Mark Scheme (Results)

Summer 2025

Pearson Edexcel International Advanced Level in Physics (WPH16)
Paper 01 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:

This mark scheme is published to help teachers and candidates understand the exam requirements. Please note that the mark schemes can be better understood when viewed alongside the question paper and the Principal Examiner Report for Teachers.

It's important to emphasise that a mark scheme is a work in progress that can be further refined and expanded based on students' responses to a particular paper.

It is important to avoid making assumptions about future mark schemes based on a document from one year.

Although the guiding principles of assessment remain constant, the details may vary based on the content of a particular examination paper.

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.**

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. '<u>resonance</u>'

1.2 Bold lower case will be used for emphasis e.g. '**and**' when two pieces of information are needed for 1 mark.

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 This does not apply in 'show that' questions or in any other question where the units to be used have been given, for example in a spreadsheet.

2.3 The mark will not be awarded for the same missing or incorrect unit only once within one clip in epen.

2.4 Occasionally, it may be decided not to insist on a 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.

2.5 The mark scheme will indicate if no unit error is to be applied by placing brackets around the unit.

3. Significant figures

3.1 Use of too many significant figures in the theory questions will not prevent a mark being awarded if the answer given rounds to the answer in the MS.

3.2 Too few significant figures will mean that the final mark cannot be awarded in 'show that' questions where one more significant figure than the value in the question is needed for the candidate to demonstrate the validity of the given answer.

3.3 The use of one significant figure might be inappropriate in the context of the question e.g. reading a value off a graph. If this is the case, there will be a clear indication in the MS.

3.4 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}

3.5 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 **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.

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

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

5. Quality of Written Expression

5.1 Questions that asses the ability to show a coherent and logically structured answer are marked with an asterisk.

5.2 Marks are awarded for indicative content and for how the answer is structured.

5.3 Linkage between ideas, and fully-sustained reasoning is expected.

6. Graphs

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

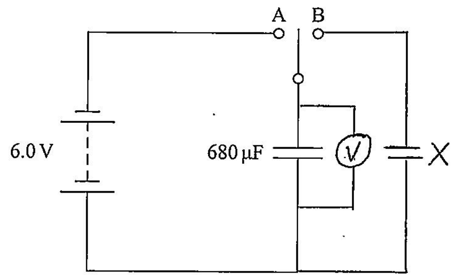
6.2 Sometimes a separate mark will be given for units or for each axis if the units are complex. This will be indicated on the mark scheme.

6.3 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.

6.4 Points should be plotted to within 1 mm.

- Check the two points furthest from the best line. If both OK award the 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	Acceptable Answer	Additional Guidance	Mark
1(a)(i)	Maximum **TWO** from: • Do not exceed the working p.d. of the capacitor **(1)** • Connect the capacitor with the correct polarity **(1)** • Discharge the capacitor (fully) before handling **(1)**	Ignore references to switching off power supply, general safety issues and PPE	**2**
1(a)(ii)	• Voltmeter connected across 680 μF capacitor only **(1)** • Additional capacitor (labelled X) connected in parallel with 680 μF capacitor [from position B to below 680 μF capacitor] **(1)**	<u>Example of circuit</u>  Including an additional voltmeter does not score MP1. Including an additional power supply or voltmeter in series does not score MP2	**2**

1(b)	An answer that makes reference to the following points: • There are not enough data points **(1)** • The range of data is too small **Or** The scales on the graph are too small **(1)** • The spread of data about the best fit line is not reasonable **Or** The best fit line may not be linear **(1)**	Ignore references to significant figures, repeats, inconsistent intervals Do not allow reference to an anomaly/outlier Allow reference to data points indicating a curve Ignore reference to origin	3

(Total for Question 1 = 7 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
2(a)	A description that makes reference to the following points: • Place the flask in (a beaker of) ice **(1)** • Use a hot plate to heat the beaker/flask **(1)** • Heat the beaker gradually **Or** Stir the water in the beaker **Or** Read the thermometer/scale perpendicularly **(1)** • Record values of temperature (from the thermometer) and corresponding pressure (from the pressure gauge) **(1)** • Record pressure at (minimum of) 5 different values of temperature (until the water boils) **Or** Record pressure at intervals of 20°C or less **(1)** • Plot a graph of pressure against temperature and extrapolate the line to pressure = 0 **Or** Plot a graph of pressure against temperature and determine the gradient and *y*-intercept to calculate point where pressure = 0 **(1)**	Accept alternative heating method, e.g. Bunsen burner, water bath, immersion heater in a beaker of water, NOT heater or electric heater Must be for different temperatures/pressures, not to repeat and calculate mean Accept clearly labelled sketch graph Allow graph of temperature against pressure and determine *y*-intercept	**6**

