

AQA GCSE PHYSICS (HIGHER) • 8463

PHYSICS



EXAM QUESTION PACK

4.3.1 CHANGES OF STATE AND THE PARTICLE MODEL (PACK 2)

SCORE

/131

PERCENTAGE

%

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Q1.

A student wanted to determine the density of the irregular shaped object shown in **Figure 1**

Figure 1



- (a) Plan an experiment that would allow the student to determine the density of the object.

[illegible]

(6)

- (b) Another student did a similar experiment.

He determined the density of five common plastic materials.

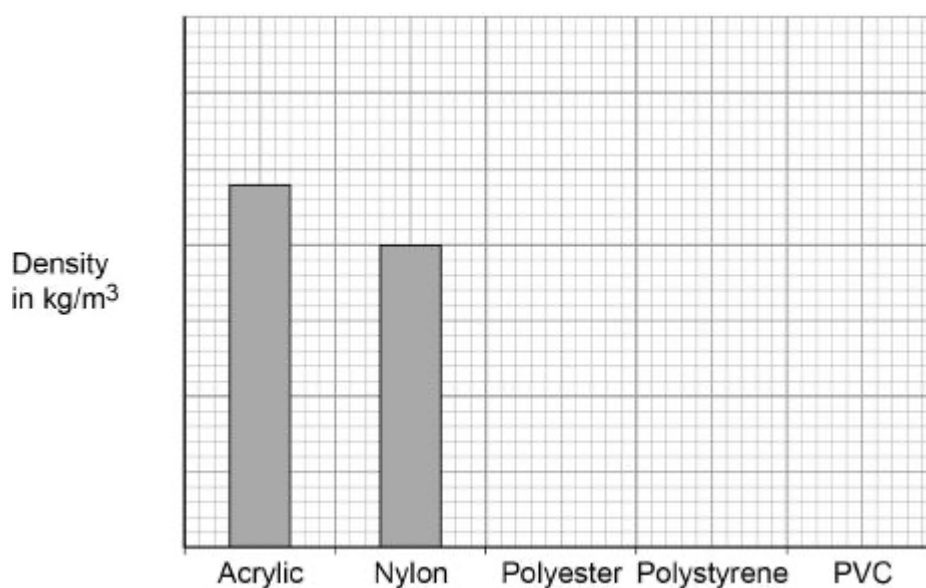
Table 1 shows the results.

Table 1

Plastic material	Density in kg/m ³
Acrylic	1200
Nylon	1000
Polyester	1380
Polystyrene	1040
PVC	1100

Figure 2 shows the results plotted in a bar chart.

Figure 2



Complete **Figure 2**

You should:

- Write the correct scale on the y-axis.
- Draw the bars for polyester, polystyrene and PVC.

(4)

(c) The student is given a piece of a different plastic material.

The student determined the density of the material three times.

Table 2 shows the results.

Table 2

	Density in kg/m ³
1	960
2	1120
3	1040

Determine the uncertainty in the student's results.

Uncertainty = _____ kg/m³

(2)

(Total 12 marks)

Q2.

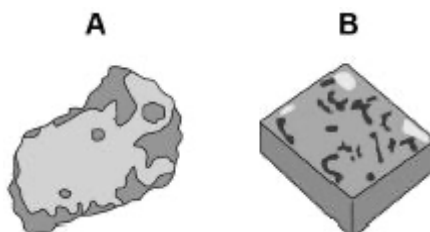
Two large semi-precious stones are discovered.

A student is asked to find out what material each of the two stones is made of.

The student does this by determining the density of the material of each stone.

Figure 1 shows the two stones.

Figure 1



- (a) The student wants to measure the volume of stone **A**. Stone **A** cannot be measured using a metre rule as the stone is an irregular shape.

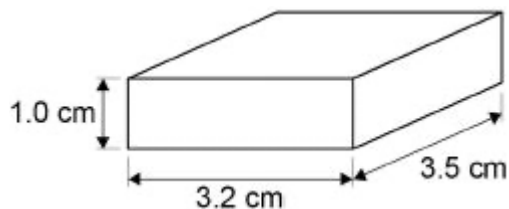
Describe how the student could determine the volume of stone **A** by putting it into water.

(3)

The student makes measurements of stone **B** using a metre rule.

The measurements of stone **B** are shown in **Figure 2**.

Figure 2



- (b) Which piece of equipment could the student use to get a more accurate measurement of the length of stone **B**?

Tick **one** box.

Electronic balance

☐

Microscope

☐

Newtonmeter

☐

Vernier callipers

☐

(1)

- (c) Use the following equation to calculate the volume of stone **B** in cm^3

volume = length $\times$ width $\times$ height

Volume = _____ cm^3

(1)

- (d) The mass of stone **B** is 56 grams.

Use your answer from part (c) to calculate the density of stone **B** in g/cm^3

Use the following equation.

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

Density = _____ g/cm^3

(2)

- (e) The student calculates the density of the material stone **A** is made of as 5.2 g/cm^3

The student looks up the density of some materials in a text book.

Figure 3 shows this information.

Figure 3

Material	Density in g/cm^3
Amber	1.1 – 1.2
Cubic Zirconia	5.5 – 5.9
Garnet	3.8 – 3.9
Haematite	5.1 – 5.3

What material is stone **A** made of?

Tick **one** box.

Amber

☐

Cubic Zirconia

☐

Garnet

☐

Haematite

☐

(1)

(Total 8 marks)

Q3.

Water exists as ice, water or steam.

- (a) Complete the sentences.

Choose the answers from the box.

ice	steam	water
------------	--------------	--------------

The particles are arranged in a regular pattern in _____.

The particles are close together but not in a pattern in _____.

The particles move quickly in all directions in _____.

(2)

- (b) Which will have the most internal energy?

Tick **one** box.

1 kg of ice

☐

1 kg of steam

☐

1 kg of water

☐

(1)

- (c) Which will have the lowest density?

Tick **one** box.

Ice

☐

Steam

☐

Water

☐

(1)

The image shows an iceberg floating in the sea.



