Mark Scheme (Results)

January 2020

Pearson Edexcel International Advanced Level
In Physics (WPH13) Paper 01
Practical Skills in Physics I

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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.

Using the Mark Scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:

- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit.

( ) means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.

Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.

ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

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**

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]
[Bald answer scores 0, reverse calculation 2/3] **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. 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 a max mark, the final mark not being awarded unless the QoWC condition has been satisfied.

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.

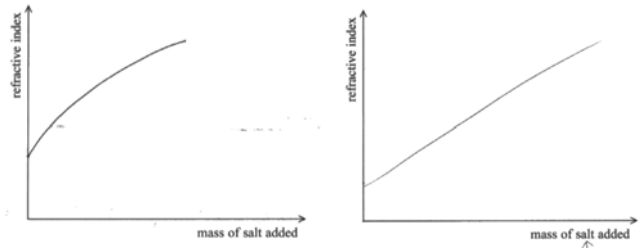
6.4 Points should be plotted to within 1 mm.

- Check the two points furthest from the best line. If both OK award 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.

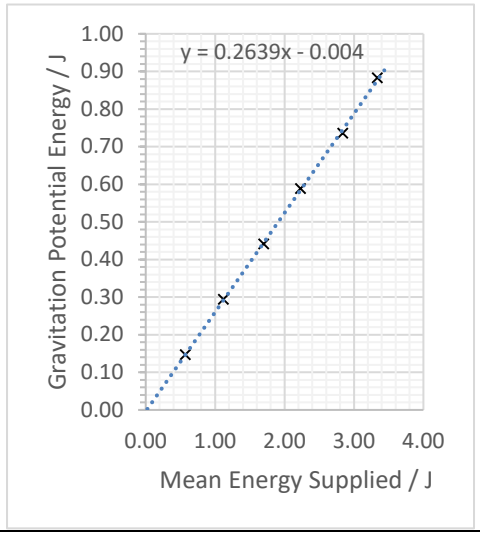
For a line mark there must be a thin continuous line which is the best-fit line for the candidate's results.

Question Number	Answer	Mark
1(a)	A diagram which includes apparatus to; • change **and** measure diode temperature (e.g. water bath, Bunsen burner and beaker of water, thermometer) (1) • measure potential difference – connected in parallel with diode (e.g. voltmeter, multimeter on Volts setting) (1) • measure current – connected in series with diode (e.g. ammeter, multimeter on Amps setting) (1) • power source **and** means of changing p.d. (e.g. cell/battery and potential divider or variable resistor) (1) Accept incorrect symbols if correctly labelled	**4**
1(b)	• Comment identifying an appropriate safety issue (1) • Associated control measure (1) <u>Examples</u> • Risk of scalding from hot water • Clamp beaker • Risk of burns from hot apparatus • Wear gloves • Risk of electric shock from power supply • Keep separate from water bath **Or** Use a low voltage power supply	**2**
	Total for question 1	**6**

Question Number	Answer	Mark
2(a)	• Identifies upthrust = weight (of displaced fluid) (1) • See $W = m \times g$ **and** $m = V \times \rho$ (1) • See $V = A \times d$ **and** $A = \pi r^2$ (1) • A conversion to SI units (1) (e.g. g to kg)	**4**
2(b)	• Calculates gradient using large triangle (1) • Use of their gradient = $1/\pi r^2$ (1) • Diameter = 6.9 to 7.1 cm (1) Accept use of a correct pair of values from the graph and the equation stated for 1 mark only. <u>Example of calculation</u> gradient = (6.8 cm – 1.6 cm) / 200 g = 0.026 cm g^{-1} $r = \sqrt{\frac{1}{0.026\,\pi}} = 3.5$ cm diameter = $2 \times r$ = 7.0 cm	**3**
2(c)	• Mass/weight of the beaker (not included) (1) • Add the mass of the beaker to the mass of the load (and plot total) **Or** subtracting the depth when mass added is 0 (1)	**2**
	Total for question 2	**9**

