Pearson Edexcel

Mark Scheme (Results)

October 2023

Pearson Edexcel International Advanced Level In Physics (WPH16)
Paper 01 Unit 6: Practical Skills in Physics II

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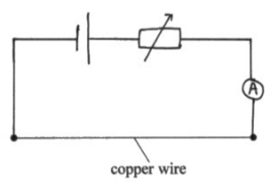
October 2023
Question Paper Log Number: P75626A
Publications Code: WPH16_01_MS_2310

General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Question Number	Answer	Mark
1(a)	**EITHER** The wire will get hot **(1)** Turn off the power supply between readings **Or** Add a resistor to the circuit **(1)** **OR** There may be a short circuit **(1)** Add a resistor to the circuit **(1)** **OR** There is a risk of electric shock (from the copper wire) **(1)** Use insulated wire **(1)**	**2**
1(b)	Circuit including d.c. power supply and ammeter in series with copper wire **(1)** Circuit includes means of varying current, e.g. variable resistor **(1)** [Ignore additional components that do not prevent circuit working as expected] 	**2**
1(c)	There are not enough readings **(1)** The range of readings is too small **(1)** The (relationship predicts that the graph should be a straight line through the origin **Or** The relationship is in the form $y = mx$ **(1)** An accurate best fit line can't be drawn **Or** A straight line graph can't be confirmed **Or** A y-intercept of zero can't be confirmed **Or** Direct proportionality can't be confirmed **(1)**	**4**
	Total for question 1	**8**

Question Number	Answer		Mark
2(a)	Uses $T = 2\pi\sqrt{\frac{l}{g}}$ with $l = H - h$ Clear algebra leading to formula <u>Example of derivation</u> $T = 2\pi\sqrt{\frac{l}{g}}$ where $l = H - h$ So $T = 2\pi\sqrt{\frac{H-h}{g}}$ $\therefore T^2 = 4\pi^2\left(\frac{H-h}{g}\right) = \frac{4\pi^2 H - 4\pi^2 h}{g} = \frac{4\pi^2 H}{g} - \frac{4\pi^2 h}{g}$	**(1)** **(1)**	2
2(b)	1. Use a metre rule to measure h 2. Ensure metre rule is vertical using a set square **Or** Use a set square to read off the scale **Or** Measure to the bottom of the bob and add the radius of the bob 3. Use a (timing) marker (at the centre of the oscillation) 4. Measure (time for) multiple oscillations **and** divide by the number of oscillations **Or** Repeat the measurement of T **and** calculate the mean **Or** Start timing the oscillations once the oscillations have settled 5. Determine T for (at least) 5 different values of h 6. Plot a graph of T^2 against h and determine the intercept (to calculate H) [ANNOTATE WITH MPs AWARDED]	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	6
2(c)	The recording can be viewed in slow motion Judging when an oscillation is complete will be more accurate	**(1)** **(1)**	2
	Total for question 2		**10**

<table>
<tr><th>Question Number</th><th>Answer</th><th></th><th>Mark</th></tr>
<tr><td>3(a)</td><td>EITHER
$\ln P = \ln P_0 - bh$
Compares to $y = c + mx$ where the gradient is $-b$ is the gradient (which is constant)

