2 (a) A teacher prepares some equipment to demonstrate electromagnetism.
Figure 2 shows the equipment.

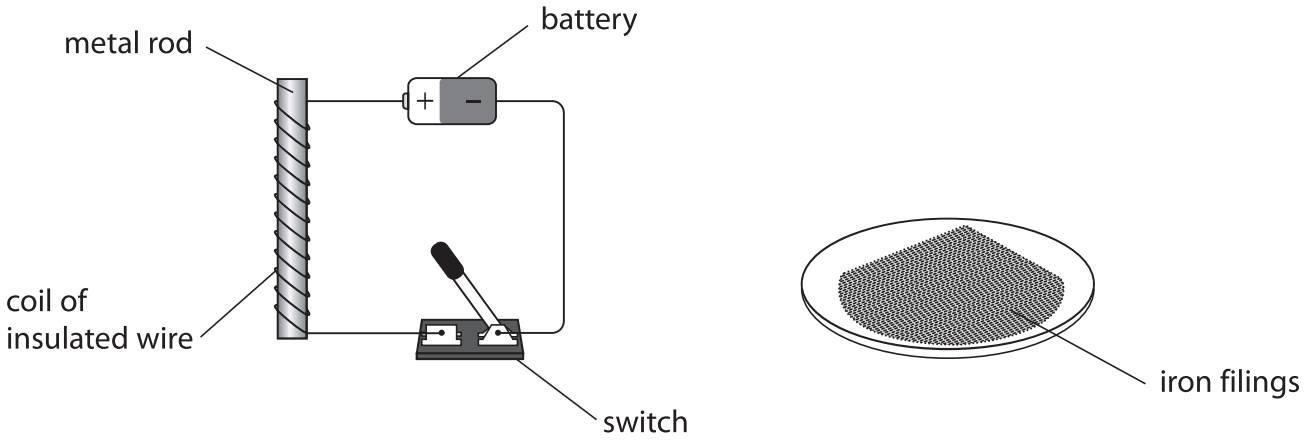


Figure 2

The teacher wants to show that iron filings

- are picked up by the metal rod when the switch is closed
- fall off the metal rod when the switch is opened again.

(i) Suggest a suitable metal for the rod.

(1)

.....

(ii) Give **two** reasons for your choice.

(2)

1 .....

.....

2 .....

.....

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

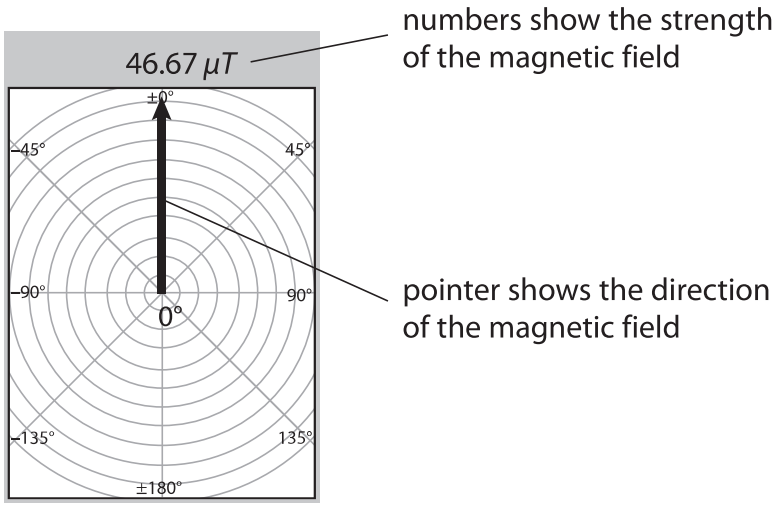
DO NOT WRITE IN THIS AREA

(b) A student's mobile phone has an app to measure a magnetic field.

The student places the phone on a table and rotates the phone until it is pointing north.

There are no magnets near to the phone.

Figure 3 shows the display on the screen of the phone.



(Source: adapted from MGS Lite app for iPhone)

Figure 3

(i) State why the strength of the magnetic field shown is not zero.

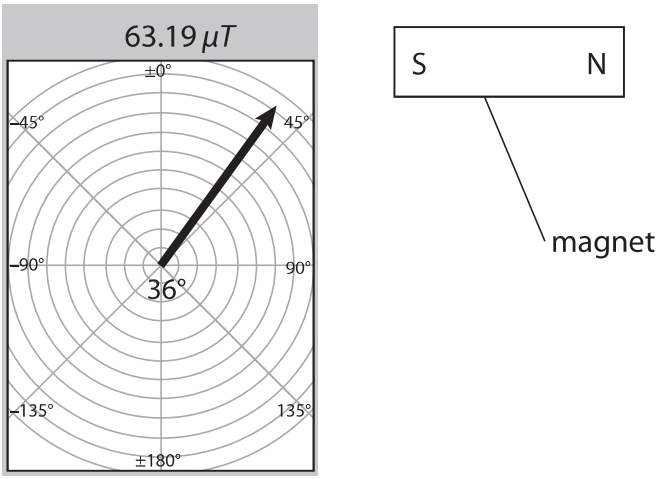
(1)

.....

.....

The student places a magnet near to the phone on the table.

Figure 4 shows the magnet and the new display on the screen.



(Source: adapted from MGS Lite app for iPhone)

Figure 4

(ii) State **two** changes in the magnetic field measured by the phone from Figure 3 to Figure 4.

(2)

1 .....

.....

2 .....

.....

