



# Mark Scheme (Results)

January 2024

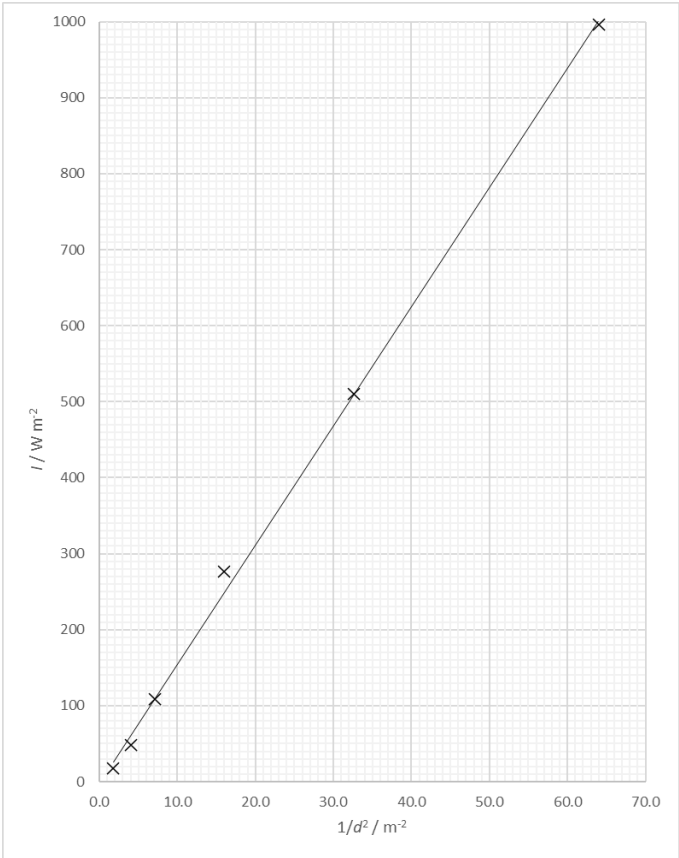
Pearson Edexcel International Advanced  
Subsidiary Level In Physics (WPH13)  
Paper 01: Practical Skills in Physics I

Question Number	Answer	Mark
1(a)(i)	<ul style="list-style-type: none"> <li>0.001 kg (accept 1 g)</li> </ul>	1
1(a)(ii)	<ul style="list-style-type: none"> <li>Use of percentage uncertainty = (half) resolution / measurement <math>\times</math> 100% (1)</li> <li>Percentage uncertainty = 0.024% (1)</li> <li>(e.c.f. from 1(a)(i))</li> </ul> <p>Use of full resolution scores 1 mark only, if percentage uncertainty is correct.</p> <p><u>Example of calculation</u></p> <p>Percentage uncertainty = <math>0.0005 \text{ kg} / 2.070 \text{ kg} \times 100\% = 0.024\%</math></p>	2
1(b)	<p><b>EITHER</b></p> <ul style="list-style-type: none"> <li>Check for zero error (1)</li> <li>(Correct the value) to eliminate <u>systematic error</u> (1)</li> </ul> <p>MP2 dependent on MP1</p> <p><b>OR</b></p> <ul style="list-style-type: none"> <li>Repeat measurement in different places and calculate a mean (1)</li> <li>To reduce the effects of <u>random error</u> (1)</li> </ul> <p>MP2 dependent on MP1</p> <p><b>OR</b></p> <ul style="list-style-type: none"> <li>Do not use excessive force when tightening the jaws</li> <li>As this could introduce a <u>random error</u></li> </ul> <p>MP2 dependent on MP1</p>	2
1(c)(i)	<ul style="list-style-type: none"> <li>Use of <math>\rho = \frac{m}{V}</math> (1)</li> <li>Density = <math>0.777 \text{ (g cm}^{-3}\text{)}</math> rounded to 3 s.f. (1)</li> </ul> <p><u>Example of calculation</u></p> <p>Density = <math>\frac{2070 \text{ g}}{21 \text{ cm} \times 4.27 \text{ cm} \times 29.7 \text{ cm}} = 0.777 \text{ (g cm}^{-3}\text{)}</math></p>	2
1(c)(ii)	<p><b>EITHER</b></p> <ul style="list-style-type: none"> <li>The measurements (of thickness and mass) are larger (1)</li> <li>So, the <u>percentage</u> uncertainty is smaller (for the same uncertainty) (1)</li> </ul> <p>MP2 dependent on MP1</p> <p><b>OR</b></p> <ul style="list-style-type: none"> <li>For a single sheet, the measurements (of thickness and mass) are smaller</li> <li><b>Or</b> for a single sheet, the measurement (of thickness and mass) is too small (1)</li> <li>So, the <u>percentage</u> uncertainty is larger (for the same uncertainty) (1)</li> </ul> <p>MP2 dependent on MP1</p>	2
<b>Total for question 1</b>		<b>9</b>

