Pearson Edexcel

Mark Scheme (Final)

Summer 2023

Pearson Edexcel International Advanced Subsidiary Level In Physics (WPH13)
Paper 01
Unit 3: 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.

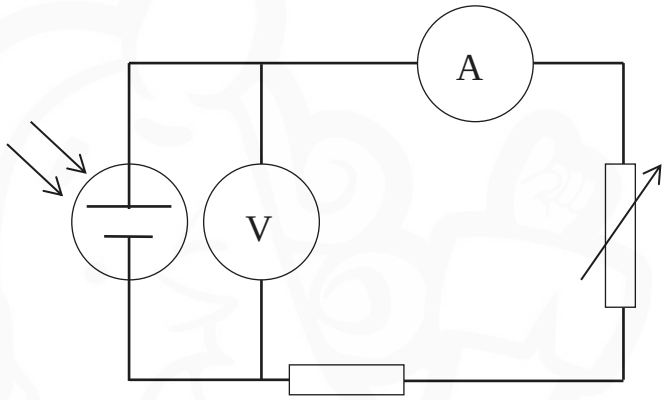
Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:
- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities. Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

Question Number	Answer	Mark
1(a)(i)	• 1.72 (mm) **(1)**	1
1(a)(ii)	• Use of percentage uncertainty = (half resolution / measurement) × 100% **(1)** • Percentage uncertainty = 0.29 (%) e.c.f. 1(a)(i) **(1)** Allow 1 mark only for a correct percentage calculated using the full resolution (0.01 mm) <u>Example of calculation</u> Percentage uncertainty = (0.005 / 1.72) × 100% = 0.29 %	2
1(a)(iii)	**EITHER** • Check for zero error (on the micrometer) **(1)** • to remove <u>systematic</u> error **(1)** **OR** • Prevent over-tightening/deformation **(1)** • By using the ratchet when closing **(1)**	2
1(b)	• Add the 20g mass (a distance from the pivot) **and** move the ruler to find the new balance point **Or** move the ruler to unbalance it **and** add/move the 20g mass to find the new balance point **(1)** • Measure the distance from the pivot to the centre of gravity of the ruler **and** measure the distance from the pivot to the (centre of the) 20g mass **(1)** • Calculate the mass of the ruler using the principle of moments • Repeat measurements of distance for different positions of the 20g mass **and** calculate the mean mass of the ruler **(1)** **(1)** Accept "centre of gravity" for balance point in MP1 Accept additions to the diagram for MP1 & MP2	4
	Total for question 1	9

