L-Università ta' Malta

MATSEC
Examinations Board

Marking Scheme

SEC Physics

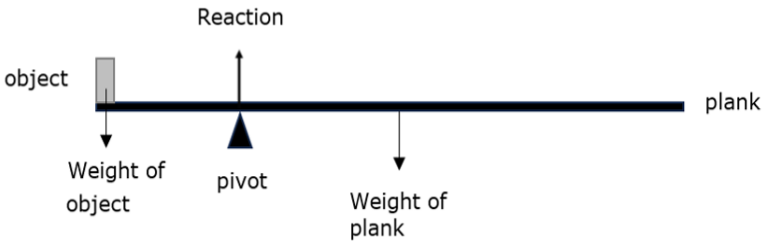
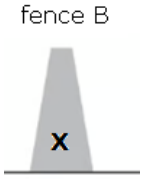
Main Session 2024

Marking schemes published by the MATSEC Examination Board are not intended to be standalone documents. They are an essential resource for markers who are subsequently monitored through a verification process to ensure consistent and accurate application of the marking scheme.

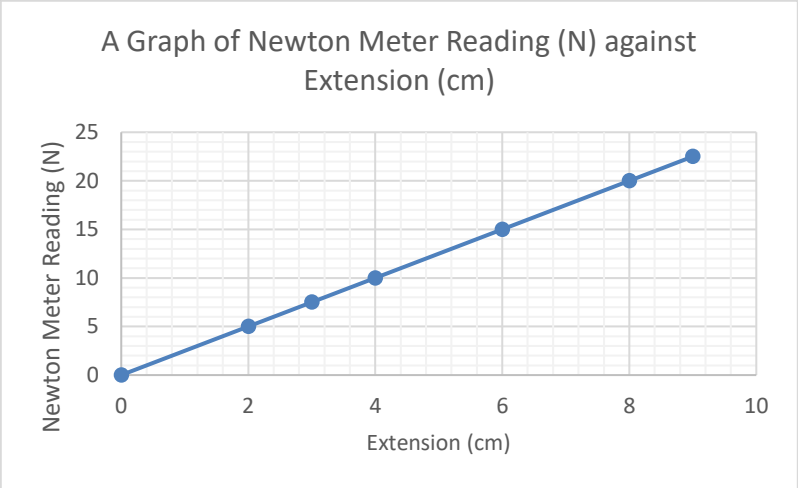
In the case of marking schemes that include model solutions or answers, it should be noted that these are not intended to be exhaustive. Variations and alternatives may also be acceptable. Examiners must consider all answers on their merits, and will have consulted with the MATSEC Examinations Board when in doubt.

PAPER I

Question Number			Suggested Answers	Marks Distribution	Marks
1	a		*Pressure is* the force acting perpendicular on a surface, per unit area. Accept also if 'perpendicular' is not stated.		1
	b		Trapped air is a gas and therefore the particles are far **away from each other**. Particles are **moving haphazardly and at a fast speed**, colliding with each other and with the walls of the tube.	1 1	2
	c	i	X: **L**; Y: **K**; Z: **J**		1
		ii	The **air is trapped and the flexible pipe is sealed** thus, no change in mass since **no particles are being added/removed**.	1 1	2
	d		$P = h\rho g$ $P = 0.75 \times 1000 \times 10$ $P = 7500\ Pa$	1 1	2
	e		**Pressure of the trapped air increases**. Heat energy of the water is transferred to trapped air, which **makes the air particles to move faster, colliding more frequently increasing pressure**.	1 1	2
				Total:	**10**
2	a		gradient of graph = $\frac{\text{change in y}}{\text{change in x}}$ $= \frac{75-0}{2-0}$ = 37.5 m/s^2 (Accept any other method)	1 1	**2**
	b		area under graph = ½ bh $= \frac{75 \times 2}{2}$ = 75 m (Accept any other method)	1 1	2
	c		mv at A – mv at rest = (10000 x 75) – (10000 x 0) = 750 000 kgm/s	1 1	2
	d		force = momentum change /time = 750 000/2 = 375 000 N	1 1	2
	e		inertia the aircraft starts to move while the pilot is still at rest	1 1	2
				Total:	**10**