- (d) The iceberg has a mass of 11 200 kg

The volume of the iceberg is 12.0 m³

Calculate the density of the iceberg.

Use the equation:

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

Density = _____ kg/m³

(2)

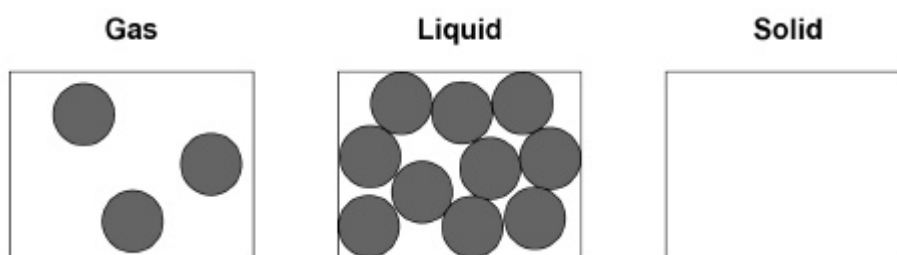
- (e) Explain why the iceberg will melt.

(2)

(Total 8 marks)

Q4.

The diagram shows a model of the particles in a gas and in a liquid.



- (a) Complete the diagram to show the arrangement of particles of the same substance as a solid.

(2)

- (b) What is the name of the process when a substance changes from a gas to a liquid?

Tick **one** box.

Condensing

☐

Evaporating

☐

Freezing

☐

Melting

☐

(1)

- (c) The substance in the diagram has a:

- melting point of 98 °C
- boiling point of 883 °C

What is the state of the substance at 20 °C?

Tick **one** box.

Gas ☐ Liquid ☐ Solid ☐

(1)

(d) What type of change is a change of state?

Tick **one** box.

Chemical	☐
Kinetic	☐
Permanent	☐
Physical	☐

(1)

(e) Which **two** statements are correct about the particles when a liquid turns into a gas?

Tick **two** boxes.

Particles are bigger	☐
Particles are lighter	☐
Particles have more chemical energy	☐
Particles have more kinetic energy	☐
Particles move faster	☐

(2)

(f) Which **two** quantities are needed to calculate the energy required to turn a liquid into a gas with no change in temperature?

Tick **two** boxes.

Mass of the liquid	☐
Specific heat capacity of the gas	☐
Specific latent heat of vaporisation	☐

Time the liquid is heated



(2)

- (g) A mass of 2.0 kg of water is heated.

The temperature increase of the water is 80 °C

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

Calculate the change in thermal energy when the water is heated.

Use the equation:

change in thermal energy = mass × specific heat capacity × temperature change

Change in thermal energy = _____ J

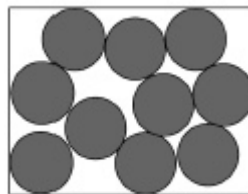
(2)

(Total 11 marks)

Q5.

Figure 1 shows a model of the particles in a liquid.

Figure 1



- (a) Give **one** similarity and **one** difference you would see in **Figure 1** if it showed the same substance as a gas.

Similarity _____

Difference _____

(2)

- (b) Describe **two** limitations of the model shown in **Figure 1**.

1. _____

2. _____

(2)

- (c) Explain why substances have different melting points.

(2)

- (d) Some fire extinguishers contain liquid carbon dioxide.

Suggest how carbon dioxide gas can be changed to liquid carbon dioxide without reducing its temperature.

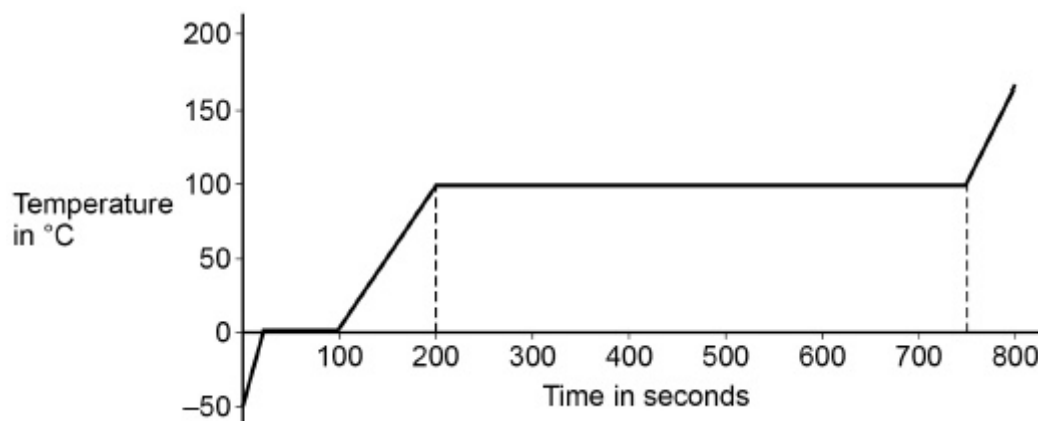
(1)

Ice was heated at a constant rate.

Eventually all the ice changed to a gas.

Figure 2 shows how the temperature changed over 800 seconds.

Figure 2



- (e) What change of state occurs between 200 seconds and 750 seconds?

(1)

- (f) Explain how **Figure 2** shows that the specific latent heat of vaporisation is greater than the specific latent heat of fusion.

Use data from **Figure 2**.

(2)

- (g) 1695 kJ of energy is transferred to water at 100 °C

The specific latent heat of vaporisation of water is $2.260 \times 10^6 \text{ J / kg}$

Calculate the mass of water changed into a gas at 100 °C

Use the Physics Equations Sheet.

Mass of water = _____ kg

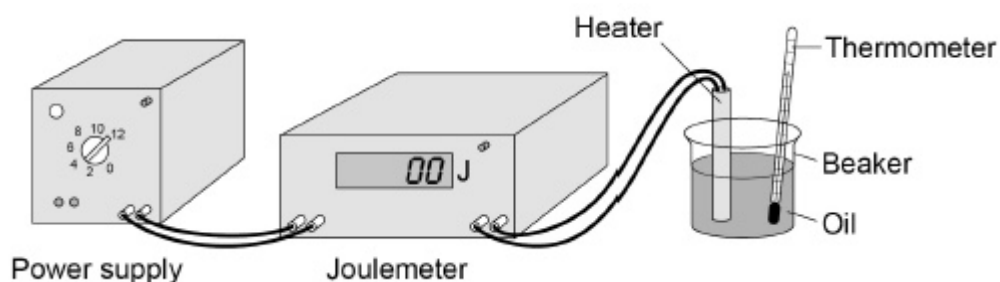
(3)

(Total 13 marks)

Q6.

