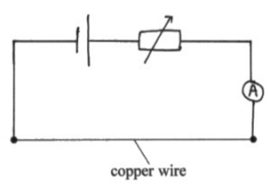
Mark Scheme (Results)

October 2023

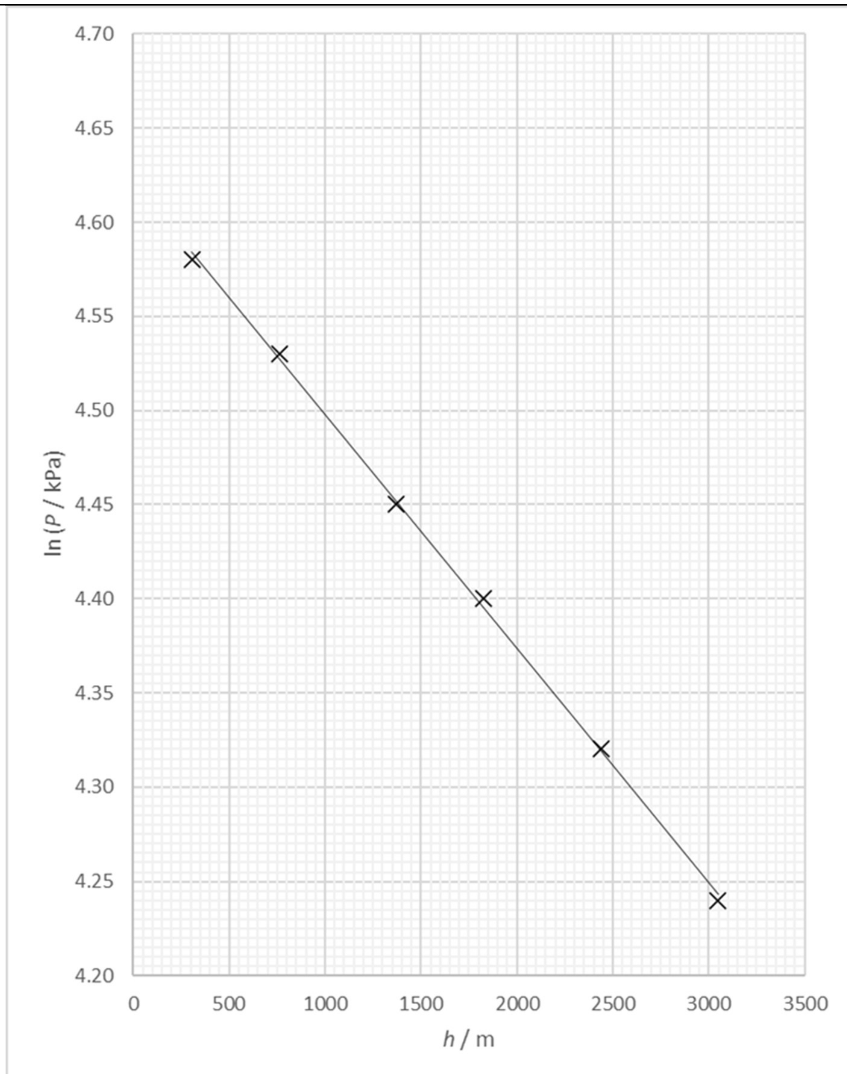
Pearson Edexcel International Advanced Level In Physics (WPH16)
Paper 01 Unit 6: Practical Skills in Physics II

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 $l = H - h$	**(1)**	
	Clear algebra leading to formula	**(1)**	**2**
	<u>Example of derivation</u> $T = 2\pi\sqrt{\frac{l}{g}}$ where $l = H - h$ So $T = 2\pi\sqrt{\frac{H-h}{g}}$ $\therefore T^2 = 4\pi^2\left(\frac{H-h}{g}\right) = \frac{4\pi^2 H - 4\pi^2 h}{g} = \frac{4\pi^2 H}{g} - \frac{4\pi^2 h}{g}$		
2(b)	1. Use a metre rule to measure h	**(1)**	
	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	**(1)**	
	3. Use a (timing) marker (at the centre of the oscillation)	**(1)**	
	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	**(1)**	
	5. Determine T for (at least) 5 different values of h	**(1)**	
	6. Plot a graph of T^2 against h and determine the intercept (to calculate H)	**(1)**	**6**
	[ANNOTATE WITH MPs AWARDED]		
2(c)	The recording can be viewed in slow motion	**(1)**	
	Judging when an oscillation is complete will be more accurate	**(1)**	**2**
	Total for question 2		**10**

Question Number	Answer	Mark
3(a)	**EITHER** $\ln P = \ln P_0 - bh$ **(1)** Compares to $y = c + mx$ where the gradient is $-b$ is the gradient (which is constant) **(1)** MP2 dependent on MP1 **OR** $\ln P = - bh + \ln P_0$ **(1)** Compares to $y = mx + c$ where the gradient is $-b$ is the gradient (which is constant) **(1)** MP2 dependent on MP1	2
3(b)(i)	Values of ln P correct and consistent to 3 d.p. Accept consistent to 2 d.p. **(1)** Axes labelled: y as ln (P / kPa) and x as h / m **(1)** Appropriate scales chosen **(1)** Processed data plotted accurately **(1)** Best fit line drawn **(1)** [Accept graph with values of ln P in Pa, log values only credit MP3,4,5] [ANNOTATE WITH MPs AWARDED, TICK CHECKED PLOTS]	5

***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 Value of gradient in range (−)1.20×10^{-4} to (−)1.30×10^{4} Value of gradient given to 2 or 3 s.f., and negative [Allow unit of m^{-1}] <u>Example of calculation</u> gradient = $\frac{4.56 - 4.25}{500 - 3000} = \frac{0.31}{-250} = -1.24 \times 10^{-4}$	**(1)** **(1)** **(1)**	**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)** Value of P in range 105 kPa to 108 kPa [accept 2,3,4 SF] **(1)** MP3 dependent on MP2 <u>Example of calculation</u> ln P_0 = 4.62 ln $P = 4.62 + (-1.24 \times 10^{-4} \times -414) = 4.67$ $P = e^{4.67}$ = 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) <u>random error</u>	**(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) <u>random error</u>	**(1)**	
	MP2 dependent on MP1 [Allow MP2 if MP1 partially correct]		
	OR		
	Check **and** correct for zero error	**(1)**	
	To eliminate <u>systematic error</u> [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**
	<u>Example of calculation</u>		
	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**
	<u>Example of calculation</u>		
	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)** **(1)** So the percentage uncertainty is reduced (by a factor of 4) 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 $2 \times \frac{\Delta D}{D}$] Uncertainty in D = 0.069 (cm^2) 2 SF only <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 Uncertainty in D = 0.069 (cm^2) 2 SF only <u>Example of calculation</u> U in $D^2 = \frac{3.46^2 - 3.44^2}{2} = 0.069$ (cm^2)	**(1)** **(1)** **(1)** **(1)**	**2**
4(b)(ii)	**EITHER** Addition of uncertainties shown U in A = 0.052 (cm^2) 2 SF only e.c.f. (b)(i) <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 U in A = 0.053 (cm^2) 2 SF only <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)	**(1)** **(1)** **(1)** **(1)**	**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**