

- 2 (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 3 shows some water in a measuring cylinder and a lump of iron.

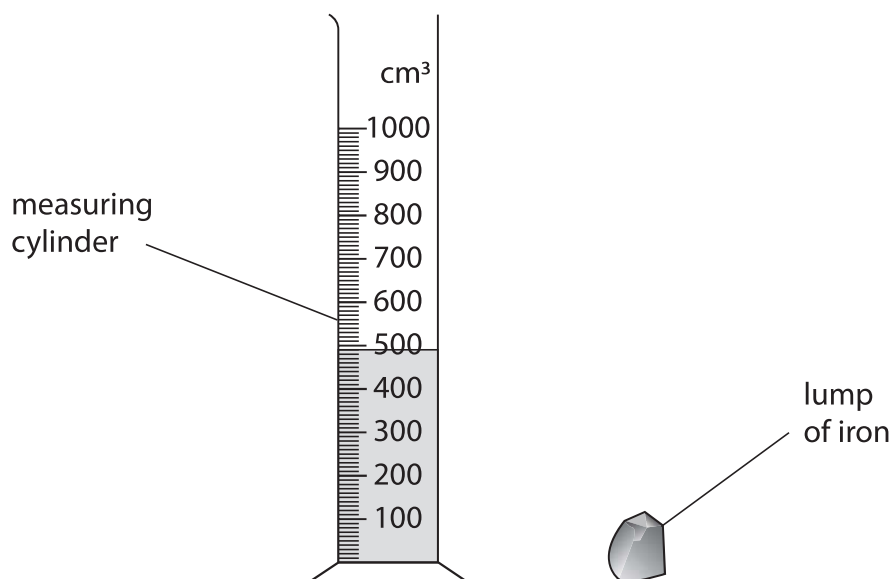


Figure 3

The lump of iron is lowered fully into the water.

The water level in the measuring cylinder rises to 530 cm³.

The density of iron is 7.9 g/cm³.

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



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- 3 (a) Figure 4 shows the shape of the magnetic field near a bar magnet.

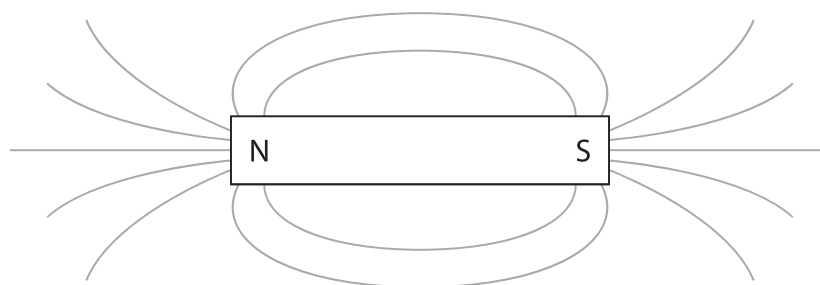


Figure 4

- (i) Draw arrows on the field lines in Figure 4 to show the direction of the magnetic field. (1)
- (ii) Place a letter X on Figure 4 at a place where the magnetic field is strongest. (1)
- (iii) Describe **two** differences between the magnetic field shown in Figure 4 and a uniform magnetic field. (2)

- (b) State how a uniform magnetic field may be obtained in a school laboratory. (1)

- (c) Figure 5 shows the directions of some plotting compass needles placed at different points near the Earth's surface.

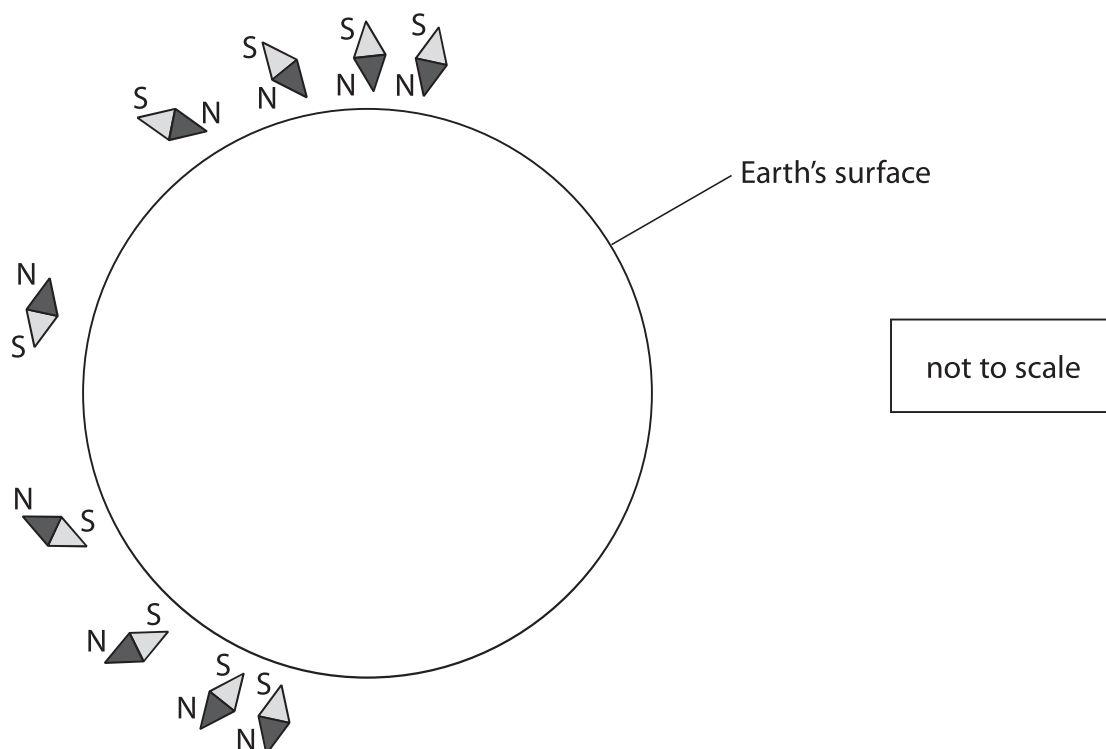


Figure 5

- (i) Sketch, on Figure 5, the Earth's magnetic field outside and inside the Earth. (2)
- (ii) State which part of the Earth generates its magnetic field. (1)

(d) A wire is placed at right angles to the Earth's magnetic field.