Students investigated the specific heat capacity of different oils.

The diagram shows the equipment used.



This is the method used.

1. Put 200 g of an oil in a beaker.
2. Record the temperature of the oil.
3. Switch on the heater.
4. After 5 minutes, record the temperature of the oil and the reading on the joulemeter.

5. Repeat steps 1–4 with different oils.

(a) Give **one** variable the students controlled in the investigation.

_____ (1)

The table shows the students' results for one oil.

Temperature at start in °C	Temperature after 5 minutes in °C
21	68

(b) What is the resolution of the thermometer used in the investigation?

Resolution = _____ °C (1)

The students calculated the specific heat capacity of the oil as 2100 J/kg °C

The correct value for the specific heat capacity of the oil is 1630 J/kg °C

(c) Calculate the percentage difference between the two values.

Percentage difference = _____ %

(2)

(d) Suggest **two** improvements the students could make to obtain a more accurate value for the specific heat capacity.

1. _____

2. _____

(2)

(e) A company is considering what metal to use to make saucepans.

They use data about the:

- cost of each metal
- specific heat capacity of each metal.

Suggest **two** other properties the company needs to consider when deciding which metal to use.

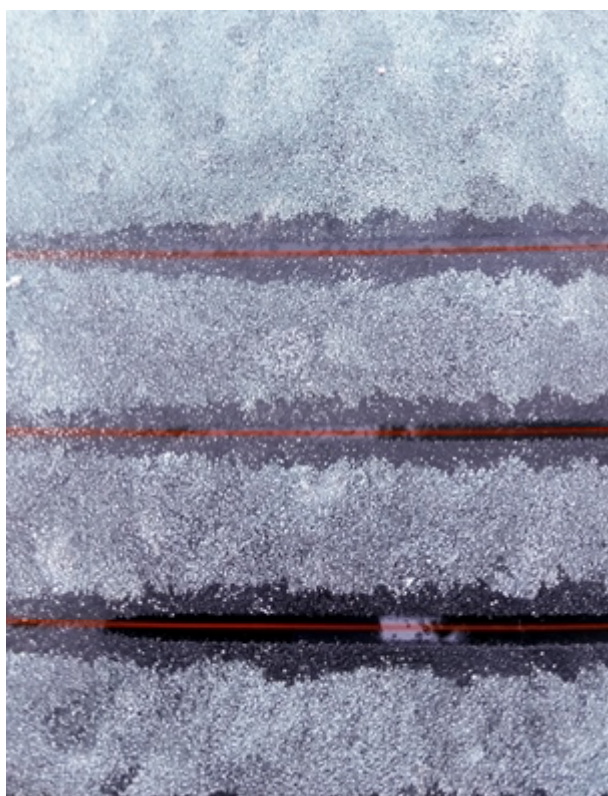
1. _____
2. _____

(2)
(Total 8 marks)

Q7.

Figure 1 shows solid ice on a car's rear window.

Figure 1

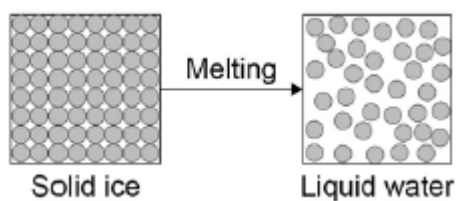


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The glass window contains an electrical heating element.

- (a) Use the particle model in **Figure 2** to describe how the heating element causes the arrangement of the ice particles to change as the ice melts.

Figure 2



You should include a description of how the particles are arranged in the solid ice and in the water.

(6)

- (b) A car manufacturer tests different heating elements by measuring how long it takes ice to melt.

During the test some variables must be controlled.

Identify **two** control variables in the car manufacturer's test.

Tick **two** boxes.

The colour of the car

☐

The current in the heating element

☐

The mass of ice

☐

The size of the car

☐

The time taken for the ice to melt

☐

(2)

- (c) Some of the energy supplied by the heater causes the ice to melt without the temperature of the ice increasing.

What is the name given to this energy supplied by the heater?

Tick **one** box.

Latent heat of freezing	
Latent heat of fusion	
Latent heat of vaporisation	

(1)

- (d) When the heater is supplied with 120 J of energy each second, the internal energy of the ice increases by 45 J each second.

Use the following equation to calculate the efficiency of the heater.

$$\text{Efficiency} = \frac{\text{Output energy transfer}}{\text{input energy transfer}}$$

Give your answer to two decimal places.

Efficiency = _____

(2)

(Total 11 marks)

Q8.

The particle model can be used to explain the properties of gases.

- (a) Describe the direction of motion of the particles in a gas.

(1)

- (b) Explain why heating a gas increases the average speed of the gas particles.

(3)

- (c) Water can exist as either a liquid or a gas at 100 °C.

Explain why a mass of gaseous water at 100 °C contains more energy than an equal mass of liquid water at 100 °C.

(2)

- (d) Water vapour is a gas. Gases change state when they cool.

The figure below shows condensation on a cold bathroom mirror.



© Dwight Eschliman/Getty Images

A volume of $2.5 \times 10^{-5} \text{ m}^3$ of condensation forms on the mirror.

Density of water = 1000 kg / m^3

Specific latent heat of vaporisation of water = $2.26 \times 10^6 \text{ J / kg}$.

Calculate the energy released when the condensation forms.

Energy released = _____ J

(5)

- (e) Central heating boilers burn gas and use the energy released to heat water.

Modern condensing central heating boilers take advantage of the energy that is released when water condenses.

Waste water vapour produced when the water is heated in the boiler is used to preheat the cold water entering the boiler.

