Mark Scheme (Results)

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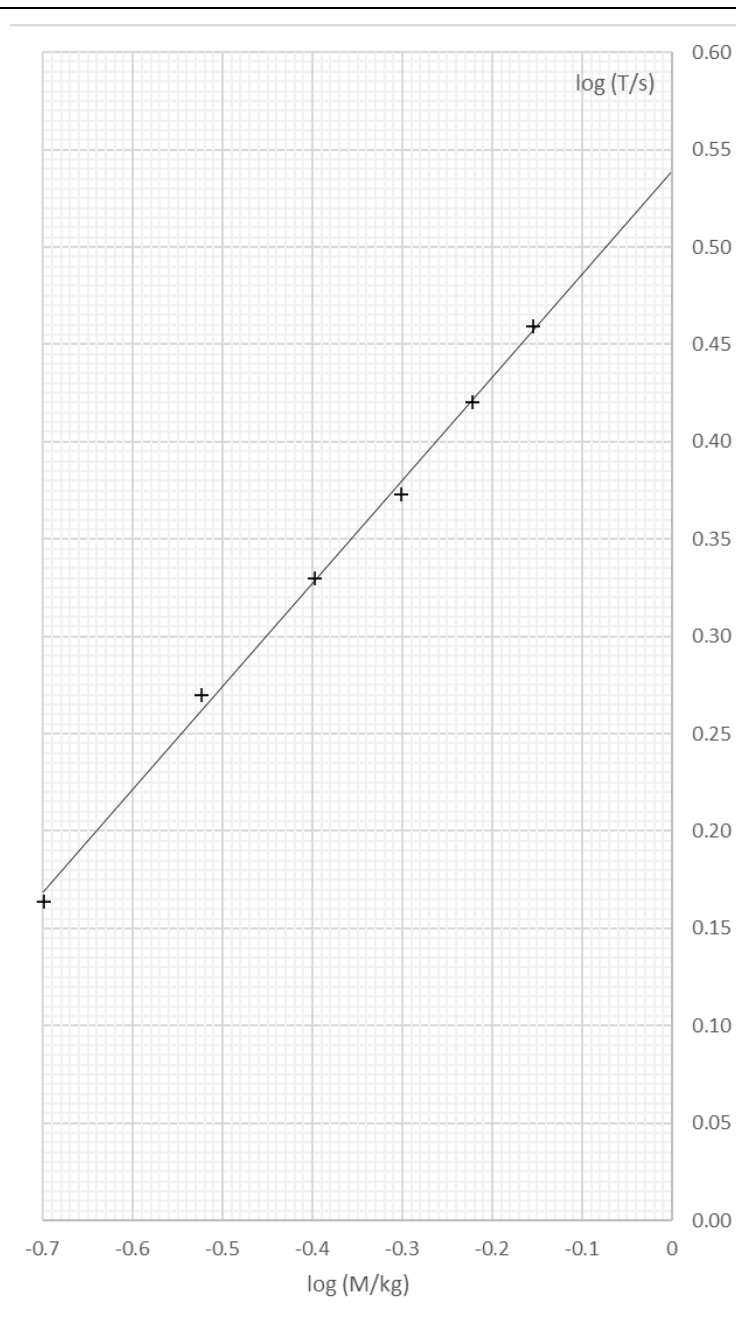
Pearson Edexcel International Advanced Level in Physics (WPH16) Paper 01 Practical Skills in Physics II

Question Number	Answer		Mark
1(a)	Any **TWO** from		
	Connect the capacitor with the correct polarity	**(1)**	
	Do not exceed the working p.d. of the capacitor	**(1)**	
	Ensure the capacitor is fully discharged when handling	**(1)**	**2**
1(b)	Clamp metre rule in position **and** use a set square to ensure metre rule is vertical accept spirit level	**(1)**	
	Ensure the metre rule is close to the mass	**(1)**	
	View the ruler perpendicularly **Or** Use a set square to read off the ruler	**(1)**	**3**
1(c)(i)	Mean value of h = 0.242 m 3 d.p. only	**(1)**	**1**
	Example of calculation Mean value of $h = \frac{(0.246 + 0.239 + 0.243 + 0.241)\text{m}}{4} = 0.2423$ m = 0.242 m		
1(c)(ii)	Calculation of half range shown Accept furthest from mean	**(1)**	
	Correct percentage uncertainty given to 1 or 2 sig figs (e.c.f. 1(c)(i))	**(1)**	**2**
	Example of calculation Half range $= \frac{(0.246 - 0.239)\text{m}}{2} = 3.5 \times 10^{-3}$ (m) Percentage uncertainty $= \frac{3.5 \times 10^{-3}\text{m}}{0.242\text{m}} \times 100 = 1.4\%$ Allow rounding or use of furthest from the mean to give half range of 4mm, so %U=1.7%		
1(c)(iii)	Use of $E = \frac{1}{2}CV^{2}$ **and** $E = mgh$	**(1)**	
	Use of efficiency $= \frac{\text{useful energy output}}{\text{total energy input}}$	**(1)**	
	Efficiency = 0.56 Allow 56% e.c.f. 1(c)(i)	**(1)**	**3**
	Example of calculation $E = \frac{1}{2}CV^{2} = 0.5 \times (4700 \times 10^{-6})\text{C} \times (6\text{V})^{2} = 0.0846$ J $E = mgh = (20 \times 10^{-3})\text{kg} \times 9.81\text{ms}^{2} \times 0.242\text{m} = 0.0475$ J Efficiency $= \frac{0.0475\text{J}}{0.0846\text{J}} = 0.56$		
	Total for question 1		**11**

