

Question number	Answer	Mark
1(a)	D	(1)

Question number	Answer	Mark
1(b)	C	(1)

Question number	Answer	Additional guidance	Mark
1(c)(i)	<p>An explanation that combines identification – application of knowledge (1 mark) and reasoning/justification – application of understanding (1 mark):</p> <ul style="list-style-type: none"> <li>frictional forces increase as more trucks are added (1)</li> </ul> <p>Plus <b>one</b> from:</p> <ul style="list-style-type: none"> <li>hence, in order to keep constant speed, the student must increase the force she applies to <b>Z</b> (1)</li> <li>when <b>Y</b> and <b>Z</b> separate, the frictional forces (to the left) are more than magnetic attraction between <b>Y</b> and <b>Z</b> (1)</li> </ul>		(2)

Question number	Answer	Mark
1(c)(ii)	An answer that combines the following points to provide a plan: <ul style="list-style-type: none"> <li>• use of a Newton meter used horizontally (1)</li> <li>• record largest force observed (1)</li> <li>• repeat readings several times under same conditions (1)</li> </ul>	(3)

Question number	Answer	Mark
1(c)(iii)	An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (1 mark): <ul style="list-style-type: none"> <li>• the applied force must be resolved horizontally to determine the force that separates the engine from the trucks</li> <li>• and since the (size of) the resolved force is always less than the (size of) the actual force then a larger force (applied at an angle) is needed to separate the trucks from the engine</li> </ul>	(2)

Question number	An		Mark
<b>2(a)</b>	substitution into correctly rearranged equation (1) $I = \frac{F}{B} \times l$ $= \frac{0.089}{0.47} \times 0.713$ evaluation to 2 s.f. (1) current = 0.27 (A)	give full marks for correct numerical answer without working	<b>(2)</b>

Question number	Answer	Additional guidance	Mark
2(b)	<p>Any three from:</p> <ul style="list-style-type: none"> <li>• use a higher current as the force depends on the current (1)</li> <li>• use more/stronger/larger range of magnets (1)</li> <li>• use a force meter with smaller range, e.g. 0.00 to 0.01 (1)</li> <li>• use a longer distance from pivot to increase the moment of the force on the wire (1)</li> </ul>	<p>accept voltage for current</p> <p>add variable resistor (in series) with power supply</p> <p>accept use more sensitive force meter</p>	(3)

Question number	Answer	Mark
2(c)	<p>An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (1 mark):</p> <ul style="list-style-type: none"> <li>• if the voltage changes sign, then the current is changing direction</li> <li>• so in Figure 21 the current is a.c. as the voltage is changing sign and in Figure 22 the current is d.c. as the voltage is always positive</li> </ul>	(2)

Question number	Answer	Additional guidance	Mark
2(d)	<p>An explanation that combines identification – understanding (1 mark) and reasoning/justification – understanding (3 marks):</p> <ul style="list-style-type: none"> <li>• the transmission wire carries an alternating current (1)</li> <li>• the force is caused by this current which varies in size and direction (1)</li> <li>• the direction of this force depends on the direction of the current so the direction of the force also changes (1)</li> <li>• the magnitude of this force depends on the magnitude of the current so the magnitude of the force also changes (1)</li> </ul>	<p>allow responses that link the changes in the force to the interaction of the changing field around the wire with the constant field of the Earth</p>	(4)

Question Number	Answer	Acceptable answers	Mark
<b>3(a)(i)</b>	<p>Substitution (1) 2900 = 230 × current</p> <p>Transposition (1) <math>\frac{2900}{230}</math></p> <p>Evaluation (1) 13 (A)</p>	<p>Award full marks for correct answer with no working</p> <p>Allow substitution and transposition in either order</p> <p>Ignore powers of ten errors until evaluation</p> <p>Allow numbers which round up to 13</p>	<b>(3)</b>

