Mark Scheme (Results)

January 2021

Pearson Edexcel International Advanced Subsidiary In Physics (WPH13)
Paper 1 Practical Skills in Physics I

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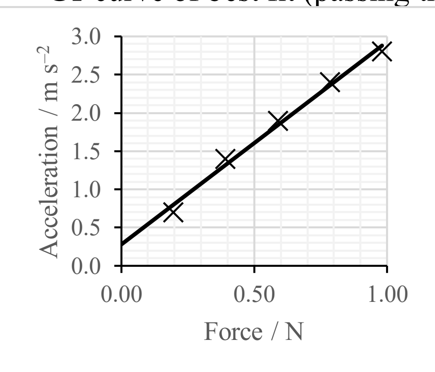
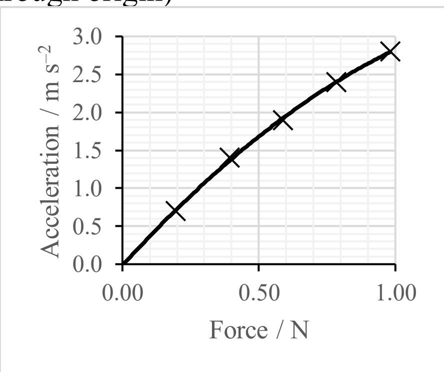
General Marking Guidance

- 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.

Question Number	Answer		Mark
1(a)	• A measurement of distance travelled • A measurement of time taken • Appropriate measuring equipment for both, e.g. metre rule, stop clock, light gates • See $s = ut + ½at^2$ • Repeat and calculate mean **OR** • A measurement of distance travelled • A measurement of (initial and) final velocity • Appropriate measuring equipment for both, e.g. metre rule, stop clock, light gates • See $v^2 = u^2 + 2as$ • Repeat and calculate mean **OR** • A measurement of (initial and) final velocity • A measurement of time taken • Appropriate measuring equipment for both, e.g. stop clock, light gates • See $a = (v – u)/t$ • Repeat and calculate mean For MP4 - accept correctly re-arranged versions - accept gradient of a correctly described graph - accept versions of equations where $u = 0$ has already been included. e.g. $s = ½at^2$ MP1-2 could be described for the falling mass, as acceleration is the same	(1) (1) (1) (1) (1) (1) (1) (1) (1) (1) (1) (1) (1) (1) (1)	**5**
1 (b)(i)	• (0.98, 2.8) and (0.78, 2.4) plotted correctly • Straight line of best fit with a positive *y*-axis intercept **Or** curve of best fit (passing through origin)	(1) (1)	**2**
1 (b)(ii)	• (Straight) line of best fit does not pass through the origin, so the conclusion is correct **Or** line of best fit is a curve, so the conclusion is correct **Or** accept answer consistent with incorrectly drawn line in (b)(i)	(1)	**1**
1(c)	• Masses removed from the hanger are placed on the glider **Or** masses removed from the glider are placed on the hanger	(1)	**1**
	Total for question 1		**9**





<table>
<tr><th>Question Number</th><th>Answer</th><th></th><th>Mark</th></tr>
<tr><td>2(a)(i)</td><td>• Normal drawn and critical angle indicated</td><td>(1)</td><td>1</td></tr>
<tr><td>2(a)(ii)</td><td>• Use of $\sin C = \frac{1}{n}$ with their measured value of C
• Refractive index = 1.58 to 1.70

<table>
<tr><th>C / °</th><th>n</th></tr>
<tr><td>36</td><td>1.70</td></tr>
<tr><td>37</td><td>1.66</td></tr>
<tr><td>38</td><td>1.62</td></tr>
<tr><td>39</td><td>1.59</td></tr>
</table>

MP1 accept correct use of $n_1 \sin \theta_1 = n_2 \sin \theta_2$, with $n_2 = 1$ and $\theta_2 = 90°$

<u>Example calculation</u>
$C = 38°$
$\sin 38° = \frac{1}{n}$
$n = 1.62$</td><td>(1)
(1)</td><td>2</td></tr>
<tr><td>2(b)</td><td>• Use of $\sin C = \frac{1}{n}$ with either 40.5° or 41.5°
• Range of refractive index calculated

