Revision Pack Topic 3- The Particle Model

Changes of state and the particle model	R/A/G
Density of materials	
Density of a material is defined by the equation: $$\text{Density} = \frac{\text{mass}}{\text{volume}}$$	
The particle model can be used to explain the different states of matter and differences in density	
Draw simple diagrams for a solid, liquid and gas	
Solids, liquids and gases have a different density, this can be shown by the arrangement of atoms or molecules	
Required practical 17: Density	
Explain how the main sub-cellular structures, including the nucleus, cell membranes, mitochondria, chloroplasts in plant cells and plasmids in bacterial cells are related to their functions. Most animal cells have the following parts: • a nucleus • cytoplasm • a cell membrane • mitochondria • ribosomes. In addition to the parts found in animal cells, plant cells often have: • chloroplasts • a permanent vacuole filled with cell sap. Plant and algal cells also have a cell wall made of cellulose, which strengthens the cell	
Changes of state	
Describe how mass is conserved when solids, liquids and gases change state	
Changes of states are physical changes which are different from chemical changes because the material can reverse back to its original properties	
Internal energy and energy transfers	
Internal energy is energy stored inside a system by the particles (atoms & molecules)	
Internal energy is the total kinetic energy and potential energy of all the particles that make up a system	
Heating changes the energy stored within a system by increasing the energy of the particles that make up the system, this can; • Increase the temperature of the system • Produce a change in state	
Specific heat capacity	
The increase in temperature depends on the mass of the substance heated, the type of material and the energy input to the system:	

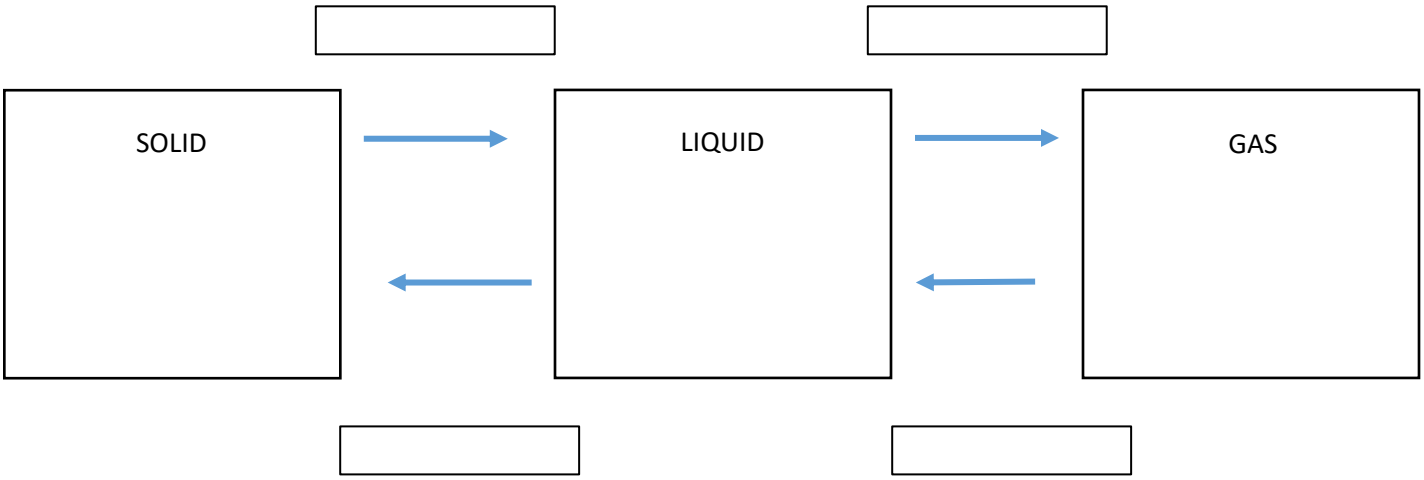
Revision Pack Topic 3- The Particle Model

