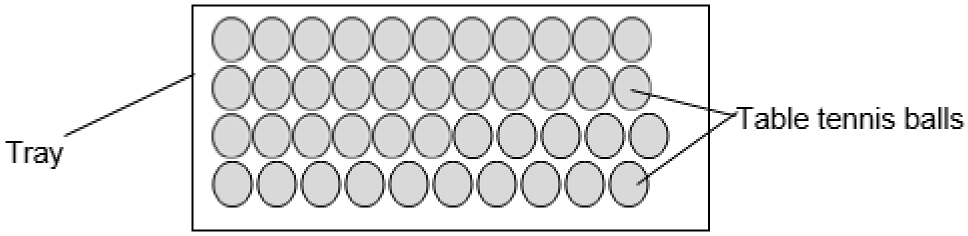
6-3 Particle model of matter – Physics

1.0 A teacher uses a tray filled with table tennis balls to model how particles are arranged in materials, as shown in **Figure 1**

Figure 1



1.1 Initially the balls are arranged in regular pattern as shown in **Figure 1**.

Which state of matter is best represented by the balls in **Figure 1**?

[1 mark]

Tick **one** box.

solid ☐

liquid ☐

gas ☐

1.2 The teacher then moves the tray from side to side so that the table tennis balls are no longer in a regular pattern.

Which state of matter is now best represented by the balls?

[1 mark]

Tick **one** box.

solid ☐

liquid ☐

gas ☐

1.3 The teacher next performs another demonstration by moving the tray more vigorously so that some of the balls jump out of the tray.

The teacher tells the students that the balls that have left the tray represent gas particles.

Which **two** processes could this demonstration represent?

[2 marks]

Tick **two** boxes.

boiling ☐

condensing ☐

evaporation ☐

freezing ☐

melting ☐

1.4 Gases can be at different temperatures.

[1 mark]

Tick **one** box.

The temperature of a gas is related to

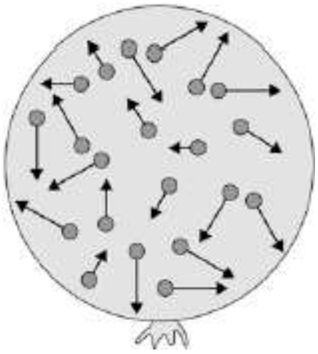
the average size of the particles ☐

the average mass of the particles ☐

the average kinetic energy of the particles ☐

2.1 **Figure 2** shows some of the gas particles in a balloon.

Figure 2



Describe the movement of the gas particles inside the balloon.

[2 marks]

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2.2 The gas in the balloon has a mass of 0.032 kg.

The balloon has a volume of 0.025 m^3.

Calculate the density of the gas in the balloon.

[2 marks]

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Density of gas = ____________________ kg/m^3

2.3 The balloon is held by a diver.

Above the water, the pressure is 1.0×10^5 Pa.

Calculate the value of the p × V constant for the balloon.

Give your answer in standard form to 2 significant figures.

[2 marks]

Constant = ______________ Pa m^3

2.4 The diver dives underwater with the balloon.

At a depth of 25 m, the pressure was 3.5×10^5 Pa.

Calculate the volume of the ball at this depth.

Give your answer to 2 significant figures.

[2 marks]

Volume = ______________ m^3

2.5 Explain what would happen to the temperature of the gas in the balloon if it was moved very quickly to the greater depth.

[2 mark]

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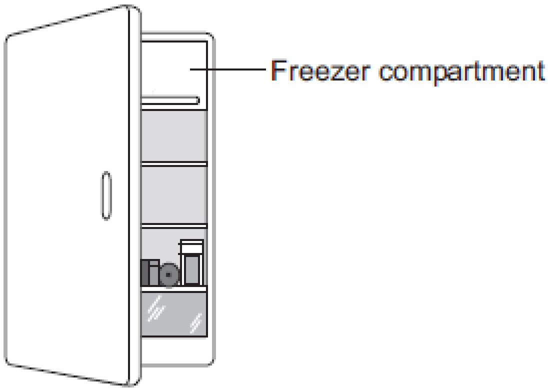
3.0 **Figure 3** shows a fridge with a freezer compartment.

Figure 3



3.1 Energy is transferred to cool food when it is placed in the fridge.

Complete the sentence to describe how energy is transferred to cool the food.

[2 marks]

food	**fridge**	**surroundings**

Energy is transferred from the ________________ to the ______________,

this energy is then transferred to the ______________.

3.2 The fridge and freezer compartment contain water in three different states.

Use your knowledge of the particle model to explain the differences in how the particles are arranged in solids liquids and gases

Include in your answer any differences in how the particles move in each state of matter.