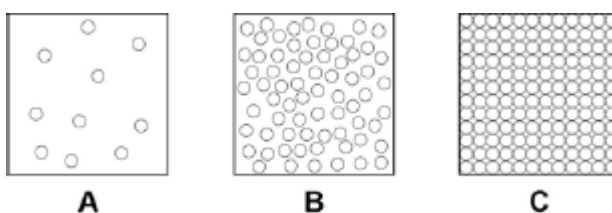
Give some of the arguments in favour of condensing boilers compared to older non-condensing boilers.

(4)

(Total 15 marks)

Q9.

The figure below shows a simple model of the three states of matter.



- (a) What is the correct equation to work out the density of a material?

(1)

- (b) A student explains density to his teacher using the particle model in the figure above.

His teacher says there are limitations to the model.

Give **two** limitations of the particle model in the figure above.

1. _____

2. _____

(2)

- (c) When the gas in a container with a fixed volume is heated, the pressure increases as the temperature increases.

Explain why the pressure increases.

Use the model in the figure above to help you.

(4)

(Total 7 marks)

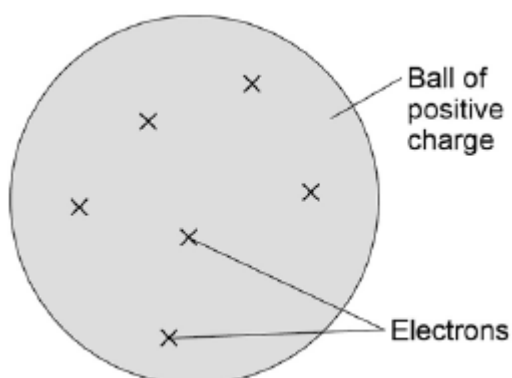
Q10.

Figure 1 shows the plum pudding model of the atom.

This model was used by some scientists after the discovery of electrons in 1897.

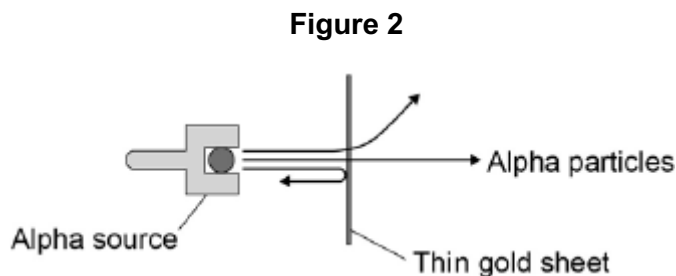
Figure 1

Plum-pudding model



In 1911 the scientists Geiger and Marsden investigated the effect of firing alpha particles at very thin sheets of gold foil.

Their experiment is shown in **Figure 2**. The arrows show the paths taken by alpha particles in the experiment.



- (a) Explain why scientists replaced the plum pudding model of the atom with the nuclear model of the atom as a result of the experiment.

(4)

- (b) According to modern measurements:

- the radius of an atom is about $1 \times 10^{-10}\text{m}$
- the radius of an atomic nucleus is about $1 \times 10^{-14}\text{m}$

Show that these values fit with the nuclear model of the atom.

(2)

- (c) In 1931 a scientist discovered that there are hydrogen atoms with mass number 2 as well as hydrogen atoms with mass number 1.

A year later, another scientist discovered neutrons.

Explain why the discovery of neutrons could explain the presence of hydrogen

atoms with different mass numbers.

(3)

- (d) How would the results of the experiment shown in **Figure 2** change if neutrons were used instead of alpha particles to bombard a thin sheet of gold?

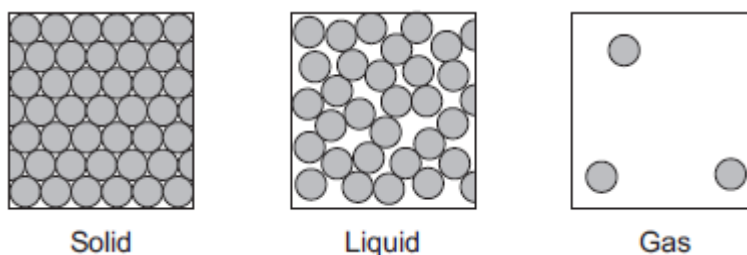
(2)

(Total 11 marks)

Q18.

In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.

The diagram shows the arrangement of particles in a solid, a liquid and a gas.



Use the diagram above and your own knowledge to compare solids, liquids and gases in terms of their particles.

You should include information about the arrangement, movement and energy of the particles.

(Total 6 marks)

Q19.

Figure 1 shows a woman filling her bathroom sink with hot water.



- (a) The mirror changes from being dry to being covered with small drops of water.

Name the process causing this change on the mirror.

(1)

- (b) The woman dries herself with a towel. She hangs the wet towel in the bathroom to dry.

Figure 2 shows two places she could hang the towel.

Figure 2



The towel will dry faster if it is hung from the unheated towel rail instead of the towel ring.

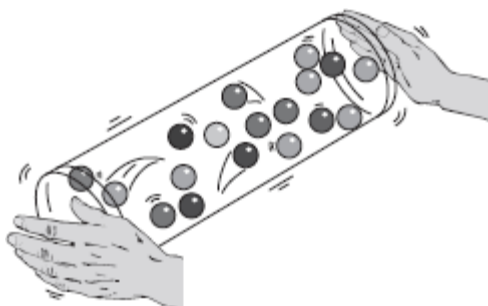
Explain why.

(2)

(Total 3 marks)

Q20.

A student shakes a tube containing small balls to model the movement of particles in a gas.



(a) Why is this a good model for the movement of particles in a gas?

Tick (✓) **two** boxes.

The balls move slowly.

☐

1

1

1

(Total 4 marks)

[illegible]

(4)

- (b) At the end of the race, the athlete is covered with a 'space blanket' made from shiny foil to prevent him from cooling too quickly.



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He wraps the space blanket around his body to reduce energy transfer to the surroundings.