Change in thermal energy (J) — Mass (kg) — Specific heat capacity (J/kg°C) — Temperature change (°C) $\Delta E = mc\Delta\theta$	
The specific heat capacity of a substance is the amount of energy required to raise the temperature of one kilogram of the substance by one degree Celsius.	
Specific Latent Heat	
If a change of state happens the energy needed for a substance to changes state is called latent heat. When a change of state occurs, the energy supplied changes the energy stored but not the temperature	
Specific latent heat is the amount of energy required to change the state of one kilogram of the substance with no change in temperature. **Energy (E) = Mass (m) × Specific Latent Heat (L)** **Energy is given in joules (J), mass is in kg and SLH is in J/kg.**	
Specific heat of fusion – change of state from solid to liquid	
Specific heat of vaporisation – change of state from liquid to a vapour	
Interpret heating and cooling graphs that show a change of state	
Particle Motion in gases:	
Particles in a gas are in constant random motion	
The temperature of the gas is related to the average kinetic energy of the molecules	
Changing the temperature of a gas, held at a constant volume changes the pressure exerted on a gas	
You should be able to explain how the motion of molecules in a gas is related to both its temperature and its pressure	
You should be able to explain quantitatively the relation between the temperature of a gas and its pressure at a constant volume.	

Revision Pack Topic 3- The Particle Model

Solids, Liquids and Gases

Complete the boxes to represent particles within a solid, liquid and gas. Label the changes of states from one state to the other.



Define sublimation: _____

_____

A change of state is a physical change, what is the difference between a physical and a chemical change:

_____

_____

State the conservation of mass:

_____

_____

Does mass change when a change of state occurs? Why / why not?

_____

_____

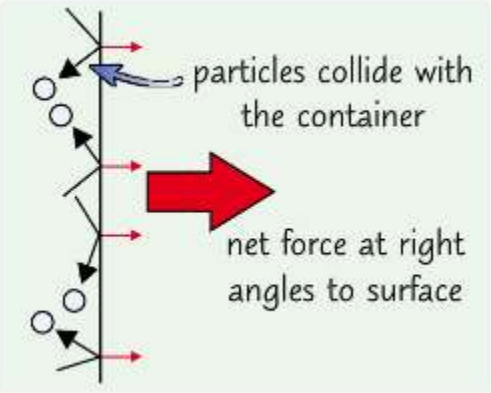
Revision Pack Topic 3- The Particle Model

Complete the table to explain the properties of a solid, liquid and gas.

	Forces of attraction?	Arrangement?	Energy?	Movement?
SOLID				
LIQUID				
GAS				

Pressure:

Particles in gases are free to move around, use this image to explain what happens when they bang into each other and the side of the container



Define pressure:_____

_____

Explain what will happen to the levels of kinetic energy in a closed system if you heat gas particles:

_____

_____

Describe the effect of increases temperature on pressure:

_____

_____

Revision Pack Topic 3- The Particle Model

Density of materials:

The density of an object can tell you how many particles have are present in a given space.

The equation for density is:

State the units for density: _____

Rearrange the equation to find the mass of an object:

Rearrange the equation to find the volume of an object:

Practice questions:

A gold bar has a mass of 8kg and a volume of $6m^3$, what is the density?

A bottle of coca cola has a mass of 0.5kg and a volume of 3 m^3 what is the density?

A concrete block has a density of 25000kg/ m^3 and a volume of 15 m^3, what is the mass?

A bed has a density of 19 000 kg/ m^3 and a mass of 25kg, what is the volume?

Revision Pack Topic 3- The Particle Model

Be prepared to be given volume is standard form! Practice here:

Change the following numbers into standard form:

20000000

0.0000001

257000

0.0005

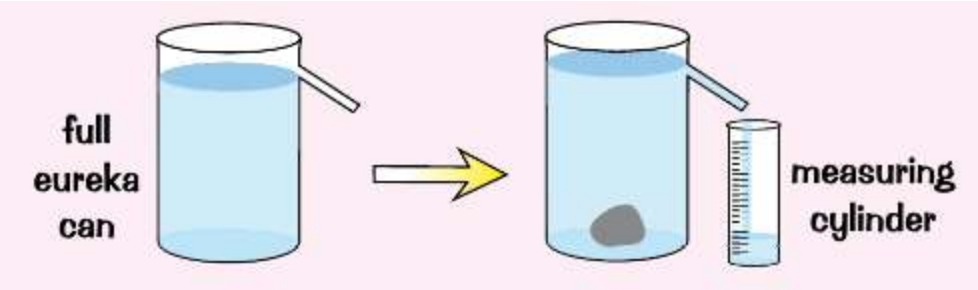
The density of an object depends on_____ and how its particles are _____.