Question Number	Answer	Mark
3(a)	• Mass (of solution) obtained using a (top pan) balance (1) • Volume (of solution) measured with a measuring cylinder (1) • Calculate density = mass / volume ($\rho = m / V$) (1)	**3**
3(b)	• Positive intercept on the refractive index axis (1) • Refractive index increases as mass of salt added increases (1) 	**2**
3(c)	• Measure θ_2 for different θ_1 (1) • Measure at least 5 pairs of angles (1) • Plot graph of sin θ_1 against sin θ_2 (1) • Refractive index is the gradient of the line (1)	**4**
3(d)(i)	• Use of $n_1 \sin \theta_1 = n_2 \sin \theta_2$ (with $n_1 = 1$) (1) • Max value = 1.38 (1) • Min value = 1.30 (1) <u>Example of calculation</u> $n_{max} = \frac{\sin 33.5^\circ}{\sin 23.5^\circ} = 1.384$ $n_{min} = \frac{\sin 32.5^\circ}{\sin 24.5^\circ} = 1.296$	**3**
3(d)(ii)	• Use of half range of values (1) • Percentage uncertainty = 3 (%) (1) Allow ecf from (d)(i) <u>Example of calculation</u> Range of values = 1.38 – 1.30 = 0.08 Half range of values = 0.04 percentage uncertainty $= \frac{0.04}{1.34} \times 100\% = 3\%$	**2**
	Total for question 3	**14**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>4(a)</td><td>Max 2 from
• Mass is not measured to the nearest gram
Or mass is not measured (in kg) to 3 d.p. (1)
• Inconsistent/incorrect number of significant figures for GPE (1)
• Mean energy supplied values should be 3 s.f. (to match measured values) (Accept 2 d.p.) (1)</td><td>2</td></tr>
<tr><td>4(b)</td><td>• Use of $E_g = mgh$ (1)
• Change in gravitational potential energy = 0.88 (J) (1)
• Mean energy supplied = 3.34 (J) (1)

<u>Examples of calculation</u>
$E_g = 0.12 \text{ kg} \times 0.75 \text{ m} \times 9.81 \text{N kg}^{-1} = 0.883 \text{ J}$
Mean = (3.32 J + 3.36 J + 3.33 J) ÷ 3 = 3.34 J</td><td>3</td></tr>
<tr><td>4(c)</td><td>• Labels axes with quantities and units (1)
• Sensible scales (1)
• Plotting (2)
• Line of best fit (1)
 

<table>
<tr><th>Change GPE / J</th><th>Mean E Supplied / J</th></tr>
<tr><td>0.147</td><td>0.573</td></tr>
<tr><td>0.29</td><td>1.12</td></tr>
<tr><td>0.441</td><td>1.7</td></tr>
<tr><td>0.59</td><td>2.23</td></tr>
<tr><td>0.74</td><td>2.84</td></tr>
<tr><td>0.88</td><td>3.34</td></tr>
</table></td><td>5</td></tr>
<tr><td>4(d)</td><td>• Calculates gradient using large triangle (1)
• Efficiency = 0.25 to 0.27 (accept value converted to %) (1)

<u>Example of calculation</u>
Gradient = (0.79 J – 0.26 J) ÷ (3.00 J – 1.00 J) = 0.265</td><td>2</td></tr>
<tr><td>4(e)</td><td>• Continue increasing the mass and extend the graph (1)
• Identify the mass/point at which the line starts to curve (1)
• Take smaller increments in mass around this point (1)
OR
• Using larger masses, calculate the efficiency (using efficiency = mgh ÷ mean energy supplied) and plot a graph of efficiency against mass (1)
• Identify the mass/point where the graph peaks
Or identify the mass where efficiency starts to decrease (1)
• Take smaller increments in mass around this point (1)</td><td>3</td></tr>
<tr><td></td><td>Total for question 4</td><td>15</td></tr>
</table>

Question Number	Answer	Mark
5(a)	• (Diameter is 1/20 the original) so area is 1/400 original (1) • (For the same breaking stress) maximum force needed to break the sample is only 20N (so it is safe) (1) Accept correct calculations of both areas (with no comparison) for MP1 Accept repeated/combined calculations using $\sigma = F / A$ leading to a force of 20N to score both marks.	**2**
5(b)	• Use of $W = mg$ **and** $A = \pi d^2/4$ (1) • Use of $\sigma = F / A$ (1) • Breaking stress of sample = 2.62×10^7 (Pa) **Or** Force for manufacturers breaking stress = 18.1 (N) (1) • Comparative statement consistent with their value (1) For MP1 accept use of $A = \pi r^2$ <u>Example of Calculation</u> $W = mg = 1.9 \text{ kg} \times 9.81 \text{ N kg}^{-1} = 18.6 \text{ N}$ $A = \pi d^2/4 = \pi \times (0.00095 \text{ m})^2 / 4 = 7.1 \times 10^{-7} \text{ m}^2$ $\sigma = F / A = 18.6 \text{ N} / 7.1 \times 10^{-7} \text{ m}^2 = 2.62 \times 10^7 \text{ Pa}$	**4**
	Total for question 5	**6**

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