<u>Example calculation</u>
$\sin 40.5° = \frac{1}{n}$
$n = 1.54$
$\sin 41.5° = \frac{1}{n}$
$n = 1.51$
$1.51 \le n \le 1.54$</td><td>(1)
(1)</td><td>2</td></tr>
<tr><td>2(c)</td><td>• Use of $n_1 \sin \theta_1 = n_2 \sin \theta_2$
• Refractive index = 1.53
• Comparative statement consistent with the range from (b)

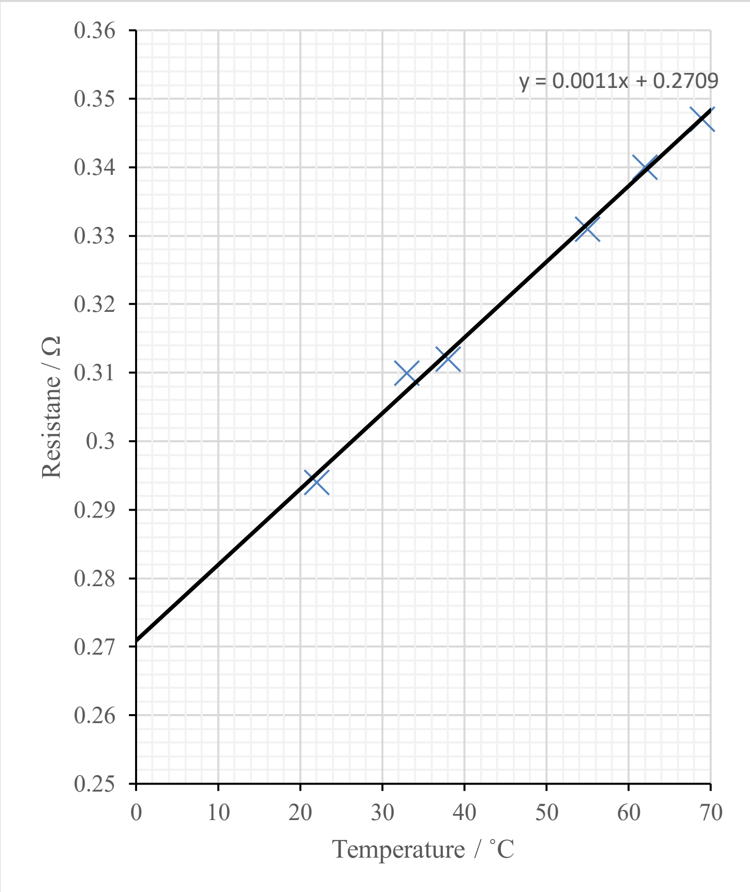
<u>Example calculation</u>
$\sin 64 = n \sin 36$
$n = 1.53$</td><td>(1)
(1)
(1)</td><td>3</td></tr>
<tr><td>2(d)</td><td>• The monochromatic light has a single wavelength/frequency
Or White light is a mixture/range of wavelengths/frequencies
• The different wavelengths/colours would refract by different angles
Or different wavelengths/colours would have different refractive indexes
• Monochromatic light would give less uncertainty in the <u>angle</u> (incident/refraction/critical)
Or monochromatic light allows for a more accurate measurement of <u>angle</u></td><td>(1)
(1)
(1)</td><td>3</td></tr>
<tr><td>2(e)</td><td>• Angle resolution of 0.1° compared to protractor resolution of 1°
• Beam from the collimator is narrow<u>er</u> (than the ray from a ray box)
• So, uncertainty in angle (of refraction) is smaller

For MP1 – accept descriptions of protractor with resolution 0.5°
For MP3 – must be clear the uncertainty is for the angle measurement</td><td>(1)
(1)
(1)</td><td>3</td></tr>
<tr><td></td><td>Total for question 2</td><td></td><td>14</td></tr>
</table>