(iii) Describe how the student could use the mobile phone to investigate the strength of the magnetic field at different distances from the magnet.

(3)

.....

.....

.....

.....

.....

(Total for Question 2 = 9 marks)

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DO NOT WRITE IN THIS AREA

4 Three students carry out an investigation to determine their powers when running up stairs.

(a) Figure 7 shows a diagram of the stairs with four distances, A, B, C and D, marked.

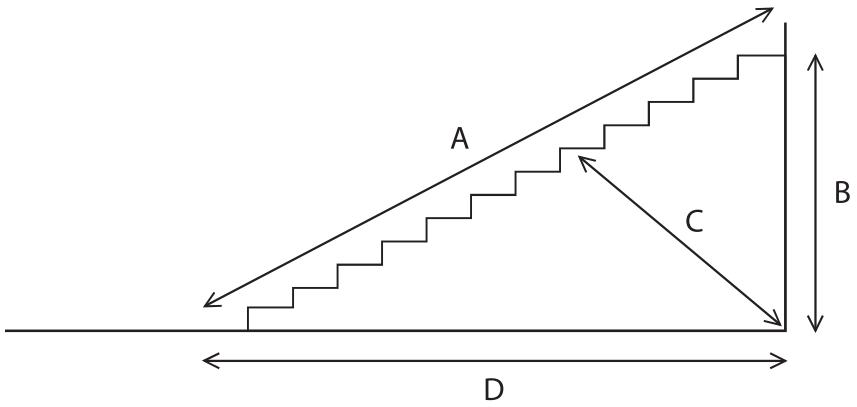


Figure 7

The students need to calculate the work done against gravity.

Which distance should be used in the calculation?

(1)

- ☒ **A** A
- ☒ **B** B
- ☒ **C** C
- ☒ **D** D

(b) They take turns to run up the stairs and use a stopwatch to measure the time taken.

The students estimate their own weight.

Figure 8 shows a table of their results.

The table is not complete.

student	student estimate of weight in N	distance in m	work done	time taken in s	power in W
A	550	4.0	2200	5.0	440
B		4.0	1960	4.5	436
C	510	4.0	2040		425

Figure 8

(i) State the unit for work done.

(1)

unit for work done is .....

(ii) Use the data for student B to calculate his estimated weight.

(2)

weight = ... N

(iii) Use the data for student C to calculate the time she takes.

(2)

time taken = ... s

(iv) Use the data for all three students to calculate the average power of the students.

(2)

average power = ... W

(c) Identify a significant source of error in the investigation and state how this error can be reduced.

(2)

source of error

.....

.....

can be reduced by

.....

.....

(Total for Question 4 = 10 marks)

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

6 (a) When water boils and turns into steam, there are changes in the arrangement of particles and the density.

Which of these shows the changes?

(1)

		space between particles in steam	density of steam
☒	**A**	bigger than in water	greater than water
☒	**B**	bigger than in water	less than water
☒	**C**	smaller than in water	greater than water
☒	**D**	smaller than in water	less than water

(b) Figure 11 shows some water in a measuring cylinder and a lump of iron.

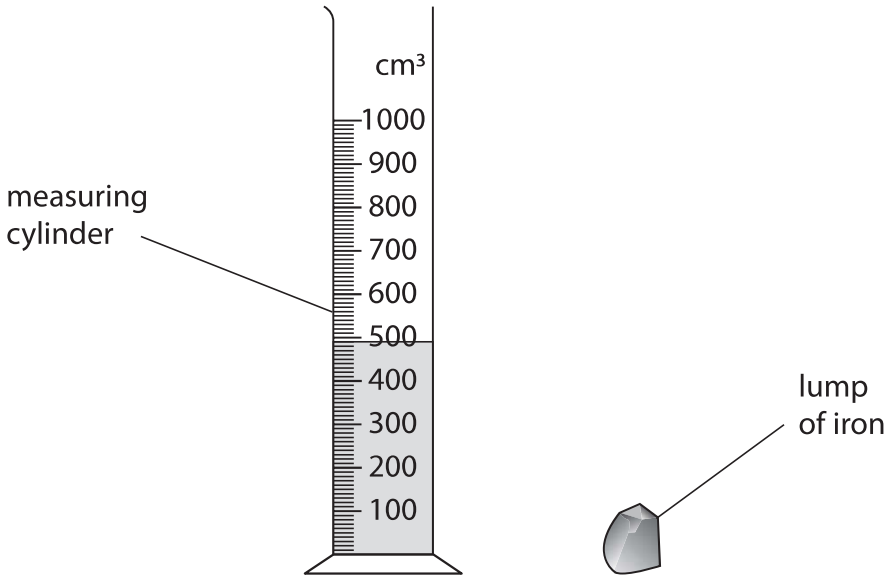


Figure 11

The lump of iron is lowered fully into the water.

The water level in the measuring cylinder rises to 530 cm^3.

The density of iron is 7.9 g / cm^3.

Calculate the mass of the lump of iron.

Use the equation

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

Give your answer to 2 significant figures.

(4)

mass = ... g

(c) A piece of wood has a similar shape and volume to the lump of iron.

The density of the wood is 0.82 g / cm^3.

The density of water is 1.00 g / cm^3

Explain why the method used in part (b) cannot be used to determine the mass of the piece of wood.

(2)

.....

.....

.....

.....

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

*(d) A student needs to determine the specific heat capacity of water.

Figure 12 shows some of the equipment the student uses.

