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Mark Scheme (Results)

January 2018

Pearson Edexcel
International Advanced Level
in Physics (WPH06)
Paper 01 Experimental Physics

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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] ✓ 1
[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.]

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}

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.

4.6 Example of mark scheme for a calculation:

'Show that' calculation of weight

Use of L × W × H ✓

Substitution into density equation with a volume and density ✓

Correct answer [49.4 (N)] to at least 3 sig fig. [No ue] ✓
[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] 3
[Bald answer scores 0, reverse calculation 2/3]

Example of answer:
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, 7 etc.

5.4 Points should be plotted to within 1 mm.

- Check the two points furthest from the best line. If both OK award 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 OK, otherwise no mark.

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)	To minimise random error **Or** the diameter may not be uniform (1)	**1**
1 (b) (i)	Mean thickness = 1.55 (mm) (Do not accept 1.6) (1) Example of calculation Mean thickness = (1.58 + 1.52 + 1.55 + 1.54 + 1.56)/5 = 1.55 mm	**1**
1 (b) (ii)	Calculates ½ range [= 0.03 mm] (Accept range = 0.06 mm) (1) %U = 1.94 % (Accept 3.87 % using range) (1) (Accept 1 or 2 sf, ecf from b(i)) Example of calculation ½ range = (1.58 – 1.52) mm/2 = 0.06 mm/2 = 0.03 mm %U for thickness = 0.03 mm / 1.55 mm × 100 % = 1.94 %	**2**
1 (c) (i)	Use of Volume = πr^2 × mean thickness (1) Volume = 1510 mm^3 (Accept 1.51 cm^3, 1.51 × 10^{-6} m^3) (1) (Allow ecf from b(i)) Example of calculation Volume =π× $(35.2/2)^2$ mm^2 × 1.55 mm = 1510 mm^3	**2**
1 (c) (ii)	Calculates %U in diameter [= 0.28 %] (1) Doubles %U in diameter [= 0.56 %] (1) %U in volume = 2.5 % (Accept 4.5% using range) (1) (Accept 1, 2 or 3 sf, allow ecf b(ii)) Example of calculation %U for diameter = 0.1 mm / 35.2 mm × 100 % = 0.284 % %U for area = 2 × 0.284 % = 0.568 % %U for thickness = 1.94 % Total %U = 0.568 + 1.94 = 2.51 %	**3**
1 (d)	Use of $\rho = m / V$ (1) Density = 7.92 × 10^{-3} g mm^{-3} (Accept 7.92 g cm^{-3} or 7920 kg m^{-3}) (1) (allow ecf from (c)(i)) Example of calculation $\rho = m / V$ = 11.96 × 10^{-3} kg / 1510 × 10^{-9} m^{-3} = 7920 kg m^{-3}	**2**
1 (e)	Lower limit to measured density = 7720 kg m^{-3} (7560 kg m^{-3} if range used) (allow ecf from c(ii) and d) (1) Lower than density of 7860 kg m^{-3} so could be carbon steel (answer consistent with candidate's values) (1) (MP2 dependent on MP1) Example of calculation	

	Lower limit = 7720 kg m^{-3} × (1 − 2.5%/100) = 7720 kg m^{-3} **Or** %D = 0.76 % (allow ecf from d) (1) %D is less than %U so could be carbon steel (answer consistent with candidate's values) (1) (MP2 dependent on MP1) <u>Example of calculation</u> $\%D = \frac{7920-7860}{7860} \times 100\ \% = 0.763\ \%$	**2**
	Total for question 1	**13**