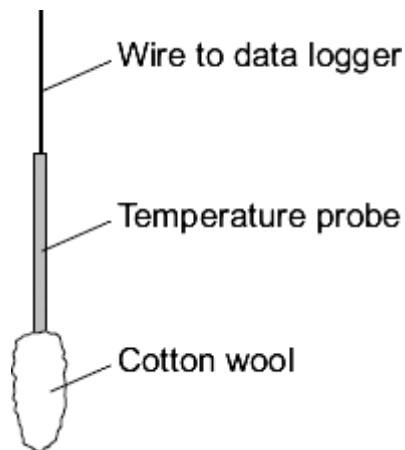
How does the space blanket reduce energy transfer to the surroundings?

(3)

(Total 7 marks)

Q22.

A student investigated the evaporation of three different liquids using the apparatus shown.

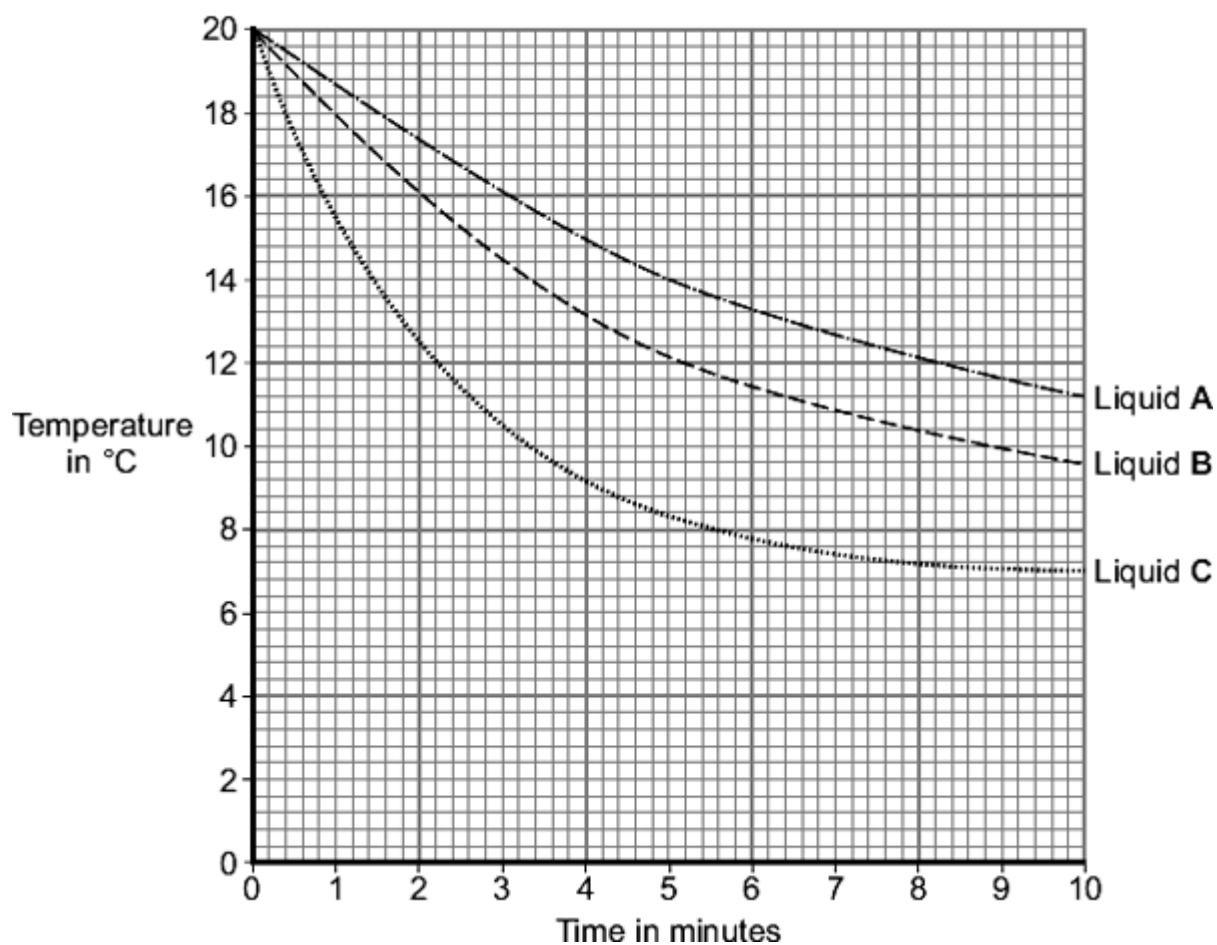


Identical pieces of cotton wool were soaked in one of three liquids, **A**, **B** or **C**, that have different boiling points. The same volume of liquid, at the same starting temperature, was used each time.

The temperature of the cotton wool was measured during a ten minute period.

The results are shown on **Graph 1**.

Graph 1



- (a) Which liquid has the lowest boiling point?

Explain your choice.

Liquid _____

Explanation _____

(2)

- (b) Room temperature is 20 °C.

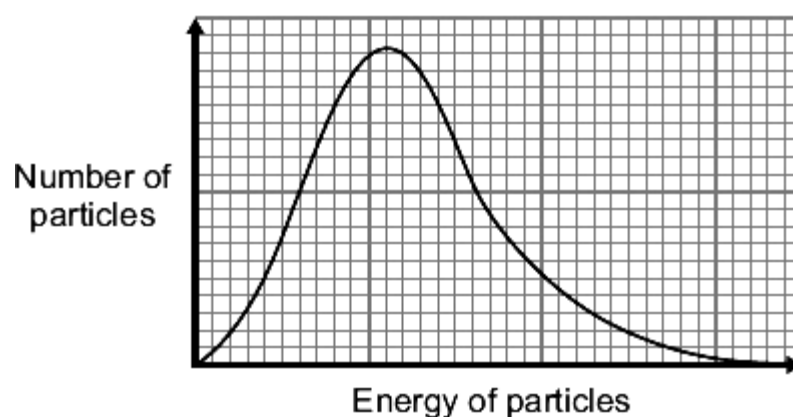
The line for liquid **C** reached a lower limit of 7 °C.