3	a			1 mark for each arrow and label	3
	b		If the wooden plank is in equilibrium, the total clockwise moment is **equal** to the total anti-clockwise moment.		1
	c		$Total\ Clockwise\ Moment = Force\ \times perpendicular\ distance$ $Total\ Clockwise\ Moment = 50\ \times 0.6$ $Total\ Clockwise\ Moment = 30\ Nm$		2
	d		$Total\ Anti-Clockwise\ Moment$ $= Force\ \times perpendicular\ distance$ $30 = F\ \times 0.4$ $F = \frac{30}{0.4} = 75\ N$ $W = m\ g$ $75 = m\ \times 10$ $m = 7.5\ kg$	2 1	3
	e		No changes since the distance from the pivot is zero. No turning effect.		1
				Total:	**10**
4	a		Tension		1
	b		Friction Arrow at ground level pointing in the opposite direction of movement.		2
	c	i	2500 N		1
		ii	Zero		1
		iii	Newton's 1st law An object will remain at rest or keep moving at constant velocity provided that no external force acts on it.	1 1	2
	d	i	 . X to be showing a lower centre of gravity		1
		ii	B is more stable It has a wider base so a lower centre of gravity.		2
				Total:	**10**

<table>
<tr><td>5</td><td>a</td><td></td><td>
<table>
<tr><td>U (cm)</td><td>10</td><td>10</td><td>10</td><td>10</td><td>10</td><td>10</td><td>10</td></tr>
<tr><td>L (cm)</td><td>40</td><td>42</td><td>43</td><td>44</td><td>46</td><td>48</td><td>49</td></tr>
<tr><td>Helical Spring Length (cm)</td><td>12</td><td>14</td><td>15</td><td>16</td><td>18</td><td>20</td><td>21</td></tr>
<tr><td>Extension (cm)</td><td>0</td><td>2</td><td>3</td><td>4</td><td>6</td><td>8</td><td>9</td></tr>
<tr><td>Newton Meter Reading (N)</td><td>0</td><td>5.0</td><td>7.5</td><td>10.0</td><td>15.0</td><td>20.0</td><td>22.5</td></tr>
</table>
</td><td>2 marks for helical spring

1 mark for extension</td><td>3</td></tr>
<tr><td></td><td>b</td><td></td><td> 
</td><td></td><td>4</td></tr>
<tr><td></td><td>c</td><td></td><td>The helical spring <u>extends proportionally to the force applied</u>,provided the <u>elastic limit is not exceeded</u>.
Accept also that the spring obeys Hooke’s law provided the elastic limit is not exceeded.</td><td></td><td>2</td></tr>
<tr><td></td><td>d</td><td></td><td>When using a stiffer spring, the values for the extension are smaller.</td><td></td><td>1</td></tr>
<tr><td colspan="5"></td><td>Total:</td><td>10</td></tr>
<tr><td>6</td><td>a</td><td>i</td><td>Two rays drawn correctly from O with arrows
and reflected by mirror, seemingly coming from I.</td><td>1
1</td><td>2</td></tr>
<tr><td></td><td></td><td>ii</td><td>Normal drawn at 90° to mirror.
Angles i and r correctly labeled.</td><td>1
1</td><td>2</td></tr>
<tr><td></td><td></td><td>iii</td><td>Any 2 from same size as O, upright, <u>laterally</u> inverted, equal distances of O and I from mirror.</td><td></td><td>2</td></tr>
<tr><td></td><td>b</td><td>i</td><td>Refraction.</td><td></td><td>1</td></tr>
<tr><td></td><td></td><td>ii</td><td>Angle i inside > critical angle.
Total internal reflection occurs.</td><td>1
1</td><td>2</td></tr>
<tr><td></td><td></td><td>iii</td><td>Any valid answer, e.g. in telecommunications</td><td></td><td>1</td></tr>
<tr><td colspan="5"></td><td>Total:</td><td>10</td></tr>
<tr><td>7</td><td>a</td><td></td><td>The planets are rotating around the Earth instead of the Sun.</td><td></td><td>1</td></tr>
<tr><td></td><td>b</td><td></td><td>Telescope or radio telescope.</td><td></td><td>1</td></tr>
<tr><td></td><td>c</td><td></td><td>Gravitational force/ force of gravity.</td><td></td><td>1</td></tr>
</table>