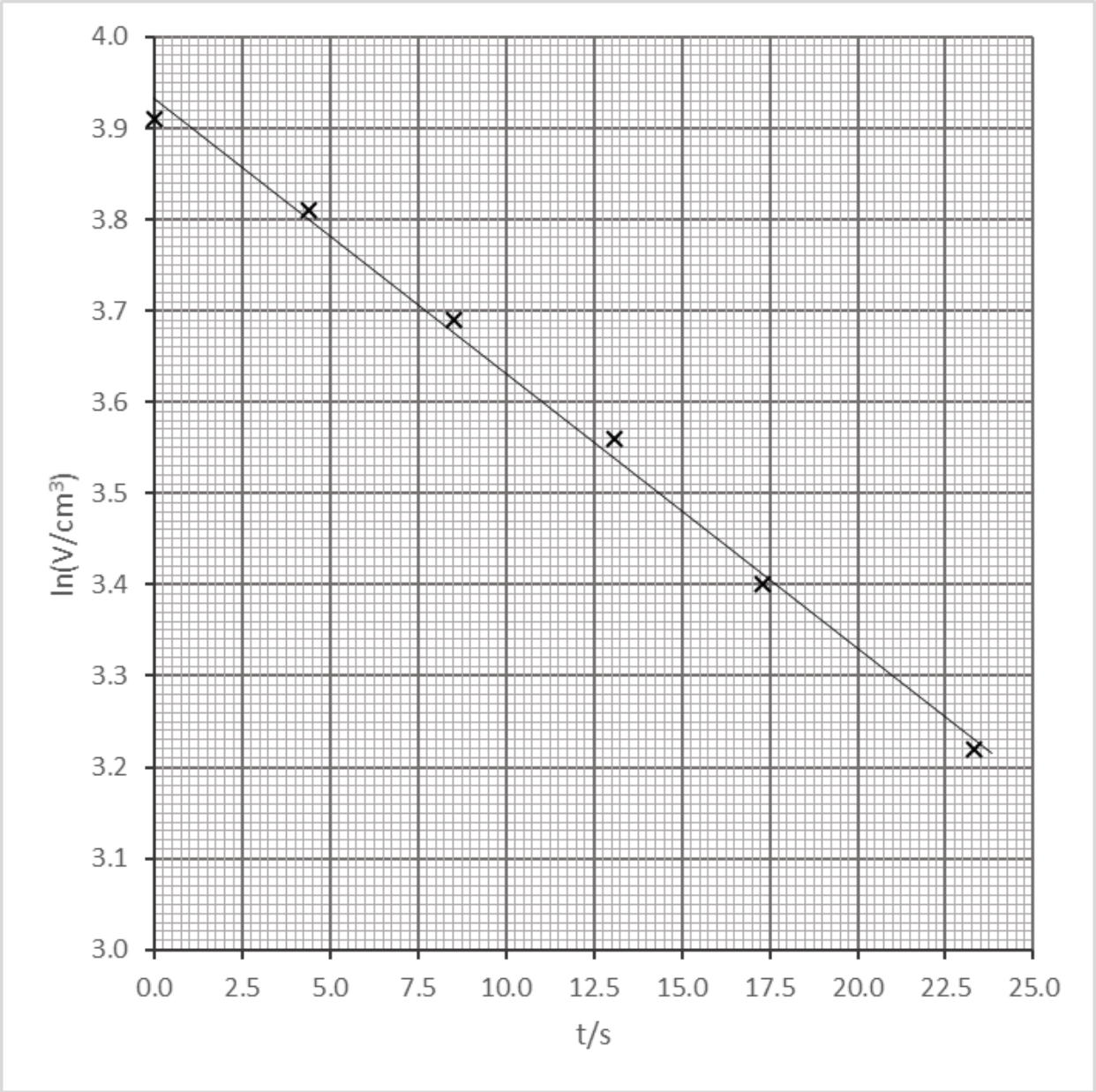
Question Number	Answer		Mark
2 (a)	The smallest (measuring) interval (on an instrument)	(1)	**1**
2 (b)	**Note this question is to be marked holistically** (i) *a diagram of the apparatus, showing the length l to be measured,* (1) Suitable setup with length *l* clearly indicated from support to centre of bob (ii) *one source of uncertainty in the measurement of T,* (1) Difficulty of starting/stopping stopwatch at same point in swing **Or** reaction time. (iii) *a description of how an accurate value for T can be determined,* (1) Measure nT **and** divide by n. (1) Repeat **and** calculate a mean. Place a marker at the centre of the oscillation (where bob has maximum speed). (Accept equilibrium position/point) (1) Start the stopwatch after a few oscillations (once oscillations have settled) **Or** use small amplitude oscillations. (1) (iv) *the graph you would plot and how you would use the graph to determine g.* Plot T^2 against l (1) Measure gradient and $g = 4\pi^2/\text{gradient}$ (1) **Or** (1) Plot T against $\sqrt{l}$ (1) Measure gradient and $g = 4\pi^2/\text{gradient}^2$		**8**
	Total for question 2		**9**

Question Number	Answer		Mark
3 (a)	Any means of preventing background light reaching light meter.	(1)	**1**
3 (b)	Ruler has resolution of 1 mm So in measurement of 50 mm %U is 2 % which is reasonable. Example of calculation %U = 1/50 × 100 % = 2 %	(1) (1)	**2**
3 (c)	Correct manipulation of formula for k 3 k values correctly calculated (8.0, 7.9, 8.1) Comment consistent with calculated values. Example of calculation $k = 800 \times 0.10^2 = 8.0$ $k = 350 \times 0.15^2 = 7.9$ $k = 130 \times 0.25^2 = 8.1$	(1) (1) (1)	**3**
	Total for question 3		**6**