The wire is 0.600 m long and carries a current of 93.1 mA.

The force on the wire is 1.11×10^{-5} N.

Calculate the magnetic flux density of the Earth's magnetic field.

Use the equation

$$F = B \times I \times l$$

(2)

magnetic flux density = T

(Total for Question 3 = 10 marks)



- 4 (a) Figure 6 shows a 'Mars rover' descending to the surface of the planet Mars.

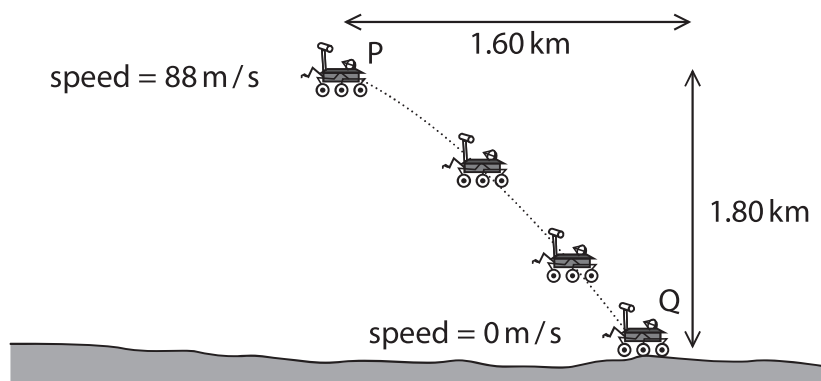


Figure 6

- (i) Calculate the change in gravitational potential energy of the rover as it descends from position P to position Q.

Mass of rover = 1100 kg

Gravitational field strength on Mars = 3.7 N/kg

Give your answer to 2 significant figures.

(3)

change in gravitational potential energy = J

- (ii) Use data from Figure 6 to calculate the change in kinetic energy of the rover as it descends from position P to position Q.

(2)

change in kinetic energy = J



- (iii) The rover is slowed down safely using thrusters and a parachute (not shown in Figure 6).

The thrusters use jets of gas to control movements and the parachute is designed to be used in the atmosphere of Mars.

Describe the energy changes involved in terms of the work done by various forces as the rover descends.

(3)

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- (b) The rover uses solar panels for its power needs.

The solar panels can provide 1200 W of power.

- (i) Show that the solar panels can provide 2.16 MJ of energy in 30 minutes.

(1)

- (ii) The solar panels convert 27% of the energy they receive from the Sun into electricity.

Calculate the solar energy received by the panels that provides the 2.16 MJ of energy.

(2)

energy received = J

(Total for Question 4 = 11 marks)

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- 6 (a) Explain the difference between the term 'specific heat capacity' and the term 'specific latent heat' when applied to heating substances.

(2)

- (b) Figure 10 shows some apparatus that may be used to determine the specific heat capacity of water.

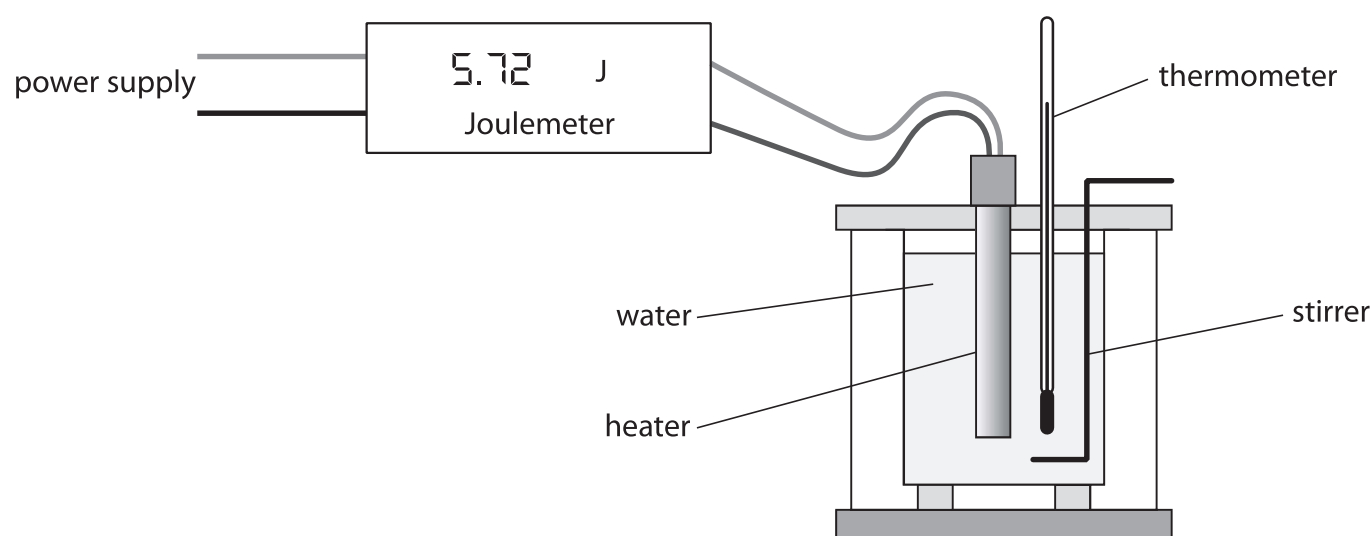


Figure 10

A student measures the initial temperature of the water.