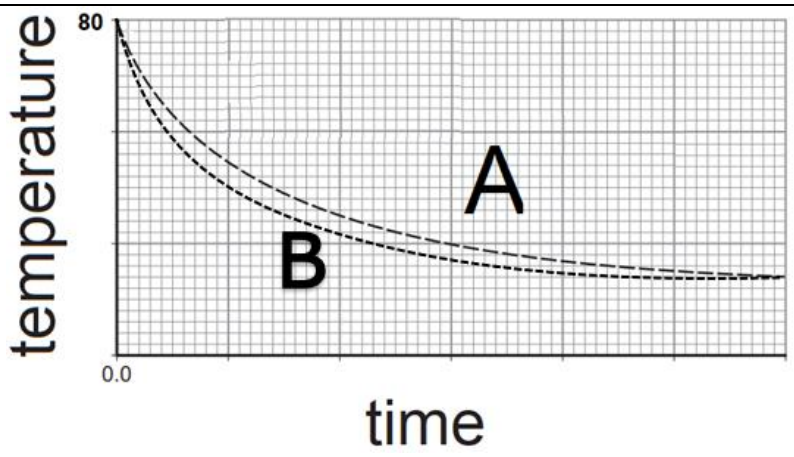
	d		Uranus, **Saturn** and Neptune.		2
	e	i	The distance travelled by light in 1 year.		1
		ii	$1.5 \times 10^{11} \div 9.46 \times 10^{15}$ $=1.6 \times 10^{-5}$ light years	1 1	2
		iii	Time = s/v $= 1.5 \times 10^{11} \div 3.0 \times 10^{8}$ = 500 s	1 1	2
				Total:	**10**
8	a		They are remains of once living organisms.		1
	b		Any 2 from petrol(gasoline), diesel (oil), gas.		2
	c		Once used they will not be replenished / cannot be reused.		1
	d		Input – chemical Useful output – kinetic Wasted output – heat and sound		1 1 1
	e		Any valid e.g., reducing pollution, dwindling resource, etc.		1
	f		75% of the input energy is available at wheels as kinetic energy.		1
	g		To recharge the car batteries.		1
				Total:	**10**
9	a		Polythene.		1
	b		Electrons, positive, electrons.		3
	c		The hanging rod will move away from the rod which is held. This is because like poles repel.	1 1	2
	d	i	**Friction** between the hose and the fuel might (or between aircraft and air) cause a **transfer of electrons** (or movement of charges) between them leading to a net charge on the fuel and pipes.	1 1	2
		ii	The person refuelling the plane connects a conducting wire from the plane to the ground. **<u>Electrons flow through the wire down to earth (or from earth to plane)</u>**, **<u>discharging the plane</u>** OR **to refuel safely**.	1 1	2
				Total:	**10**
10	a		Gamma.		1
	b		Medical exams that use ionizing radiation include: X-rays. CT or CAT (computed tomography) scans/ absorption of iodine 123 by thyroid gland/sterilisation of equipment.		1
	c	i	Ionising radiation can cause damage to cells resulting in growth of cancer cells.		1

		ii	The badge has 3 <u>filters made up of different materials</u>, to determine the type of radiation. <u>Alpha, beta and gamma is stopped/reduced to a different extent by the different materials</u>. Therefore, the <u>same quantity of radiation incident on the badge will produce a different degree of darkening under each filter</u>.		3
		iii	Due to the presence of background radiation.		1
	d	i	The time taken for half the atoms (or activity) of a radioactive substance to decay.		1
		ii	40mg divided by 2 (6 hours) = 20mg divided by 2 (6 hours) = 10mg. (Accept 25% or 1/4)		2
				Total:	**10**