A _____ material has particles that are tightly packed together, the particles in less dense materials would be more _____.

You can increase the density of a material if you _____ it.

How to measure density:

To find the density of a solid object see the image below. What measurements would you need to make before placing the object in the water?



_____

_____

Revision Pack Topic 3- The Particle Model

What equation would you then use to measure the density of a solid object?

To find the density of a liquid you would need a balance and a measuring cylinder. Write a short method using the mentioned equipment

-
-
-
-
-

INTERNAL ENERGY:

Define a system:

_____

_____

Where is energy stored within a system?

_____

Use the word to help you fill in the gaps:

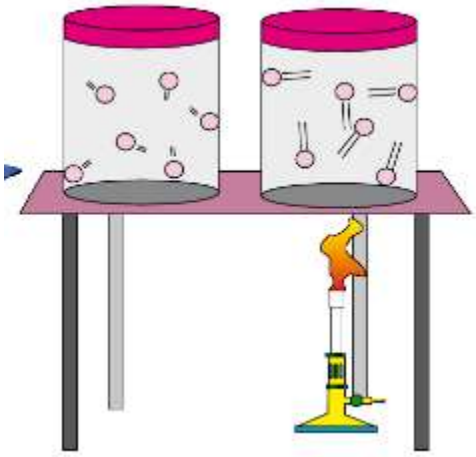
The _____ of a system is the _____ that its _____

have in their _____ and _____ energy stores.

kinetic energy	energy	total energy	Internal energy
Potential	particles	transfer	vibrate

Revision Pack Topic 3- The Particle Model

Using the diagram to help you, explain how heating the system can change the particle energy and lead to a change in state:



_____

_____

_____

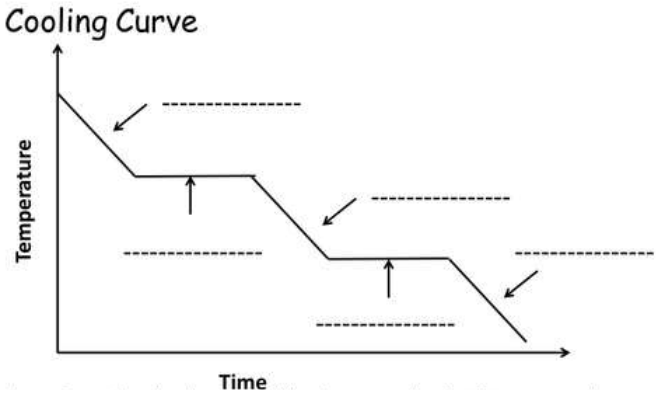
_____

Heating and cooling graphs:

A change in state requires energy. Label the graphs to show the change of state at each part of the graph and the state of the object.

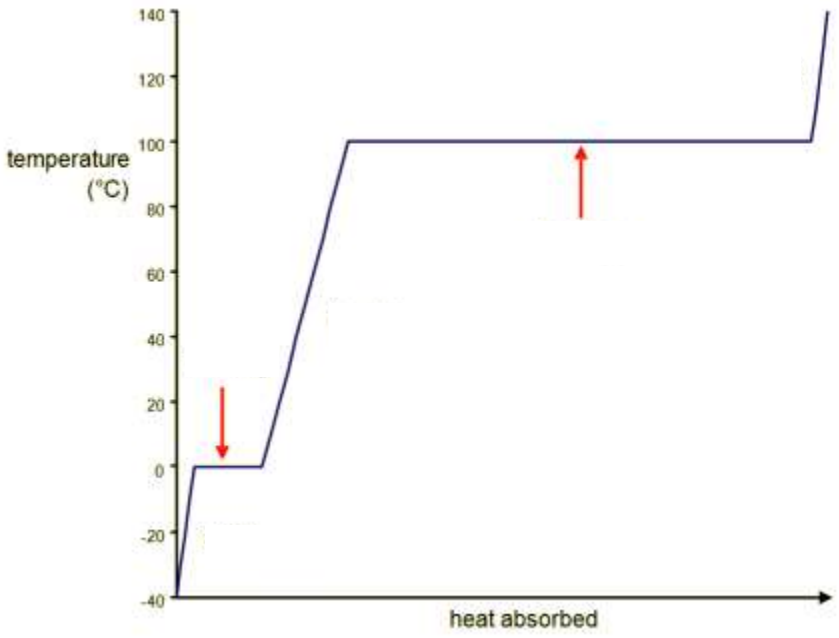
**Hint check the axis of each graph

COOLING GRAPH:



Revision Pack Topic 3- The Particle Model

HEATING GRAPH:



When heat or energy is used to melt or boil a substance the internal energy increases.