2(b)	An answer that makes reference to the following points: • Data logger records pressure and temperature simultaneously **(1)** • Temperature probe has a better resolution **Or** Temperature probe has smaller uncertainty **Or** Temperature probe reduces parallax error **(1)** • So the readings will be closer to the true values **(1)** Ignore references to sampling rate and reaction time	Accept readings/measurements Accept converse relating to thermometer MP3 dependent on MP1 or MP2	**3**

(Total for Question 2 = 9 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
3(a)	An explanation that makes reference to the following points: • A micrometer screw gauge has a resolution of 0.01 mm **Or** A micrometer screw gauge has an uncertainty of 0.005 mm **(1)** • So the percentage uncertainty will be 0.4 % which is small **(1)**	Do not accept accuracy/precision, or implied in calculation <u>Example of calculation</u> $\%U = \frac{0.005\text{ mm}}{1.21\text{ mm}} \times 100 = 0.4\%$	**2**
3(b)	An explanation that makes reference to the following points: **EITHER** • The distance between the filament bulb and slides/solar cell **(1)** • As the intensity of light varies as an inverse square law **(1)** **OR** • The (level of the) background light **(1)** • (As any variation) will vary the reading on the voltmeter **(1)**	Do not accept “to keep the intensity of light constant”?	**2**

<table>
<tr><td>3(c)(i)</td><td>An explanation that makes reference to the following points:

EITHER
• ln V = ln $A - Bw$ (1)

• Compares to $y = c + mx$ where the gradient is $-B$ (which is constant) (1)

OR
• ln $V = -Bw$ + ln A (1)

• Compares to $y = mx + c$ where the gradient is $-B$ (which is constant) (1)</td><td>

MP2 dependent on MP1

MP2 dependent on MP1</td><td>2</td></tr>
<tr><td>3(c)(ii)</td><td>• Values of ln V correct and consistent to 3 d.p. (1)
[Accept correct and consistent to 2 d.p.]

• Axes labelled: y as ln (V / mV) and x as w / mm (1)

• Appropriate scales chosen (1)

• Processed values plotted accurately (1)
[ALL points plotted to ±1 mm]

• Best fit line drawn (1)</td><td>
<table>
<tr><th>w / mm</th><th>V / mV</th><th>ln (V / mV)</th><th>ln (V / mV)</th></tr>
<tr><td>1.21</td><td>381</td><td>5.943</td><td>5.94</td></tr>
<tr><td>2.46</td><td>375</td><td>5.927</td><td>5.93</td></tr>
<tr><td>4.88</td><td>366</td><td>5.903</td><td>5.90</td></tr>
<tr><td>6.10</td><td>361</td><td>5.889</td><td>5.89</td></tr>
<tr><td>8.55</td><td>352</td><td>5.864</td><td>5.86</td></tr>
<tr><td>10.97</td><td>344</td><td>5.841</td><td>5.84</td></tr>
</table>
</td><td>5</td></tr>
</table>

<table>
<tr>
<td>3(c)(iii)</td>
<td>
• Uses large triangle to calculate gradient
[data from table must be on best fit line] (1)

• Value of gradient in range (−)0.0100 to (−)0.0110 (1)

• Calculated gradient given to 2 or 3 s.f., negative, no unit (1)
</td>
<td>
<u>Example of calculation</u>

Gradient $= \frac{5.933 - 5.852}{2.00 - 9.80} = \frac{0.081}{-7.80} = -1.04 \times 10^{-2}$

Allow unit of mm^{-1}

Bald answer can score MP2 only
</td>
<td>3</td>
</tr>
<tr>
<td>3(c)(iv)</td>
<td>
• Uses $\ln\left(\frac{V}{A}\right) = -Bw$ (1)

• Uses $\ln\left(\frac{V}{A}\right) = -Bw$ with $\frac{V}{A} = 0.75$ (1)

• Divides w by 1.22 mm [Accept 1.21 mm] (1)

• Correct value given to next whole number above e.c.f. 3(c)(iii) (1)
</td>
<td>
For MP1 and MP2 allow substitution into $V = Ae^{-Bw}$