The power supply is switched on for 10 minutes and then switched off.

Explain how the student should then obtain an accurate reading for the final temperature of the water, to be used in the calculation of the specific heat capacity.

(3)

*(c) A container of gas is at room temperature.

The gas is then heated.

The volume of the container remains the same.

By considering changes in velocities of the gas particles, explain how the temperature increase affects

- the average kinetic energy of the particles
- the pressure the particles exert on the walls of the container.

(6)

(Total for Question 6 = 11 marks)

TOTAL FOR PAPER = 60 MARKS



P 6 9 4 7 2 A 0 1 9 2 0

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

(2)

1

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2

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- (b) Figure 3 shows the dimensions of a solid block of concrete.

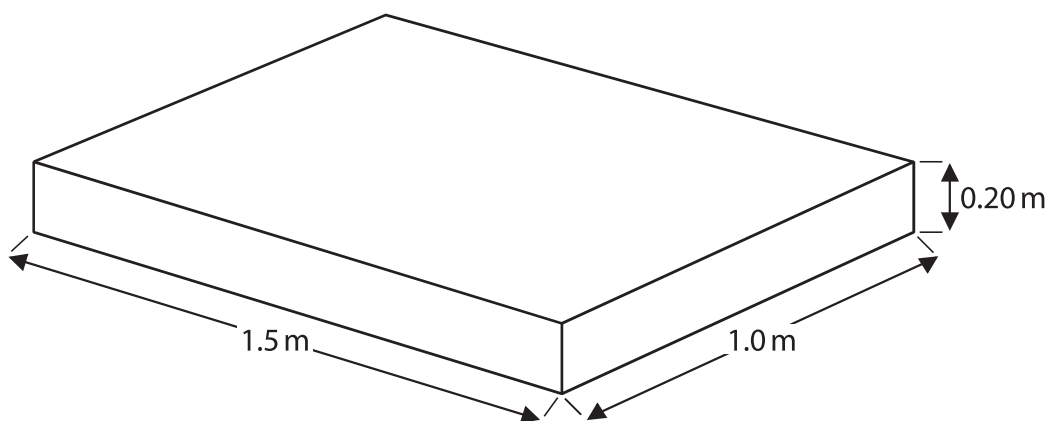


Figure 3

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 4 shows a shed made mostly of concrete blocks.

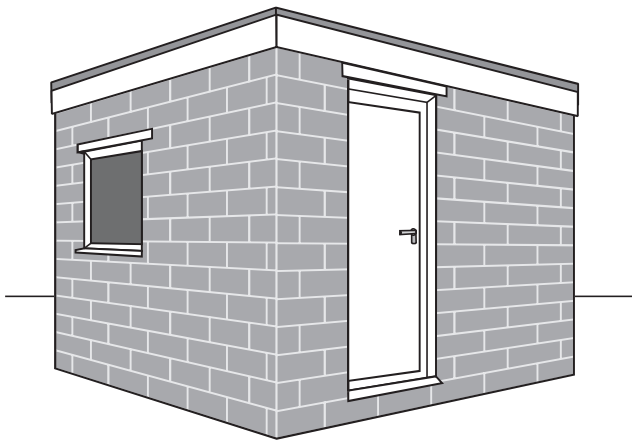


Figure 4

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

(2)

1

2

(d) On a very cold day, the temperature of the air is -4°C .

Calculate the value of this temperature on the kelvin scale.

(1)

temperature = K

(Total for Question 2 = 8 marks)

- 3 (a) A student uses plotting compasses to investigate the magnetic field between the poles of two bar magnets.

Figure 5 shows **one** of the plotting compasses and **one** of the bar magnets.



Figure 5

The student places the two magnets on a piece of paper with a pole of one magnet a few centimetres away from a pole of the other magnet.

The student places 20 plotting compasses on the paper near the magnets.

Figure 6 shows the direction in which each of the plotting compasses points.

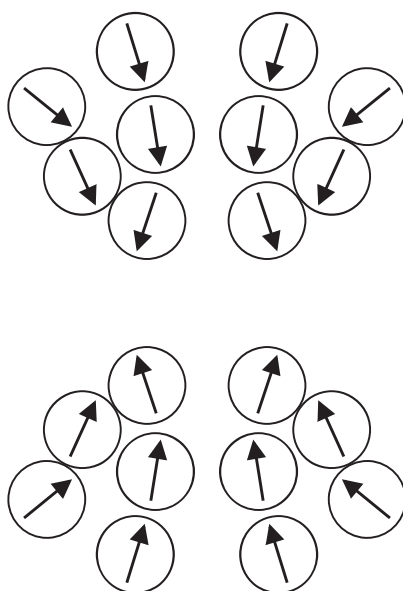


Figure 6

- (i) Draw two rectangles on Figure 6 to show the positions of the two bar magnets.

Label the N-pole and the S-pole of each magnet.

(2)



- (ii) The student wants to determine the shape of the magnetic field for a larger area around the magnets.

Describe how the student should continue the investigation using just one plotting compass.

(3)

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- (b) Two long, thin magnets are held with their N-poles facing each other.
The force, F , between the magnets can be calculated using the equation

$$F = \frac{K}{d^2}$$

where

K is a constant value

d is the distance between the magnets.

- (i) The magnets are 4.0 cm apart.

The force between the magnets is 1.2 N.

Calculate the value of K .

State the unit.

(3)

$K =$ unit

- (ii) The magnets are held the same distance apart but with the N-pole of one magnet now facing the S-pole of the other magnet.

The value of K does not change.

State how the force would compare with the force in part (i).