Question Number	Answer	Mark
2(a)	<ul style="list-style-type: none"> <li>Diagram includes battery (accept cell), switch, ammeter and voltmeter (1)</li> <li>Ammeter in series and voltmeter in parallel with motor (1)</li> </ul> <p>(Accept voltmeter in parallel with the battery if no other resistance components are added)</p> <p><u>Examples of suitable diagrams</u></p>	2
2(b)(i)	<ul style="list-style-type: none"> <li>Clamp/fix the metre rule in position (1)</li> <li>Ensure the metre rule is vertical using a set square (1)</li> <li>Place the metre rule close to the mass</li> <li><b>Or</b> read the height from bottom of the mass</li> <li><b>Or</b> attach a marker to the mass (1)</li> <li>Take measurements perpendicular to the scale, e.g. using set square (1)</li> </ul>	4
2(b)(ii)	<ul style="list-style-type: none"> <li>Random error will cause variation/anomalies in the values (accept suitable examples of random error e.g. reaction time, parallax error when measuring height) (1)</li> <li>(Repeat readings) allow a mean to be calculated to give a (more) accurate value (1)</li> </ul>	2
2(c)	<p><b>EITHER</b></p> <ul style="list-style-type: none"> <li>power input = <math>VI</math> <b>Or</b> power of motor = <math>VI</math> (1)</li> <li>useful power output = <math>mgh / t</math> <b>Or</b> power of lifting mass = <math>mgh / t</math> (1)</li> </ul> <p>(accept power of lifting mass = <math>Fv</math> <b>and</b> <math>F = mg</math> and <math>v = h/t</math>) (1)</p> <ul style="list-style-type: none"> <li>efficiency = power of lifting mass / power of motor (1)</li> <li><b>Or</b> efficiency = <math>(mgh / t) / (VI)</math> (1)</li> </ul> <p>(accept efficiency = useful power output / power input, if quantities defined)</p> <p>MP3 dependent on MP1 <b>and</b> MP2</p> <p><b>OR</b></p> <ul style="list-style-type: none"> <li>energy input = <math>VI t</math> <b>Or</b> energy transferred to motor = <math>VI t</math> (1)</li> <li>useful energy output = <math>mgh</math> (1)</li> <li><b>Or</b> energy transferred to lifting mass = <math>mgh</math> (1)</li> </ul> <p>(accept energy transferred to lifting mass = <math>Fh</math> <b>and</b> <math>F = mg</math>) (1)</p> <ul style="list-style-type: none"> <li>efficiency = energy transferred to lifting mass / energy transferred to motor (1)</li> <li><b>Or</b> efficiency = <math>(mgh) / (VI t)</math> (1)</li> </ul> <p>(accept efficiency = useful energy output / energy input, if quantities defined)</p> <p>MP3 dependent on MP1 <b>and</b> MP2</p>	3
<b>Total for question 2</b>		<b>11</b>

Question Number	Answer	Mark
3(a)	<ul style="list-style-type: none"> <li>Laser light may cause damage/irritation to the eye <b>Or</b> laser light may temporarily dazzle the student (1)</li> <li>Do not look (directly) into the laser beam <b>Or</b> stand behind the laser <b>Or</b> wear dark lens safety glasses (accept light absorbing glasses) <b>Or</b> avoid reflective surfaces (1)</li> </ul>	2
3(b)(i)	<b>EITHER</b> (1) <ul style="list-style-type: none"> <li>Measure the distance between the centres of (adjacent) minima (1)</li> <li>Repeat for different pairs (of adjacent minima) and calculate a mean value</li> </ul> <b>OR</b> (1) <ul style="list-style-type: none"> <li>Measure the distance between the centres of multiple minima (1)</li> <li>Divide the distance by the number of gaps between minima</li> </ul>	2
3(b)(ii)	<b>EITHER</b> (1) <ul style="list-style-type: none"> <li>Increase the distance between the hair and the screen <b>Or</b> use a laser with a longer wavelength (1)</li> <li>As this will increase the separation between minima MP2 dependent on MP1</li> </ul> <b>OR</b> <ul style="list-style-type: none"> <li>Use a measuring device with a higher resolution (accept named device e.g., vernier caliper) (1)</li> <li>As this will reduce the uncertainty in the measurement (1)</li> <li>MP2 dependent on MP1</li> </ul>	2
3(c)(i)	<ul style="list-style-type: none"> <li>Calculation of mean (1)</li> <li>Mean value of <math>d = 79.2 \text{ (}\mu\text{m)}</math> rounded to 3 s.f. (1)</li> </ul> <u>Example of calculation</u> Mean value of $d = \frac{76 + 84.4 + 77.1}{3} = 79.2 \text{ }\mu\text{m}$	2
3(c)(ii)	<ul style="list-style-type: none"> <li>Use of half range for uncertainty (accept difference to furthest from the mean) (1)</li> <li>Percentage uncertainty = 5.3% (furthest from the mean gives 6.5%) (1) (e.c.f. from 3(c)(i) for both value and range)</li> </ul> <u>Example of calculation</u> Uncertainty = half range = $\frac{84.4 - 76}{2} = 4.2 \text{ }\mu\text{m}$ Percentage uncertainty = $\frac{4.2}{79.2} \times 100 = 5.3\%$	2
3(d)	<b>EITHER</b> (1) <ul style="list-style-type: none"> <li>Upper limit = 192 MPa (1)</li> <li>The upper limit is below 210 MPa so the suggestion is <b>not</b> correct MP2 dependent on MP1</li> </ul> <b>OR</b> <ul style="list-style-type: none"> <li>Percentage difference = 14%</li> <li>As the percentage difference is greater than 6%, the suggestion is <b>not</b> correct MP2 dependent on MP1</li> </ul> <u>Example of calculation</u> (1) Upper limit = $181 \times 1.06 = 192 \text{ MPa}$ (1)	2
<b>Total for question 3</b>		<b>12</b>

