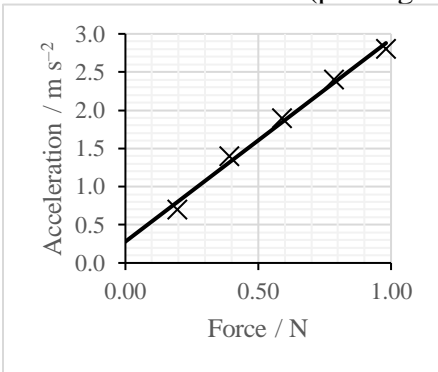
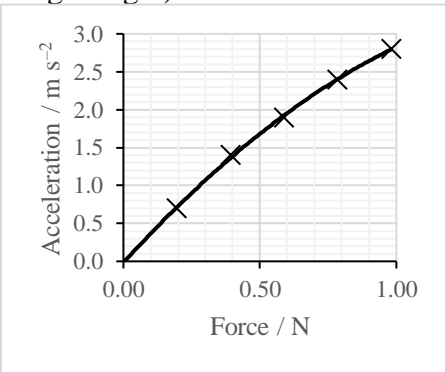




Mark Scheme (Results)

January 2021

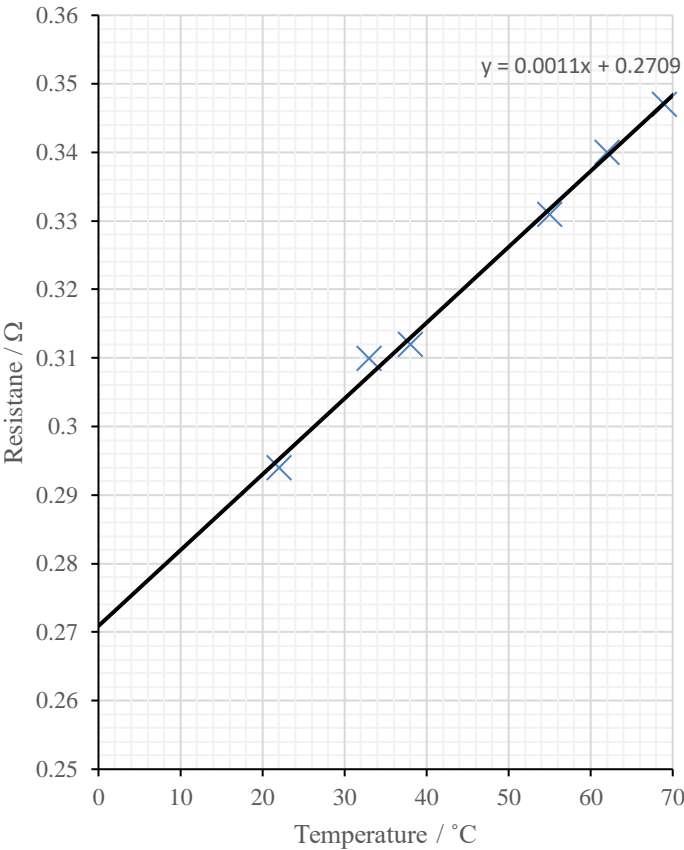
Pearson Edexcel International Advanced Subsidiary
In Physics (WPH13)
Paper 1 Practical Skills in Physics I

Question Number	Answer	Mark
1(a)	<ul style="list-style-type: none"> • A measurement of distance travelled (1) • A measurement of time taken (1) • Appropriate measuring equipment for both, e.g. metre rule, stop clock, light gates (1) • See $s = ut + \frac{1}{2}at^2$ (1) • Repeat and calculate mean (1) <p>OR</p> <ul style="list-style-type: none"> • A measurement of distance travelled (1) • A measurement of (initial and) final velocity (1) • Appropriate measuring equipment for both, e.g. metre rule, stop clock, light gates (1) • See $v^2 = u^2 + 2as$ (1) • Repeat and calculate mean (1) <p>OR</p> <ul style="list-style-type: none"> • A measurement of (initial and) final velocity (1) • A measurement of time taken (1) • Appropriate measuring equipment for both, e.g. stop clock, light gates (1) • See $a = (v - u)/t$ (1) • Repeat and calculate mean (1) <p>For MP4</p> <ul style="list-style-type: none"> - accept correctly re-arranged versions - accept gradient of a correctly described graph - accept versions of equations where $u = 0$ has already been included. <p>e.g. $s = \frac{1}{2}at^2$</p> <p>MP1-2 could be described for the falling mass, as acceleration is the same</p>	5
1 (b)(i)	<ul style="list-style-type: none"> • (0.98, 2.8) and (0.78, 2.4) plotted correctly (1) • Straight line of best fit with a positive y-axis intercept (1) Or curve of best fit (passing through origin) <div style="display: flex; justify-content: space-around;">   </div>	2
1 (b)(ii)	<ul style="list-style-type: none"> • (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(c)	<ul style="list-style-type: none"> • Masses removed from the hanger are placed on the glider Or masses removed from the glider are placed on the hanger 	1
Total for question 1		9