MP2 dependent on MP1

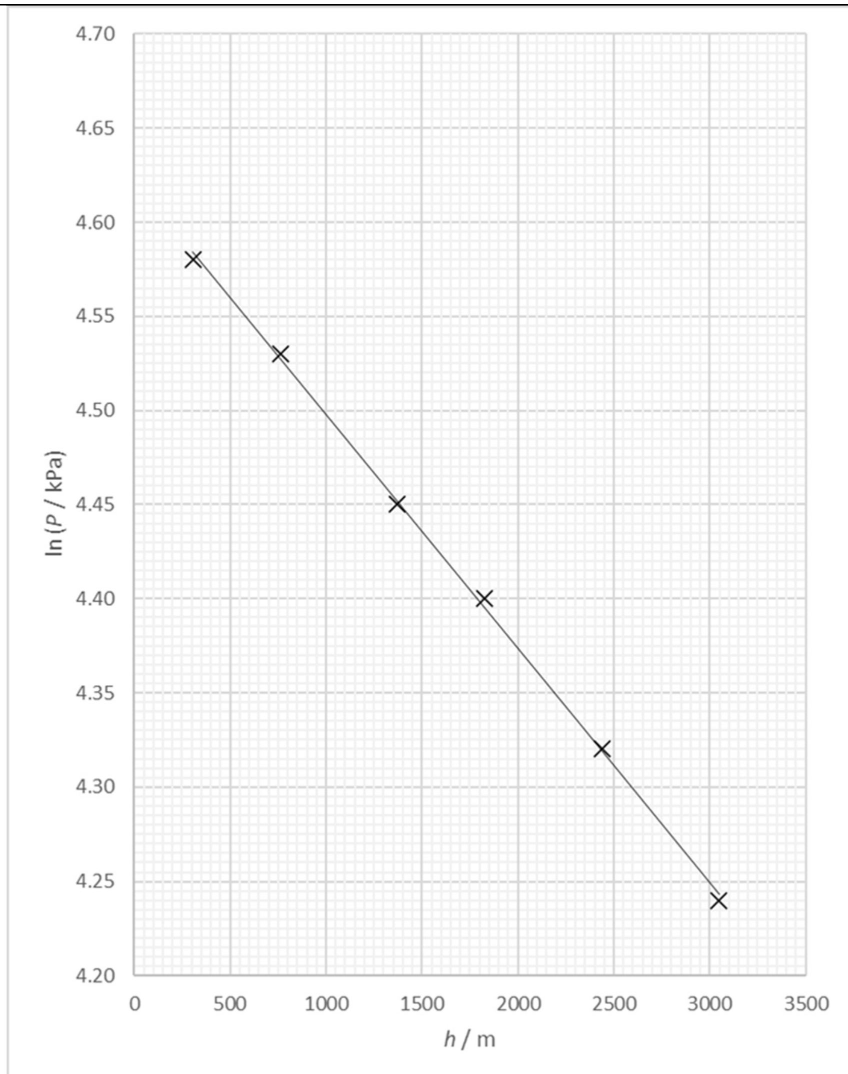
OR
$\ln P = - bh + \ln P_0$
Compares to $y = mx + c$ where the gradient is $-b$ is the gradient (which is constant)

MP2 dependent on MP1</td><td>
(1)
(1)

(1)
(1)</td><td>2</td></tr>
<tr><td>3(b)(i)</td><td>Values of ln P correct and consistent to 3 d.p. Accept consistent to 2 d.p.
Axes labelled: y as ln (P / kPa) and x as h / m
Appropriate scales chosen
Processed data plotted accurately
Best fit line drawn

[Accept graph with values of ln P in Pa, log values only credit MP3,4,5]
[ANNOTATE WITH MPs AWARDED, TICK CHECKED PLOTS]</td><td>(1)
(1)
(1)
(1)
(1)</td><td>5</td></tr>
</table>

***h* / m**	***P* / kPa**	**ln (*P* / kPa)**
305	97.7	4.582
762	92.5	4.527
1372	85.9	4.453
1829	81.2	4.397
2438	75.3	4.321
3048	69.7	4.244

		
3(b)(ii)	Uses large triangle to calculate gradient **(1)** Value of gradient in range (–)1.20 × 10^{-4} to (–)1.30 × 10^{4} **(1)** Value of gradient given to 2 or 3 s.f., and negative **(1)** [Allow unit of m^{-1}] <u>Example of calculation</u> gradient = $\frac{4.56 - 4.25}{500 - 3000} = \frac{0.31}{-250}$ = −1.24 × 10^{-4}	**3**

3(b)(iii)	Uses gradient = (−) $\frac{Mg}{kT}$ **(1)** Correct value of M e.c.f. 3(b)(ii) **(1)** Value of M given to 2 or 3 s.f., correct unit **(1)** <u>Example of calculation</u> $M = -\frac{-1.24 \times 10^{-4} \times 1.38 \times 10^{-2}\ \text{JK}^{-1} \times 288\text{K}}{9.81\text{ms}^{-2}} = 5.02 \times 10^{-26}$ kg	**3**
3(b)(iv)	Reads ln P_0 from y-intercept **Or** Calculates (ln) P_0 using gradient and data point from best fit line **Or** Substitutes for (ln) P_0 using gradient and data point from best fit line **(1)** Calculates P at h = (−)414 m **(1)** **(1)** Value of P in range 105 kPa to 108 kPa [accept 2,3,4 SF] MP3 dependent on MP2 <u>Example of calculation</u> ln P_0 = 4.62 ln P = 4.62 + (−1.24 × 10^{-4} × −414) = 4.67 $P = e^{4.67}$ = 107 kPa	**3**
	Total for question 3	**16**

