Pearson Edexcel

Mark Scheme (Results)

Summer 2023

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

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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.

Mark scheme notes

Underlying principle

The mark scheme will clearly indicate the concept that is being rewarded, backed up by examples. It is not a set of model answers.

For example:

(iii) Horizontal force of hinge on table top

66.3 (N) or 66 (N) **and** correct indication of direction [no ue] [Some examples of direction: acting from right (to left) / to the left / West / opposite direction to horizontal. May show direction by arrow. Do not accept a minus sign in front of number as direction.]	(1)	**1**

This has a clear statement of the principle for awarding the mark, supported by some examples illustrating acceptable boundaries.

1. Mark scheme format

1.1 You will not see 'wtte' (words to that effect). Alternative correct wording should be credited in every answer unless the ms has specified specific words that must be present. Such words will be indicated by underlining e.g. 'resonance'

1.2 Bold lower case will be used for emphasis.

1.3 Round brackets ( ) indicate words that are not essential e.g. "(hence) distance is increased".

1.4 Square brackets [ ] indicate advice to examiners or examples e.g. [Do not accept gravity] [ecf].

2. Unit error penalties

2.1 A separate mark is not usually given for a unit but a missing or incorrect unit will normally mean that the final calculation mark will not be awarded.

2.2 Incorrect use of case e.g. 'Watt' or 'w' will not be penalised.

2.3 There will be no unit penalty applied in 'show that' questions or in any other question where the units to be used have been given, for example in a spreadsheet.

2.4 The same missing or incorrect unit will not be penalised more than once within one question (one clip in ePen).

2.5 Occasionally, it may be decided not to penalise a missing or incorrect unit e.g. the candidate may be calculating the gradient of a graph, resulting in a unit that is not one that should be known and is complex.

2.6 The mark scheme will indicate if no unit error penalty is to be applied by means of [no ue].

3. Significant figures

3.1 Use of an inappropriate number of significant figures in the theory papers will normally only be penalised in 'show that' questions where use of too few significant figures has resulted in the candidate not demonstrating the validity of the given answer.

3.2 The use of g = 10 m s^{-2} or 10 N kg^{-1} instead of 9.81 m s^{-2} or 9.81 N kg^{-1} will be penalised by one mark (but not more than once per clip). Accept 9.8 m s^{-2} or 9.8 N kg^{-1}

3.3 In questions assessing practical skills, a specific number of significant figures will be required e.g. determining a constant from the gradient of a graph or in uncertainty calculations. The MS will clearly identify the number of significant figures required.

4. Calculations

4.1 Bald (i.e. no working shown) correct answers score full marks unless in a 'show that' question.

4.2 If a 'show that' question is worth 2 marks then both marks will be available for a reverse working; if it is worth 3 marks then only 2 will be available.

4.3 **use of** the formula means that the candidate demonstrates substitution of physically correct values, although there may be conversion errors e.g. power of 10 error.

4.4 **recall** of the correct formula will be awarded when the formula is seen or implied by substitution.

4.5 The mark scheme will show a correctly worked answer for illustration only.

Example of mark scheme for a calculation:

<u>'Show that' calculation of weight</u>

Use of L × W × H	(1)	
Substitution into density equation with a volume and density	(1)	
Correct answer [49.4 (N)] to at least 3 sig fig. [No ue]	(1)	**3**

[If 5040 g rounded to 5000 g or 5 kg, do not give 3rd mark; if conversion to kg is omitted and then answer fudged, do not give 3rd mark]
[Bald answer scores 0, reverse calculation 2/3]

<u>Example of calculation</u>
80 cm × 50 cm × 1.8 cm = 7200 cm^3
7200 cm^3 × 0.70 g cm^{-3} = 5040 g
5040 × 10^{-3} kg × 9.81 N/kg= 49.4 N

5. Graphs

5.1 A mark given for axes requires both axes to be labelled with quantities and units, and drawn the correct way round.

5.2 Sometimes a separate mark will be given for units or for each axis if the units are complex. This will be indicated on the mark scheme.

5.3 A mark given for choosing a scale requires that the chosen scale allows all points to be plotted, spreads plotted points over more than half of each axis and is not an awkward scale e.g. multiples of 3, 4, 7 etc.

5.4 Points should be plotted to within 1 mm.

- Check the two points furthest from the best line. If both are OK award the mark.
- If either is 2 mm out do not award mark.
- If both are 1 mm out do not award mark.
- If either is 1 mm out then check another two and award mark if both of these are OK, otherwise no mark.