(1)

(Total for Question 3 = 9 marks)



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- 4 (a) Two cyclists ride on a hilly road and go through points P, Q, R and S.

The diagram in Figure 7 shows how the vertical height of the road changes during the journey from P to S.

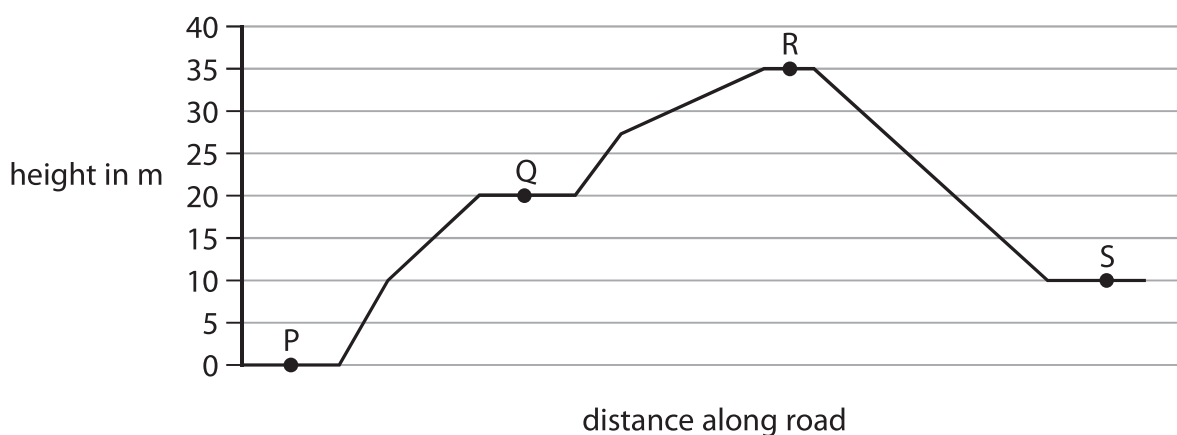


Figure 7

- (i) The greatest overall change in gravitational potential energy for each cyclist is between which two points on the journey?

(1)

- ☐ A P and Q
- ☐ B Q and R
- ☐ C P and S
- ☐ D R and S

- (ii) The total weight of one cyclist and bicycle is 700 N.

Calculate the total amount of work done against gravity when the cyclist travels from point P to point Q in the journey.

(2)

work done = J



- (iii) The gravitational potential energy of the other cyclist changes by 11 250 J when travelling from point Q to point R.

Calculate the mass of this cyclist.

Gravitational field strength = 10 N/kg

Use the equation

$$\Delta GPE = m \times g \times \Delta h$$

(2)

mass = kg

- (iv) Explain why the total amount of work done by a cyclist between points Q and R is different from the change in gravitational potential energy of the cyclist between points Q and R.

(2)

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- (v) The cyclists lubricated the chains and the wheel bearings of their bicycles before setting off.

Lubricating the chains and wheel bearings helps to

(1)

- ☐ **A** decrease the amount of work done against gravity
- ☐ **B** decrease the efficiency of the cyclist and bicycle
- ☐ **C** increase the efficiency of the cyclist and bicycle
- ☐ **D** increase the overall amount of energy transferred by the cyclist



(b) The kinetic energy of another cyclist is 2800 J.

The mass of the cyclist is 85 kg.

Calculate the velocity of this cyclist.

Use the equation

$$KE = \frac{1}{2} \times m \times v^2 \quad (3)$$

velocity = m/s

(Total for Question 4 = 11 marks)



- 6 (a) An electric kettle contains 1.41 kg of water at 25 °C.

The kettle is switched on.

After a while, the water reaches boiling point at 100 °C.

The specific heat capacity of water is 4200 J/kg °C.

- (i) Calculate the amount of thermal energy supplied to the water by the kettle.
Give your answer to the appropriate number of significant figures.

Use an equation selected from the list of equations at the end of the paper.

(3)

energy supplied = J

- (ii) The kettle is kept switched on and the water continues to boil.

After a while, the mass of the water in the kettle has decreased to 1.21 kg.

The thermal energy supplied to the water during this time was 450 000 J.

Calculate the specific latent heat of vaporisation of water.

Use an equation selected from the list of equations at the end of the paper.

(3)

specific latent heat of vaporisation = J/kg



*(b) This question is about determining the specific heat capacity of aluminium.
An aluminium block is placed in boiling water as shown in Figure 10.

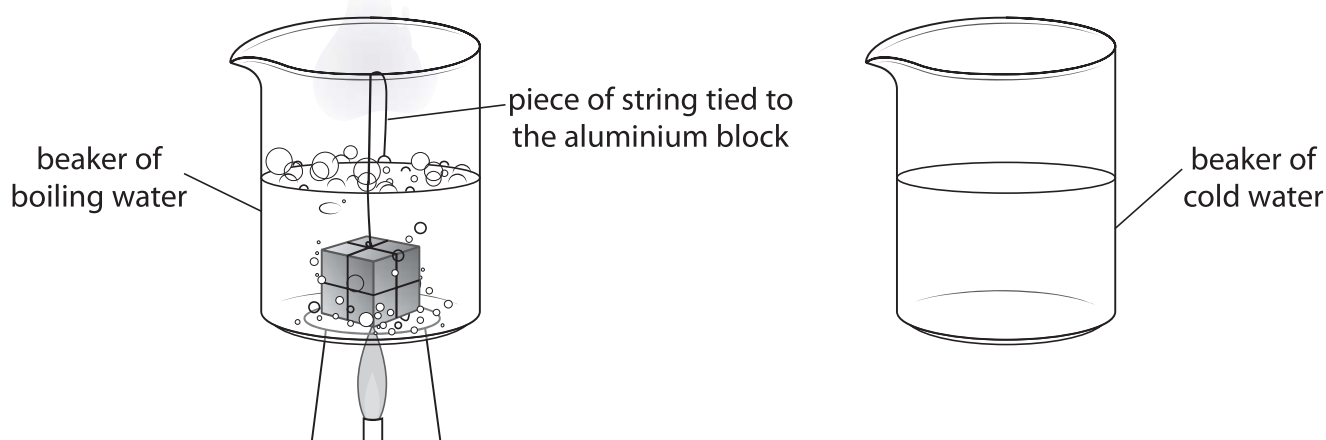


Figure 10

The piece of string is tied to the aluminium block so the block can be transferred from the boiling water to the cold water.