<u>Example of calculation</u>

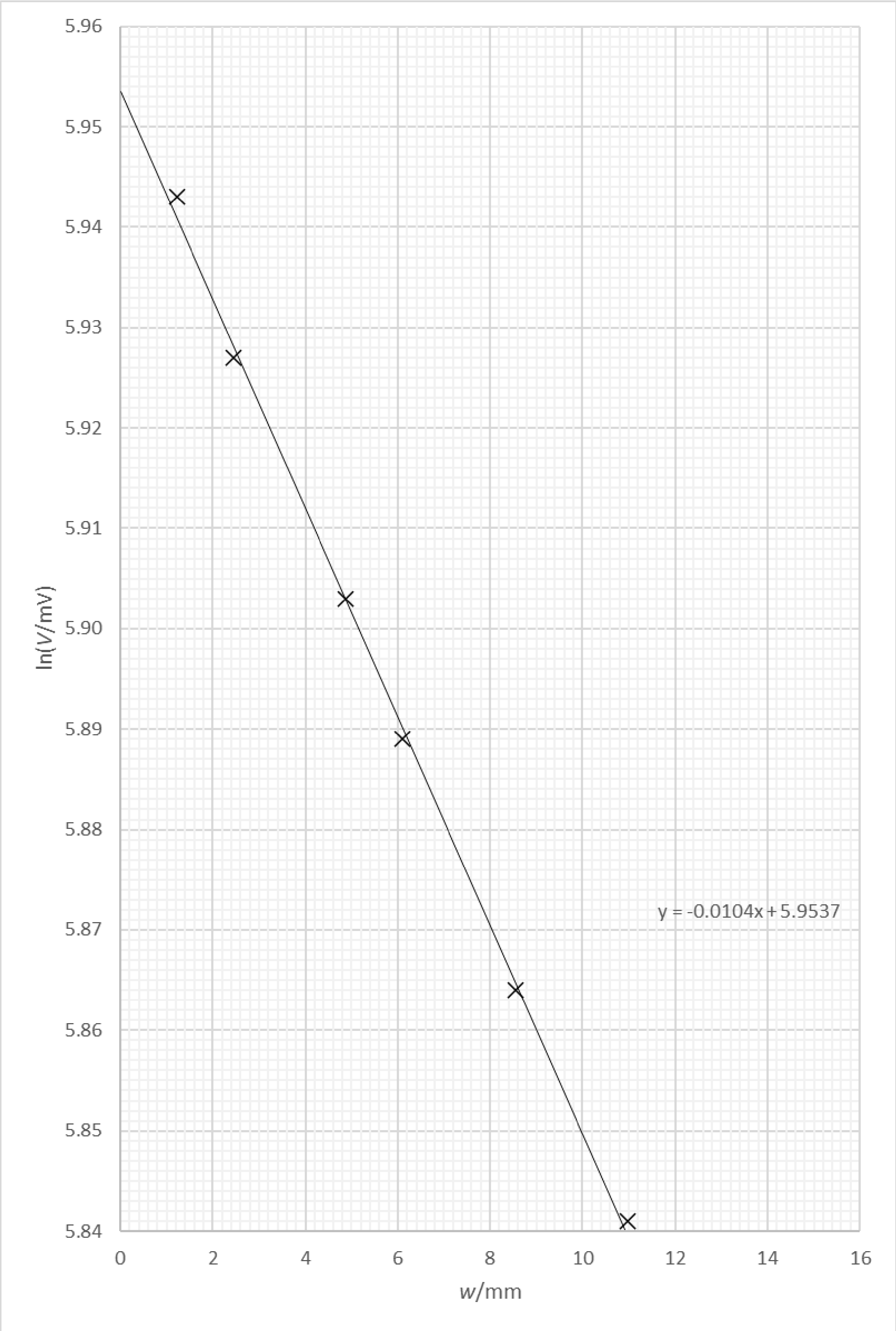
$\ln\left(\frac{V}{A}\right) = -Bw$

$\ln 0.75 = -(1.04 \times 10^{-2}\ mm^{-1})\ w$

$w = \frac{-0.29}{-1.04 \times 10^{-2}\ mm^{-1}} = 27.66\ mm$

Number of slides $= \frac{27.66\ mm}{1.22\ mm} = 22.7 = 23$
</td>
<td>4</td>
</tr>
</table>

(Total for Question 3 = 18 marks)


5.96
5.95
5.94
5.93
5.92
5.91
5.90
5.89
5.88
5.87
5.86
5.85
5.84
ln(V/mV)
0
2
4
6
8
10
12
14
16
w/mm
y = -0.0104x + 5.9537