Explain why the temperature did **not** fall below 7 °C.

(1)

- (c) **Graph 2** shows the distribution of energy among particles in a liquid.

Graph 2



Explain, in terms of the particles in a liquid, why evaporation causes cooling.

You may use information from **Graph 2** to help you with your answer.

(4)
(Total 7 marks)

Mark schemes

Q1.

- (a) **Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.

5–6

Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.

3–4

Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

1–2

No relevant content

0

Indicative content

- measure mass
- use a top pan balance or scales

- part fill a measuring cylinder with water
- measure initial volume
- place object in water
- measure final volume
- volume of object = final volume – initial volume

- fill a displacement / eureka can with water
- water level with spout
- place object in water
- collect displaced water
- measuring cylinder used to determine volume of displaced water

- use of:

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

- (b) all y-axis values correct (minimum of 3)
allow 1 mark for two correct values

2

all bars drawn to the correct height
allow 1 mark for two correct bars
allow $\pm \frac{1}{2}$ small square

2

- (c)
$$\frac{(1120 - 960)}{2}$$

ignore + and / or – signs

1

= 80 (kg/m³)
an answer of 160 scores 1 mark

Q2.

- (a) (use a) displacement / eureka can filled with water

1

collect the water that is displaced (by the stone)

1

measure volume of water with a measuring cylinder

1

or

(use a) measuring cylinder of water (1)

take a start and end level of the water (in the measuring cylinder) (1)

*allow idea of measure how far water has risen
from original level*

calculate volume of water rise (1)

- (b) Vernier callipers

1

- (c) 11.2 (cm³)

allow 11

1

- (d) $\frac{56}{11.2}$

allow ecf from part (c)

1

5(.0)(g/cm³)

1

an answer of 5(.0) scores 2 marks

- (e) haematite

1

[8]

Q3.

- (a) ice
water
steam

allow 1 mark for 1 or 2 correct answers

2

- (b) 1 kg of steam

1

- (c) steam

- (d) $\rho = 11\,200 / 12.0$ 1
- $\rho = 933 \text{ (kg/m}^3\text{)}$ 1
- an answer of 933 (kg/m³) scores 2 marks* 1
- (e) the internal energy of the iceberg increases 1
- allow there is a temperature difference between ice and water / air* 1
- because
- therefore*
- energy is transferred from the sea/water to the ice(berg) 1

[8]

Q4.

- (a) (approximate same size particles as each other and as liquid and gas) touching 1
- do **not** accept particles that overlap* 1
- regular arrangement (filling the square) 1
- (b) condensing 1
- (c) solid 1
- (d) physical 1
- (e) particles have more kinetic energy 1
- particles move faster 1
- (f) mass of the liquid 1
- specific latent heat of vaporisation 1
- (g) $2 \times 4\,200 \times 80$ 1
- 672 000 (J) 1
- an answer of 672 000 (J) scores 2 marks* 1

[11]

Q5.

- (a) (similarity) same size / shape particles

1

(difference) further apart / fewer in same area
allow none / not many touching

1

- (b) any **two** from:

- no movement shown
- atoms / molecules / ions / particles are not solid spheres
- no forces between the spheres
- only 2D

2

- (c) • different forces between particles

allow substances have different types of bond

1

- (so) different amounts of energy required (to break forces)

1

- (d) high(er) pressure (within fire extinguisher)

1

- (e) liquid to gas

1

- (f) (change from solid to liquid) 80 seconds

and

(change from liquid to gas) takes 550 seconds

1

(therefore) takes longer so more (thermal) energy is supplied (to change state)

1

- (g) $1\,695\,000 = m \times 2.260 \times 10^6$

1

$$m = \frac{1\,695\,000}{2.260 \times 10^6}$$

1

0.75

an answer of 0.75 scores 3 marks
allow conversion of kJ to J

1

[13]

Q6.

- (a) mass of oil

or

time the heater was turned on

		1
(b)	1 (°C)	1
(c)	$\frac{470}{1630} \times 100$	
	28.8 (%)	1
	or	
	$\frac{470}{2100} \times 100$	
	22.4 (%)	1
(d)	insulate the beaker	
	or	
	add a lid	1
	use a smaller heater	
	or	
	submerge heater fully in oil	1
(e)	any two from:	
	• density / mass (of the metal) • reactivity (of the metal) • toxicity (of the metal) • strength / hardness (of the metal) • thermal conductivity (of the metal) • corrosion resistance (of the metal)	2
		[8]

Q7.

- (a) **Level 3 (5–6 marks):**
A clear, logical explanation containing accurate ideas presented in the correct order with links between ideas.
- Level 2 (3–4 marks):**
Key ideas presented with some linked together to form a partial explanation.
- Level 1 (1–2 marks):**
Fragmented ideas, some may be relevant, insufficient links to form an explanation.
- 0 marks:**
No relevant content.

Indicative content

- current in the wire causes heating
- increases temperature of the metal wires / ice

Solid

- arrangement of particles is regular
- particles vibrate about a fixed position

Melting

- internal energy of the ice increases, increasing the temperature to melting point
- so (as the temperature increases) particles vibrate faster
- eventually particles vibrate fast enough to break free from the (strong) bonds
- therefore the arrangement of particles becomes irregular

Liquid

- arrangement of particles is irregular
- particles movement (translational) is random

6

(b) The current in the heating element

1

The mass of ice

1

(c) latent heat of fusion

1

$45 / 120 = 0.375$

1

0.38

allow 0.38 with no working shown for 2 marks

allow 0.375 with no working shown for 1 mark

1

[11]

Q8.

(a) random

accept in all directions

1

description must be of random motion

(b) heating increases the temperature of the gas

1

temperature is proportional to kinetic energy

1

if kinetic energy increases speed increases

1

(c) energy is needed to change the state of the water

1

to break the bonds	1
(d) $1000 = m / 2.5 \times 10^{-5}$	1
$m = 2.5 \times 10^{-5} \times 1000$	1
$m = 0.025 \text{ (kg)}$	1
$E = 0.025 \times 2\,260\,000$	1
$E = 56\,500 \text{ (J)}$	1
<i>allow 56 500 (J) without working shown for 5 marks</i>	
<i>0 marks awarded for $E = m \times L$</i>	
(e) any four from:	
• because the water is preheated) the change in temperature of the water is less • so less energy is used to heat the water ($E=mc\Delta\theta$) • therefore they (condensing boilers) are more efficient • so less energy is wasted • less gas is burned to heat the same amount of water • less waste gas (CO_2) is produced by the boiler or (because less gas is used) they are cheaper to run / save money	4
	[15]

Q9.