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Describe how a student could use this apparatus, and any additional items needed, to determine the specific heat capacity of aluminium.

Your answer should include how the student would

- obtain the necessary measurements
- use the measurements to calculate the specific heat capacity of aluminium.

(6)

(Total for Question 6 = 12 marks)

TOTAL FOR PAPER = 60 MARKS



P 6 6 6 3 1 A 0 1 9 2 0

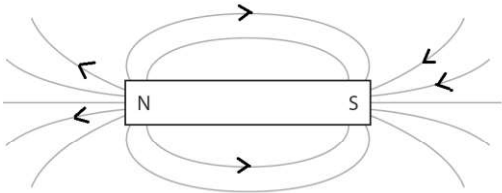
Question number	Answer	Mark
2(a)	[x] B bigger than in water less than water A is incorrect because the density of steam is less than water. C is incorrect because the space between the particles increases. D is incorrect because the space between the particles increases and density of steam is less than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

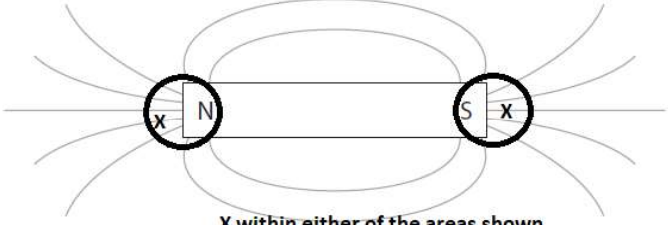
Question number	Answer	Additional guidance	Mark
2 (b)	calculation of change in volume (1) $(530 \text{ cm}^3 - 490 \text{ cm}^3) = 40 \text{ (cm}^3\text{)}$ substitution (1) $7.9 = \frac{\text{mass}}{40}$ rearrangement and evaluation (1) (mass = 7.9×40) (mass =) 316 (g) evaluation to 2 sig fig (1) 320 (g)	measurement mark – using scale allow use of incorrect volume answers without working 316 (g) 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) 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 mark	(4) AO2.2

Question number	Answer	Additional guidance	Mark
2 (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) A02.2

Question number	Answer	Additional guidance	Mark
2 (d)	A description including idea of change of state / solid changes (1) to gas / vapour (directly) (1)	accept equivalents e.g. turns into / goes from to allow reverse i.e. gas → solid may be via appropriate example e.g. ice → water vapour / steam or reverse (2 marks)	(2) A01.1

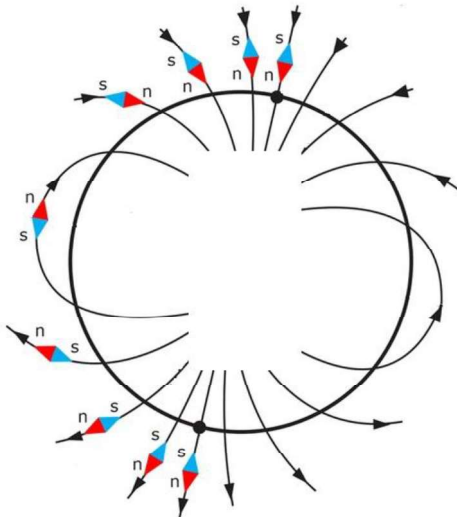
Total 9 marks

Question number	Answer	Additional guidance	Mark
3 (a) (i)	consistent arrows showing magnetic field direction(s) (1) 	arrows showing direction out of N, towards and into S minimum of two arrows all arrows shown must be in the correct direction	(1) AO1.2

Question number	Answer	Additional guidance	Mark
3(a) (ii)	'X' placed just/immediately to the left of the N pole or just/immediately to the right of S pole (1)  X within either of the areas shown	allow on the letters N or S do not allow further inside the magnet	(1) AO1.1

Question number	Answer	Additional guidance	Mark
3 (a) (iii)	A description to include any two from: (in comparison with bar magnet's field shown the uniform field has:) 1. only one direction (1) 2. straight lines (1) 3. parallel lines (1) 4. equidistant lines (1) 5. same strength of field everywhere (1)	(in comparison with uniform field the bar magnet's field lines:) vary in direction curved lines converge / diverge vary in distance(s) apart / gap vary in strength of field if no other mark is awarded, credit any diagram showing a uniform magnetic field for 1 mark	(2) AO3.2

Question number	Answer	Additional guidance	Mark
3 (b)	(inside) a solenoid / long coil (with a current / power supply) (1)	give credit for diagrams accept: horseshoe magnet (between / using) pair of Magnadur / flat magnets (between / using) Helmholtz coils (between / using) two bar magnets, with unlike poles facing each other	(1) AO1.2

Question number	Answer	Additional guidance	Mark
3(c) (i)	Sketch including any two from at least two field lines outside the Earth approximately aligning with compasses (1) at least two field lines continue inside the Earth towards imaginary poles (1) all arrows on lines drawn in the correct direction(s) outside the Earth (1) 	field lines need to have a gap inside the Earth ignore arrows on field lines inside the Earth	(2) AO3.1