Question Number	Acceptable Answer	Additional Guidance	Mark
4(a)(i)	An explanation that makes reference to the following points: • The measurement (of time) will be larger **(1)** • But the uncertainty will be constant **(1)** • So the percentage uncertainty will be reduced **(1)**	Do not accept time period or T will be larger (for MP1 only).	**3**
4(a)(ii)	• Use a (timing) marker at the centre of the oscillation **(1)** • Start timing after several oscillations **Or** Use a small initial displacement **(1)**		**2**
4(a)(iii)	• Calculates mean time (period) using all values [mean must be in data range] **(1)** • Mean value of T = 0.69 s given to 2 d.p. only **(1)**	<u>Example of calculation</u> Mean value of $10T = \frac{(6.88 + 6.93 + 6.84 + 6.96)\text{ s}}{4} = \frac{27.61\text{ s}}{4} = 6.90\text{ s}$ Mean value of T = 6.90 s / 10 = 0.69 s	**2**
4(a)(iv)	• Uses half range **Or** Uses furthest from the mean [Values consistent with those used to calculate mean] **(1)** • Percentage uncertainty = 0.9% given to 1 or 2 s.f. e.c.f. (a)(iii) **(1)**	<u>Example of calculation</u> Half range $= \frac{(6.96 - 6.84)\text{ s}}{2} = 0.06\text{ s}$ Percentage uncertainty $= \frac{0.06\text{ s}}{6.90\text{ s}} \times 100 = 0.87\ \% = 0.9\%$ Use of full range scores 0	**2**

4(b)(i)	An explanation that makes reference to the following points: **EITHER** • Repeat at different orientations (at each end of the spring) and calculate a mean **(1)** • To reduce (the effect of) <u>random error</u> **(1)** **OR** • Check and correct for zero error **(1)** • To eliminate/reduce <u>systematic error</u> **(1)**	ONE mark only for "repeat and calculate a mean to reduce (the effect of) <u>random errors</u>" Do not allow eliminate/avoid. MP2 dependent on MP1 ONE mark only for "check for zero error to eliminate <u>systematic error</u>" Do not allow system/systemic. MP2 dependent on MP1	**2**
4(b)(ii)	**EITHER** • Uses %U in D **and** %U in d Accept $\frac{\Delta D}{D}$ **and** $\frac{\Delta d}{d}$ **(1)** • Uses 2 × %U in D **and** 2 × %U d Accept $2 \times \frac{\Delta D}{D}$ **and** $2 \times \frac{\Delta d}{d}$ **(1)** • %U = 2.1(%) given to minimum 2 s.f. **(1)** **OR** • Uses uncertainties to calculate maximum **or** minimum in $\frac{D^2}{2d^2}$ [Accept max/max or min/min] **(1)** • Uses half range from calculated maximum **and** minimum values [Accept max/max or min/min] **(1)** • %U = 2.1(%) given to minimum 2 s.f. **(1)** [Only credit if both maximum and minimum are correct and half range calculated]	<u>Example of calculation</u> %U in $D = \frac{0.2\text{ mm}}{59.4\text{ mm}} \times 100 = 0.34\%$ %U in $d = \frac{0.1\text{ mm}}{13.9\text{ mm}} \times 100 = 0.72\%$ %U in $\frac{D^2}{2d^2}$ = 2 × %U in D + 2 × %U in d = 2 × 0.34% + 2 × 0.72% = 2.1 % <u>Example of calculation</u> $\frac{D^2}{2d^2} = \frac{(59.4\text{ mm})^2}{2 \times (13.9\text{ mm})^2} = 9.13$ Maximum $\frac{D^2}{2d^2} = \frac{(59.4\text{ mm} + 0.2\text{ mm})^2}{2 \times (13.9\text{ mm} - 0.1\text{ mm})^2} = 9.326$ Minimum $\frac{D^2}{2d^2} = \frac{(59.4\text{ mm} - 0.2\text{ mm})^2}{2 \times (13.9\text{ mm} + 0.1\text{ mm})^2} = 8.940$ %U in $\frac{D^2}{2d^2} = \frac{9.326 - 8.940}{2 \times 9.13} \times 100 = 2.1\%$	**3**

4(b)(iii)	An explanation that makes reference to the following points: **EITHER** • Lower limit of v = 0.259 **(1)** • The lower limit is below the value of 0.265 so the spring could be made from steel **Or** valid conclusion comparing limit with 0.265 **(1)** **OR** • %D = 4 % using 0.265 as denominator **(1)** • As 4 % is less than 6% so the spring could be made from steel **Or** valid conclusion comparing %D with 6% **(1)**	<u>Example of calculation</u> Lower limit of $v = 0.276 \times (1 - 0.06) = 0.259$ Must see number being compared to. <u>Example of calculation</u> $\%D = \frac{0.276 - 0.265}{0.265} \times 100 = 4.2\ \%$ Must see number being compared to.	2

(Total for Question 4 = 16 marks)

TOTAL FOR PAPER = 50 MARKS

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