[6 marks]

3.3 The temperature of the air inside the freezer compartment is –5 °C.

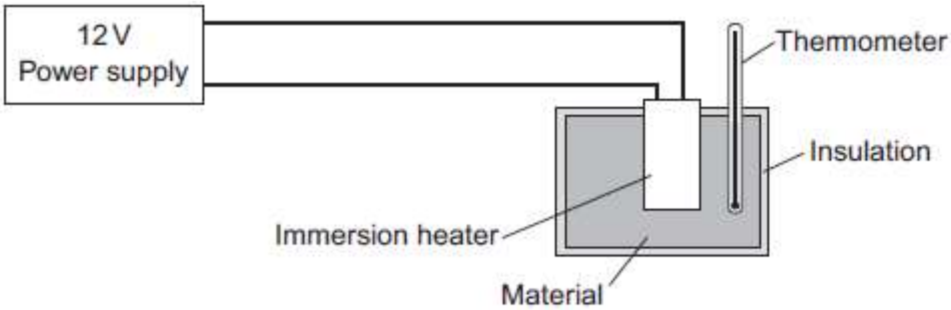
The temperature of the air inside the fridge is 5 °C

Explain why the particles in the freezer compartment move at a different speed than those in the main part of the fridge.

[2 marks]

4.0 A student used the apparatus in **Figure 4** to compare the specific heat capacities of different metals.

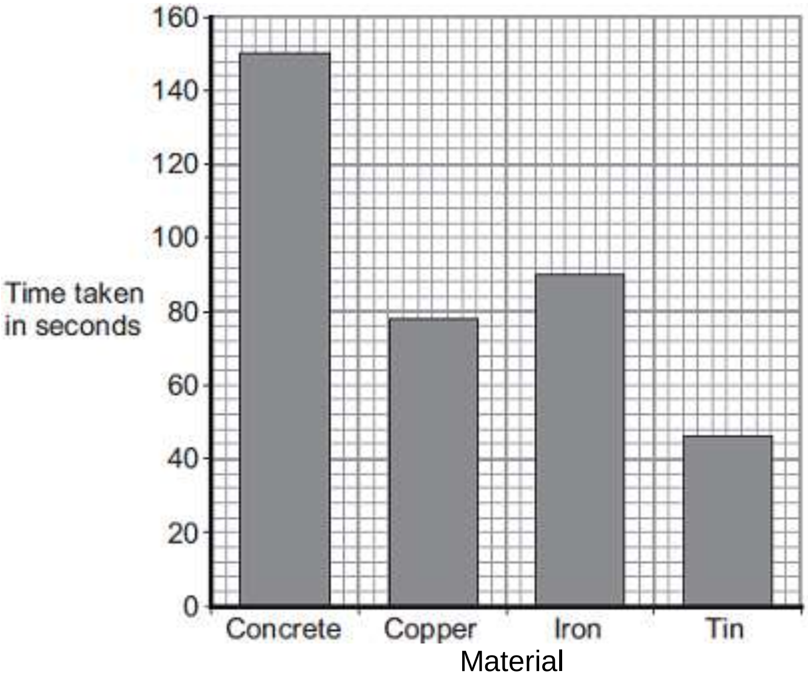
Figure 4



The student measured the time taken to increase the temperature of each material by 10 °C.

Figure 5 shows the student's results.

Figure 5



4.1 The student makes the following conclusion;

'The specific heat capacity of concrete is five times greater than tin.'

Use data from the bar chart to decide if the student's conclusion is correct.

[2 marks]

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4.2 The iron block had a mass of 1.023 kg.

The specific heat capacity of iron is 450 J / kg °C.

Calculate the energy transferred by the heater to increase the temperature of the iron block by 10 °C.

Use the correct equation from the physics equation sheet.

Give your answer to two significant figures.

[3 marks]

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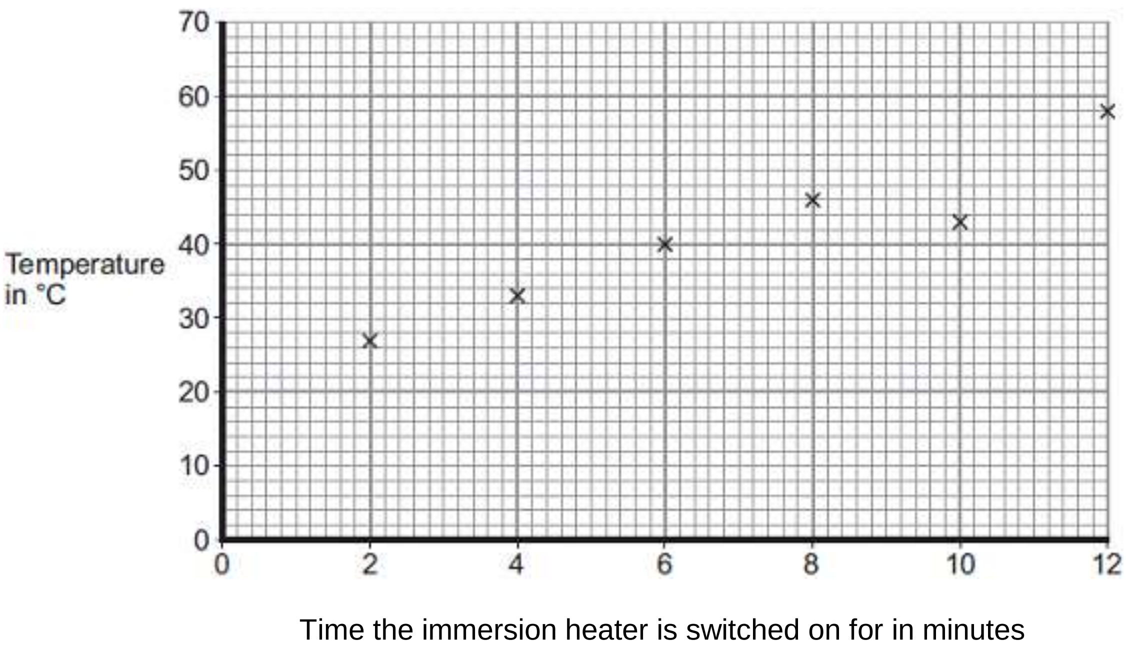
Energy transferred = ____________________ J