Question number	Answer	Additional guidance	Mark
3(c) (ii)	(magnetic outer) core (1)	moving charges/ions	(1) AO1.1

Question number	Answer	Additional guidance	Mark
3(d)	rearrangement and substitution (1) $(B = \frac{F}{I \times l})$ $= \frac{1.11 \times 10^{-5}}{93(.1 \times 10^{-3}) \times 0.6(000)}$ evaluation (1) $2.0 \times 10^{-4} \text{ (T)}$	0.0002 (T) accept any number that rounds to $2.0 \times 10^{-4} \text{ (T)}$ e.g. $1.989 \times 10^{-4} \text{ (T)}$ any number that rounds to $2.0 \times 10^{-7} \text{ (T)}$ e.g. $1.987 \times 10^{-7} \text{ (T)}$ is awarded 1 mark only award full marks for the correct answer without working	(2) AO2.1

Total 10 marks

Question number	Answer	Additional guidance	Mark
4(a) (i)	select and substitute (1) $(\Delta GPE = m \times g \times \Delta h)$ $= 1100 \times 3.7 \times 1.8 (\times 10^3)$ evaluation (1) 7326 000 (J) evaluation to 2 s.f. (1) 7 300 000 (J)	any number rounding to 7 300 000 7326 scores 1 mark independent mark -any final answer stated to 2 s.f.	(3) AO2.1

Question number	Answer	Additional guidance	Mark
4(a) (ii)	select and substitute (1) $(\Delta KE = \frac{1}{2} m \times v^2)$ $= \frac{1}{2} 1100 \times 88^2$ evaluation (1) 4 300 000 (J)	ignore minus signs accept numbers that round to 4 300 000 (J) e.g. 4 259 200 (J) award full marks for the correct answer without working	(2) AO2.1

Question number	Answer	Additional guidance	Mark
4 (a) iii	A description linking three from: 1. work is done against / by gravity (1) 2. idea of work done by the thrusters / jets (on the rover) (1) 3. (work done) by air/atmospheric resistance on the parachute (and rover) (1) 4. this reduces the kinetic energy (store) (1) 5. (there is a) decrease in the gravitational potential energy (store) of the rover (1) 6. (there is a) transfer of chemical energy from the thrusters (1) 7. energy transferred to thermal energy (store) (1) 8. (transfer) mechanically (to the thermal store) (1)	KEY: attempt to explain <u>how work done</u> contributes towards the energy changes / conservation of energy if no other mark scored allow one mark for work = force x distance	(3) AO2.1

Question number	Answer	Additional guidance	Mark
4(b) (i)	select and substitute (1) ($E = P \times t$) = 1200 x 30 x 60 (in J)	all three numbers needed to show that allow 1800 (seconds) for 30x60 ignore evaluation	(1) AO1.1

Question number	Answer	Additional guidance	Mark
4(b) (ii)	select, rearrange and substitute (1) (input energy supplied = $\frac{\text{energy provided by panel}}{\text{efficiency}}$) = $\frac{2.16 \text{ (MJ)}}{(0.)27}$ evaluation (1) $8(.0) \times 10^6 \text{ (J)}$	$\frac{2 \ 160 \ 000}{(0.)27}$ $8 \ 000 \ 000 \text{ (J)}$ $8(.0) \text{ MJ}$ award full marks for the correct answer without working $8(.0) \times 10^4 \text{ (J)}$ gains 1 mark (uses 27% incorrectly)	(2) AO2.1

TOTAL 11 marks

Question number	Answer	Additional guidance	Mark
6(a)	an explanation linking specific heat capacity concerns change in temperature (1) whereas specific latent heat concerns change of state (1)	accept specific heat capacity concerns heating <u>up</u> / cooling accept any named change of state e.g. melting / freezing / evaporating /boiling accept specific latent heat related to no change in temperature	(2) AO1.1

Question number	Answer	Additional guidance	Mark
6 (b)	an explanation linking any three from: stir the water before taking a reading of temperature (1) (continue to) observe temperatures after switching off (1) record the maximum / highest / peak temperature reached (1) take temperature reading at eye level (1) conduction (and convection) take time (1)	allow "for longer than 10 minutes" allow wait(ing period) in correct context until the temperature stops changing takes time (for water / thermometer) to heat through	(3) AO1.2

SSQ NO:	CS NO:	Answer	Mark
6(c)*		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 1 (6 marks) • particles move faster (at a higher temperature) • greater velocity / speed means greater kinetic energy • since $KE = \frac{1}{2} m v^2$ • heating increases KE (store) • KE (store) increase leads to higher (average) speeds • faster particles (at higher temperature so) hit container with more force / momentum exchange • bigger pressure because $p = F / A$ • particles hit container more frequently (at higher temperature) • so more force exerted on (walls of) container	(6) AO1.1

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1-2	• Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • Presents an explanation with some structure and coherence. (AO1)
Level 2	3-4	• Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5-6	• Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • Presents an explanation 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
	0	No rewardable material.	Eg - 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.
Level 1	1–2	<u>Additional guidance</u> isolated idea(s) of physics e.g. recognising the speed-temperature relationship or the pressure temperature relationship	<u>Possible candidate responses</u> particles faster (at higher temperature) KE increases pressure increases (at a higher temperature)
Level 2	3–4	<u>Additional guidance</u> limited details about KE or limited details about pressure or linked ideas about kinetic energy and pressure	<u>Possible candidate responses</u> faster particles have greater kinetic energy (store) (particles) hitting container more often causes greater pressure faster particles cause greater force bigger pressure because force increased
Level 3	5–6	<u>Additional guidance</u> understanding is detailed and fully developed. includes detail about both kinetic energy and force involvement in pressure, but one aspect may be covered in greater detail than the other one	<u>Possible candidate responses</u> greater speed means greater kinetic energy since $KE = \frac{1}{2} m v^2$ AND bigger pressure because more frequent collisions causes an increase in force greater speed means greater kinetic energy AND bigger pressure because $p = F / A$ and (total) force increased because of hitting container walls with bigger momentum (changes)