PAPER 2A

Question Number			Suggested Answers	Marks Distribution	Marks
1	a		$(5.2 \times 10^6) + 2(1.3 \times 10^7) = 3.12 \times 10^7$ N		1
	b		a = F/m = $3.12 \times 10^7 / 2.0 \times 10^6$ = 15.6 m/s^2	1 1	2
	c		$1.7 \times 10^6 / 2 \times 10^6 = 0.85 = 85\%$		1
	d		As fuel is burned, total mass decreases. Acceleration inversely proportional to mass.	1 1	2
	e		Decreases.		1
	f		Resultant force forward increases (Less backward force). Acceleration increases.	1 1	2
	g		KE = $mv^2/2 = 1.0 \times 10^5 \times (7700)^2/2$ = 2.965×10^{12} J	1 1	2
	h		PE = mgh = $1.0 \times 10^5 \times 10 \times 300\,000$ = 3×10^{11} J	2 1	3
	i		$(2.965 \times 10^{12}) + (3 \times 10^{11}) = 3.265 \times 10^{12}$ J		1
	j		To limit the rise in temperature of the shuttle to safe values.		1
	k		Air resistance backwards and labelled (drag). Weight downwards and labelled.	1 1	2
	l		Increase in air resistance. Resultant backward force increases, hence braking occurs in less distance/time.	1 1	2
				Total:	**20**
2	a	i	Transverse – vibrations perpendicular to wave travel direction. Longitudinal – vibrations parallel to wave travel direction.		2
		ii	It increases.		1
		iii	Different wavelength. Same speed in air.		2
	b	i	Sound frequencies above about 20 kHz		1
		ii	Total distance travelled = speed x time = 0.006 x 340 = 2.04 m Hence distance to wall = 2.04/2 = 1.02 m		3
		iii	Much faster speed of radio waves means very short timing intervals.		1
	c	i	Ruler / tape measure.		1

		ii	Distance between hammer knock and microphone.		1
		iii	Measure distance as in (i) above. Hit the hammer against the plate to make the sound. Note the reading of the timer. Use the formula speed = distance measured/time taken.		4
		iv	Any one valid precaution, eg repeat for different distances.		1
	d		Sound travels faster in solids (rock) than in air.		1
	e		No sound is heard in **vacuum** of space (lack of particles) as sound propagation needs a medium.		2
				Total:	**20**
3	a		Black is a good emitter of heat energy.		1
	b		Conduction. Conduction is the flow of heat through matter (without the movement of the matter itself).	1 1	2
	c		Radiation. All objects which have heat energy emit Infra-red (IR) waves.	1 1	2
	d		$Q = m\,c\,\Delta\theta$ $Q = 2 \times 3800 \times 15$ $Q = 114000\ J$ *Accept both positive or negative answers.*	1 1 1	3
	e		The curves increase the surface area of the radiator. (or the water takes a longer path therefore remains in the radiator for a longer time) Thus, more heat can be transferred in the same amount of time.	1 1	2
	f		The 2 beakers are filled in with hot water at 80 °C (from the same source) and covered with the lid, allowing thermometer to be placed in the centre of each. They are then placed at equal distance from the fan one in front and one at the back. The stopwatch and the electric fan are switched on simultaneously. A reading of time and temperature is taken at regular intervals for both thermometers, until both thermometers reach 20°C.		4

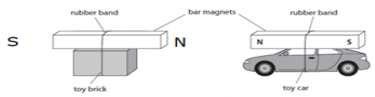
<table>
<tr><td></td><td>g</td><td></td><td> 
</td><td>labelling A and B

labelling axes

correct curve</td><td>3</td></tr>
<tr><td></td><td>h</td><td></td><td>Thermometers can gain heat energy from nearby sources / surroundings.</td><td></td><td>1</td></tr>
<tr><td></td><td>i</td><td></td><td><u>Both thermometers reached room temperature.</u>
Either <u>heat transfer stops</u>, or water in the beakers is in <u>thermal equilibrium</u> with the surroundings.</td><td>1