The student used the same apparatus to heat a 1 kg block of aluminium.

He recorded the temperature of the block as it was heated from room temperature.

The results are shown in **Figure 6**.

Figure 6



4.3 After how many minutes did the student record the incorrect temperature?

[1 mark]

Time = ______________ minutes

4.4 Draw the line of best fit for the points plotted in **Figure 6**.

[1 mark]

4.5 What was the temperature of the room?

[1 mark]

Temperature ________________ °C

4.6 Another student suggested repeating the experiment using a heater with a greater power.

Explain what effect this would have on the gradient of the graph the student drew.

[3 marks]

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5.1 You have been given a metal cube and a small statue with an irregular shape.

Describe how to measure the density of each of these objects.

[6 marks]

MARK SCHEME

Qu No.		Extra Information	Marks
1.1	solid		1
1.2	liquid		1
1.3	boiling evaporation		1 1
1.4	the average kinetic energy of the particles		1

Qu No.		Extra Information	Marks
2.1	motion is random range of speeds **or** range of directions		1 1
2.2	$\rho = 0.032 / 0.026$ $\rho = 1.3$ (kg/m^3)	 allow 1.28 (kg/m^3) allow 1.3 (kg/m^3) with no working for **2** marks	1 1
2.3	$pV = 1.0 \times 10^5 \times 0.025$ $= 2.5 \times 10^3$ (Pa m^3)		1 1
2.4	$V = \text{constant} / p = 2.5 \times 10^3 / 3.5 \times 10^5$ $= 0.0071$ (m^3)	allow ecf allow 7.1×10^{-3} (m^3)	1 1
2.5	<u>work done</u> on the gas so <u>internal energy</u> increases (so temperature increases)	 ignore reference to other sources of temperature change eg cold water, insulation etc	1 1

Qu No.		Extra Information	Marks
3.1	food fridge surroundings	**2** marks for all three in the correct place **1** mark for 2 or 1 in the correct place	2
3.2			
Level 3:	A detailed and coherent description of both the arrangement and motion of the particles in the different states of matter		5-6
Level 2:	A coherent description of both the arrangement and motion of the particles in the different states of matter.		3-4
Level 1:	Simple description of the arrangement and/or motion of the particles in the different states of matter		1-2
	No relevant content		0
Indicative content			
Solid Particles closely packed in a regular pattern Particles vibrate about a fixed position **Liquid** Particles closely packed in an irregular pattern Particles are able to move relative to each other **Liquid** Particles are widely spread in no pattern Particles move randomly and rapidly.			
3.3	Air molecules in fridge will have a greater speed. because the air is at a greater temperature so greater kinetic energy	allow **2** marks for the converse.	1 1

Qu No.		Extra Information	Marks
4.1	conclusion is not correct because 45 / 150 = 3.3 3.3 is less than 5	allow 40-50 for TIn	1 1
4.2	E = 1.023 x 450 x 10 E = 4 600 (J)		1 1
	Answer to 2 sig. figs.	allow 2 marks for a correct answer to an incorrect number of sig figs eg 4 604 (J) allow 1 mark for an incorrect answer to an incorrect number of sig figs eg 4 603 (J) if substitution is correct	1
4.3	10 (minutes)		1
4.4	Correct line of best fit drawn		1
4.5	20 (°C)		1
4.6	gradient would be greater because energy supplied per second would be greater. so rate of increase of temperature would be greater. **or** more energy supplied (in 12 minutes) so greater final temperature (so greater temperature difference)		1 1 1

Qu No.		Extra Information	Marks
5.1			
Level 3:	Clear and coherent description of both methods including equation needed to calculate density. Steps are logically ordered and could be followed by someone else to obtain valid results.		5-6
Level 2:	Clear description of one method to measure density **or** partial description of both methods. Steps may not be logically ordered.		3-4
Level 1:	Basic description of measurements needed with no indication of how to use them.		1-2
	No relevant content		0
Indicative content			
For both measure mass using a balance calculate density using ρ = m / V Metal cube measure length of cube's sides using a ruler calculate volume Small statue immerse in water measure volume / mass of water displaced volume of water displaced = volume of small statue			