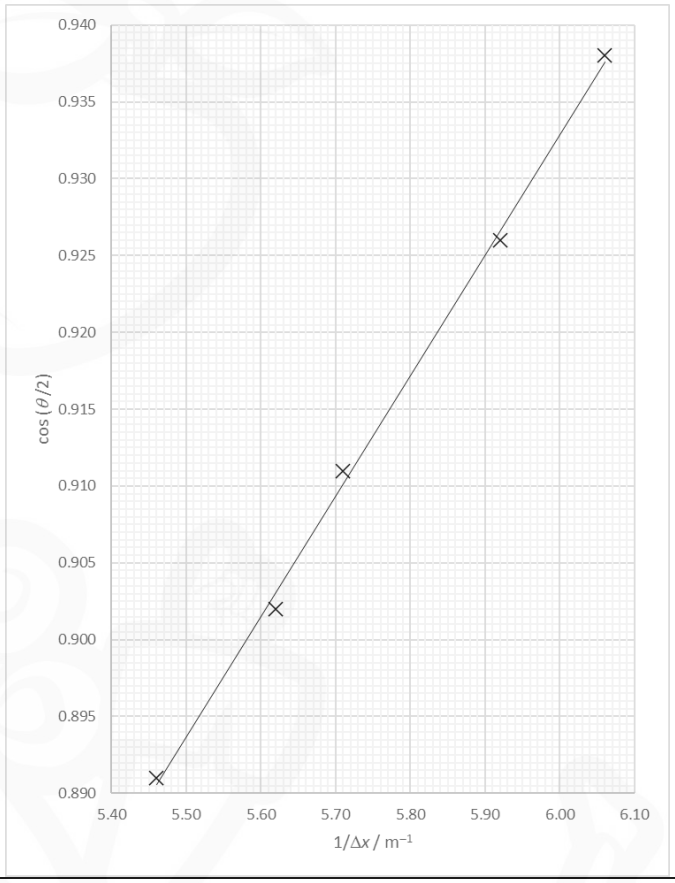
Question Number	Answer	Mark
2(a)(i)	• Using the lens produces a parallel beam of light **Or** using the lens concentrates the light on the solar cell **(1)** • The light from the filament bulb spreads out **Or** to increase the intensity of light **Or** to ensure the intensity of light is even **(1)** Accept use of diagrams to support statement for MP1 / MP2	**2**
2(a)(ii)	**Max TWO from** • Control background light [Accept any method to control background light] **(1)** • Keep the solar cell at the same distance from the filament bulb **(1)** • Keep the solar cell at the same angle to the filament bulb **(1)**	**2**
2(b)(i)	• Ammeter in series with the solar cell, resistor and variable resistor **(1)** • Voltmeter in parallel with the solar cell **(1)** 	**2**
2(b)(ii)	• To limit the (maximum) current in the solar cell **Or** to avoid short-circuiting the solar cell **(1)**	**1**
2(c)	**Max TWO from** • Solar cells do not emit greenhouse gases [accept a named greenhouse gas] **Or** using solar cells does not contribute to global warming **Or** using solar cells would not cause acid rain **Or** using solar cells would reduce the need for fossil fuels **(1)** • Solar cells use a renewable energy source **(1)** • Sunlight/energy used is free **(1)** • No need for mains wiring **Or** can be used where there is no mains electricity **(1)**	**2**
	Total for question 2	**9**

Question Number	Answer	Mark
3(a)(i)	**Max TWO from** • The vernier calipers have a smaller resolution **Or** the vernier calipers have a lower uncertainty **(1)** • The vernier calipers can measure without parallax error **(1)** • Tips of vernier calipers are easier to align with the rings (as surface is curved) **(1)**	**2**
3(a)(ii)	• Repeat the measurement **and** calculate a mean value **(1)** • Measure the diameter in different orientations **(1)** If no other marks awarded, allow 1 mark for "check for zero error before measuring"	**2**
3(b)(i)	• Calculation of mean value using all three values **(1)** • Mean $a = 1.22 \times 10^{-18}$ (m^2 V) rounded to 3 s.f. **(1)** Example of calculation Mean value of $a = (1.23 + 1.11 + 1.32) \times 10^{-18} / 3 = 1.22 \times 10^{-18}$ m^2 V	**2**
3(b)(ii)	• Use of half their range for uncertainty [Accept use of furthest value from the mean] **(1)** • Percentage uncertainty = 9 (%) e.c.f. 3(b)(i) **(1)** Example of calculation Uncertainty = half range = $(1.32 - 1.11) \times 10^{-18} / 2 = 0.105 \times 10^{-18}$ m^2 V Percentage uncertainty = $(0.105 \times 10^{-18} / 1.22 \times 10^{-18}) \times 100 = 8.6$ %	**2**
3(b)(iii)	**Max TWO from** • More pairs of values were used • Adding a line of best fit acts as an averaging method **(1)** • Adding a line of best fit can identify anomalous values **(1)** • The gradient value will ignore any systematic error **(1)** **Or** the line/intercept will identify any systematic error [accept named examples of systematic error, e.g., zero error] **(1)**	**2**
3(c)(i)	• Use of $a = \frac{h^2}{2em_e}$ **(1)** • $h = 6.52 \times 10^{-34}$ (J s) **(1)** Example of calculation $h = \sqrt{(2 \times 1.6 \times 10^{-19} \times 9.11 \times 10^{-31} \times 1.46 \times 10^{-18})} = 6.52 \times 10^{-34}$ (J s)	**2**
3(c)(ii)	**EITHER** **(1)** • Calculation of upper limit of h **(1)** • Conclusion based on comparison to 6.63×10^{-34} J s e.c.f. 3(c)(ii) For 1 mark only – accept the calculation of 6% limit of 6.63×10^{-34} J s **OR** • Calculation of percentage difference from 6.63×10^{-34} J s e.c.f. 3(c)(i) **(1)** • Conclusion based on comparison to 6 % **(1)** Examples of calculation Upper limit of $h = 6.52 \times 10^{-34} \times 1.06 = 6.92 \times 10^{-34}$ J s As this is above value of 6.63×10^{-34} J s then the calculated value is accurate Percentage difference = $((6.63 - 6.52) \times 10^{-34} / 6.63 \times 10^{-34}) \times 100 = 1.7$ % As this is less than 6 % then calculated value is accurate	**2**
	Total for question 3	**14**