(a) density = mass / volume	1
(b) any two from:	
• no forces shown between spheres • atoms / molecules / ions are not solid spheres • not all the same size.	2
(c) at higher temperatures particles have more kinetic energy	1
(so) the (average) speed of the particles increases	1
(so there are) more frequent collisions with the wall of the container	1
which apply a greater force on wall of container (so pressure rises)	1
	[7]

Q10.

- (a) most alpha particles went straight through, suggesting lots of empty space 1
- a few alpha particles bounced back, suggesting small central nucleus 1
- with all the positive charge 1
- the plum pudding model does not explain the results because it shows the whole atom as a ball of positive charge with no empty space 1
- (b) the figures show that the radius of an atom is 10 000 times bigger than the nucleus 1
- consistent with the nuclear model, which says that the atom has a tiny nucleus at the centre of the atom 1
- (c) all hydrogen atoms have just one proton (in the nucleus) 1
- some hydrogen atoms also have one neutron 1
- protons and neutrons have the same relative mass so mass number of these atoms is 2 1
- (d) neutrons are not attracted or repelled by a positive nucleus 1
- so the neutrons would all pass through the foil 1

[11]**Q18.**

Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should apply a 'best-fit' approach to the marking.

0 marks

No creditworthy response

Level 1 (1 – 2 marks)

At least **one** relevant statement is made

Level 2 (3 – 4 marks)

Relevant statements are made about two of the states

or

a relevant statement is made about each state

Level 3 (5 – 6 marks)

Relevant statements are made about each of the three states

Examples of the Physics points made in the response:

ignore statements about the states of matter

*a description without mention of particles, but clearly about particles, can gain **max** 4 marks*

solids:

- arranged in a regular pattern
allow closely / tightly packed / compact
- particles vibrate about fixed points
allow cannot move freely / around
- particles have low energy.

liquids:

- pattern is irregular
allow close together
- particles are not fixed in place **or** can move freely / around
- particles have more energy than solids and / or less energy than gases.

gases:

- particles are in a random pattern
allow far apart
- particles move (about) freely / randomly
allow move fast(er)
- particles have high energy.

[6]

Q19.

(a) condensation

1

(b) larger (exposed) surface area

1

(so) water can evaporate faster

or

(so) more water (molecules) can escape

allow more water can evaporate

1

[3]

Q20.

(a) balls are far apart from each other

1

balls move randomly

1

(b) solid

1

gas

1

[4]

Q21.

- (a) energy transferred from athlete / skin / body to water / sweat
allow water / sweat heated by athlete

1

(so) more energetic (water / sweat) particles escape (from the liquid)
accept particles with higher speeds escape (from the liquid)

1

water / sweat evaporates
accept particles escape from the (surface of the) liquid

1

(which) lowers the average energy of (remaining) water / sweat particles
allow reference to the total energy of the liquid reducing
allow lowers the athlete's temperature
ignore cool down

1

- (b) any **three** from:
accept IR / radiation / heat / infrared / energy throughout

- the blanket traps air
- air is an insulator
accept for 2 marks trapped air reduces conduction / convection
- space blanket reflects infrared radiation (back to the body)
ignore incident solar radiation
ignore reflects light
ignore bounces off
- space blanket is a poor emitter / radiator of infrared radiation
*do **not** accept does not emit infrared radiation*

3

[7]

Q22.

- (a) (liquid C)
no mark awarded for stating liquid C
no marks awarded if liquid A or B chosen

(causes) biggest temperature decrease
allow cools quicker / the quickest

1

(because it) evaporates quickest
allow evaporates quicker
allow most / more evaporated
ignore references to boiling

1

- (b) all of the liquid has evaporated
accept no net energy transfer
allow it was dry 1
- (c) particles with most energy / highest speed evaporate
allow hottest particles 1
- these particles escape from the (surface of the) liquid
accept overcoming the attractive forces (between particles) 1
- decreasing mean energy of particles (left in liquid)
allow some reference to the total energy of the liquid
reducing 1
- which lowers the temperature
ignore cool down 1

[7]

Examiner reports

Q1.

Foundation

- (a) This levels of response question had three tiers. When students are asked to describe a plan or method, their answer must contain all of the key steps in a logical sequence and lead to a valid outcome. This practical is one of the required practicals on the specification, so a displacement technique should have been described by students but this was not always the case. To achieve a level 3 response students should state:
- the variables are to be measured
 - the measuring instruments to be used
 - how the measurement is to be made
 - how the gathered data is to be processed.

Some students described the method without stating that the volume of the displaced water would equal the volume of the object. Measuring cylinders did not always get a mention with a significant number assuming that beakers would give an accurate enough measurement. Whilst some described how the object needed lowering carefully into the water to avoid splashes and excess spillage, others would have obtained very inaccurate measurements by collecting what overflowed from buckets and bowls. Some went no further than the volume measurement which was occasionally described as the density. 'Weighing' the object to get the mass, often without a mention of a balance or scales, was common.

There were some methods described which would not work, such as measuring dimensions, timing falls, or checking for sinking and floating. Some students described melting, smashing and breaking the object.

Very few students were able to write an answer which would lead to a valid outcome, with key steps identified and logically sequenced. Just over a third of students scored zero.

- (b) 57% of the students scored at least 2 marks with 39% gaining full marks but 17% did not score on this question and 5% made no attempt. There were some good answers putting 0, 250, 500 etc. on the y axis and accurate plotting of the three bars required. Some students put too many values on the y-axis making it difficult to judge if they were correct and giving more chance of getting one or more of the values wrong.
- (c) Only a small minority of students scored both marks and over two-thirds scored zero. It was possible to get the correct answer of 80 in a variety of ways and students did so but the concept of uncertainty seemed to be poorly understood.

