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# Mark Scheme (Results)

## October 2019

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

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**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 sugn in front of number as direction.]

This has a clear statement of the principle of 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 the 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 advise 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 cause the final calculation mark to be lost.

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

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

2.4 The same missing or incorrect unit will not be penalised more than once within a question.

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].

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## 3. Significant figures

Use of an inappropriate numberof 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.

## 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 candidates demonstrates subsistution 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 the 3rd mark; if conversion to kg is omitted then the answer is fudged, do not give 3rd mark.]

[Bald answer scores 0, reverse calculation 2/3]

Example of answer:

$80 \text{ cm} \times 50 \text{ cm} \times 1.8 \text{ cm} = 7200 \text{ cm}^3$

$7200 \text{ cm}^3 \times 0.70 \text{ g cm}^{-3} = 5040 \text{ g}$

$5040 \times 10^{-3} \text{ kg} \times 9.81 \text{ N/kg}$

$= 49.4 \text{ N}$

## 5. Quality of Written Communication

5.1 Indicated by QoWC in mark scheme. QWC – Work must be clear and organised in a logical manner using technical wording where appropriate.

5.2 Usually it is part of the max mark.

## 6. Graphs

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

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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 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 are OK, otherwise no mark.

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

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| Question Number | Answer | Mark |
|---|---|---|
| 1(a)(i) | (A larger distance will) reduce the percentage uncertainty (1)<br><br>Accept %U, % uncertainty, **not** uncertainty/ error.<br>Accept words that imply reduce but **not** eliminate. | **(1)** |
| 1(a)(ii) | Any **ONE** from:<br><br>Repeat at different places **and** calculate a mean (1)<br>to reduce (the effect of) random errors (1)<br><br>OR<br>Check for zero error (on the micrometer) (1)<br>to eliminate systematic error (1)<br><br>OR<br>Use the ratchet (1)<br>to avoid squashing the metal **Or** to reduce (the effect of) random errors (1)<br><br>OR<br>Squeeze to remove air gaps (1)<br>to eliminate systematic error (1)<br><br>OR<br>Take measurements away from the folded edge (1)<br>as the fold will be thicker **Or** to reduce (the effect of) random errors (1)<br><br>MP2 is dependent on MP1 | **(2)** |
| 1(b)(i) | Units consistent with readings in mm (1)<br>Values listed as 0.47, 0.49, 0.47, 0.48 (accept any order, 2 sf) (1)<br><br><u>Example</u><br><br>total thickness / mm<br>0.47 \| 0.49 \| 0.47 \| 0.48 | **(2)** |
| 1(b)(ii) | Correct mean to 2 sf (1)<br>Correct absolute uncertainty using half range (accept 1, 2 or 3 sf) (1)<br><br>Allow e.c.f. from 1(b)(i) for both marks<br><br>Example of calculation | |

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| | | |
|---|---|---|
| | Mean thickness = (0.47 + 0.49 + 0.47 + 0.48) mm / 4 = 0.48 mm<br>Half range = (0.49 – 0.47) / 2 = 0.01 mm | **(2)** |
| 1(c)(i) | Use of $\rho = m/V$ (1)<br>2700 (kg $m^{-3}$) (accept 2680) (1)<br><br>Allow ecf from (b)(ii))<br><br><u>Example of calculation</u><br><br>$\rho = \frac{3.62 \times 10^{-3}\text{kg}}{0.30\text{m} \times 0.30\text{m} \times (0.48 \times 10^{-3})\text{m}/32} = 3.62 \times 10^{-3}$ kg/ $1.35 \times 10^{-6}$ $m^3$ = 2680 kg $m^{-3}$ | **(2)** |

| | | |
|---|---|---|
| 1(c)(ii) | Correct calculation of percentage uncertainty in $\rho$ shown (1)<br>(allow ecf from (b)(ii)) (1)<br>Correct upper and/or lower limit based on calculated percentage uncertainty (allow ecf from (c)(i)) (1)<br>Valid conclusion based on comparison of given density with calculated limit (dependent on MP2)<br><br><u>Example of calculation</u><br><br>%U = (2 × 0.1/30 + 0.01/0.48 + 0.01/3.62) × 100% = 0.67% + 2.1% + 0.28% = 3.1 %<br>Upper limit = 2700 kg $m^{-3}$ × 103.1% = 2780 kg $m^{-3}$<br>The quoted value falls within the limits therefore the metal could be aluminium (1)<br>(1)<br><br>**Or** (1)<br><br>Correct calculation of percentage uncertainty in $\rho$ shown<br>(allow ecf from (b)(ii))<br>Correct calculation percentage difference shown<br>(allow ecf from (c)(i))<br>Valid conclusion based on comparison of correct percentage difference and calculated percentage uncertainty (dependent on MP2)<br><br><u>Example of calculation</u><br><br>%U = (2 × 0.1/30 + 0.01/0.48 + 0.01/3.62) × 100% = 0.67% + 2.1% + 0.28% = 3.1 %<br>%D = (2700 –2710)/2710 × 100% = 0.37%<br>%D is less than %U therefore the metal could be aluminium | **(3)** |
| | **Total for Question 1** | **12** |