What is this energy used to break?

_____

What do the flat parts of the graph represent?

_____

_____

SPECIFIC LATENT HEAT

Define specific latent heat:

_____

_____

Energy is released during_____

Revision Pack Topic 3- The Particle Model

State the difference between **specific latent heat of fusion** and the **specific latent heat of vaporisation.**

_____

_____

_____

_____

Identify the formula for specific latent heat, include the units:

Practice using the equation:

Rearrange the equation to find the mass of a substance?

Rearrange the equation to find the energy of a substance?

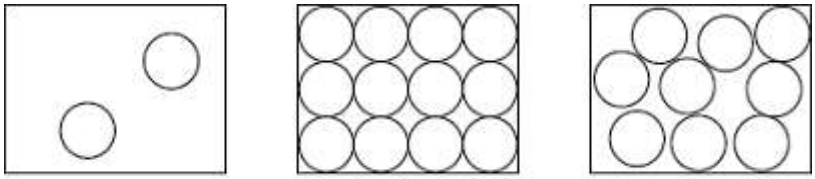
Use the equation to work out:

The specific heat of vaporisation for water (boiling) is 3,800,000J/kg. How much energy is needed to completely boil 1.5kg of water?

The specific heat of fusion for a particular substance is 120 000J/kg. How much energy is needed to melt **250g (**HINT** UNITS!!!) of it?

Revision Pack Topic 3- The Particle Model

Q1.(a) The diagrams, **X**, **Y** and **Z**, show how the particles are arranged in the three states of matter.



X **Y** **Z**

(i) Which **one** of the diagrams, **X**, **Y** or **Z**, shows the arrangement of particles in a liquid?

Write the correct answer in the box. ☐ **(1)**

(ii) Which **one** of the diagrams, **X**, **Y** or **Z**, shows the arrangement of particles in a gas?

Write the correct answer in the box. ☐ **(1)**

(b) Draw a ring around the correct answer in each box to complete each sentence.

(i) In a gas, the particles are

- vibrating in fixed positions.
- moving randomly.
- not moving.

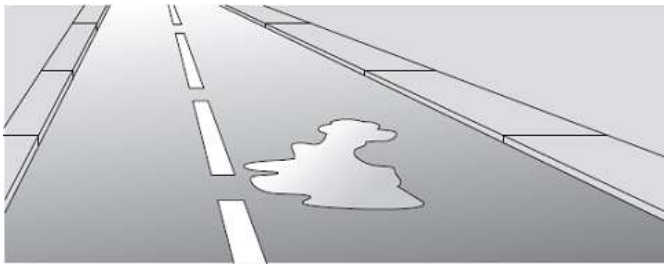
(1)

(ii) In a solid, the forces between the particles are

- stronger than
- equal to
- weaker than

the forces between the particles in a liquid. **(1)**

(c) The picture shows a puddle of water in a road, after a rain shower.



(i) During the day, the puddle of water dries up and disappears. This happens because the water particles move from the puddle

into the air. What process causes water particles to move from the puddle into the air?

Draw a ring around the correct answer.

condensation **evaporation** **radiation**

1)

(ii) Describe **one** change in the weather which would cause the puddle of water to dry up faster.

.....

.....**(1)(Total 6 marks)**

Q2.In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.

The information in the box is about the properties of solids and gases.

Solids:
- have a fixed shape
- are difficult to compress (to squash).

Gases:
- will spread and fill the entire container
- are easy to compress (to squash).

Use your knowledge of kinetic theory to explain the information given in the box.

You should consider:
- the spacing between the particles
- the movement of individual particles
- the forces between the particles.

HINT – think back to the table at the start of this booklet!

.....

.....

.....

.....

.....

.....

.....

.....

.....

Revision Pack Topic 3- The Particle Model

.....

.....

.....

Extra space .....

.....

.....

.....

.....

.....

.....