Question Number	Answer		Mark
2(a)	Substitution of units for all variables into formula	**(1)**	
	Clear working leading to units of N s m^{-2}	**(1)**	**2**
	Example of working		
	$\eta = \frac{\pi \rho P r^4 t}{8LM} = \frac{(\text{kg m}^{-3})(\text{N m}^{-2})(\text{m}^4)(\text{s})}{(\text{m})(\text{kg})} = \text{N s m}^{-6}\text{m}^4 = \text{N s m}^{-2}$		
2(b)	1. Measure the internal diameter of the pipe using vernier calipers	**(1)**	
	2. Repeat the measurement (of diameter) at different orientations and calculate the mean	**(1)**	
	3. Ensure pipe is horizontal using a spirit level **Or** (Turn on the tap and wait until) pressure difference is constant **Or** Keep stopwatch close to the mass balance	**(1)**	
	4. Measure M and corresponding value of t	**(1)**	
	5. Record at least 5 sets of values.	**(1)**	
	6. Plot a graph of M against t and calculate the gradient to determine η	**(1)**	**6**
	Accept valid alternative graphs with M and t as variables		
	Accept a stated gradient if correct		
2(c)	The data logger will record mass and time simultaneously	**(1)**	
	The data logger has a high sampling rate	**(1)**	**2**
	Total for question 2		**10**

Question Number	Answer		Mark
3(a)	Measure multiple oscillations and divide by the number of oscillations	**(1)**	
	Use a marker at the centre of the oscillation **Or** use a marker on the mass	**(1)**	
	Repeat the measurement of T and calculate a mean **Or** Allow the oscillations to settle before timing	**(1)**	**3**
3(b)(i)	**EITHER**		
	$\log T = \log a + b \log M$	**(1)**	
	Compares with $y = c + mx$ where b is the gradient (which is constant)	**(1)**	
	MP2 dependent on MP1		
	OR		
	$\log T = b \log M + \log a$	**(1)**	
	Compares with $y = mx + c$ where b is the gradient (which is constant)	**(1)**	**2**
	MP2 dependent on MP1		
3(b)(ii)	Values of log M correct and consistent to 3 d.p. Allow consistent to 2 d.p.	**(1)**	
	Values of log T correct and consistent to 3 d.p. Allow consistent to 2 d.p.	**(1)**	
	Axes labelled: y as log (T / s) and x as log (M / kg)	**(1)**	
	Appropriate sensible scales chosen	**(1)**	
	log values plotted accurately	**(1)**	
	Best fit line drawn	**(1)**	**6**

M / kg	T / s	log (M / kg)	log (T / s)
0.200	1.46	−0.699	0.164
0.300	1.86	−0.523	0.270
0.400	2.14	−0.398	0.330
0.500	2.36	−0.301	0.373
0.600	2.63	−0.222	0.420
0.700	2.88	−0.155	0.459

The graph shows a plot of log (T/s) on the y-axis (ranging from 0.00 to 0.60) against log (M/kg) on the x-axis (ranging from -0.7 to 0).