Question Number	Answer	Mark										
2(a)(i)	<ul style="list-style-type: none">Normal drawn and critical angle indicated	(1) 1										
2(a)(ii)	<ul style="list-style-type: none">Use of $\sin C = \frac{1}{n}$ with their measured value of CRefractive index = 1.58 to 1.70 <table border="1"><thead><tr><th>$C / ^\circ$</th><th>n</th></tr></thead><tbody><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></tbody></table> <p>MP1 accept correct use of $n_1 \sin \theta_1 = n_2 \sin \theta_2$, with $n_2 = 1$ and $\theta_2 = 90^\circ$</p> <p><u>Example calculation</u> $C = 38^\circ$ $\sin 38^\circ = \frac{1}{n}$ $n = 1.62$</p>	$C / ^\circ$	n	36	1.70	37	1.66	38	1.62	39	1.59	(1) (1) 2
$C / ^\circ$	n											
36	1.70											
37	1.66											
38	1.62											
39	1.59											
2(b)	<ul style="list-style-type: none">Use of $\sin C = \frac{1}{n}$ with either 40.5° or 41.5°Range of refractive index calculated <p><u>Example calculation</u> $\sin 40.5^\circ = \frac{1}{n}$ $n = 1.54$ $\sin 41.5^\circ = \frac{1}{n}$ $n = 1.51$ $1.51 \leq n \leq 1.54$</p>	(1) (1) 2										
2(c)	<ul style="list-style-type: none">Use of $n_1 \sin \theta_1 = n_2 \sin \theta_2$Refractive index = 1.53Comparative statement consistent with the range from (b) <p><u>Example calculation</u> $\sin 64 = n \sin 36$ $n = 1.53$</p>	(1) (1) (1) 3										
2(d)	<ul style="list-style-type: none">The monochromatic light has a single wavelength/frequency Or White light is a mixture/range of wavelengths/frequenciesThe different wavelengths/colours would refract by different angles Or different wavelengths/colours would have different refractive indexesMonochromatic 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>	(1) (1) (1) 3										
2(e)	<ul style="list-style-type: none">Angle resolution of 0.1° compared to protractor resolution of 1°Beam from the collimator is <u>narrower</u> (than the ray from a ray box)So, uncertainty in angle (of refraction) is smaller <p>For MP1 – accept descriptions of protractor with resolution 0.5° For MP3 – must be clear the uncertainty is for the angle measurement</p>	(1) (1) (1) 3										
Total for question 2		14										

Question Number	Answer	Mark
3(a)	<ul style="list-style-type: none"> • 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) <p>MP2-5 could be awarded for information shown on the diagram (e.g. metre rule and set squares seen on the diagram).</p> <p>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.</p>	5
3(b)	<ul style="list-style-type: none"> • 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) <p>MP1 and 2 Accept calculation of area under both curves which are then subtracted</p> <p><u>Example calculation</u> 77 squares counted Energy of 1 square = $0.5 \text{ N} \times 0.025 \text{ m} = 0.0125 \text{ J}$ Energy transferred = $77 \times 0.0125 \text{ J} = 0.96 \text{ J}$</p>	3
Total for question 3		8

Question Number	Answer	Mark
4(a)	<ul style="list-style-type: none"> Percentage uncertainty = 2.4% (accept 2%, 2.38%, 2.381%) (1) <p><u>Example Calculation</u></p> <p>Percentage uncertainty = $\frac{0.25}{10.5} \times 100\%$</p> <p>Percentage uncertainty = 2.4%</p>	1
4(b)	<p>Max 3 from</p> <ul style="list-style-type: none"> (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 (1) 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)	<ul style="list-style-type: none">Inconsistent number of decimal places for resistance Or resistance should be to 3 d.p. (to match ohmmeter resolution) (1)Inconsistent intervals in temperature Or large jump in temperature from 38 to 55 °C (1)	2														
5(b)	<ul style="list-style-type: none">Labels axes with quantities and units (1)Sensible scales (1)Plotting (2)Line of best fit (1) <div><table data-bbox="1032 665 1311 956"><thead><tr><th>$T / ^\circ\text{C}$</th><th>R / Ω</th></tr></thead><tbody><tr><td>69</td><td>0.347</td></tr><tr><td>62</td><td>0.34</td></tr><tr><td>55</td><td>0.331</td></tr><tr><td>38</td><td>0.312</td></tr><tr><td>33</td><td>0.31</td></tr><tr><td>22</td><td>0.294</td></tr></tbody></table></div>	$T / ^\circ\text{C}$	R / Ω	69	0.347	62	0.34	55	0.331	38	0.312	33	0.31	22	0.294	5
$T / ^\circ\text{C}$	R / Ω															
69	0.347															
62	0.34															
55	0.331															
38	0.312															
33	0.31															
22	0.294															
5(c)	<ul style="list-style-type: none">Extends line to y-axis intercept (1)Correct R_0 for the line drawn (1)Calculates gradient using large triangle (1)Use of gradient = αR_0 (1)$\alpha = 4.0 \times 10^{-3}$ to $4.2 \times 10^{-3} \text{ } (^{\circ}\text{C}^{-1})$ (1)Value of α to 2 or 3 sig fig and with correct units $^{\circ}\text{C}^{-1}$ (1) <p>For MP5 – accept a correct calculation using the given value for R_0 and gradient.</p> <p>For MP1 – 5 accept calculation of y-axis intercept using gradient or use of simultaneous equations for 2 pairs of points on the line.</p> <p><u>Example calculation</u> Gradient = $(0.348 - 0.282) / (70 - 10) = 0.0011 \text{ } \Omega \text{ } ^{\circ}\text{C}^{-1}$ α = gradient / R_0 = $0.0011 / 0.271 = 4.1 \times 10^{-3} \text{ } ^{\circ}\text{C}^{-1}$</p>	6														

5(d)	<ul style="list-style-type: none"> • Realistic modification suggested (1) • Explains how this improves the accuracy of the values (1) <p><u>Examples</u></p> <ul style="list-style-type: none"> • 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 <p>Ignore higher resolution for a digital thermometer.</p>	2
	Total for question 5	15