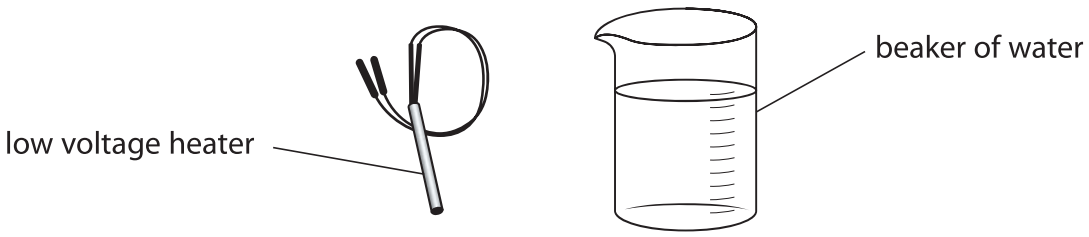


Figure 12

Describe the method the student should use to determine the specific heat capacity of water.

Your description should include, with reasons,

- any other equipment needed
- the measurements needed.

You may draw a diagram if it helps your answer.

(6)

(Total for Question 6 = 13 marks)

TOTAL FOR PAPER = 60 MARKS

2 (a) Figure 3 shows some objects and words describing these objects.

Draw one line from each object to its description.

(2)

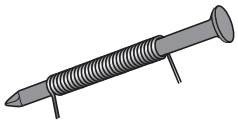
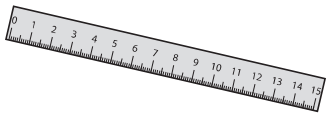
object	**description**
 nail in a current-carrying coil	non-magnetic
 plotting compass needle	permanent magnet
 wooden ruler	temporary magnet

Figure 3

(b) Figure 4 shows a wire passing through a piece of card.
The wire carries an electric current.

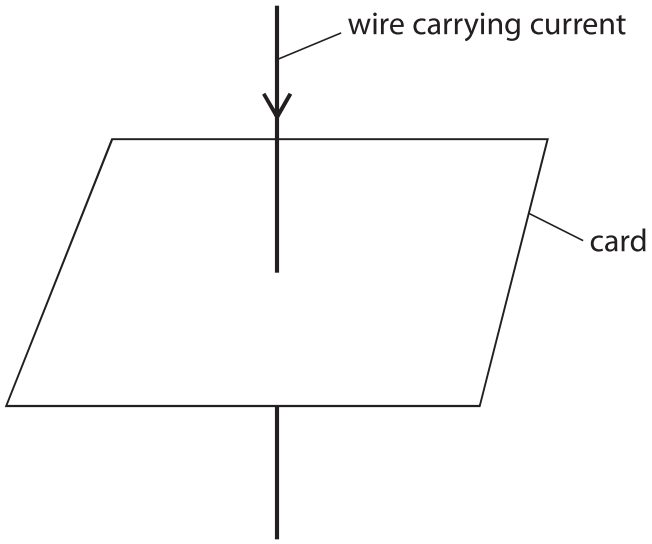


Figure 4

(i) Draw **one** magnetic field line on Figure 4, to show the shape of the magnetic field produced by the current.

(1)

(ii) Draw **one** arrow on the field line you have drawn to show the direction of the magnetic field.

(1)

(c) A student measures the strength of the magnetic field at several distances from the wire in Figure 4.
Figure 5 shows most of the student's results.

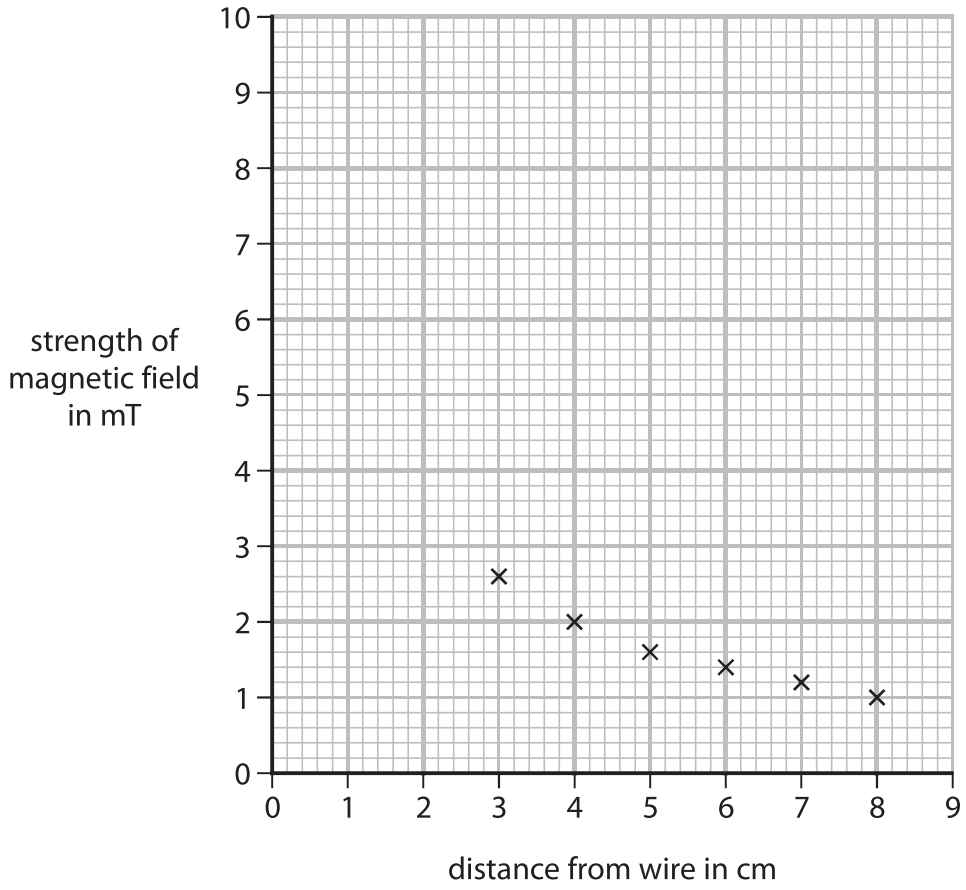


Figure 5

Figure 6 shows two extra sets of results.
mT is a unit of strength of a magnetic field.

