Mark Scheme (Results)

Summer 2023

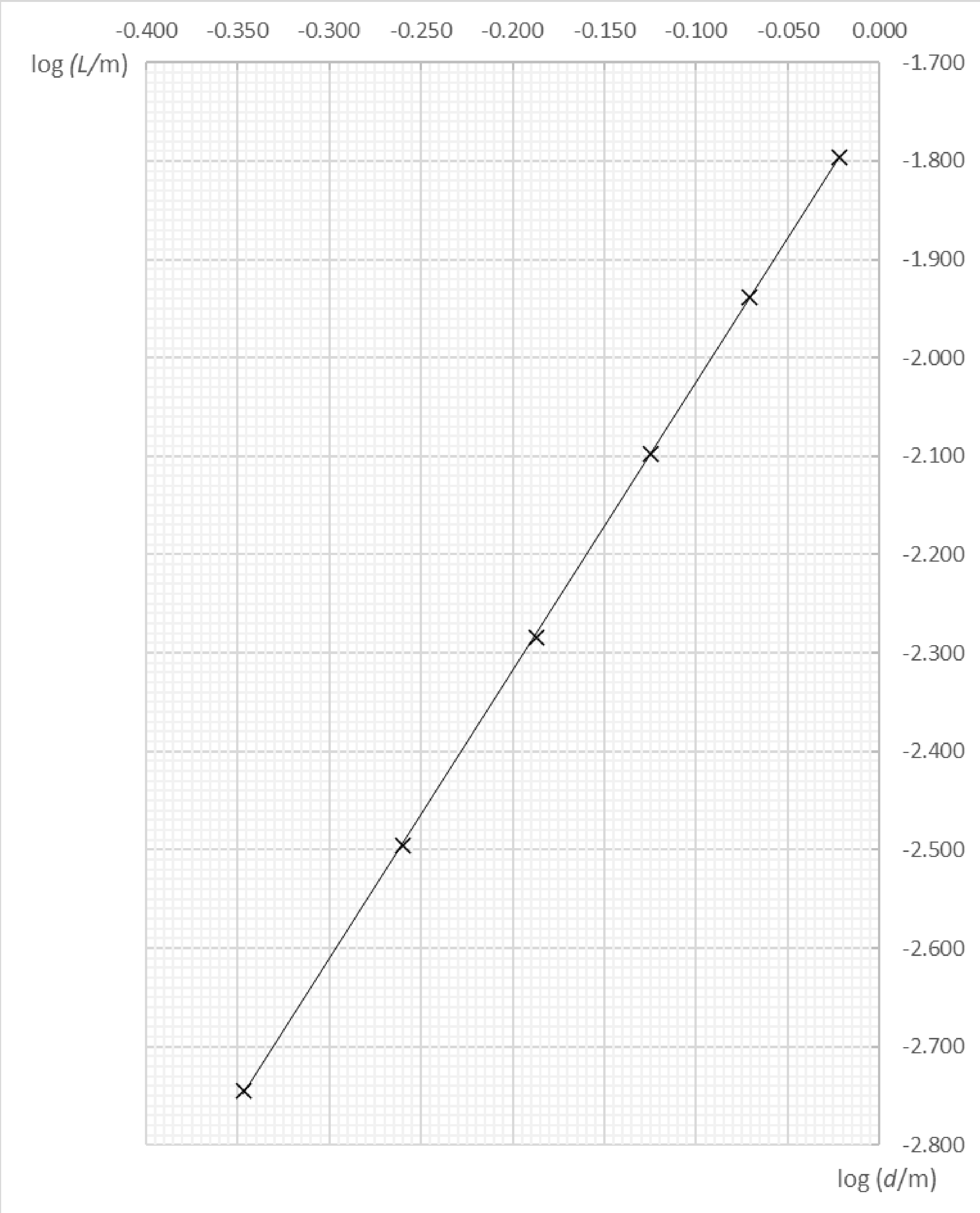
Pearson Edexcel International Advanced Subsidiary Level In Physics (WPH16)
Paper 01
Unit 6: Practical Skills in Physics II

Question Number	Answer	Mark
1(a)	**EITHER** Measure time **(1)** For a known volume (of water to flow out of the tube) **(1)** Use (volume flow rate $=$) $\frac{\text{volume}}{\text{time}}$ **(1)** **OR** Measure volume (of water to flow out of the tube) **(1)** For a known time **(1)** Use (volume flow rate $=$) $\frac{\text{volume}}{\text{time}}$ **(1)**	**3**
1(b)	Uses number of divisions × 50 ms per division **(1)** Use of $f = \frac{1}{T}$ **(1)** f = 6.3 Hz Accept 6.25 Hz **(1)** <u>Example of calculation</u> Number of divisions = 6.4 Time for $2T$ = 6.4 divisions × 50 ×10^{-3}s = 0.32 s $T = \frac{0.32\text{s}}{2}$ = 0.16 s $f = \frac{1}{0.16\text{s}}$ = 6.25 Hz	**3**
1(c)	Measure the flow rate and frequency (at the same h) **(1)** Repeat for different values of h **(1)** Plot a graph of flow rate against f **(1)**	**3**
1(d)	The data logger can be used remotely (without monitoring) **(1)** The data logger can record measurements over a long period of time **Or** The data logger can record a large amount of data **(1)**	**2**
	Total for question 1	**11**