Question Number	Answer	Acceptable answers	Mark
<b>3(a)(ii)</b>	<p>Substitution (1) 97 = 2.9 × time × 17</p> <p>Transposition (1) <math>\frac{97}{2.9 \times 17}</math> OR <math>\frac{97}{49.3}</math></p> <p>Evaluation (1) 2.0 (h)</p>	<p>Award full marks for correct answer with no working</p> <p>Allow substitution and transposition in either order</p> <p>Ignore powers of ten errors until evaluation</p> <p>Allow <math>\frac{97}{17} = 5.7</math> for 1 mark</p> <p>Allow numbers which round up to 2.0</p>	<b>(3)</b>

Question Number	Indicative Content	Mark
<b>QWC</b>	<p data-bbox="224 253 321 288"><b>*3(b)</b></p> <p data-bbox="337 253 1317 288">An explanation including some of the following points</p> <ul data-bbox="386 329 1317 901" style="list-style-type: none"> <li>• a current/voltage/emf is induced when there is relative movement between a magnet and a coil of wire</li> <li>• the current is bigger when the movement is faster</li> <li>• the current is alternating/regularly changing direction</li> <li>• the current is zero when the magnet is not moving</li> <li>• points P and R on the graph correspond to the fastest movement of the magnet</li> <li>• the magnet is changing direction at points O, Q, S on the graph (quoting positive and negative current values from graph is sufficient to indicate a change in direction of current on graph)</li> <li>• the magnet is at the top/bottom of its movement at points O, Q, S on the graph</li> <li>• the magnet is not moving at points O, Q, S on the graph</li> </ul> <p data-bbox="386 932 1252 966">IGNORE references to number of turns or stronger magnet</p>	<b>(6)</b>

<b>Level</b>	<b>0</b>	No rewardable content
<b>1</b>	<b>1 - 2</b>	<ul style="list-style-type: none"> <li>a limited explanation linking induced current to idea of <u>movement</u> of magnet OR limited reference linking graph to type of current with no link to model e.g. magnet moving in coil (induces a current) / (magnetic) field lines cut coil OR (the graph shows) an alternating current</li> <li>spelling, punctuation and grammar are used with limited accuracy</li> <li>the answer communicates ideas using simple language and uses limited scientific terminology</li> </ul>
<b>2</b>	<b>3 - 4</b>	<ul style="list-style-type: none"> <li>a simple explanation linking the motion of the magnet to the size/direction of the induced current OR {a limited explanation linking induced current to idea of <u>movement</u> of magnet AND limited reference linking graph to type of current with no link to model} e.g. Magnet moving in the coil induces a current. The faster it moves the bigger the induced current. OR Magnet moving in the coil induces a current. When the magnet changes direction, the current changes direction. OR Magnet moving in the coil induces a current. The graphs shows an alternating current. OR Magnet moving in the coil induces a current. The current is positive at P and negative at R.</li> <li>the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately</li> </ul>
<b>3</b>	<b>5 - 6</b>	<ul style="list-style-type: none"> <li>a detailed explanation linking the motion of the magnet to the size/direction of the induced current AND reference to graph for one factor e.g. Magnet moving in the coil induces a current. The faster it moves the bigger the induced current. The magnet is moving fastest at point P on the graph. OR Magnet moving in the coil induces a current. When the magnet changes direction the current changes direction. At P and R the magnet is moving in opposite directions. OR Magnet moving in the coil induces a current. The current is positive at P and negative at R. The magnet is moving up at P and down at R.</li> <li>the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately</li> <li>spelling, punctuation and grammar are used with few errors</li> </ul>

Total for Question 6 = 12 marks

Question Number	Answer	Acceptable answers	Mark
<b>4(a)(i)</b>	D		<b>(1)</b>

Question Number	Answer	Acceptable answers	Mark
<b>4(a)(ii)</b>	ampere(s), amp(s), A		<b>(1)</b>

Question Number	Answer	Acceptable answers	Mark
<b>4(b)(i)</b>	A description linking magnet (1) (in/near) coil (1)  (magnet/coil) spins/moves/turns (1)	IGNORE handle turns	<b>(3)</b>