1</td><td>2</td></tr>
<tr><td colspan="4"></td><td>Total:</td><td>20</td></tr>
<tr><td>4</td><td>a</td><td></td><td>The outside/casing is plastic.
Plastic is an insulator/ the light fitting is double insulated.</td><td>1
1</td><td>2</td></tr>
<tr><td></td><td>b</td><td>i</td><td>As pd increases, temperature and resistance increase.
This reduces the increase of current flow with increasing pd/ as pd increases, the gradient decreases hence R increases.</td><td>1

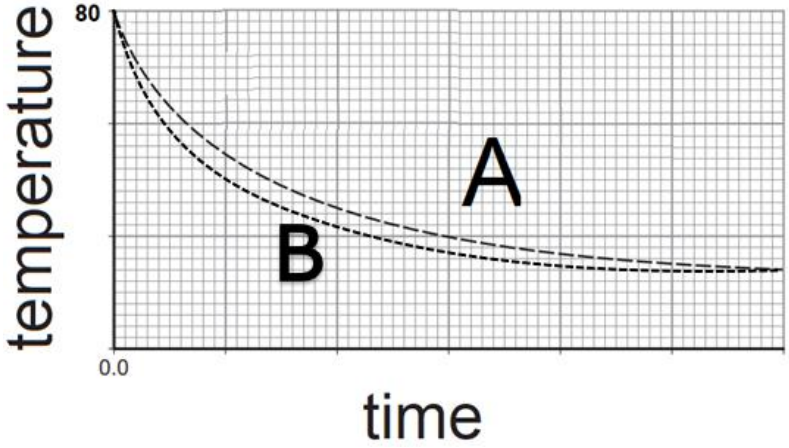
1</td><td>2</td></tr>
<tr><td></td><td></td><td>ii</td><td>Filament lamp.</td><td></td><td>1</td></tr>
<tr><td></td><td>c</td><td>i</td><td>6 V</td><td></td><td>1</td></tr>
<tr><td></td><td></td><td>ii</td><td>R = V/I
= 6/2
= 3 Ω</td><td></td><td>2</td></tr>
<tr><td></td><td></td><td>iii</td><td>3A – 2A = 1A</td><td></td><td>1</td></tr>
<tr><td></td><td></td><td>iv</td><td>R = V/I
= 6/1
= 6 Ω</td><td></td><td>2</td></tr>
<tr><td></td><td></td><td>v</td><td><table>
<tr><th></th><th>Decreases</th><th>Stays the same</th><th>Increases</th></tr>
<tr><td>V across X</td><td></td><td>√</td><td></td></tr>
<tr><td>Current in X</td><td>√</td><td></td><td></td></tr>
<tr><td>Total current</td><td>√</td><td></td><td></td></tr>
</table></td><td></td><td>3</td></tr>
<tr><td></td><td>d</td><td>i</td><td>  </td><td></td><td>1</td></tr>
</table>