Question Number	Answer	Mark
2(a)	Any **TWO** from Do not point source towards the body **(1)** Keep a safe distance from the source **(1)** Use the source for as short a time as possible **(1)** Handle with tongs **(1)** [Ignore answers relating to PPE, shielding and storage]	**2**
2(b)(i)	**EITHER** $\ln C = \ln C_0 - \mu x$ **(1)** Compares with $y = c + mx$ where $-\mu$ is the gradient which is constant **(1)** MP2 dependent on MP1 **OR** $\ln C = -\mu x + \ln C_0$ **(1)** Compares with $y = mx + c$ where $-\mu$ is the gradient which is constant **(1)** MP2 dependent on MP1	**2**
2(b)(ii)	1. Measure thickness of x with a micrometer **(1)** 2. Record the count (rate) C over a long period of time **(1)** 3. Obtain count (rate) C for at least 5 different values of thickness x. **(1)** 4. Keep the distance between the source and detector constant **(1)** Any **TWO** from: 5. Record thickness x in several places and calculate a mean **(1)** 6. Check and correct for zero error (on the micrometer) **(1)** 7. Record the background count (rate) **and** subtract from the count (rate) C **(1)**	**6**
	Total for question 2	**10**

Question Number	Answer		Mark
3(a)	Record initial and final positions (of centre) of beam **and** subtract to give *d*	**(1)**	
	Any **TWO** from:		
	Use a set square to ensure 15 cm ruler is vertical	**(1)**	
	Clamp 15 cm ruler in position (vertically)	**(1)**	
	Read perpendicular to the scale **Or** Ensure the ruler is close to the beam	**(1)**	**3**
3(b)(i)	Values of log *L* correct to 3 d.p. [Accept 2 d.p.]	**(1)**	
	Values of log *d* correct to 3 d.p. [Accept 2 d.p.]	**(1)**	
	Axes labelled: *y* as log (*d* / m) and *x* as log (*L* / m)	**(1)**	
	Appropriate scales chosen	**(1)**	
	log values plotted accurately	**(1)**	
	Best fit line drawn	**(1)**	**6**

***L* / m**	***d* / m**	**log (*L* / m)**	**log (*d* / m)**
0.950	0.0160	–0.022	–1.796
0.850	0.0115	–0.071	–1.939
0.750	0.0080	–0.125	–2.097
0.650	0.0052	–0.187	–2.284
0.550	0.0032	–0.260	–2.495
0.450	0.0018	–0.347	–2.745



-0.400
-0.350
-0.300
-0.250
-0.200
-0.150
-0.100
-0.050
0.000
log (L/m)
-1.700
-1.800
-1.900
-2.000
-2.100
-2.200
-2.300
-2.400
-2.500
-2.600
-2.700
-2.800
log (d/m)

3(b)(ii)	Uses large triangle to calculate gradient **(1)** Value of gradient in range 2.75 to 2.95 **(1)** Value of calculated gradient given to 2 or 3 s.f., positive, no unit **(1)** <u>Example of calculation</u> gradient = $\frac{-1.88 - -2.60}{-0.050 - -0.295} = \frac{0.72}{0.245}$ = 2.94	**3**
3(b)(iii)	Correct value of log k from y intercept **Or** Correct value of log k from calculation using gradient and points from graph e.c.f. 3(b)(ii) **(1)** Conversion of log k to k **(1)** Values of r and k shown in mathematical relationship **(1)** <u>Example of calculation</u> log k = log d – r log L = –2.60 – (2.94 × –0.295) = –1.73 $k = 10^{-1.73} = 0.0186$ $d = 0.0186\, L^{2.95}$	**3**
	Total for question 3	**15**

Question Number	Answer	Mark
4(a)(i)	Any **TWO** from: Measure multiple oscillations and divide by the number of oscillations **(1)** Use a (fiducial) marker **(1)** Allow the oscillations to settle **Or** Start timing after a number of oscillations **(1)**	2
4(a)(ii)	Mean T = <u>0.68</u> (s) **(1)** Calculation using half range shown **Or** Calculation of furthest from mean shown **(1)** Uncertainty in T = 0.02 (s) decimal places consistent with mean **(1)** <u>Example of calculation</u> Mean $T = \frac{(3.43+3.36+3.28+3.49)\text{s}}{5\times4} = \frac{13.56\text{s}}{20} = 0.678 = 0.68$ (s) Uncertainty $= \frac{3.49\text{s}-3.28\text{s}}{5\times2} = \frac{0.21}{10} = 0.021 = 0.02$ (s)	3
4(b)	Vernier calipers will have resolution of 0.1 mm **Or** Vernier calipers will have an uncertainty of 0.05 mm **(1)** So the percentage uncertainty is 0.25 % which is small **(1)** [Do not accept precision or accuracy for resolution] <u>Example of calculation</u> %U in Vernier calipers $= \frac{0.05\text{mm}}{20\text{mm}} \times 100 = 0.25$ %	2