distance from wire in cm	strength of magnetic field in mT
1.0	8.1
2.0	3.9

Figure 6

(i) Plot the two extra points on Figure 5.

(2)

(ii) Draw a best fit curve on the graph in Figure 5.

(1)

(iii) Use the graph in Figure 5 to calculate the change in strength of magnetic field when the distance from the wire changes from 4 cm to 8 cm.

(2)

change in strength of magnetic field = ... mT

(iv) The distance from the wire affects the strength of the magnetic field.

State **one** other factor that affects the strength of the magnetic field.

(1)

.....

(Total for Question 2 = 10 marks)

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DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

4 This question is about energy changes.

(a) Figure 8 shows a water slide.
A person travels from the top to the bottom of the water slide.

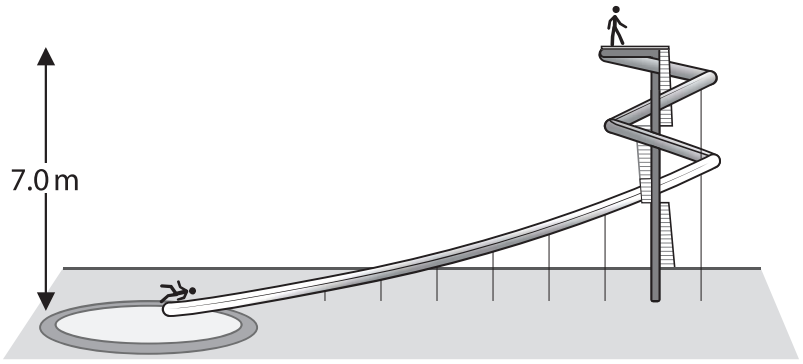


Figure 8

(i) The mass of the person, $m = 72$ kg.
The change in vertical height, $h = 7.0$ m
Gravitational field strength, $g = 10$ N / kg

Calculate the change in gravitational potential energy for the person.

Use the equation

change in gravitational potential energy = $m \times g \times h$

(2)

change in gravitational potential energy = ... J

(ii) The person comes to rest after the end of the water slide.

Explain what happens to the energy as the person comes to rest after the end of the water slide.

(2)

.....

.....

(b) Figure 9 shows a person pushing a box from the bottom of a slope to the top of the slope.

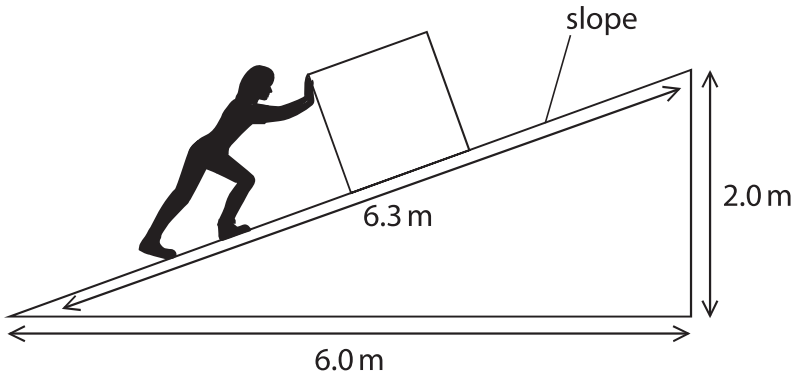


Figure 9

Explain which one of the three distances shown in Figure 9 should be used to calculate the work done against the force of friction between the box and the slope.

(2)

.....

.....

.....

.....

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(c) Calculate the kinetic energy of a tennis ball travelling at 28 m/s.
The mass of the tennis ball = 58 g.

Use the equation

$$KE = \frac{1}{2} \times m \times v^2$$

(3)

kinetic energy = ... J

(Total for Question 4 = 9 marks)

6 (a) Describe, in terms of particles, **two** differences between a solid and a liquid of the same substance.

(2)

1 .....

.....

2 .....

.....

(b) Figure 13 shows the dimensions of a solid block of concrete.