..... **(Total 6 marks)**

Q3. Energy can be transferred through some materials by convection.

(a) Use the correct answer from the box to complete the sentence.

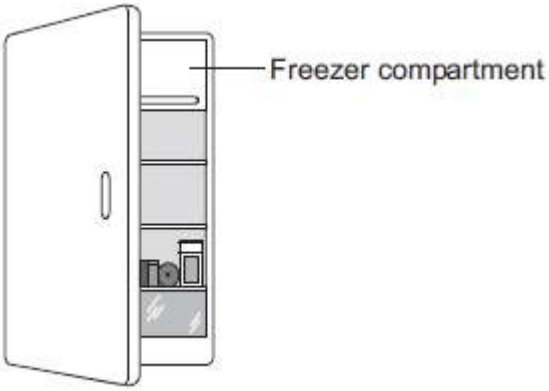
gas	**liquid**	**solid**

Energy **cannot** be transferred by convection through a ..... .**(1)**

(b) The figure below shows a fridge with a freezer compartment. The temperature of the air inside the freezer compartment is –5 °C.

Use the correct answer from the box to complete each sentence.

Each answer may be used once, more than once or not at all.



decreased	**unchanged**	**increased**

When the air near the freezer compartment is cooled, the energy of the

air particles is ..... . The spaces between the air particles are

..... .The density of the air is ..... . **(3)**

Revision Pack Topic 3- The Particle Model

(c) The table below shows some information about three fridges, **A**, **B** and **C**.

The efficiency of each fridge is the same.

Fridge	Volume in litres	Energy used in one year in kWh
A	232	292
B	382	409
C	622	524

(i) Which fridge, **A**, **B** or **C**, would cost the least to use for 1 year? ☐

Give **one** reason for your answer.

.....

.....**(2)**

(ii) A householder looks at the data in the table above. What should she conclude about the pattern linking the volume of the fridge and the energy it uses in one year?

.....

.....**(1)**

(iii) The householder could not be certain that her conclusion is correct for all fridges.

Suggest **one** reason why not.

.....

.....**(1)(Total 8 marks)**

Q4. Density can be explained using the particle model.

(a) What is the unit of density (ρ)?

Tick **one** box.

joules, J ☐

joules per kilogram, J / kg ☐

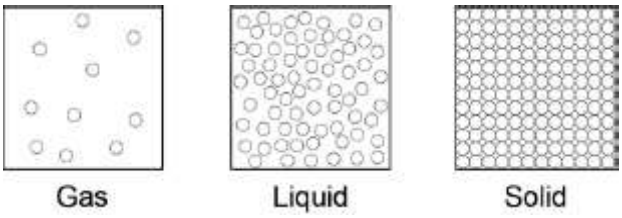
Revision Pack Topic 3- The Particle Model

kilograms, kg ☐

kilograms per metre cubed, kg / m^3 ☐

(1)

(b) The figure below shows particles of the same substance in three states of matter.



Use the figure above to explain why the solid has the highest density.

.....

.....

.....

.....**(2)**

(c) Complete the sentences. Use answers from the box.

downwards	**kinetic**	**nuclear**	**potential**	**randomly**	**slowly**

The particles in a gas are constantly moving. The particles move

..... When the temperature of the

particles in a gas is increased the particles have more

.....energy . **(2)**

(d) A gas is put into a closed container. The container and the gas inside it are heated.

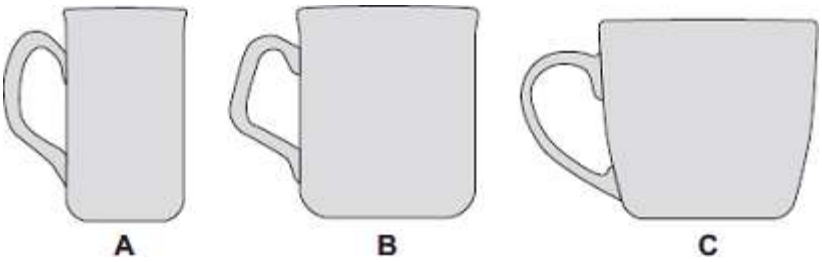
What will happen to the pressure inside the container?

.....**(1)(Total 6 marks)**

Revision Pack Topic 3- The Particle Model

Q5. The diagram shows three cups **A**, **B** and **C**.