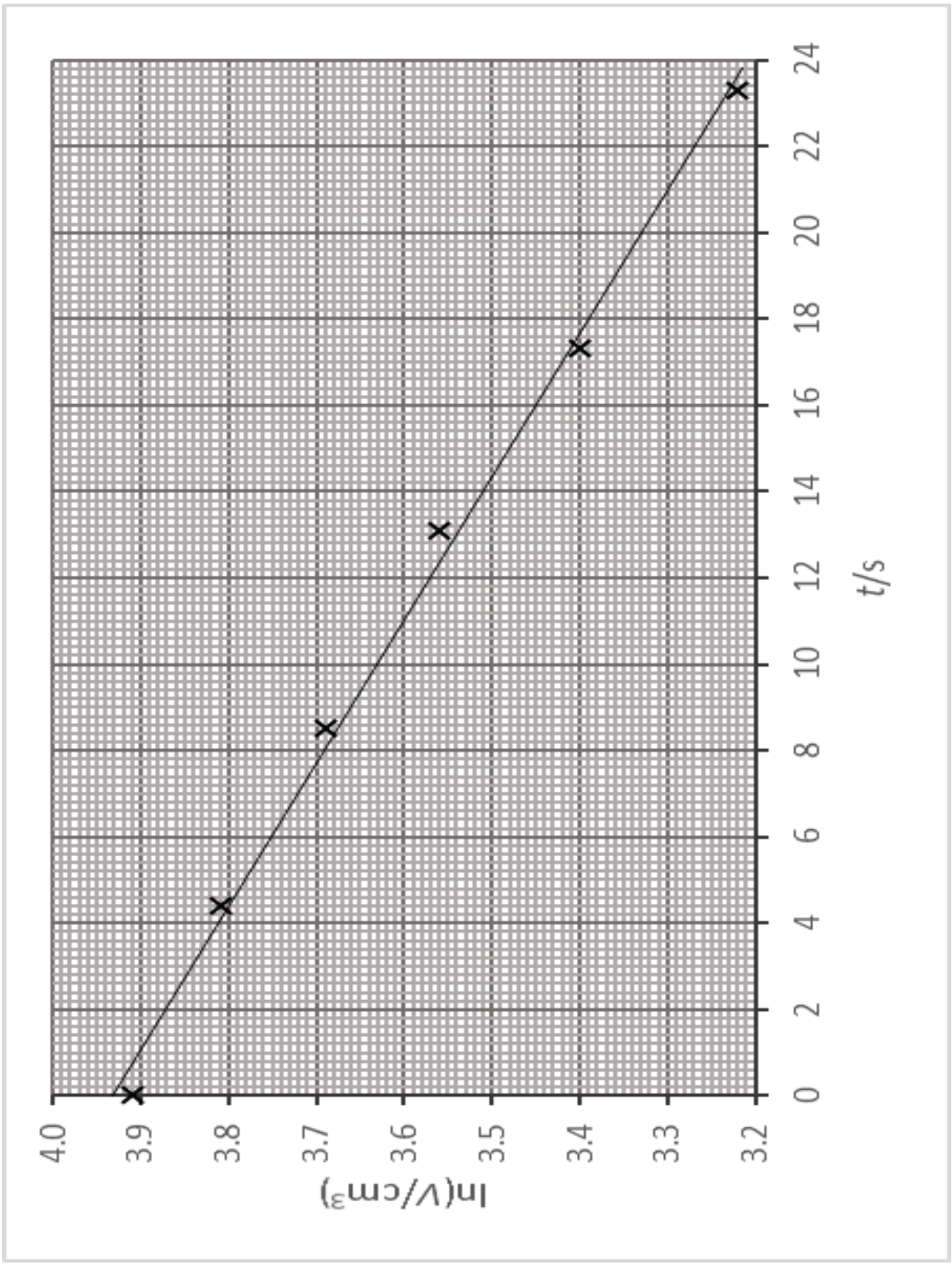
Question Number	Answer		Mark
4 (a)	Viscosity	(1)	**1**
4 (b)	Starting timer and opening tap at same time is difficult	(1)	**1**
4 (c)	$\ln V = \ln V_0 - bt$ is consistent with $y = c + mx$ Where gradient $m = -b$ (which is constant)	(1) (1)	**2**
4 (d) (i)	$\ln(V/\text{cm}^3)$ values correctly calculated to 3 or 4 sf Axes labelled: y-axis as $\ln(V/\text{cm}^3)$ and x-axis as t/s Suitable scales used Points plotted accurately Best fit line drawn	(1) (1) (1) (1) (1)	**5**
4 (d) (ii)	Large triangle used Correct calculation of gradient shown Correct b stated as positive, units s^{-1} **and** 2/3sf **Or** Intercept read from graph **and** point from line over half way Correct calculation of b Correct b stated as positive, units s^{-1} **and** 2/3sf Example of calculation Gradient = − 0.725 / 24.0 s^{-1} = − 0.0302 s^{-1} b = − gradient = 0.0302 s^{-1}	(1) (1) (1) (1) (1) (1)	**3**
	Total for question 4		**12**

V/cm^3	t/s	$\ln(V/\text{cm}^3)$
50.0	0.0	3.912
45.0	4.4	3.807
40.0	8.5	3.689
35.0	13.1	3.555
30.0	17.3	3.401
25.0	23.3	3.219

Graph for question 4 (portrait)



Graph for question 4 (landscape)



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