1 A student investigates ice, water and steam.

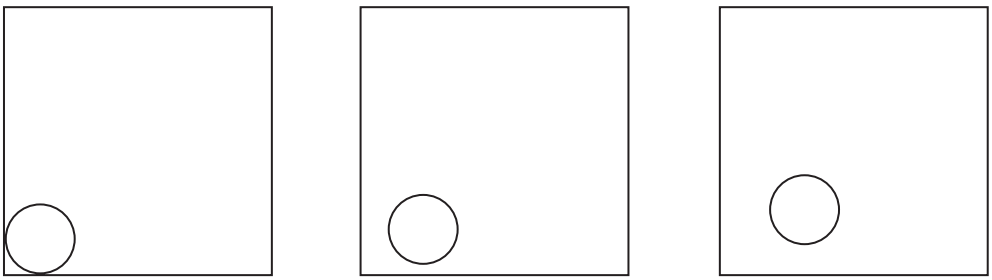
She heats up a sample of ice.

When it has all melted, she carries on heating until the water has all boiled to steam.

(a) Complete the diagram to show how the particles are arranged in ice, water and steam.

One particle in each box has been drawn for you.

(4)



ice water steam

(b) Complete the table by describing how the particles move in ice, water and steam.

(3)

Substance	How the particles move
ice	
water	
steam	

(Total for Question 1 = 7 marks)

2 James Dewar was a scientist who investigated liquid oxygen.

(a) He discovered that the boiling point of liquid oxygen is –183 °C.

(i) Convert –183 °C to a temperature on the Kelvin scale.

(1)

Temperature = ... K

(ii) Use ideas about particles to describe the changes that happen when a liquid boils to form a gas.

(3)

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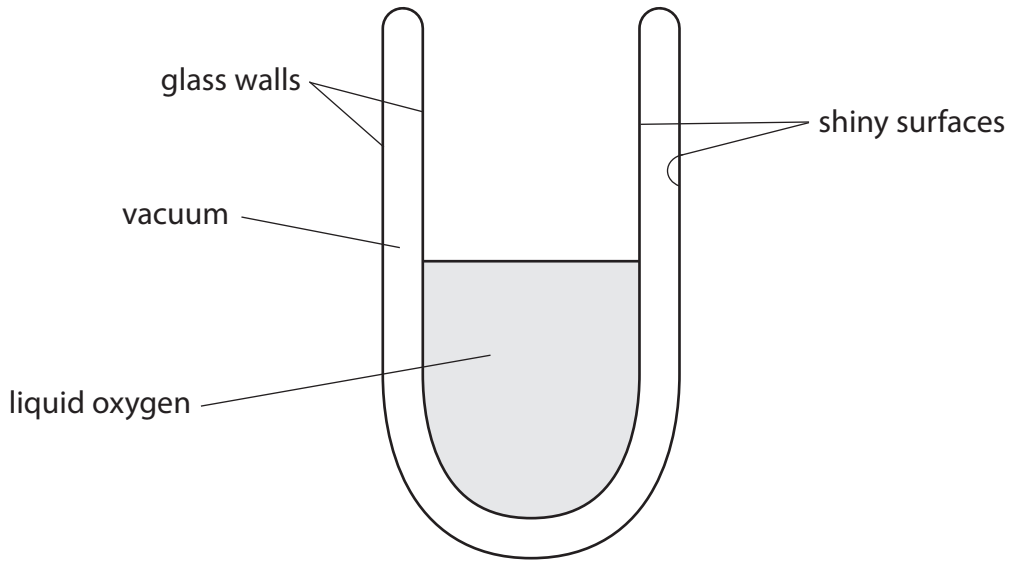
(b) Dewar invented a special flask for storing liquid oxygen in the laboratory.

It was designed to reduce heat flow from the air outside to the liquid oxygen inside.

The flask had two glass walls with a vacuum between them.

The inside glass surfaces were each covered with a thin layer of shiny metal.

The diagram shows a cross section of the flask.



(i) Explain how the **shiny surfaces** reduce the thermal energy transferred to the liquid oxygen from the laboratory.

(2)

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(ii) Explain how the **vacuum** reduces the thermal energy transferred to the liquid oxygen from the laboratory.

(2)

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(c) Dewar's flask did not have a lid when it was holding liquid oxygen.

Suggest why a lid was not needed.

(2)

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(Total for Question 2 = 10 marks)

3 The particles in the different states of matter behave differently.

(a) Draw a straight line linking each state of matter with the description of its particles.

(2)

state of matter	**description of particles**
solid	close together, moving about and can slide past one another
liquid	far apart, moving quickly and at random
gas	close together, vibrating about fixed positions

(b) Ethyne is a substance that is a gas at room temperature.

At a temperature of –81 °C, ethyne can exist as a solid, a liquid or a gas.

This temperature is called the triple point of ethyne.

(i) Complete the table by giving the missing temperatures.

(2)

	Temperature in °C	**Temperature in kelvin**
room temperature		291
triple point of ethyne	–81	

(ii) State what happens to the average kinetic energy of the gas molecules as the temperature is lowered from room temperature to the triple point of ethyne.

(1)

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(iii) State what happens to the volume of an ethyne molecule when the gas changes to a solid at the triple point.

(1)

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(Total for Question 3 = 6 marks)

4 The properties of materials can be explained using particle theory.

Brownian motion provides evidence to support particle theory.

(a) (i) Give an example of Brownian motion.

(1)

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(ii) Explain how Brownian motion supports the idea that matter is made from tiny particles in continuous motion.

(2)

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(b) These are some observations about samples of ice, water and steam.

	Shape	**Size**
ice	keeps a fixed shape	keeps a fixed size
water	takes the shape of the container	keeps a fixed size
steam	takes the shape of the container	fills the container

Explain each of the observations in terms of the arrangement and motion of the particles.

You may use diagrams to help your answer.

(6)

particles in ice .....

particles in water .....

particles in steam .....

(Total for Question 4 = 9 marks)

5 The picture shows a runner.

(a) As he runs, the runner gets hot.

To avoid overheating, his body sweats.

As the sweat evaporates, it cools his body.

Use ideas about particles to explain why evaporation leads to cooling.

(3)

(b) At the end of a long race, runners are given a shiny foil sheet to wear.

This stops them cooling down too quickly.

(i) Suggest why a runner might cool down too quickly if he does not wear a foil sheet.

(2)

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(ii) Explain how the foil sheet reduces heat loss.

(2)

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(Total for Question 5 = 7 marks)

6 A student blows up two balloons to the same size.

She puts one balloon into a freezer.

After a while, the student compares the two balloons.

The balloon that has been cooled is smaller.

(a) Use ideas about particles to explain why the cooled balloon is smaller.

(4)

(b) The student decides to investigate the link between temperature and the size of the balloon.

She writes a plan.

> I will change the temperature of the balloon by putting it into a freezer.
>
> To get a range of different temperatures I will put the balloon into the freezer for different times.
>
> I will measure the temperature of the balloon using a thermometer.
>
> To measure the size of the balloon I will take it out of the freezer and line it up next to a ruler.
>
> To make sure it is a fair test I will repeat the experiment three times.
>
> I will plot a graph of size against temperature.

There are several faults in the student's plan.

Identify **three** of these faults and suggest an improvement to correct each one.

(6)

1 .....

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2 .....

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3 .....

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(Total for Question 7 = 10 marks)