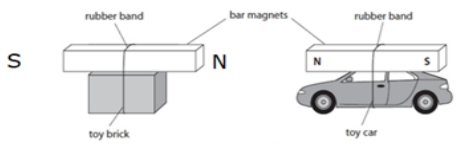
		ii	Use hotter water (than 60 °C). Add ice cubes. Temperature above 60 °C.	1 1	2
		iii	The current increases. Resistance decreases, as the temperature increases. OR The current decreases and resistance increases. Temperature decreases.	1 1	2
		iv	Accept any value between 0.01 A and 0.012 A.		1
				Total:	**20**
5	a	i			1
		ii	The magnetic field of each bar magnet extends only to a certain distance beyond the magnet. So it is only when the cars are moved close together that the magnetic fields interact.	1 1	2
		iii	With one magnet on the toy brick and toy car, she measures, using a metre ruler, the distance at which the toy car experiences a force. She then places two magnets on each toy and again measures the distance at which the car starts to move backwards. The experiment is repeated, each time adding an additional magnet to each toy. The more magnets are placed on each toy, the greater is the distance between the toy brick and the toy car, when the toy car starts to experience a push.	1 1 1 1	4
	b		Steel is a magnetic material while aluminium is not. Steel cans are attracted to the magnet (roller) and are carried further around until they fall by gravity into container B. Aluminium is not attracted to the roller and therefore falls first into container A.	1 2	3
	c	i	Fleming's left-hand rule. It states that if we arrange our thumb, forefinger, and middle finger of the left hand perpendicular to each other, then the thumb points towards the direction of the magnetic force, the forefinger points towards the direction of the magnetic field and the middle finger points towards the direction of the current.	1 2	3

		ii	As the wire between the magnets moves up, the plastic rod moves down. This produces a force on the force meter.	1 1	2
		iii	Increasing the number of pairs of magnets/Increasing the current/Adding more turns to the wire.		3
		iv	The wire between the poles would move down causing the plastic rod to move up. (Award 1 mark even if they only mention that the wire moves down). This produces no force on the force meter OR decreases the force on the force meter.	1 1	2
				Total:	**20**

PAPER 2B

Question Number			Suggested Answers	Marks Distribution	Marks
1	a		$(5.2 \times 10^6) + 2(1.3 \times 10^7) = 3.12 \times 10^7$ N		2
	b		a = F/m = $3.12 \times 10^7 / 2.0 \times 10^6$ = 15.6 m/s^2		2
	c	i	Total mass decreases.		1
		ii	Acceleration inversely proportional to mass.		1
	d		Decreases. Decreases. Increase.	1 1 1	3
	e		KE = $mv^2/2 = 1.0 \times 10^5 \times (7700)^2/2$ = 2.965×10^{12} J	2 1	3
	f		PE = mgh = $1.0 \times 10^5 \times 10 \times 300\,000$ = 3×10^{11} J	2 1	3
	g		To limit the rise in temperature of the shuttle to safe values.		1
	h		Air resistance backwards (drag). Weight downwards (W) or force of gravity downwards.	1 1	2
	i		Surface area **increases.** Resultant backward force **increases.**	1 1	2
				Total:	**20**
2	a	i	Transverse – perpendicular. Longitudinal – parallel.	1 1	2
		ii	It increases.		1
		iii	Different wavelength. Same speed in air.	1 1	2
	b	i	30 000 Hz.		1
		ii	No.		1
		iii	Total distance = speed x time = 0.006 x 34 = 2.04 m		2
		iv	Distance to wall = 2.04/2 = 1.02 m.		1
	c	i	Ruler / tape measure.		1
		ii	Distance between hammer knock and microphone.		1
		iii	In order from top 4 – 1 – 3 – 5 – 2.		5
		iv	Speed = distance measured/timer reading.		1
	d		Light travels faster than sound.		1
	e		Sound cannot travel through the vacuum of space OR lack of particles.		1
				Total:	**20**

3	a		good		1
	b		1^{st} and 4^{th}		2
	c		2^{nd} and 3^{rd}		2
	d		$Q = m\,c\,\Delta\theta$ $Q = 2 \times 3800 \times 15$ $Q = 114000\ J$ Accept positive and negative answers		3
	e		Heat energy radiated per second **increases.** The efficiency **increases**.	1 1	2
	f		A reading of time and temperature is taken at regular intervals for both thermometers, until both thermometers reach 20°C. (4) The stopwatch and the electric fan are switched on simultaneously. (3) The 2 beakers are filled in with the same amount of water at 80 °C and covered with the lid, allowing thermometer to be placed in the centre of each. (1) They are then placed at equal distance from the fan one in front and one at the back. (2)		4
	g				3
	h		Temperature of water in beakers might not be uniform throughout. Thermometers can gain heat energy from nearby sources / surroundings. Accept any other relevant answer.		1
	i		Stops. Temperature.	1 1	2
				Total:	**20**
4	a	i	Live -brown Neutral- blue.		2
		ii	Yes,	1 1	2