Energy is transferred from hot water in the cups to the surroundings.



(a) Use the correct answer from the box to complete each sentence.

condensation	**conduction**	**convection**

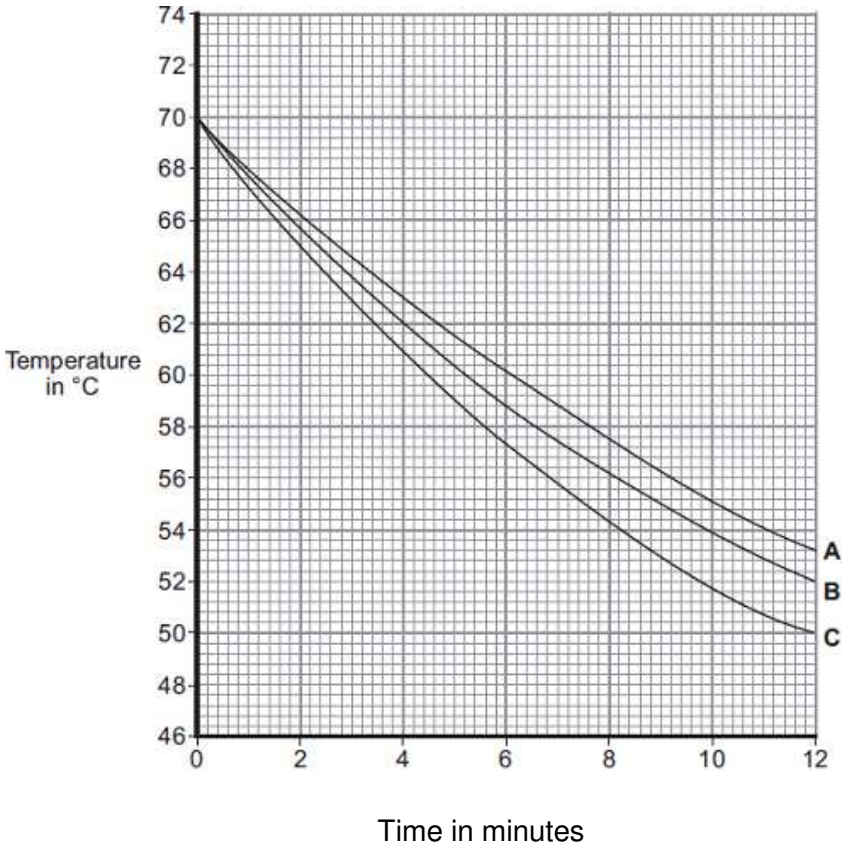
Energy is transferred through the walls of the cup by ..... .

In the air around the cup, energy is transferred by ..... .**(2)**

(b) Some students investigated how the rate of cooling of water in a cup depends on the surface area of the water in contact with the air.

They used cups **A**, **B** and **C**. They poured the same volume of hot water into each cup and recorded the temperature of the water at regular time intervals.

The results are shown on the graph.



Revision Pack Topic 3- The Particle Model

(i) What was the starting temperature of the water for each cup?

Starting temperature = ... °C **(1)**

ii) Calculate the temperature fall of the water in cup **B** in the first 9 minutes.

.....

Temperature fall = ... °C **(2)**

(iii) Which cup, **A**, **B** or **C**, has the greatest rate of cooling?

Using the graph, give a reason for your answer.

.....

.....**(2)**

(iv) The investigation was repeated using the bowl shown in the diagram.

The same starting temperature and volume of water were used.

Draw on the graph in part **(b)** another line to show the expected result. **(1)**

(v) After 4 hours, the temperature of the water in each of the cups and the bowl was 20°C.

Suggest why the temperature does **not** fall below 20°C.

.....**(1)**

(c) (i) The mass of water in each cup is 200 g.

Calculate the energy, in joules, transferred from the water in a cup when the temperature of the water falls by 8°C.

Specific heat capacity of water = 4200 J / kg°C.

.....

.....

.....

Energy transferred = ... J **(3)**

Revision Pack Topic 3- The Particle Model

(ii) Explain, in terms of particles, how evaporation causes the cooling of water.

.....

.....

.....

.....