Question Number	Answer	Mark
4(a)	**EITHER** • The elastic cord may snap **(1)** • So, wear safety goggles **Or** use a safety screen **(1)** **OR** • The stands may topple over **(1)** • Clamp stands to the bench **Or** put a heavy mass on the stand base **(1)** **OR** • The mass may fall **(1)** • Wear safety gloves/boots **Or** keep hands/feet away from under the mass **Or** place cushion/box under the mass **(1)** MP2 is dependent on MP1	**2**
4(b)(i)	**Mark 4(b)(i) and (b)(ii) holistically** **Max TWO from** • Parallax error when using the metre rule [accept x] **Or** parallax error when using the protractor [accept θ] **(1)** • Error measuring θ due to thickness of cord **(1)** • (Zero of) protractor/rule not aligned correctly **Or** protractor/rule may move while measuring **(1)** • Applying an additional force to the cord while measuring **Or** cord/mass may move while measuring **(1)**	**2**
4(b)(ii)	**Max ONE from** • Ensure viewing measurement perpendicular to protractor/rule **Or** hold the protractor/rule close to the cord **(1)** • Mark the position of the centre of the cord **(1)** • Clamp metre rule and/or protractor **(1)** • Ensure the protractor/rule does not touch the cord/mass **(1)** [suggested modification must be linked to a source of uncertainty mentioned in (b)(i)]	**1**
4(c)(i)	• $\cos\left(\frac{\theta}{2}\right) = \left(\frac{mg}{k}\right)\frac{1}{x}$ is in the form $y = mx$ (+ c) **Or** gradient $= \frac{\cos\left(\frac{\theta}{2}\right)}{\frac{1}{x}}$ **(1)** • So, the gradient is $\left(\frac{mg}{k}\right)$ **Or** $g = \frac{\text{gradient} \times k}{m}$ **(1)**	**2**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>4(c)(ii)</td><td>

Correct values of $\frac{1}{\Delta x}$ rounded to 3 s.f. (1)
Labels axes with quantities and units (1)
Sensible scales (1)
Plotting (2)
Line of best fit (1)

<table>
<tr><th>$\cos\left(\frac{\theta}{2}\right)$</th><th>$\Delta x$ / m</th><th>$\frac{1}{\Delta x}$ / m^{-1}</th></tr>
<tr><td>0.938</td><td>0.165</td><td>6.06</td></tr>
<tr><td>0.926</td><td>0.169</td><td>5.92</td></tr>
<tr><td>0.911</td><td>0.175</td><td>5.71</td></tr>
<tr><td>0.902</td><td>0.178</td><td>5.62</td></tr>
<tr><td>0.891</td><td>0.183</td><td>5.46</td></tr>
</table>


</td><td>6</td></tr>
<tr><td>4(c)(iii)</td><td>

Calculates gradient using large triangle (1)
Gradient value between 0.076 and 0.079 (m) (1)
Gradient rounded to 2 or 3 s.f. (1)

<u>Example of calculation</u>
gradient = (0.9405–0.8935)/(6.1–5.5) = 0.047/0.6 = 0.078
</td><td>3</td></tr>
<tr><td>4(c)(iv)</td><td>

Use of gradient = mg / k (1)
Correct value of g from gradient given with a correct unit [ecf from 4(c)(iii)] (1)

<u>Example of calculation</u>
$g = = \frac{\text{gradient} \times k}{m} = \frac{0.078 \times 145}{1.2}$ = 9.43 m s^{-2}
</td><td>2</td></tr>
<tr><td></td><td>Total for question 4</td><td>18</td></tr>
</table>

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