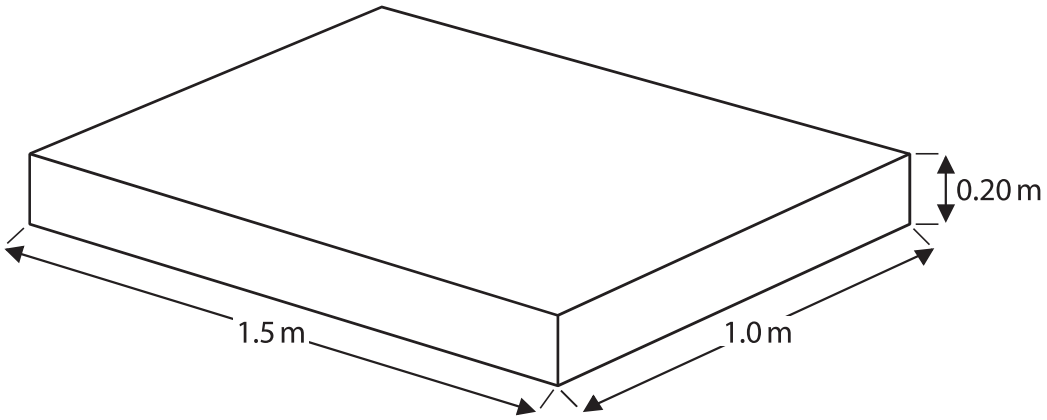


Figure 13

Density of concrete, ρ, = 2100 kg / m^3.

Calculate the mass of the concrete block.

Use the equation:

$$m = \rho \times V$$

(3)

mass of concrete block = ... kg

(c) Figure 14 shows a shed made mostly of concrete blocks.

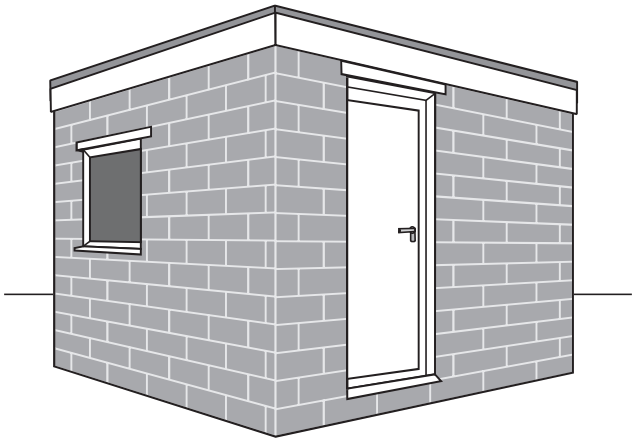


Figure 14

State **two** practical ways to reduce heat loss from this shed.

(2)

1 .....

.....

2 .....

.....

*(d) A student has two metal strips and a ruler, as shown in Figure 15.

A teacher tells the student that

- one metal strip is made of aluminium
- the other metal strip is made of stainless steel.

The student looks up data in a reference book, finding some density values:

density of aluminium = 2710 kg / m^3

density of stainless steel = 7850 kg / m^3

The student has access to more of the same metal strips, if needed, and may ask for any extra measuring devices.

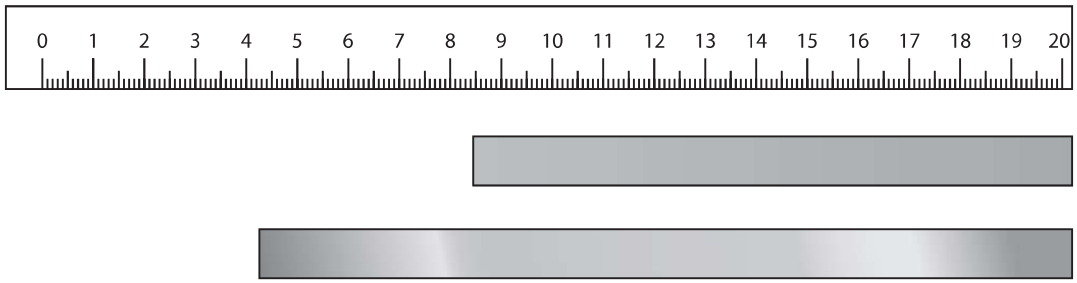


Figure 15

Plan how the student could confirm the teacher's statements, by determining the density of each of the strips as accurately as possible.

(6)

(Total for Question 6 = 13 marks)

TOTAL FOR PAPER = 60 MARKS

Question number	Answer	Additional guidance	Mark
2 (a)(i)	(soft) iron (1)	allow (in this context) nickel (alloys) cobalt steel	**(1)** **AO1**

Question number	Answer	Additional guidance	Mark
2 (a)(ii)	would be magnetised (when switch is closed) (1) would be demagnetised when switch is open (1)	(is) magnetic (is) electromagnetic induced magnetism magnetism can be switched off accept for either mark not permanent magnet **or** temporary magnet	**(2)** **AO1**

Question number	Answer	Additional guidance	Mark
2 (b)(i)	the Earth/world/planet has a magnetic field / core(1)	Earth/world/planet has a north (and south) pole	**(1)** **AO3**

Question number	Answer	Additional guidance	Mark
2(b)(ii)	direction (of the field) has changed / rotated (1) (strength of the) field has **increased** (1)	(from 0 to) 36° from N to NE field is stronger (changed by) 16.52 (μT) numbers have increased (from 46.67 to 63.19)	**(2)** **AO3**

Question number	Answer	Additional guidance	Mark
2 (b)(iii)	a description including **three** from use of equipment to measure distance (1) ruler / tape measure obtain a measurement (1) measure / record strength of the field (at a certain point) change the conditions (1) move the phone / magnet (to a different location) process the results (1) e.g. • draw a diagram • make a table • compare results/values • see when (field) stays constant	measure the distance between phone and magnet rotate the phone/magnet	**(3)** **A03**

Total 9 marks

Question number	Answer	Additional guidance	Mark
4 (a)	B A, C and D are incorrect because these do not measure the vertical change in height above the earth's surface.		**(1)** **AO1**

