

**Paper 2 (4PH1/2P)**

Question number	Answer	Additional guidance	Mark
<b>1(a)(i)</b>	Acceleration = change in velocity ÷ time taken	allow in words or acceptable symbols	<b>1</b>

Question number	Answer	Additional guidance	Mark
<b>1(a)(ii)</b>	Process includes: <ul style="list-style-type: none"> <li>• substitution</li> <li>• evaluation</li> <li>• unit</li> </ul> e.g. acceleration = $46/0.20$ (1) acceleration = 230 (1) unit = $\text{m/s}^2$ (1)	mark independently	<b>3</b>

Question number	Answer	Additional guidance	Mark
<b>1(b)(i)</b>	Momentum = mass × velocity	allow in words or acceptable symbols e.g. $p = m \times v$	<b>1</b>

Question number	Answer	Additional guidance	Mark
<b>1(b)(ii)</b>	Process includes: <ul style="list-style-type: none"> <li>• conversion of mass to kg</li> <li>• substitution</li> <li>• evaluation</li> </ul> e.g. 0.057 kg seen anywhere (1) ( $p =$ ) $0.057 \times 46$ (1) ( $p =$ ) 2.6 (kg m/s)(1)	2622 gains 2 marks allow 2.622	<b>3</b>

Question number	Answer	Mark
<b>1(c)</b>	An explanation that makes reference to three of the following points: <ul style="list-style-type: none"> <li>• increase impact time (1)</li> <li>• (for) same change of momentum (1)</li> <li>• reference to force = change of momentum/time (1)</li> <li>• reduces force (1)</li> </ul>	<b>3</b>

**Total for Question 1 = 11 marks**

Question number	Answer	Additional guidance	Mark
2(a)	Idea of friction (between particles)	allow rubbing	1

Question number	Answer	Additional guidance	Mark
2(b)	An explanation linking: <ul style="list-style-type: none"> <li>electrons in the ground (1)</li> <li>are repelled from the surface layers (1)</li> </ul>	reject for one mark movement of positive charges	2

Question number	Answer	Additional guidance	Mark
2(c)(i)	To remove (or add) electrons from the outer shells/levels of an atom	allow turning (atoms) into ions	1

Question number	Answer	Additional guidance	Mark
2(c)(ii)	Charge = current $\times$ time	allow in words or any rearranged form e.g. $Q = I \times t$	1

Question number	Answer	Additional guidance	Mark
2(c)(iii)	<ul style="list-style-type: none"> <li>Rearrangement</li> <li>Substitution and evaluation</li> </ul> $t = Q/I \text{ (1)}$ $= 15/32\,000$ $= 0.00047 \text{ (s) (1)}$	POT error = -1  award full marks for correct numerical answer without working	2

Question number	Answer	Additional guidance	Mark
2(c)(iv)	Process includes: <ul style="list-style-type: none"> <li>• substitution of <math>V (= IR)</math> into energy equation</li> <li>• substitution</li> <li>• rearrangement</li> <li>• evaluation</li> </ul> $E = QIR \text{ (1)}$ $510 \times 10^6 = 15 \times 32 \times 10^3 \times R \text{ (1)}$ $(R =) \frac{510 \times 10^6}{15 \times 32 \times 10^3} \text{ (1)}$ $1060 \text{ (}\Omega\text{) (1)}$	allow calculation of V from $E = QV$ or $E = VIt$  allow substitution into $V = IR$ allow rearrangement of $V = IR$  1062.5 must see answer to at least 2 significant figures in order to determine that evaluation is correct  some supporting working must be seen with correct answer to receive full marks	<b>4</b>

**Total for Question 2 = 11 marks**

Question number	Answer	Additional guidance	Mark
<b>3(a)(i)</b>	Advantage: any suitable (1) e.g. <ul style="list-style-type: none"> <li>• does not contribute to global warming</li> <li>• wind available in all parts of Earth</li> <li>• can be used on a large or small scale</li> </ul> Disadvantage: any suitable (1) e.g. <ul style="list-style-type: none"> <li>• noisy</li> <li>• visual pollution</li> <li>• harm to (migratory flocks of) birds</li> </ul>	ignore renewable as given in the stem	<b>2</b>

Question number	Answer	Additional guidance	Mark
<b>3(a)(ii)</b>	A description that makes reference to the following three points: <ul style="list-style-type: none"> <li>• no output until 5 m/s (1)</li> <li>• linear increase of output from 5 m/s to 15 m/s (1)</li> <li>• output constant at 0.6 MW for speeds over 15 m/s (1)</li> </ul>	data points must be referenced  allow 1 mark for correct trend without any data references.	<b>3</b>

Question number	Answer	Additional guidance	Mark
<b>3(b)</b>	A description that includes reference to five of the following points: <p>construction:</p> <ul style="list-style-type: none"> <li>• soft iron core (1)</li> <li>• primary coils (1)</li> <li>• secondary coils (1)</li> </ul> <p>operation:</p> <ul style="list-style-type: none"> <li>• lower voltage applied to the primary coils/RA (1)</li> <li>• must be a.c. (1)</li> <li>• number of primary coils &lt; secondary coils (1)</li> <li>• turns ratio of 220 (1)</li> </ul>	may be shown on a labelled diagram	<b>5</b>