<table>
<tr><td></td><td></td><td></td><td>the outside/casing is plastic/ plastic is an insulator/ the light fitting is double insulated.</td><td></td><td></td></tr>
<tr><td></td><td></td><td>iii</td><td>Fuse.</td><td></td><td>1</td></tr>
<tr><td></td><td>b</td><td>i</td><td>6 V.</td><td></td><td>1</td></tr>
<tr><td></td><td></td><td>ii</td><td>R = V/I
= 6/2
= 3 Ω</td><td>1
1</td><td>2</td></tr>
<tr><td></td><td></td><td>iii</td><td>3 – 2 = 1 A</td><td></td><td>1</td></tr>
<tr><td></td><td></td><td>iv</td><td>R = V/I
= 6/1
= 6 Ω</td><td>1
1</td><td>2</td></tr>
<tr><td></td><td></td><td>v</td><td>
<table>
<tr><td></td><td>Decreases</td><td>Stays the same</td><td>Increases</td></tr>
<tr><td>Voltage cross X</td><td></td><td>√</td><td></td></tr>
<tr><td>Current in X</td><td>√</td><td></td><td></td></tr>
<tr><td>Total current</td><td>√</td><td></td><td></td></tr>
</table>
</td><td></td><td>3</td></tr>
<tr><td></td><td>c</td><td>i</td><td>
<table>
<tr><td>Set up the circuit as shown in Figure 3</td><td>1</td></tr>
<tr><td>Take readings of the current through the thermistor as the temperature falls.</td><td>3</td></tr>
<tr><td>Plot a graph of Current/A on y axis against Temperature/ °C on x axis.</td><td>5</td></tr>
<tr><td>Pour boiling water into the beaker.</td><td>2</td></tr>
<tr><td>Record how the current varies with temperature.</td><td>4</td></tr>
</table>
</td><td></td><td>4</td></tr>
<tr><td></td><td></td><td>ii</td><td>Resistance will decrease with increasing temperature (or resistance increases when the temperature decreases) current is inversely proportional to resistance.</td><td>1
1</td><td>2</td></tr>
<tr><td colspan="5"></td><td>Total:</td><td>20</td></tr>
<tr><td>5</td><td>a</td><td>i</td><td> 
</td><td></td><td>1</td></tr>
<tr><td></td><td></td><td>ii</td><td>The magnetic field of each bar magnet extends only to a certain distance beyond the magnet. So it is only when the cars are moved close together that the magnetic fields interact.</td><td></td><td>2</td></tr>
<tr><td></td><td></td><td>iii</td><td>Shape of magnetic field (lines must not overlap).
Arrows from N to S.</td><td>1
1</td><td>2</td></tr>
</table>

		iv	She then places two magnets on each toy and again measures the distance at which the car starts to move backwards. 2 The experiment is repeated, each time adding an additional magnet to each toy. 3 With one magnet on the toy brick and toy car, Fiona measures, using a metre ruler, the distance at which the toy car experiences a force. 1	1 1 1	3
		v	As more magnets are placed on each toy, the toy car starts to experience a push when it is further away.		1
	b	i	Steel is a magnetic material while aluminium is not.		1
		ii	Steel cans are attracted to the magnet (roller) and are carried further around until they fall by gravity into container B. Aluminium is not attracted to the roller and therefore falls first into container A.	1 1	2
	c	i	Fleming's left-hand rule.		1
		ii	TRUE FALSE TRUE		3
		iii	Direction of force: Downwards (or reversed). Reading on force meter: a decrease in reading (or no reading).	1 1	2
		iv	Electric fan, drill, vacuum cleaner, etc or any other TWO valid devices.		2
				Total:	**20**