Question number	Answer	Additional guidance	Mark
4 (b)(i)	joule(s)	J j Nm newton metre(s) kg m^2 s^{-2} kg m^2/s^2 Ignore SI prefixes do not accept nm	**(1)** **AO1**

Question number	Answer	Additional guidance	Mark
4 (b)(ii)	selection of and substitution into E = F x d (1) 1960 = weight x 4.0 rearrangement and evaluation (1) (weight =) 490 (N)	accept P x t = F x d 436 x 4.5 = weight x 4.0 490.5 or 491 award full marks for the correct answer without working 530 scores 1 mark (used data to calculate median value)	**(2)** **AO2**

Question number	Answer	Additional guidance	Mark
4 (b)(iii)	selection of and substitution into P = E÷t (1) 425 = 2040 ÷ t rearrangement and evaluation (1) (time =) 4.8 (s)	 0.208 scores 1 mark 867000 scores 1 mark award full marks for the correct answer without working	**(2)** **AO2**

Question number	Answer	Additional guidance	Mark
4 (b)(iv)	values for power selected and added (1) $\frac{440 + 436 + 425}{(3)}$ evaluation (1) 434 (W)	 $\frac{1301}{(3)}$ accept values that round to 434 e.g. 433.667 accept 436 (median average) for 2 marks 1301 scores 1 mark 1017(.666) scores 1 mark award full marks for the correct answer without working	**(2)** **AO2**

Question number	Answer	Additional guidance	Mark
4 (c)	estimate of weight (1) measure (actual) weight (1)	ignore reaction time use scales ignore repeating measurements	**(2)** **A03**

Total 10 marks

Question number	Answer	Mark
6 (a)	[x] **B** bigger than in water less than water A is incorrect because the density of steam is less than water. C is incorrect because the space between the particles increases. D is incorrect because the space between the particles increases and density of steam is less than water.	**(1)** **AO1**

Question number	Answer	Additional guidance	Mark
6 (b)	calculation of change in volume (1) (530 cm^3 – 490 cm^3) = 40 (cm^3)	measurement mark – using scale	**(4)** **AO2**
	substitution (1) $7.9 = \frac{mass}{40}$	allow use of incorrect volume	
	rearrangement and evaluation (1) (mass = 7.9 x 40) (mass =) 316 (g)	answers without working 316 scores 3 marks 0.316 kg scores 3 marks 316 to any other power of 10 scores 2 marks 4187 or 3871 scores 2 marks (incorrect volume)	
	evaluation to 2 sig fig (1) 320 (g)	any answer written to 2sf independent mark answers without working 320 scores 4 marks 320 to any other power of ten scores 3 marks 4200 scores 3 marks 3900 scores 3 marks	

Question number	Answer	Additional guidance	Mark
6 (c)	an explanation linking density of wood less (than that of water) (1) less (volume of) water displaced (than volume of wood) (1)	 allow wood floats / should be submerged allow wood absorbing water allow (idea of) incorrect volume reading allow (idea that) the volume cannot be measured this way	**(2)** **AO2**

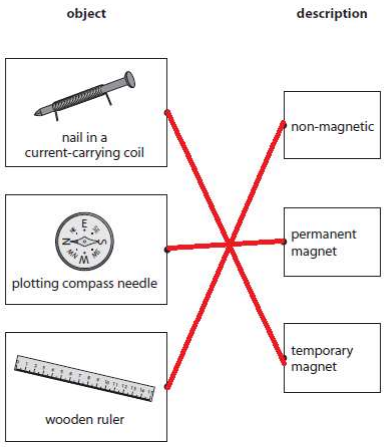
Question number	Indicative content	Mark
***6(d)**	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. Equipment • Thermometer • Measuring cylinder / balance • Power supply • Stirrer • Joule meter / ammeter / voltmeter • Stopwatch / clock Measurements • Mass / volume of water • Initial / final / change of temperature of water • Voltage / current / energy / power • Time (heated for) Detail • Lid/insulation to reduce energy loss • Ensure heater fully immersed / keep stirring the water • Use of equation $\Delta Q = m \times c \times \Delta\theta$ / calculation of input energy • Repeat and find average • Plot graph of temp change and time / energy Credit can be given for correctly labelled diagrams	**(6)** **AO1**

Level	Mark	Descriptor
	0	• No rewardable material.
Level 1	1-2	• Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific, enquiry, techniques and procedures lacks detail. (AO1) • Presents a description which is not logically ordered and with significant gaps. (AO1)
Level 2	3-4	• Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas, enquiry, techniques and procedures is not fully detailed and/or developed. (AO1) • Presents a description of the procedure that has a structure which is mostly clear, coherent and logical with minor steps missing. (AO1)
Level 3	5-6	• Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas, enquiry, techniques and procedures is detailed and fully developed. (AO1) • Presents a description that has a well-developed structure which is clear, coherent and logical. (AO1)

Level	Mark	Additional Guidance	General additional guidance – the decision within levels e.g. - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	Additional guidance one measurement **or** two items of equipment **or** one piece of detail	Possible candidate responses measure the temperature of the water to start with **or** the student needs a power supply and a thermometer **or** insulated material around the beaker
Level 2	3–4	Additional guidance two items of equipment and at least one measurement **or** one piece of equipment and two measurements **or** two items of equipment and one piece of detail **or** one measurement and one piece of detail	Possible candidate responses The student needs a measuring cylinder to measure the volume of water. They also need a thermometer **Or** Measure the temperature rise of the water and use a balance to measure the mass **or** They need a power supply for the heater and a voltmeter. Keep the heater in the water. **or** Measure temperature rise of the water. Keep stirring the water all the time.
Level 3	5–6	Additional guidance two items of equipment and two measurements and one piece of detail.	Possible candidate responses The student needs a balance to find the mass of water. They also need a thermometer to measure the rise in temperature of the water. Then use the equation $\Delta Q = m \times c \times \Delta\theta$