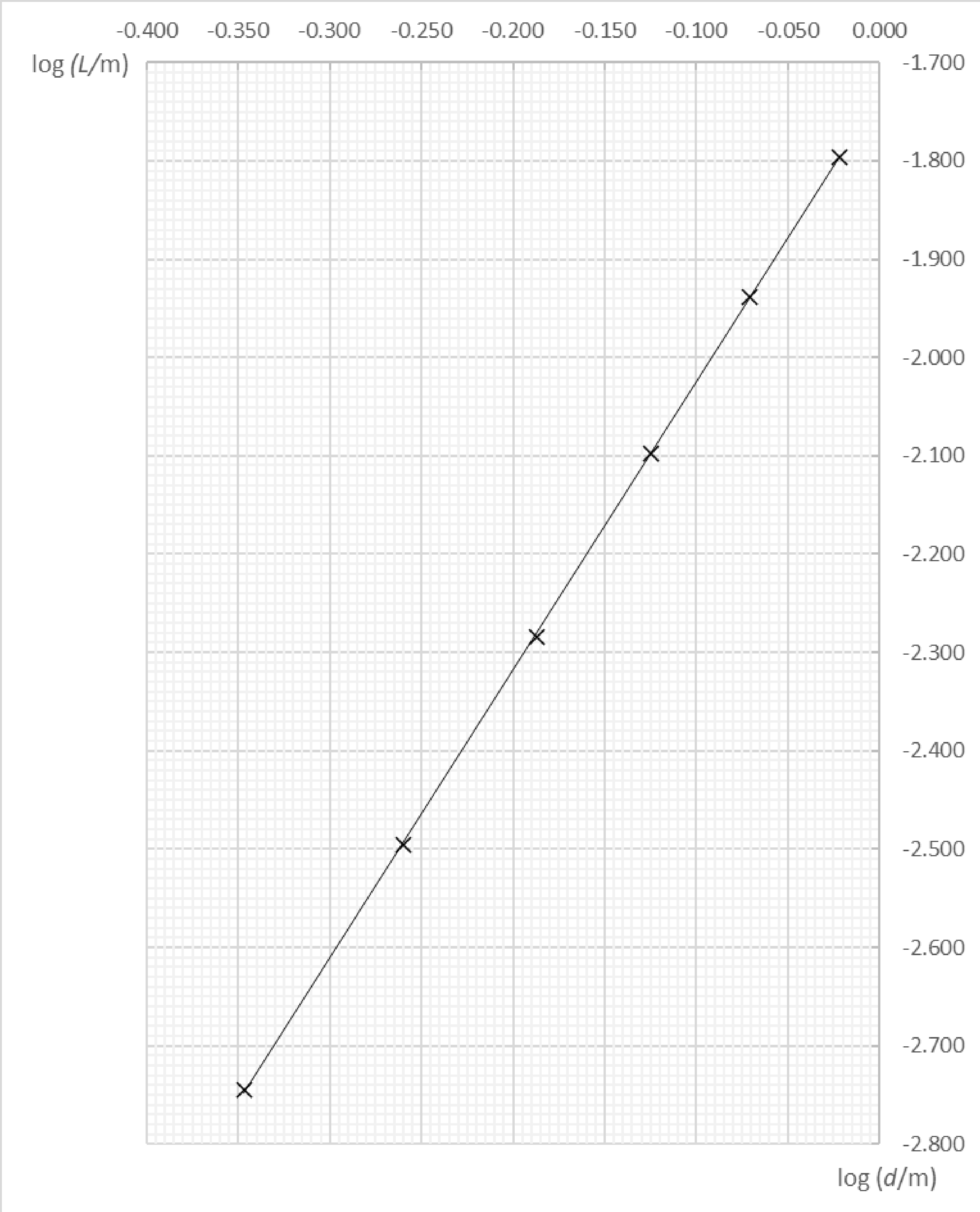
5.5 For a line mark there must be a thin continuous line which is the best-fit line for the candidate's results.

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> $\log k = \log d - r \log L = -2.60 - (2.94 \times -0.295) = -1.73$ $k = 10^{-1.73} = 0.0186$ $d = 0.0186\, L^{2.95}$	**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 $T = \frac{(3.43+3.36+3.28+3.49)\text{s}}{5\times 4} = \frac{13.56\text{s}}{20} = 0.678 = 0.68$ (s) Uncertainty $= \frac{3.49\text{s}-3.28\text{s}}{5\times 2} = \frac{0.21}{10} = 0.021 = 0.02$ (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>
$\rho = \frac{16\pi m}{D^2 T^2 g} = \frac{16\pi \times 48.95\times10^{-3}\ \text{kg}}{(2.38\times10^{-2}\text{m})^2 \times (0.61\text{s})^2 \times 9.81\text{ms}^{-2}} = \frac{2.46\ \text{kg}}{2.07\times10^{-3}\ \text{m}^3}$ = 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 $D^2 = 2 \times \frac{0.01\text{cm}}{2.38\text{cm}} \times 100 = 0.84$ %
%U in $T^2 = 2 \times \frac{0.01\text{s}}{0.61\text{s}} \times 100 = 3.28$ %
%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 $\rho = \frac{16\pi m}{D^2 T^2 g} = \frac{16\pi \times 48.95\times10^{-3}\ \text{kg}}{(2.37\times10^{-2}\text{m})^2 \times (0.60\text{s})^2 \times 9.81\text{ms}^{-2}} = \frac{2.46\ \text{kg}}{1.98\times10^{-3}\ \text{m}^3}$
= 1242 (kg m^3)
Minimum $\rho = \frac{16\pi m}{D^2 T^2 g} = \frac{16\pi \times 48.95\times10^{-3}\ \text{kg}}{(2.39\times10^{-2}\text{m})^2 \times (0.62\text{s})^2 \times 9.81\text{ms}^{-2}} = \frac{2.46\ \text{kg}}{2.15\times10^{-3}\ \text{m}^3}$
= 1144 (kg m^3)
U in $\rho = \frac{(1242-1144)\text{kgm}^{-3}}{2}$ = 49 (kg m^3)
%U = $\frac{49\text{kgm}^{-3}}{1190\text{kgm}^{-3}} \times 100$ = 4.1 (%)</td><td>(1)
(1)
(1)

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

Question Number	Answer		Mark
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**

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