Higher

- (a) This levels of response question had three tiers. When students are asked to describe a plan or method, their answer must contain all of the key steps in a logical sequence and lead to a valid outcome. This practical is one of the Required Practical Activities on the specification, so a displacement technique should have been described but this was not always the case. To achieve a level 3 response students should state:
- the variables to be measured
 - the measuring instruments to be used

- how the measurement is to be made
- how the data gathered is to be processed.

Some students described the method without stating that the volume of the displaced water would equal the volume of the object. Measuring cylinders did not always get a mention with a significant number assuming that beakers would give an accurate enough measurement. Whilst some described how the object needed lowering carefully into the water to avoid splashes and excess spillage, others would have obtained very inaccurate measurements by collecting what overflowed from buckets and bowls. Some went no further than the volume measurement which was occasionally described as the density. 'Weighing' the object to get the mass, often without a mention of a balance or scales, was common.

There were some methods described which would not work, such as measuring dimensions, timing falls, or checking for sinking and floating. Some students described melting, smashing and breaking the object.

25% of students were able to write an answer which would lead to a valid outcome with key steps identified and logically sequenced and were judged to have written a level 3 response. A further quarter of students achieved a level 2 mark. Level 1 was awarded to 30%. A significant minority scored zero or did not attempt the question.

- (b) 67% of the students scored full marks. There were good answers putting 0, 250, 500 etc. on the y-axis and accurate plotting of the three bars required.

Some students tried to put far too many values on the y-axis making it difficult to judge if they were correct and giving more of a chance of getting one or more of the values wrong.

- (c) Only a fifth of students gained both marks and just over half scored zero. It was possible to get the correct answer of 80 in a variety of ways, and students did, but the concept of uncertainty seemed to be poorly understood.

Q2.

- (a) This question on a Required Practical Activity was not answered well with 62% of students unable to achieve any marks. A 'measuring jug' was the most common piece of equipment used.

Most students seemed to know that there has to be water displacement and so the second marking point of either method was the one most often awarded.

Whichever route they took, it was the third marking point they seldom gained as calculating or measuring volume with a measuring cylinder was not referred to by most students. Answers such as 'measure the water' or 'find the difference' were more common.

- (b) The full range of answers were seen in this question, with 30% of students choosing correctly.
- (c) 85% of students were able to calculate volume using the equation given.
- (d) 77% of students achieved full marks for calculating density. 11% of students did not attempt this question.
- (e) 81% of students were able to interpret the data given to correctly identify haematite.

Q18.

In this QWC question students were asked to compare solids, liquids and gases in terms of the arrangement, movement and energy of their particles. Many students had not read the question carefully and did not compare all three states. Others just wrote about the properties of solids, liquids and gases, rather than the particles. A good tip for students is to underline important instructions and words in the question, and use these to check that they have answered the question fully.

Quite a lot of students sitting the Foundation paper used the drawings to help them to describe the arrangement of particles. However, 'they are arranged in rows in a solid', 'solids have a better arrangement of particles' or 'there are only a few particles in a gas' were insufficient. Some students described conduction and convection, or melting and evaporation. Quite a lot of students were confused about the energy of the particles. They thought there would be a lot of friction between the particles in a solid, which would increase their energy.

Good responses were usually set out logically, for example describing solids in terms of arrangement, movement and energy of the particles, followed by liquids and gases. Alternatively, some students described the comparative arrangement of particles in all three states, and then went on to compare them in terms of their movement and energy.

Q19.

- (a) Two thirds of the students answered the question correctly, saying 'condensation'. The most common incorrect response was 'evaporation'.
- (b) Very few students gained 2 marks for this question. Half of the students gained the first marking point for the idea that the towel on the rail would have a larger surface area. This was often described as being spread out more, which was credited. For the second mark a comparison was needed in relation to evaporation being faster, or more water evaporating or escaping. Some students said more air would be able to get to the towel, but didn't link this to evaporation, so did not gain this mark. Reference to the towel drying faster was often given, but as this was stated in the question it was not creditworthy.

Q20.

- (a) Most students could recognise how the model represented the movement of particles in a gas. Some had not followed the instructions and ticked more than two boxes.
- (b) Many students misinterpreted the question stem, or did not understand what a state of matter is, and answered yes or no. Some gave air instead of gas.

Q21.

- (a) Many responses included biological explanations of thermoregulation, much of which did not relate to this question. Few students mentioned that energy is transferred from the athlete to the sweat. Some explained that the particles would gain energy, but did not go on to say that the most energetic or fastest particles would escape. The third marking point was the one that most students gained, for stating that the sweat evaporated. However, many thought that particles evaporated, rather than the liquid. Reference to lowering the average energy of the particles that were left on the skin was rarely seen. "Lowering temperature" was seen more often.
- (b) Most students gained a mark for saying that the foil blanket would reflect energy

back to the athlete, although others thought it would reflect radiation from the Sun, which was ignored. Some mentioned that shiny surfaces are poor emitters of infrared radiation, but students could not gain this mark if they said no energy was emitted. The idea that air was trapped by the blanket was rarely seen.

Q22.

- (a) A large number of students gave liquid A as their answer, so gained zero marks. The most common correct answer was that liquid C cooled the quickest. Some thought it was being heated and there were a lot of references to boiling.
- (b) Very few students gave a correct response. Most said that the room temperature prevented it cooling further, or that room temperature was 7 °C. There were many incorrect references to boiling or freezing points, condensing and turning to a liquid. A poor understanding of cooling by evaporation and change of state was demonstrated.
- (c) Many students did not understand the graph which led to confused responses. It was clear that evaporation is not well understood. Few students realised that the particles with the most energy evaporated. The most common mark gained was for particles escaping from the liquid. Some students gave descriptions referring to the total energy of the liquid reducing but few went on to mention that this lowered the temperature of the liquid. They usually just repeated information given in the question and said the liquid cooled down, which was not enough for the last marking point.