Question Number	Answer		Mark
4(a)(i)	**EITHER**		
	Repeat at different places **and** calculate a mean	**(1)**	
	To reduce (the effect of) random error	**(1)**	
	MP2 dependent on MP1 [Allow MP2 if MP1 partially correct]		
	OR		
	Use the ratchet to avoid squashing the rubber	**(1)**	
	To reduce (the effect of) random error	**(1)**	
	MP2 dependent on MP1 [Allow MP2 if MP1 partially correct]		
	OR		
	Check **and** correct for zero error	**(1)**	
	To eliminate systematic error [Accept reduce for eliminate]	**(1)**	**2**
	MP2 dependent on MP1 [Allow MP2 if MP1 partially correct]		
4(a)(ii)	Mean t = 1.04 (mm) 3 SF only	**(1)**	**1**
	Example of calculation		
	Mean $t = \frac{(1.02 + 1.06 + 1.05 + 1.01)\text{mm}}{4} = 1.035 = 1.04$ (mm)		
4(a)(iii)	Calculation using half range shown **Or** Calculation of furthest from the mean shown	**(1)**	
	Percentage uncertainty in t = 3 % e.c.f. (a)(ii) Accept 2 SF	**(1)**	**2**
	Example of calculation		
	Half range $= \frac{(1.06 - 1.01)\text{mm}}{2} = 0.025 = 0.03$ (mm)		
	%U $= \frac{0.03\text{mm}}{1.04\text{mm}} \times 100 = 2.9\% = 3\%$		
	Note: use of 0.025 in calculation gives 2.4% or 2%		

4(a)(iv)	The measurement is larger but the uncertainty is the same **Or** The measurement is larger but the resolution (of the micrometer) is the same **(1)** So the percentage uncertainty is reduced (by a factor of 4) **(1)** MP2 dependent on MP1		**2**
4(a)(v)	The length x of the rubber band does not take into account the fold (at the ends). **(1)** The (length x of the) rubber band could be measured when it is not taut **Or** The width w could be measured when the rubber band is compressed **(1)**		**2**

4(b)(i)	**EITHER** Uses 2 × percentage uncertainty in D [Accept $2 \times \frac{\Delta D}{D}$] **(1)** Uncertainty in D = 0.069 (cm^2) 2 SF only **(1)** <u>Example of calculation</u> %U in $D^2 = 2 \times \frac{0.01}{3.45} \times 100 = 0.58\%$ U in $D^2 = 3.45^2 \times \frac{0.58}{100} = 0.069$ (cm^2) **OR** Calculation of half range of D^2 shown **(1)** Uncertainty in D = 0.069 (cm^2) 2 SF only **(1)** <u>Example of calculation</u> U in $D^2 = \frac{3.46^2 - 3.44^2}{2} = 0.069$ (cm^2)	**2**
4(b)(ii)	**EITHER** Addition of uncertainties shown **(1)** U in A = 0.052 (cm^2) 2 SF only e.c.f. (b)(i) **(1)** <u>Example of calculation</u> U in $A = (0.07 + 0.06 + 0.07) \times \frac{\pi}{12} = 0.052$ (cm^2) **OR** Calculation of maximum and minimum A shown **(1)** U in A = 0.053 (cm^2) 2 SF only **(1)** <u>Example of calculation</u> Maximum $A = (11.97 + 9.42 + 10.63) \times \frac{\pi}{12} = 8.383$ cm^2 Minimum $A = (11.83 + 9.30 + 10.49) \times \frac{\pi}{12} = 8.278$ cm^2 U in $A = \frac{8.383 - 8.278}{2} = 0.053$ (cm^2)	**2**

4(c)	Calculation of a relevant limit using percentage uncertainty shown **Or** Calculation of a relevant uncertainty using percentage uncertainty shown **(1)** Upper limit ρ for rubber band = 1.20 (g cm^{-3}) **and** Lower limit ρ for rubber bung = 1.50 (g cm^{-3}) **(1)** They are **not** made from the same type of rubber as the upper limit of the rubber band does not overlap the lower limit for the rubber bung **(1)** MP3 dependent MP2 <u>Example of calculation</u> Upper limit ρ for rubber band = $1.15 \times (1 + \frac{4.3}{100}) = 1.20$ (g cm^{-3}) Lower limit ρ for rubber bung = $1.52 \times (1 - \frac{1.2}{100}) = 1.50$ (g cm^{-3})		**3**
	Total for question 4		**16**

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