Question Number	Answer	Mark
4(a)	<p><b>MAX 4 (FROM ONLY 2 PAIRS)</b></p> <ul style="list-style-type: none"> <li>• Cannot measure to the centre of the filament bulb (1)</li> <li>• So, measure the diameter of bulb separately and add the radius to the measurement of <math>d</math> (1)</li> <li>• Parallax error when measuring <math>d</math> (using the metre rule) (1)</li> <li>• Use a set square between the ruler and the sensor/bulb (1)</li> <li>• <b>Or</b> ensure eyes are perpendicular to the metre rule when taking measurements (1)</li> <li>• Background light will affect the readings on the light meter (1)</li> <li>• So, conduct the investigation in a dark room (1)</li> <li>• <b>Or</b> cover the apparatus to block background light (1)</li> <li>• <b>Or</b> measure and subtract the intensity of the background light (1)</li> </ul>	4
4(b)(i)	<p><b>EITHER</b></p> <ul style="list-style-type: none"> <li>• <math>I = k \frac{1}{d^2}</math> is in the form <math>y = mx</math> (1)</li> <li>• So, the gradient is <math>k</math> which is a constant (1)</li> </ul> <p><b>OR</b></p> <ul style="list-style-type: none"> <li>• <math>I = k \frac{1}{d^2}</math> is in the form <math>y = mx + c</math> (1)</li> <li>• So, the gradient is <math>k</math> which is a constant and there is no value for <math>c</math> (1)</li> </ul>	2

4(b)(ii)	<ul style="list-style-type: none"> <li>Correct values of <math>\frac{1}{d^2}</math></li> <li>... rounded to 3 s.f.</li> </ul> <table border="1" data-bbox="459 255 1106 600"> <thead> <tr> <th><math>d / \text{m}</math></th><th><math>I / \text{W m}^{-2}</math></th><th><math>\frac{1}{d^2} / \text{m}^{-2}</math></th></tr> </thead> <tbody> <tr><td>0.125</td><td>996</td><td>64.0</td></tr> <tr><td>0.175</td><td>510</td><td>32.7</td></tr> <tr><td>0.250</td><td>276</td><td>16.0</td></tr> <tr><td>0.375</td><td>109</td><td>7.11</td></tr> <tr><td>0.500</td><td>48</td><td>4.00</td></tr> <tr><td>0.750</td><td>18</td><td>1.78</td></tr> </tbody> </table>	$d / \text{m}$	$I / \text{W m}^{-2}$	$\frac{1}{d^2} / \text{m}^{-2}$	0.125	996	64.0	0.175	510	32.7	0.250	276	16.0	0.375	109	7.11	0.500	48	4.00	0.750	18	1.78	(1) (1) 2
$d / \text{m}$	$I / \text{W m}^{-2}$	$\frac{1}{d^2} / \text{m}^{-2}$																					
0.125	996	64.0																					
0.175	510	32.7																					
0.250	276	16.0																					
0.375	109	7.11																					
0.500	48	4.00																					
0.750	18	1.78																					
4(b)(iii)	<ul style="list-style-type: none"> <li>Labels axes with quantities and units</li> <li>Sensible scales</li> <li>Plotting</li> <li>Line of best fit</li> </ul> 	(1) (1) (2) (1) 5																					
4(b)(iv)	<ul style="list-style-type: none"> <li>Calculates gradient using large triangle</li> <li><math>k</math> between 15.4 and 16.1</li> <li><math>k</math> given to 2 or 3 s.f. <b>and</b> correct unit (W)</li> </ul> <p><u>Example of calculation</u></p> $k = \text{gradient} = \frac{940 - 200}{60 - 13} = 15.7 \text{ W}$	(1) (1) (1) 3																					
4(b)(v)	<ul style="list-style-type: none"> <li>Use of <math>I = \frac{k}{d^2}</math></li> <li><math>d</math> between 1.96 m and 2.01 m given to 2 or 3 s.f. (allow e.c.f. from 4(b)(iv))</li> </ul> <p><u>Example of calculation</u></p> $d^2 = \frac{15.7}{(8 - 4)} = 3.93$ $d = \sqrt{3.93} = 1.98 \text{ m}$	(1) (1) 2																					
Total for question 4		18																					