Question Number	Answer	Acceptable answers	Mark
<b>4(b)(ii)</b>	Any one from the following:  Increase strength of magnet (1)  Increase number of coils/turns of wire (1)  Increase speed of rotation (1)	add another magnet / move magnets closer  turn handle/magnet/coil faster  IGNORE bigger magnet/coil/ generator / longer wire	<b>(1)</b>



Question Number	Indicative Content	Mark
<b>QWC</b> * )	<p>A comparison including some of the following points</p> <p>Non- renewable sources</p> <ul style="list-style-type: none"> <li>• coal, oil, gas and nuclear</li> <li>• coal, oil, gas are fossil fuels</li> <li>• fossil fuels will run out</li> <li>• fossil fuels burn and produce CO<sub>2</sub></li> <li>• fossil fuels burn to produce atmospheric pollution</li> <li>• CO<sub>2</sub> contributes to global warming</li> <li>• are a more expensive source</li> <li>• Nuclear power stations do not produce CO<sub>2</sub></li> <li>• Nuclear power produces radioactive waste</li> <li>• Radioactive waste is dangerous and difficult to store safely</li> </ul> <p>Renewable resources</p> <ul style="list-style-type: none"> <li>• Wind, waves, solar, biofuels, geothermal and hydroelectric</li> <li>• are a free/cheaper source</li> <li>• The energy source is unreliable</li> <li>• No (net) CO<sub>2</sub> produced</li> <li>• No atmospheric pollution (except biofuels)</li> <li>• Waves and hydroelectric cause environmental changes</li> <li>• Wind farms and solar panels give visual pollution</li> <li>• Wind farms can be built off shore</li> </ul> <p>Comparison</p> <ul style="list-style-type: none"> <li>• Fossil fuel power stations are cheaper to build than wind farms for the same power output</li> <li>• Coal, oil, gas and nuclear fuel will run out, wind, waves and sun will always be available</li> <li>• Fossil fuel power stations produce CO<sub>2</sub> which may increase global warming, renewable energy generators (wind farms) do not</li> <li>• Renewable energy generators have a free/cheaper source of fuel</li> <li>• fossil fuels have to be taken out of the ground</li> <li>• Nuclear power stations produce radioactive waste, which is dangerous, none of the other energy generators do this.</li> <li>• Wind, waves and sun are unreliable sources of energy but fossil and nuclear fuels are always available</li> </ul>	<b>(6)</b>

<b>Level I</b>	<b>0</b>	No rewardable content
<b>1</b>	<b>1 - 2</b>	<ul style="list-style-type: none"> <li>• a limited statement about either renewable or non-renewable e.g. Coal is non-renewable <b>OR</b> renewable energy will not run out <b>OR</b> oil will run out</li> <li>• the answer communicates ideas using simple language and uses limited scientific terminology.</li> <li>• spelling, punctuation and grammar are used with limited accuracy.</li> </ul>
<b>2</b>	<b>3 - 4</b>	<ul style="list-style-type: none"> <li>• a simple comparison including 2 statements covering renewable and non-renewable e.g. Coal is non-renewable and solar power is renewable <b>OR</b> renewable energy sources will not run out and non-renewable sources do not pollute the atmosphere <b>OR</b> oil will run out, solar will not</li> <li>• the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately.</li> <li>• spelling, punctuation and grammar are used with some accuracy.</li> </ul>
<b>3</b>	<b>5 - 6</b>	<ul style="list-style-type: none"> <li>• a detailed comparison including at least 3 statements with a direct comparison between a renewable and a non-renewable source, at least one named e.g. Renewables will not run out but non-renewables like coal will. <b>OR</b> Coal is non-renewable. When it is burnt carbon dioxide is produced. Wind farms do not produce any carbon dioxide. <b>OR</b> Carbon dioxide is produced when coal is used. Wind farms do not produce any carbon dioxide. Wind farms are noisy. <b>OR</b> Oil will run out, solar will not. Oil causes air pollution</li> <li>• the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately.</li> <li>• spelling, punctuation and grammar are used with few errors.</li> </ul>