambda n + \ln \theta_0$ **(1)** Is in the form $y = mx + c$ where $-\lambda$ is the <u>gradient</u> **(1)** MP2 dependent on MP1	**2**
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)** <u>Example of calculation</u> $-\lambda = (4.82 - 3.20) / (10 - -50) = -1.62 / 40 = -0.0405$ $-\lambda = -0.0405$ $\lambda = 0.041$	**3**
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)** <u>Example of calculation</u> $\ln \theta = \ln \theta_0 - \lambda n$ $\ln \theta_0 = \ln \theta + \lambda n = 3.2 + (0.041 \times 50) = 5.25$ $\theta_0 = e^{5.25} = 191°$ As this is greater than 180° the claim is correct	**3**
	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 **(1)** To reduce (the effect of) <u>random error</u> **(1)** **Or** Check and correct for zero error Accept suitable method **(1)** To eliminate <u>systematic error</u> **(1)** MP2 dependent MP1	2
4(a)(ii)	Mean d = <u>8.54</u> (mm) **(1)** Calculation using half range shown **Or** Calculation of furthest from mean **(1)** Uncertainty in d = 0.02 (mm) d.p. consistent with mean **(1)** <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)	3
4(b)(i)	Use of 2 × %U in d shown **Or** Use of $2 \times \frac{\Delta d}{d}$ shown **(1)** Calculation of U in d^2 shown **(1)** U in d^2= 1.3 (mm^2) Accept 3 sig figs **(1)** <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 **(1)** Calculation of U in d^2 using half range shown **(1)** U in d^2= 1.3 (mm^2) Accept 3 sig figs **(1)** <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)	3

<table>
<tr><td>4(b)(ii)</td><td>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 1mm^2 to give 0.39%

<u>Example of calculation</u>
$A = \frac{\pi}{4}(s^2 - d^2) = \frac{\pi}{4}(881 - 114) = \frac{\pi}{4} \times 766 = 602$ mm^2
U in $A = \frac{\pi}{4}(2 + 1.3) = \frac{\pi}{4} \times 3.3 = 2.6$ mm^2
%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>
$A = \frac{\pi}{4}(s^2 - d^2) = \frac{\pi}{4}(881 - 114) = \frac{\pi}{4} \times 767 = 602$ mm^2
Max $A = \frac{\pi}{4}(s^2 - d^2) = \frac{\pi}{4}((881 + 2) - (114 - 1)) = \frac{\pi}{4} \times 770 = 605$ mm^2
Min $A = \frac{\pi}{4}(s^2 - d^2) = \frac{\pi}{4}((881 - 2) - (114 + 1)) = \frac{\pi}{4} \times 763 = 600$ mm^2
U in $A = \frac{605-600}{2} = 2.5$ mm^2
%U in $A = \frac{2.5}{602} \times 100 = 0.42$ %</td><td>(1)
(1)
(1)
(1)

(1)
(1)
(1)
(1)</td><td>4</td></tr>
<tr><td>4(c)</td><td>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%</td><td>(1)

(1)</td><td>2</td></tr>
<tr><td>4(d)(i)</td><td>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})</td><td>(1)
(1)</td><td>2</td></tr>
</table>

Question	Answer	Mark
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**