Total 11 marks

Total paper mark =60

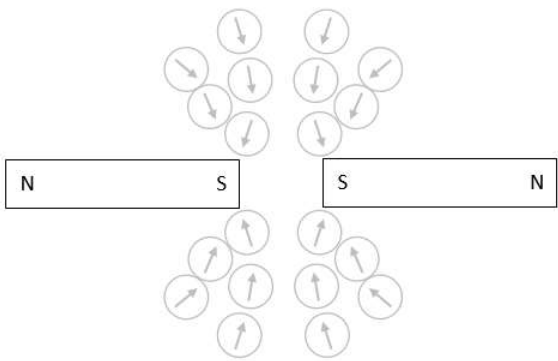
Question number	Answer	Additional guidance	Mark
2(a)	descriptions to include any two of particles / atoms in solid close(r) together (1) particles / atoms in solid (vibrate) in fixed positions but particles in liquid move (freely) (1) particles in a solid in regular arrangement but particles in liquid 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
2(b)	volume substitution (1) $1.5 \times 1.0 \times 0.2(0) (= 0.3)$ substitution in equation (1) $\text{mass} = 2100 \times (0.3(0))$ evaluation (1) $= 630 \text{ (kg)}$	ecf from calculated value of volume for this mark only award 2 marks for $6.3 \times$ 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
2(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	Answer	Additional guidance	Mark
2 (d)	269 (K)	allow use of 273.14? 269.14 (K)	(1) AO2

Total 8 marks

Question number	Answer	Additional guidance	Mark
3 (a)(i)	example:  rectangles in (approximately) correct position (1) all four poles correctly labelled (1)	judge by eye but do not allow rectangles in contact	(2) AO3

Question number	Answer	Additional guidance	Mark
3 (a)(ii)	a description to include place a (plotting) compass on the paper (near to the magnet(s)) and mark direction of the field (at that point) (1) determine how the field continues from that point (1) connect field lines to reveal overall shape(1)	place a (plotting) compass on the paper (near to the magnet(s)) and put a dot at each end of the needle move compass so that one end of the needle is over the mark (just made) join up the dots	(3) AO1

Question number	Answer	Additional guidance	Mark
3 (b) (i)	substitution of values (1) $1.2 = \frac{K}{4(.0)^2}$ rearrangement and evaluation (1) $(K=) 19$ unit (1) N cm^2	allow rearrangement before substitution $(K=) 1.2 \times 4(.0)^2$ 19.2 0.00192 award full marks for the correct answer without working independent mark N m^2	(3) AO2

Question number	Answer	Additional guidance	Mark
3 (b)(ii)	same magnitude and opposite direction (1)	allow (now) attraction for opposite direction	(1) AO1

Question 3 total 9 marks

Question number	Answer	Additional guidance	Mark
4 (a) (i)	D R and S A, B and C are incorrect because the difference in vertical positions are all less than that shown by R and S		(1) AO1

Question number	Answer	Additional guidance	Mark
4 (a)(ii)	recall (1) work done = force x distance substitution and evaluation (1) (work done =) 14,000 (J)	(work done) = 700×20 award full marks for the correct answer without working	(2) AO1

Question number	Answer	Additional guidance	Mark
4 (a)(iii)	substitution (1) $11250 = m \times 10 \times 15$ rearrangement and evaluation (1) (mass=) 75 (kg)	 award full marks for the correct answer without working. if no other marks scored then award 1 mark for answers of 0.013 (substitution mark using $h = 15$)	(2) AO2

Question number	Answer	Additional guidance	Mark
4 (a)(iv)	An explanation linking some work is done to overcome friction/air resistance (1) energy is dissipated /transferred to the environment (1)	allow energy is lost thermal energy	(2) AO1

Question number	Answer	Additional guidance	Mark
4 (a)(v)	C increase the efficiency of the cyclist and bicycle A is incorrect because lubrication has no effect on work done against gravity B is incorrect because lubrication will increase efficiency D is incorrect because the overall energy transfer will not increase		(1) AO1

Question number	Answer	Additional guidance	Mark
4 (b)	substitution (1) $2,800 = \frac{1}{2} \times 85 \times v^2$ rearrangement (1) $(v^2 =) \frac{2800 \times 2}{85}$ evaluation (1) $v = 8.1 \text{ (m/s)}$	allow substitution and rearrangement in either order 66 or 65.88 seen allow values that round to 8.1 e.g 8.1168 award full marks for the correct answer without working	(3) AO2

Total for question 4 = 11 marks

Question number	Answer	Additional guidance	Mark
6(a)(i)	substitution into $\Delta Q = m \times s \times \Delta T$ (1) $(\Delta Q) = 1.41 \times 4200 \times (100-25)$ evaluation (1) (energy =) 444,150 (J) answer to 2 sf (1) 440,000 (J)	 ignore POT error for this mark independent mark allow 3 sf 444,000 award full marks for the correct answer without working award 1 mark for answers with values 148,050 or 592,200 (incorrect temp and sf) award 2 marks for answers with values 150,000 or 148,000 or 590,000 or 592,000 (incorrect temp but allowed sf)	(3) AO2