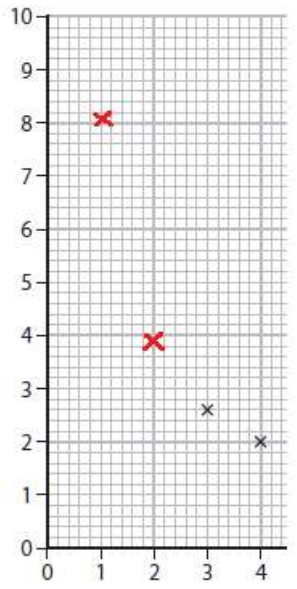
Total 13 marks

Total for paper = 60 marks

Question number	Answer	Additional guidance	Mark
2a		three links correct (2) one link correct (1)	(2) AO1

Question number	Answer	Additional guidance	Mark
2 (b) i	circle shown around wire (1)	allow tolerance for translation of 3D to 2D ignore any multiplicity of those circles	(1) AO1

Question number	Answer	Additional guidance	Mark
2 (b) ii	arrow indicating a clockwise direction (for magnetic field line drawn for i) (1)		(1) AO1

Question number	Answer	Additional guidance	Mark
2(c)i	 One mark for each point plotted correctly, to within ± 1 small square		(2) AO2

Question number	Answer	Additional guidance	Mark
2(c)ii	smooth curve drawn fitting the plotted points (1)	judge by eye	**(1) AO2**

Question number	Answer	Additional guidance	Mark
2ciii	substitution using an attempt at calculation – any subtraction seen (1) e.g. 2(.0) – 1(.0) evaluation (1) (-) 1(.0) (mT)	 accept any number that rounds to 1.0 award full marks for correct answer without working	**(2) AO3**

Question number	Answer	Mark
2 (c) iv	(size of) current	**(1) AO1**

(Total for Question 2 = 9 marks)

Question number	Answer	Additional guidance	Mark
4(a)i	substitution (1) $(\Delta GPE) = 72 \times 10 \times 7.0$ evaluation (1) 5040 (J)	do not penalise any power of ten error (p.o.t.e.) at this stage do not accept an answer without value for g (10) being used) award full marks for correct answer without working	**(2)** **AO2**

Question number	Answer	Additional guidance	Mark
4aii	an explanation to include (potential / kinetic) energy is transferred / dissipated (1) to surroundings / water / air / slide (1)	 accept lost / deceases accept friction / air resistance acts accept to **thermal** (store)	**(2)** **AO3**

Question number	Answer	Additional guidance	Mark
4b	Explanation linking **two** from: choice of distance (1) 6.3 m (calculations of work done need) the distance moved in the direction of the force (1) (friction acts) along the slope / hypotenuse (1)	 accept pushed up the slope	**(2)** **AO3**

Question number	Answer	Additional guidance	Mark
4 (c)	substitution (1) $KE = ½ \times 58\left(\times 10^{-3}\right) \times 28^2$ conversion (1) uses 58×10^{-3} or 0.058 evaluation (1) 23 (J)	do not penalise p.o.t.e. at this stage award full marks for any answer that rounds to 23 (e.g. 22.736) (J) award max two marks for any answer that rounds to 2.3 to any other power of 10 consolation mark for not squaring 28 (8.1(2) to any p.o.t.) (maximum 1 mark)	**(3)** **AO2**

(Total for Question 4 = 9 marks)

Question number	Answer	Additional guidance	Mark
6(a)	descriptions to include any **two** of • particles / atoms in solid close(r) together (1) • particles / atoms in solid (vibrate) in fixed positions but particles in liquid move (freely) (1) • particles in a solid in regular arrangement but particles in liquid are randomly arranged (1) • particles in a liquid have more (kinetic) energy (than in a solid) (1)	reverse argument difference asked for, so **must compare** for subsequent marking points allow answers in terms of forces between particles	**(2)** **AO1**

Question number	Answer	Additional guidance	Mark
6(b)	volume substitution (1) 1.5 x 1.0 x 0.2(0) (= 0.3) substitution in equation (1) mass = 2100 x (0.3(0)) evaluation (1) = 630 (kg)	 ecf from calculated value of volume for this mark only award 2 marks for 6.3 x any other power of 10 5670 gains 1 mark from use of 1.5+1.0+0.2=2.7 award full marks for correct answer without working	**(3)** **AO2**

Question number	Answer	Additional guidance	Mark
6(c)	statements to include any **two** from use cladding / (extra) insulation (1) use double thicknesses of the concrete (1) use silver / reflective / white (paint) (1) plant trees around (wind break) (1) use double glazed windows (1) (properly) close window(s)/door	 create cavity draft exclusion	**(2)** **AO1**