**Total for Question 3 = 10 marks**

Question number	Answer	Mark
4(a)	<p>A description that makes reference to three of the following points.</p> <p>For a liquid:</p> <ul style="list-style-type: none"> <li>• molecules closely spaced (1)</li> <li>• molecules slide over one another (1)</li> </ul> <p>For a gas:</p> <ul style="list-style-type: none"> <li>• molecules spread out (1)</li> <li>• molecules move with random motion (1)</li> </ul>	3

Question number	Answer	Additional guidance	Mark
4(b)(i)	<p>Process includes:</p> <ul style="list-style-type: none"> <li>• Conversion of time into seconds substitution into or rearrangement of</li> <li>• <math>P = W/t</math></li> <li>• Evaluation</li> </ul> <p>e.g.  time = 120 seconds (1)  2200 = <math>W/120</math> (1)  <math>W = 260\ 000</math> (joules) (1)</p>	<p>seen anywhere in working</p> <p>allow 264 000  answer of 4400 (joules) gains 2 marks max</p>	3

Question number	Answer	Additional guidance	Mark
4(b)(ii)	<p>Energy transferred = mass × specific heat capacity × change in temperature</p>	<p>equation can be given in words or symbols</p> <p>e.g. <math>\Delta Q = m \times c \times \Delta\theta</math></p> <p>allow <math>E</math> for <math>Q</math>, <math>T</math> for <math>\theta</math></p>	1

Question number	Answer	Additional guidance	Mark
4(b)(iii)	Process includes: <ul style="list-style-type: none"> <li>rearrangement of equation (1)</li> <li>substitution into correct equation (1)</li> <li>evaluation of temperature difference (1)</li> <li>calculation of final temperature (1)</li> </ul> e.g. $264\,000 = 1.1 \times 4200 \times \Delta\theta$ (1) $\Delta\theta = \frac{264\,000}{1.1 \times 4200}$ (1) $(\Delta\theta =) 57$ (°C) (1) final temperature = 77 (°C) (1)	allow ecf from (b)(i)	4

Question number	Answer	Additional guidance	Mark
4(c)(i)	Thermometer	allow temperature sensor AND data logger	1

Question number	Answer	Mark
4(c)(ii)	An explanation that makes reference to the following points: <ul style="list-style-type: none"> <li>actual temperature lower than calculated (1)</li> <li>energy is lost to the surroundings not all the energy is transferred to the water (1)</li> </ul>	2

**Total for Question 4 = 14 marks**

Question number	Answer	Additional guidance	Mark
5(a)(i)	Number of metal discs	allow load	1

Question number	Answer	Additional guidance	Mark
5(a)(ii)	(Soft) iron is a magnetic material	easy to magnetise/demagnetise	1

Question number	Answer	Mark
5(b)(i)	<ul style="list-style-type: none"> <li>• Scale on the <math>y</math>-axis (1)</li> <li>• Both axes labelled with variable and unit (1)</li> <li>• Plotted (1)</li> <li>• Bars drawn (1)</li> </ul>	4

Question number	Answer	Mark
5(b)(ii)	To support the weight of the (soft iron) bar (1)	1

Question number	Answer	Additional guidance	Mark
5(b)(iii)	<p>An explanation that makes reference to three of the following points:</p> <ul style="list-style-type: none"> <li>• repeat and average (1)</li> <li>• repeat anomalous result (1)</li> <li>• use intermediate weights e.g. 1, 3, 5, 7, 9 (1)</li> <li>• extend the range of the results beyond 10 weights (1)</li> <li>• use standard masses (1)</li> </ul>	however expressed	3

**Total for Question 5 = 10 marks**

Question number	Answer	Mark
6(a)(i)	B	1

Question number	Answer	Mark
6(a)(ii)	A	1

Question number	Answer	Mark
6(a)(iii)	A	1

Question number	Answer	Mark
6(a)(iv)	A	1

Question number	Answer	Additional guidance	Mark
6(b)	Any two suitable reasons: e.g. <ul style="list-style-type: none"> <li>• stars are made mostly of hydrogen (1)</li> <li>• helium is formed during fusion (1)</li> <li>• carbon is formed during fusion (1)</li> <li>• hydrogen formed after Big Bang (1)</li> </ul>	do not allow both helium from fusion and carbon from fusion allow helium formed after Big Bang	2

Question number	Answer	Additional guidance	Mark
6(c)(i)	<ul style="list-style-type: none"> <li>• Determination of <math>\lambda_0</math> AND <math>\lambda</math> (1)</li> <li>• Determination of <math>\Delta\lambda</math> (1)</li> </ul> e.g. 760 nm, 655 nm $\Delta\lambda = 105$ (nm)	allow $\pm 5$ nm	2



Question number	Answer	Additional guidance	Mark
6(c)(ii)	Rearrangement of equation $v = \frac{\Delta \lambda}{\lambda_0} \times c \quad (1)$ substitution with correct power for $c$ $v = \frac{3 \times 10^5 \times 10^5}{655} \quad (1)$ evaluation $4.8 \times 10^4 \text{ (km/s)} \quad (1)$	allow ecf from (c)(i)  if the answer is given in m/s, check that the power is $10^7$  award full marks for correct numerical answer without working	<b>3</b>

Question number	Answer	Additional guidance	Mark
6(d)	An explanation that makes reference to the following three points: <ul style="list-style-type: none"> <li>• RHS shows red shift (1)</li> <li>• LHS shows blue shift (1)</li> <li>• the galaxy is spinning (1)</li> </ul>	RHS moving away from the astronomer LHS moving towards the astronomer	<b>3</b>

**Total for Question 6 = 14 marks**

**TOTAL FOR PAPER = 70 MARKS**