Question number	Indicative content	Mark
*6(b)	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. Procedure • Measure the temperature of the boiling water • Allow sufficient time for block to reach temperature of boiling water • Measure temperature of cold water in beaker • Using a thermometer • Transfer (hot) aluminium block to cold water in the beaker. • Work quickly to avoid thermal energy loss during transfer • Measure temperature of water • Stir to ensure even distribution • Measure maximum temperature reached by water • Calculate temp rise of water by subtracting initial from final temperature. • Calculate temp drop of aluminium by subtracting final temperature from 100. • Find mass of beaker and water and aluminium • Use a balance • Empty water from beaker and dry beaker and block • Weigh beaker and block alone • Find mass of water by subtraction. • Allow plausible method of finding mass of water before putting block in. Process results • Calculate thermal energy gained water using $\Delta Q = m \times c \times \Delta\theta$ • Thermal energy gained by water = thermal energy lost by aluminium • Specific heat capacity of aluminium = $\frac{\text{thermal energy transferred}}{\text{mass of Al} \times \text{temp drop of Al}}$	(6) AO2 and AO3

Level	Mark	Descriptor
	0	No awardable content
Level 1	1–2	- The plan attempts to link and apply knowledge and understanding of scientific enquiry, techniques and procedures, flawed or simplistic connections made between elements in the context of the question. (AO2) - Analyses the scientific information but understanding and connections are flawed. An incomplete plan that provides limited synthesis of understanding. (AO3)
Level 2	3–4	- The plan is mostly supported through linkage and application of knowledge and understanding of scientific enquiry, techniques and procedures, some logical connections made between elements in the context of the question. (AO2) - Analyses the scientific information and provides some logical connections between scientific enquiry, techniques and procedures. A partially completed plan that synthesises mostly relevant understanding, but not entirely coherently. (AO3)
Level 3	5–6	- The plan is supported throughout by linkage and application of knowledge and understanding of scientific enquiry, techniques and procedures, logical connections made between elements in the context of the question. (AO2) - Analyses the scientific information and provide logical connections between scientific concepts throughout. A well-developed plan that synthesises relevant understanding coherently. (AO3)

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 one measurement	<u>Possible candidate responses</u> Heat up the block in the boiling water. Then put the block into the cold water. Measure the temperature reached by the water.
Level 2	3–4	<u>Additional guidance</u> Mostly complete description of a suitable procedure with at least two measurements and some description of processing the results.	<u>Possible candidate responses</u> As above with Measure mass of water. Use $\Delta Q = m \times c \times \Delta\theta$ to find thermal energy transferred
Level 3	5–6	<u>Additional guidance</u> Detailed description of a suitable procedure with most of the necessary measurements and a clear description of processing the results.	<u>Possible candidate responses</u> As above with Calculate temperature changes by subtraction. Calculate thermal energy lost by Al as being equal to thermal energy gained by water. Specific heat capacity of Al = $\frac{\text{thermal energy transferred}}{\text{mass of Al} \times \text{temp drop of Al}}$

Question 6 = 11 marks

Total for paper = 60 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 $\times$ time	
acceleration = change in velocity $\div$ time taken	$a = \frac{(v - u)}{t}$
force = mass $\times$ acceleration	$F = m \times a$
weight = mass $\times$ gravitational field strength	$W = m \times g$
HT momentum = mass $\times$ velocity	$p = m \times v$
change in gravitational potential energy = mass $\times$ gravitational field strength $\times$ change in vertical height	$\Delta GPE = m \times g \times \Delta h$
kinetic energy = $\frac{1}{2} \times \text{mass} \times (\text{speed})^2$	$KE = \frac{1}{2} \times m \times v^2$
efficiency = $\frac{(\text{useful energy transferred by the device})}{(\text{total energy supplied to the device})}$	
wave speed = frequency $\times$ wavelength	$v = f \times \lambda$
wave speed = distance $\div$ time	$v = \frac{x}{t}$
work done = force $\times$ distance moved in the direction of the force	$E = F \times d$
power = work done $\div$ time taken	$P = \frac{E}{t}$
energy transferred = charge moved $\times$ potential difference	$E = Q \times V$
charge = current $\times$ time	$Q = I \times t$
potential difference = current $\times$ resistance	$V = I \times R$
power = energy transferred $\div$ time taken	$P = \frac{E}{t}$
electrical power = current $\times$ potential difference	$P = I \times V$
electrical power = (current) $^2 \times$ resistance	$P = I^2 \times R$
density = mass $\div$ volume	$\rho = \frac{m}{V}$

	force exerted on a spring = spring constant $\times$ extension	$F = k \times x$
	(final velocity) ² – (initial velocity) ² = 2 $\times$ acceleration $\times$ distance	$v^2 - u^2 = 2 \times a \times x$
HT	force = change in momentum $\div$ time	$F = \frac{(mv - mu)}{t}$
	energy transferred = current $\times$ potential difference $\times$ 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 $\times$ current $\times$ length	$F = B \times I \times l$
	For transformers with 100% efficiency, potential difference across primary coil $\times$ current in primary coil = potential difference across secondary coil $\times$ current in secondary coil	$V_p \times I_p = V_s \times I_s$
	change in thermal energy = mass $\times$ specific heat capacity $\times$ change in temperature	$\Delta Q = m \times c \times \Delta\theta$
	thermal energy for a change of state = mass $\times$ specific latent heat	$Q = m \times L$
	energy transferred in stretching = 0.5 $\times$ spring constant $\times$ (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 $\times$ distance normal to the direction of the force	
	pressure = force normal to surface $\div$ area of surface	$P = \frac{F}{A}$
HT	$\frac{\text{potential difference across primary coil}}{\text{potential difference across secondary coil}} = \frac{\text{number of turns in primary coil}}{\text{number of turns in secondary coil}}$	$\frac{V_p}{V_s} = \frac{N_p}{N_s}$
	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 $\times$ density of liquid $\times$ gravitational field strength	$P = h \times \rho \times g$

END OF EQUATION LIST