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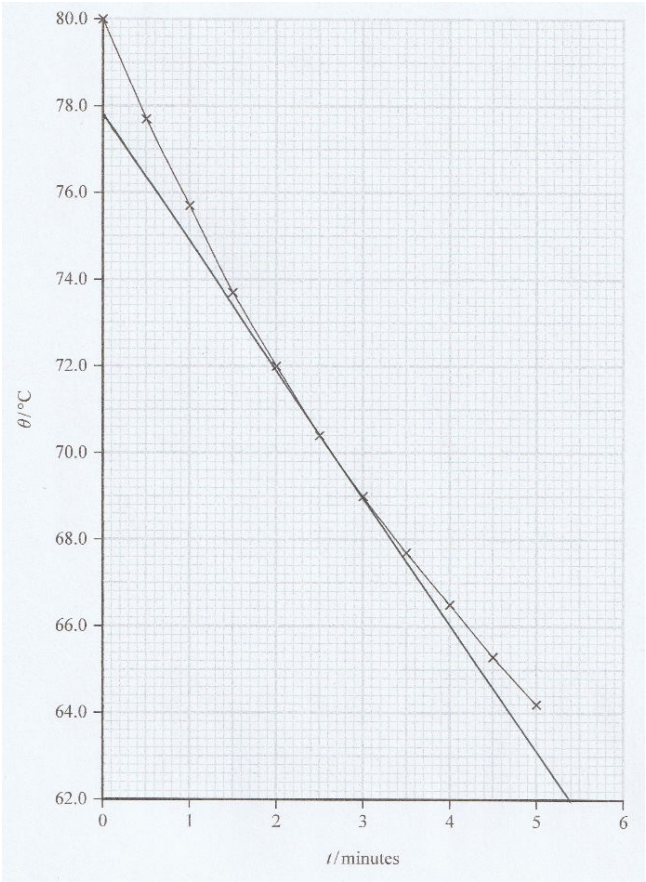
| Question Number | Answer | | Mark |
|---|---|---|---|
| **2 (a) (i)** | Tangent drawn at $\theta = 70.0$ °C<br>Gradient in range –2.80 to –3.10 (°C min$^{-1}$) to 2 or 3 sf calculated from the tangent drawn (Allow $-4.67 \times 10^{-2}$ to $-5.17 \times 10^{-2}$ °C s$^{-1}$)<br><br><u>Example of calculation</u><br><br><br><br>$\Delta\theta / \Delta t = (62.0–77.8)/5.4 = –2.93$ °C min$^{-1}$ | (1)<br>(1) | **(2)** |
| **2(a)(ii)** | Use of $\Delta E / \Delta t = mc \times \Delta\theta / \Delta t$<br>$\Delta E / \Delta t$ = 1180 to 1300 J min$^{-1}$ (20 to 22 W) to 2 or 3 sf<br><br>(allow ecf (a)(i))<br><br><u>Example of calculation</u><br><br>$\Delta E/\Delta t = 100$ cm$^3$ × 1.0 g cm$^{-3}$ × 4.2 J g$^{-1}$K$^{-1}$ × 2.93 °C min$^{-1}$<br>= 1230 J min$^{-1}$ | (1)<br>(1) | **(2)** |
| **2(b)(i)** | Volume/mass<br>**Or**<br>Temperature of the surroundings<br>**Or**<br>Initial temperature of water | (1)<br><br>(1)<br><br>(1) | **(1)** |

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| | | | |
|---|---|---|---|
| **2(b)(ii)** | Compare the gradient **Or** rate of change of temperature **Or** rate of energy transfer<br>At the same temperature/time<br>**Or**<br>Compare the time taken<br>For the same change in temperature<br>**Or**<br>Compare the temperature change<br>Over the same time interval | (1)<br>(1)<br>(1)<br>(1)<br>(1)<br>(1) | **(2)** |
| **2(b)(iii)** | Difficult to ensure temperature of surroundings remains constant<br>So repeat readings are not appropriate<br><br>MP2 dependent on MP1 | (1)<br>(1) | **(2)** |
| | **Total for Question 2** | | **9** |

| Question Number | Answer | | Mark |
|---|---|---|---|
| **3 (a)** | Zero the top pan balance without the top magnet **Or** measure the mass of a single magnet<br>Measure $x$ using a metre rule **Or** vernier calipers<br>Vary $x$ and record the corresponding balance readings | (1)<br>(1)<br>(1) | **(3)** |
| **3 (b)** | Multiply the balance readings by $g$ to obtain $F$ **Or** state balance readings are proportional to $F$<br>Plot a graph of log $F$ against log $x$ **Or** ln $F$ against ln $x$<br>To check it is a straight line **Or** to check it has a constant gradient<br><br>3a and 3b to be marked holistically | (1)<br>(1)<br>(1) | **(3)** |
| | **Total for Question 3** | | **6** |

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| Question Number | Answer | | Mark |
|---|---|---|---|
| **4 (a)** | Energy is (permanently) removed/dissipated (from the system)<br>**Or** energy is lost from the system<br><br>Resulting in a decrease in amplitude | (1)<br><br>(1) | **(2)** |
| **4 (b)** | $\ln A = \ln A_0 - \lambda n$<br>is in the form $y = c + mx$ where $-\lambda$ is the gradient (which is constant)<br><br>MP2 dependent on MP1 | (1)<br>(1) | **(2)** |
| **4 (c)(i)** | $\ln A$ values correct to 3 or 4 sf<br>Axes labelled: $y$ as $\ln(A/\text{cm})$ and $x$ as $n$<br>Suitable scales for $\ln(A/\text{cm})$ and $x$ as $n$<br>Processed data plotted accurately to ± 1mm<br>Line of best fit | (1)<br>(1)<br>(1)<br>(1)<br>(1) | **(5)** |
| **4 (c)(ii)** | Calculation of gradient using a large triangle shown<br>Correct value of $\lambda$ to 2 or 3 sf, no unit, positive | (1)<br>(1) | **(2)** |
| **4 (d)** | High sampling rate near the maximum displacement<br><br>Parallax error at the maximum displacement is eliminated | (1)<br><br>(1) | **(2)** |
| | **Total for Question 4** | | **13** |

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