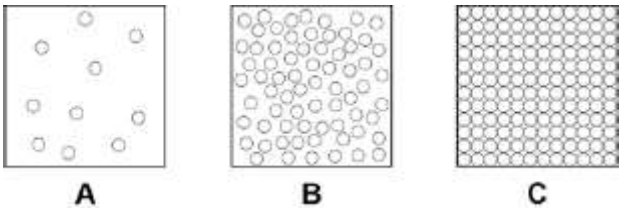
.....

.....

.....

.....**(4)(Total 16 marks)**

Q6. 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.

.....

Revision Pack Topic 3- The Particle Model

.....

.....

.....

.....

.....

.....

.....**(4)(Total 7 marks)**

Revision Pack Topic 3- The Particle Model

MARK SCHEME – USE A GREEN PEN TO MARK AND MAKE CHANGES TO YOUR WORK

M1.(a) (i) Z 1

(ii) X 1

(b) (i) moving randomly 1

(ii) stronger than 1

(c) (i) evaporation 1

(ii) any **one** from:

- becomes windy
- temperature increases

  accept (becomes) sunny"the sun" alone is insufficient
- less humid 1 **[6]**

M2. 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 also apply a 'best-fit' approach to the marking.

0 marks - No relevant content.

Level 1 (1–2 marks)

Considers either solid or gas and describes at least one aspect of the particles.

Or Considers both solids and gases and describes an aspect of each.

Level 2 (3–4 marks)

Considers both solids and gases and describes aspects of the particles.

Or Considers one state and describes aspects of the particles and explains at least one of the properties.

Or Considers both states and describes an aspect of the particles for both and explains a property for solids or gases.

Level 3 (5–6 marks)

Considers both states of matter and describes the spacing and movement / forces between the particles. Explains a property of both solids and gases.

examples of the points made in the response

Revision Pack Topic 3- The Particle Model

Solids

- (particles) close together
- (so) no room for particles to move closer (so hard to compress)
- vibrate about fixed point
- strong forces of attraction (at a distance)
- the forces become repulsive if the particles get closer
- particles strongly held together / not free to move around (shape is fixed)

any explanation of a property must match with the given aspect(s) of the particles.

Gases

- (particles) far apart
- space between particles (so easy to compress)
- move randomly
- negligible / no forces of attraction
- spread out in all directions (to fill the container) **[6]**

M3.(a) solid 1

(b) decreased - *correct order only* 1

decreased 1

increased 1

(c) (i) A

reason only scores if A chosen 1

uses least / less energy (in 1 year)

a comparison is required

accept uses least power

accept uses least kWh 1

(ii) greater the volume the greater the energy it uses (in 1 year) 1

(iii) a very small number sampled

accept only tested 3

accept insufficient evidence / data

allow not all fridges have the same efficiency ***or*** *a correct description implying different efficiencies*

only tested each fridge once is insufficient

there are lots of different makes is insufficient 1 **[8]**

M4.(a) kilograms per metre cubed, kg / m^3 1

(b) (solid has) more particles

allow atoms for particles 1

in the same volume **or** in a given volume

allow description of a given area 1

(c) randomly - *this order only* 1

kinetic 1

(d) (pressure) rises 1 **[6]**

M5.(a) conduction - *must be in correct order* 1

Convection 1

(b) (i) 70

accept ± half a square (69.8 to 70.2) 1

(ii) 15

accept 14.6 to 15.4 for ***2*** *marks*

allow for ***1*** *mark 70 − 55*

ecf from (b)(i) ± half a square 2

(iii) C 1

biggest drop in temperature during a given time

accept it has the steepest gradient this is a dependent *1*

(iv) starting at 70 °C and below graph for C must be a curve up to at least 8 minutes 1

(v) because 20 °C is room temperature

accept same temperature as surroundings 1

(c) (i) 6720

*correct answer with or without working gains **3** marks*

*6 720 000 gains **2** marks*

*correct substitution of E = 0.2 × 4200 × 8 gains **2** marks*

*correct substitution of E = 200 × 4200 × 8 gains **1** mark* 3

(ii) the fastest particles have enough energy

accept molecules for particles 1

to escape from the surface of the water 1

therefore the mean energy of the remaining particles decreases

accept speed for energy 1

the lower the mean energy of particles the lower the temperature (of the water)

accept speed for energy 1**[16]**

M6.(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]§§**