Question Number	Answer	Mark
3(a)	• Diagram showing rubber band suspended/clamped at one end (e.g. hanging from a clamp stand) (1) • Force applied to band (e.g. slotted masses hanging on free end) (1) • Measure initial length using a ruler **Or** mark position of bottom of band on ruler (1) • Measure new length/position and calculate extension (1) • Additional detail to improve accuracy e.g. method for reducing parallax **Or** additional detail to improve safety e.g. ensure feet are not under the masses in case they fall (1) MP2-5 could be awarded for information shown on the diagram (e.g. metre rule and set squares seen on the diagram). Allow MP3 and 4 for set-up where 0 on metre rule is aligned with end of band before masses are added, to measure extension directly.	**5**
3(b)	• Estimates the area inside the loop by counting squares **Or** estimates the area inside the loop by using simple shapes (1) • Calculates the energy of each square **Or** calculates the energy for one shape (1) • Energy transferred = 0.85 to 1.00 J (1) MP1 and 2 Accept calculation of area under both curves which are then subtracted <u>Example calculation</u> 77 squares counted Energy of 1 square = 0.5 N × 0.025 m = 0.0125 J Energy transferred = 77 × 0.0125 J = 0.96 J	**3**
	Total for question 3	**8**

Question Number	Answer	Mark
4(a)	• Percentage uncertainty = 2.4% (accept 2%, 2.38%, 2.381%) (1) <u>Example Calculation</u> $\text{Percentage uncertainty} = \frac{0.25}{10.5} \times 100\%$ Percentage uncertainty = 2.4%	**1**
4(b)	**Max 3 from** • (Percentage) uncertainty will be reduced (1) • The multimeter screen/display will not cause a parallax error (1) • The multimeter can measure to a higher resolution **Or** the multimeter resolution can be increased by changing the setting **Or** the multimeter measures to 2 d.p. (1) • The digital multimeter will not require interpolation of values (1)	**3**
	Total for question 4	**4**

Question Number	Answer		Mark
5(a)	• Inconsistent number of decimal places for resistance **Or** resistance should be to 3 d.p. (to match ohmmeter resolution) • Inconsistent intervals in temperature **Or** large jump in temperature from 38 to 55 ˚C	(1) (1)	**2**
5(b)	• Labels axes with quantities and units • Sensible scales • Plotting • Line of best fit	(1) (1) (2) (1)	**5**



T /˚C	R / Ω
69	0.347
62	0.34
55	0.331
38	0.312
33	0.31
22	0.294

Question Number	Answer		Mark
5(c)	• Extends line to y-axis intercept • Correct R_0 for the line drawn • Calculates gradient using large triangle • Use of gradient = αR_0 • $\alpha = 4.0\times10^{-3}$ to 4.2×10^{-3} (˚C^{-1}) • Value of α to 2 or 3 sig fig and with correct units ˚C^{-1} For MP5 – accept a correct calculation using the given value for R_0 and gradient. For MP1 – 5 accept calculation of y-axis intercept using gradient or use of simultaneous equations for 2 pairs of points on the line. <u>Example calculation</u> Gradient = (0.348-0.282) / (70-10) = 0.0011 Ω ˚C^{-1} α = gradient / R_0 = 0.0011 / 0.271 = 4.1×10^{-3} ˚C^{-1}	(1) (1) (1) (1) (1) (1)	**6**

5(d)	• Realistic modification suggested • Explains how this improves the accuracy of the values <u>Examples</u> • Take a resistance measurement at 0 ˚C • to measure R_0 accurately • Take resistance measurements for lower temperatures • to improve the accuracy of the gradient **Or** to improve the accuracy of the *y*-axis intercept • Take resistance measurements for smaller increments of temperature • to improve the accuracy of the gradient **Or** to improve the accuracy of the *y*-axis intercept • Take resistance measurements for a wider range of temperatures • to improve the accuracy of the gradient **Or** to improve the accuracy of the *y*-axis intercept • Stir the water regularly **Or** place the thermometer inside the copper coil • so the temperature of water plotted is the same as the temperature of the copper • Use a datalogger to measure temperature and resistance • so that the values are recorded simultaneously • Use a digital thermometer • to avoid parallax error Ignore higher resolution for a digital thermometer.	(1) (1)	**2**
	Total for question 5		**15**