<table>
<tr><td>4(c)(i)</td><td>Use of $T = \sqrt{\frac{16\pi m}{D^2 \rho g}}$
ρ = 1190 (kg m^3)

<u>Example of calculation</u>
$\rho = \frac{16\pi m}{D^2T^2g} = \frac{16\pi \times 48.95\times10^{-3}\ \text{kg}}{(2.38\times10^{-2}\text{m})^2 \times (0.61\text{s})^2 \times 9.81\text{ms}^{-2}} = \frac{2.46\ \text{kg}}{2.07\times10^{-3}\ \text{m}^3}$ = 1190 (kg m^3)</td><td>(1)
(1)</td><td>2</td></tr>
<tr><td>4(c)(ii)</td><td>EITHER

Uses 2 × %U in D [Allow 2 × $\frac{\Delta d}{d}$]
Uses 2 × %U in T [Allow 2 × $\frac{\Delta T}{T}$]
%U in ρ = 4.1 (%) Accept 3 sig figs

<u>Example of calculation</u>
%U in D^2 = 2 × $\frac{0.01\text{cm}}{2.38\text{cm}}$ × 100 = 0.84 %
%U in T^2 = 2 × $\frac{0.01\text{s}}{0.61\text{s}}$ × 100 = 3.28 %
%U in ρ = 0.84 % + 3.28 % = 4.12 %

OR

Calculation of maximum or minimum ρ
Calculation of U in ρ using half range shown
%U in ρ = 4.1 (%) Accept 3 sig figs

<u>Example of calculation</u>
Maximum $\rho = \frac{16\pi m}{D^2T^2g} = \frac{16\pi \times 48.95\times10^{-3}\ \text{kg}}{(2.37\times10^{-2}\text{m})^2 \times (0.60\text{s})^2 \times 9.81\text{ms}^{-2}} = \frac{2.46\ \text{kg}}{1.98\times10^{-3}\ \text{m}^3}$
= 1242 (kg m^3)
Minimum $\rho = \frac{16\pi m}{D^2T^2g} = \frac{16\pi \times 48.95\times10^{-3}\ \text{kg}}{(2.39\times10^{-2}\text{m})^2 \times (0.62\text{s})^2 \times 9.81\text{ms}^{-2}} = \frac{2.46\ \text{kg}}{2.15\times10^{-3}\ \text{m}^3}$
= 1144 (kg m^3)
U in $\rho = \frac{(1242-1144)\text{kgm}^{-3}}{2}$ = 49 (kg m^3)
%U = $\frac{49\text{kgm}^{-3}}{1190\text{kgm}^{-3}}$ × 100 = 4.1 (%)</td><td>(1)
(1)
(1)

(1)
(1)
(1)</td><td>3</td></tr>
</table>

4(c)(iii)	**EITHER** Correct value of relevant limit of calculated density using %U (e.c.f. (c)(i), (c)(ii)) Conclusion based on comparison of limit to density of glycerol MP2 dependent MP1 <u>Example of calculation</u> Upper limit of ρ = 1190 × (1 + 0.041) = 1239 (kg m^{-3}) As the upper limit is lower than 1260 kg m^{-3} then the liquid may not be glycerol. ['Show that' value gives upper limit ρ = 1200 × (1 + 0.04) = 1248 (kg m^{-3})] **OR** Correct calculation of %D shown (e.c.f. (c)(i), (c)(ii)) Conclusion based on comparison of %D and %U MP2 dependent MP1 <u>Example of calculation</u> %D = $\frac{(1260-1190)\text{kgm}^{-3}}{1260\text{kgm}^{-3}} \times 100$ = 5.6 % As % D for greater than the %U then the liquid may not be glycerol. ['Show that' value gives %D = $\frac{(1260-1200)\text{kgm}^{-3}}{1260\text{kgm}^{-3}} \times 100$ = 4.8 %] **OR** Correct value of relevant limit using uncertainties in D and T Conclusion based on comparison of limit to density of glycerol MP2 dependent MP1 <u>Example of calculation</u> Upper limit of $\rho = \frac{16\pi m}{D^2T^2g} = \frac{16\pi \times 48.95\times10^{-3}\text{ kg}}{(2.37\times10^{-2}\text{m})^2 \times (0.60\text{s})^2 \times 9.81\text{ms}^{-2}} = \frac{2.46\text{ kg}}{1.98\times10^{-3}\text{ m}^3}$ = 1242 (kg m^3) As the upper limit is lower than 1260 kg m^{-3} then the liquid may not be glycerol.	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	 2
	Total for question 4		**14**