3(b)(iii)	Calculation of gradient using large triangle shown	**(1)**	
	Value of gradient in range 0.51 to 0.55	**(1)**	
	Value of gradient given to 2 or 3 s.f., positive, no unit	**(1)**	**3**

Example of calculation

$$\text{gradient} = \frac{0.485 - 0.2}{-0.1 - -0.64} = \frac{0.285}{0.54} = 0.528$$

3(b)(iv)	Correct *y*-intercept read from graph **Or** Calculation of *y*-intercept using calculated gradient and data point from best fit line	**(1)**	
	Conversion of log value	**(1)**	
	Calculated value of *a* given to 2 or 3 s.f. e.c.f. (b)(iii)	**(1)**	**3**
	Example of calculation <u>Example of calculation</u> $\log a = y\text{-intercept} = 0.535$ $a = 10^{0.535} = 3.43$		
	Allow unit of s, incorrect unit does not score MP3		
	Total for question 3		**17**

Question Number	Answer		Mark
4(a)(i)	**EITHER**		
	Repeat (measurements of *t*) at different places and calculate a mean	**(1)**	
	To reduce (the effect of) <u>random error</u>	**(1)**	
	MP2 dependent on MP1		
	OR		
	Check and correct for zero error	**(1)**	
	To eliminate <u>systematic error</u>	**(1)**	**2**
	MP2 dependent on MP1		
4(a)(ii)	The micrometer screw gauge has a resolution of 0.01 mm **Or** the measurement will have an uncertainty of 0.005 mm	**(1)**	
	So the percentage uncertainty is 0.35% which is small	**(1)**	**2**
	<u>Example of calculation</u>		
	$\%U = \frac{0.005\text{mm}}{1.41\text{mm}} \times 100 = 0.35\%$		
4(b)(i)	Uses V = (area of semicircle + area of rectangle) × thickness	**(1)**	
	V = 6.24 (cm³)	**(1)**	**2**
	<u>Example of calculation</u>		
	Volume of semicircle $= \frac{\pi D^2 t}{8} = \frac{\pi \times (10.1\text{cm})^2 \times 0.14 \text{ cm}}{8} = 5.608 \text{ cm}^3$		
	Volume of rectangle = 10.1 cm × 0.45 cm × 0.14 cm = 0.636 cm³		
	V = 5.608 cm³ + 0.636 cm³ = 6.24 cm³		

4(b)(ii)	**EITHER**		
	Doubles %U in D $\qquad$ Accept doubles $\frac{\Delta D}{D}$	**(1)**	

Correct calculation of %U in $\frac{\pi D^2 t}{8}$
Or
Correct calculation of %U in Dxt $\qquad$ **(1)**

Calculation of U in $\frac{\pi D^2 t}{8}$ **and** U in Dxt $\qquad$ **(1)**

U = 0.16 (cm³) $\qquad$ **(1)**

Example of calculation

%U in D = 0.5%

%U in x = 2.2%

%U in t = = 1.4%

%U in $\frac{\pi D^2 t}{8}$ = (2 × 0.5%) + 1.4 % = 2.4 %

%U in Dxt = 0.5 % + 2.2 % + 1.4 % = 4.1 %

U in V = (5.61 cm³ × 2.4 %) + (0.64 cm³ × 4.1%) = 0.135 cm³ + 0.026 cm³

= 0.16 (cm³)

OR

Uses maximum values to calculate maximum V $\qquad$ **(1)**
Or
Uses minimum values to calculate minimum V $\qquad$ **(1)**

Maximum V = 6.40 (cm³) **Or** minimum V = 6.08 (cm³) $\qquad$ **(1)**

Correct calculation of half range $\qquad$ **(1)**

U = 0.16 (cm³)

Example of calculation

Maximum $V = \frac{\pi \times (10.15cm)^2 \times 0.142cm}{8} + 10.15cm \times 0.46cm \times 0.142cm$

= 5.74 cm³ + 0.66 cm³ = 6.40 (cm³)

Minimum $V = \frac{\pi \times (10.05cm)^2 \times 0.138cm}{8} + 10.05cm \times 0.44cm \times 0.138cm$

= 5.47 cm³ + 0.61 cm³ = 6.08 (cm³)

U in $V = \frac{(6.40 - 6.08)cm^3}{2} = 0.16$ (cm³)

4

4(c)	**EITHER**		
	Upper limit of density = 1.07 (g cm^{-3})	**(1)**	
	Accepted value is larger than 1.07 g cm^{-3} the protractor may not be made of Perspex	**(1)**	
	MP2 dependent MP1		
	Example of calculation		
	Upper limit of density = 1.04 g cm^{-3}× (1 + 0.03) = 1.07 (g cm^{-3})		
	OR		
	%D = 12%	**(1)**	
	As % D is greater than 3% the protractor may not be made of Perspex	**(1)**	**2**
	MP2 dependent MP1		
	Total for question 4		**12**