Question number	Indicative content	Mark
6 (d)*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. **AO1 (strand 2) (6 marks)** Indicative content • measure the length and width of a strip with the ruler / a metre rule • measure the thickness of the strip with a more accurate device e.g. digital callipers OR place 5 (say) of the same strip on top of each other and measure their thickness with the ruler then ÷5 to calculate a single thickness [plus air gap] • measure the mass of a strip with an electronic balance • measure the mass of (say) 5 strips then ÷5 to calculate the mass of one of them • calculate the volume (= l x w x t) in m^3 and the mass in kg • use displacement can/measuring cylinder to find the volume • mass / volume to get density • check if it's near one of the teacher's two values of density given • if it's close / not so far off it's safe to assume that strip is of the identified material • repeat for the other strip • other repeat measurements	**(6)** **AO1**

AO targeting: AO1.2

Level	Mark	Descriptor
	0	• No rewardable material.
Level 1	1-2	• Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific, enquiry, techniques and procedures lacks detail. (AO1) • Presents a description which is not logically ordered and with significant gaps. (AO1)
Level 2	3-4	• Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas, enquiry, techniques and procedures is not fully detailed and/or developed. (AO1) • Presents a description of the procedure that has a structure which is mostly clear, coherent and logical with minor steps missing. (AO1)
Level 3	5-6	• Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas, enquiry, techniques and procedures is detailed and fully developed. (AO1) • Presents a description that has a well-developed structure which is clear, coherent and logical. (AO1)

Summary for guidance

Level	Mark	Additional Guidance	General additional guidance – the decision within levels e.g. - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	<u>Additional guidance</u> Partially complete description of a suitable procedure with at least two measurements OR one measurement and another procedural point	<u>Possible candidate responses</u> measure the length measure the width of a strip measure the mass/weight of a strip e.g. repeat measurements
Level 2	3–4	<u>Additional guidance</u> Mostly complete description of a suitable procedure with at least three measurements and some description of processing the results.	<u>Possible candidate responses</u> As above with measure the thickness of the strip calculate the volume (= l x w x t) OR immerse in liquid to get volume
Level 3	5–6	<u>Additional guidance</u> Detailed description of a suitable procedure with all necessary measurements and a clear description of processing the results.	<u>Possible candidate responses</u> As above with extra detail e.g. measure the mass of (say) 5 strips then ÷5 to calculate the mass of one of them detail of obtaining volume by immersion use density =mass /volume check if density value obtained is near one of the teacher's two values

Question 6 =13 marks

If you're taking **GCSE (9–1) Combined Science** or **GCSE (9–1) Physics**, you will need these equations:

HT = higher tier

	distance travelled = average speed × time	
	acceleration = change in velocity ÷ time taken	$a = \frac{(v-u)}{t}$
	force = mass × acceleration	$F = m \times a$
	weight = mass × gravitational field strength	$W = m \times g$
HT	**momentum = mass × velocity**	$\boldsymbol{p = m \times v}$
	change in gravitational potential energy = mass × gravitational field strength × change in vertical height	$\Delta GPE = m \times g \times \Delta h$
	kinetic energy = 1/2 × mass × (speed)^2	$KE = \frac{1}{2} \times m \times v^2$
	efficiency = $\frac{(\text{useful energy transferred by the device})}{(\text{total energy supplied to the device})}$	
	wave speed = frequency × wavelength	$v = f \times \lambda$
	wave speed = distance ÷ time	$v = \frac{x}{t}$
	work done = force × distance moved in the direction of the force	$E = F \times d$
	power = work done ÷ time taken	$P = \frac{E}{t}$
	energy transferred = charge moved × potential difference	$E = Q \times V$
	charge = current × time	$Q = I \times t$
	potential difference = current × resistance	$V = I \times R$
	power = energy transferred ÷ time taken	$P = \frac{E}{t}$
	electrical power = current × potential difference	$P = I \times V$
	electrical power = (current)^2 × resistance	$P = I^2 \times R$
	density = mass ÷ volume	$\rho = \frac{m}{V}$

	force exerted on a spring = spring constant × extension	$F = k \times x$
	(final velocity)^2 – (initial velocity)^2 = 2 × acceleration × distance	$v^2 - u^2 = 2 \times a \times x$
HT	**force = change in momentum ÷ time**	$\boldsymbol{F = \frac{(mv - mu)}{t}}$
	energy transferred = current × potential difference × time	$E = I \times V \times t$
HT	**force on a conductor at right angles to a magnetic field carrying a current = magnetic flux density × current × length**	$\boldsymbol{F = B \times I \times l}$
	For transformers with 100% efficiency, potential difference across primary coil × current in primary coil = potential difference across secondary coil × current in secondary coil	$V_P \times I_P = V_S \times I_S$
	change in thermal energy = mass × specific heat capacity × change in temperature	$\Delta Q = m \times c \times \Delta\theta$
	thermal energy for a change of state = mass × specific latent heat	$Q = m \times L$
	energy transferred in stretching = 0.5 × spring constant × (extension)^2	$E = \frac{1}{2} \times k \times x^2$

If you're taking **GCSE (9–1) Physics**, you also need these extra equations:

	moment of a force = force × distance normal to the direction of the force	
	pressure = force normal to surface ÷ area of surface	$P = \frac{F}{A}$
HT	$\frac{\textbf{potential difference across primary coil}}{\textbf{potential difference across secondary coil}} = \frac{\textbf{number of turns in primary coil}}{\textbf{number of turns in secondary coil}}$	$\frac{V_p}{V_S} = \frac{N_p}{N_S}$
	to calculate pressure or volume for gases of fixed mass at constant temperature	$P_1 \times V_1 = P_2 \times V_2$
HT	**pressure due to a column of liquid = height of column × density of liquid × gravitational field strength**	$\boldsymbol{P = h \times \rho \times g}$

END OF EQUATION LIST