GCSE PHYSICS · TOPIC TEST

Particle Model of Matter

FREE Online Physics GCSE Course

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Name _____ **Date** _____

TIME ALLOWED	TOTAL MARKS	YOU WILL NEED
40 minutes	**34** COMBINED · **41** TRIPLE	a ruler, a pencil, a black or blue pen and a calculator

Instructions

- **Combined Science:** answer Questions 1–4. Skip Question 5.
- **Physics (triple):** answer all five questions.
- Write your answers in the spaces provided, in black or blue ink.
- In calculations, show clearly how you work out your answer.

Information

- The marks for each question are shown in brackets.
- Combined Science is out of 34 marks. Physics (triple) is out of 41 marks.
- The equations you need are on the last page of the questions.

Your score

Question	Q1	Q2	Q3	Q4	Q5	Total	%
Out of	9	6	11	8	7	**34 / 41**	100
Your mark							

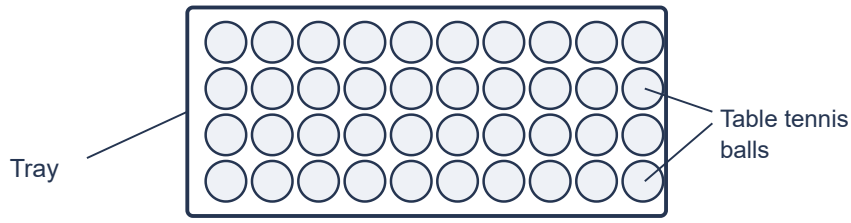
Marking your test The full mark scheme is at the back of this booklet. Try every question first, then mark your answers in a different colour.

1 Question 1

9 marks

A teacher uses a tray filled with table tennis balls to model how particles are arranged in materials.

Figure 1



1.1 Initially the balls are arranged in a regular pattern, as shown in **Figure 1**. Which state of matter is best represented by the balls in **Figure 1**?

Tick (✓) **one** box.

- solid ☐
- liquid ☐
- gas ☐

(1)

1.2 The teacher then moves the tray from side to side so that the balls are no longer in a regular pattern. Which state of matter is now best represented by the balls?

Tick (✓) **one** box.

- solid ☐
- liquid ☐
- gas ☐

(1)

1.3 The teacher next moves 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?

Tick (✓) **two** boxes.

- boiling ☐
- condensing ☐
- evaporation ☐
- freezing ☐
- melting ☐

(2)

1.4 Gases can be at different temperatures. The temperature of a gas is related to

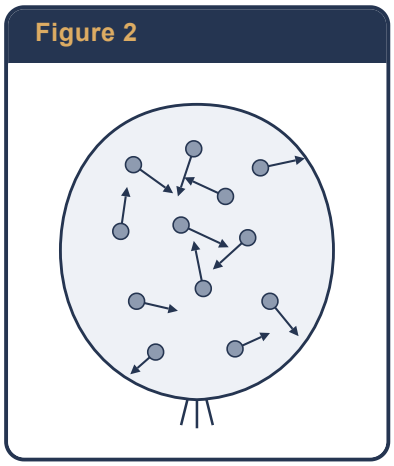
Tick (✓) **one** box.

- the average size of the particles ☐
- the average mass of the particles ☐
- the average kinetic energy of the particles ☐

(1)

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

Figure 2



Describe the movement of the gas particles inside the balloon.

(2)

1.6 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.

Density of gas = _____ **kg/m^3**

(2)

Total for this question: 9 marks

2 Question 2

6 marks

A fridge-freezer contains water in three different states: ice in the freezer, liquid water in a bottle, and water vapour in the air.

2.1 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)

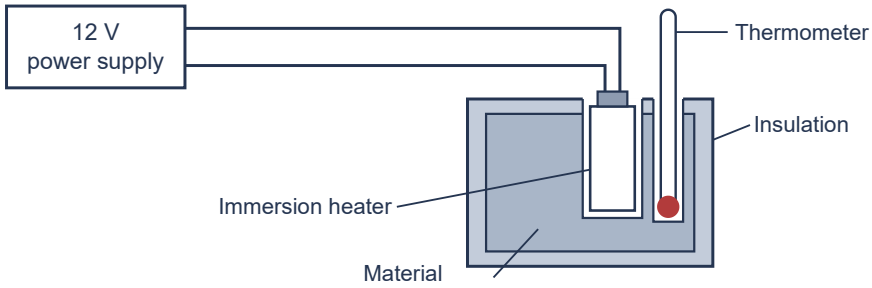
Total for this question: 6 marks

3 Question 3

11 marks

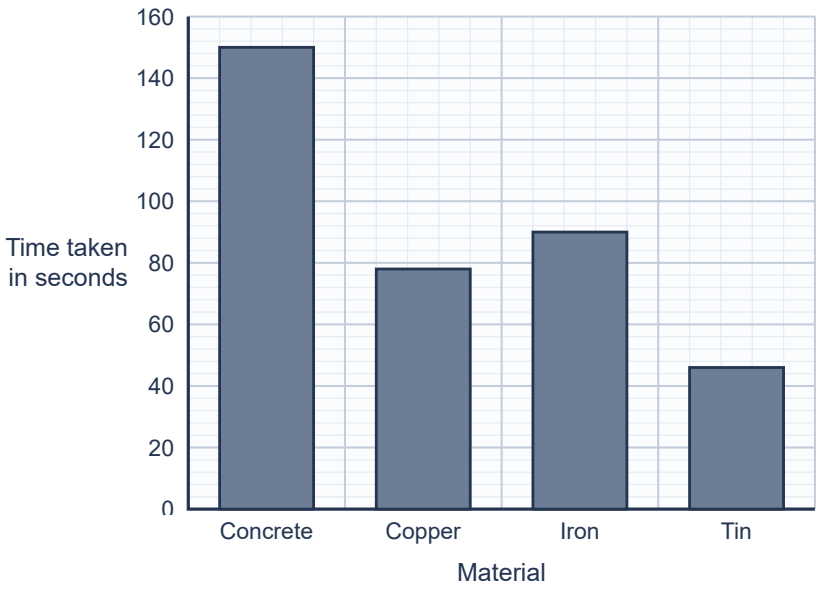
A student used the apparatus in **Figure 3** to compare the specific heat capacities of different materials.

Figure 3



The student measured the time taken to increase the temperature of each material by 10 °C. **Figure 4** shows the student's results.

Figure 4



3.1 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)

3.2 The iron block had a mass of 1.023 kg. The specific heat capacity of iron is 450 J/kg °C.

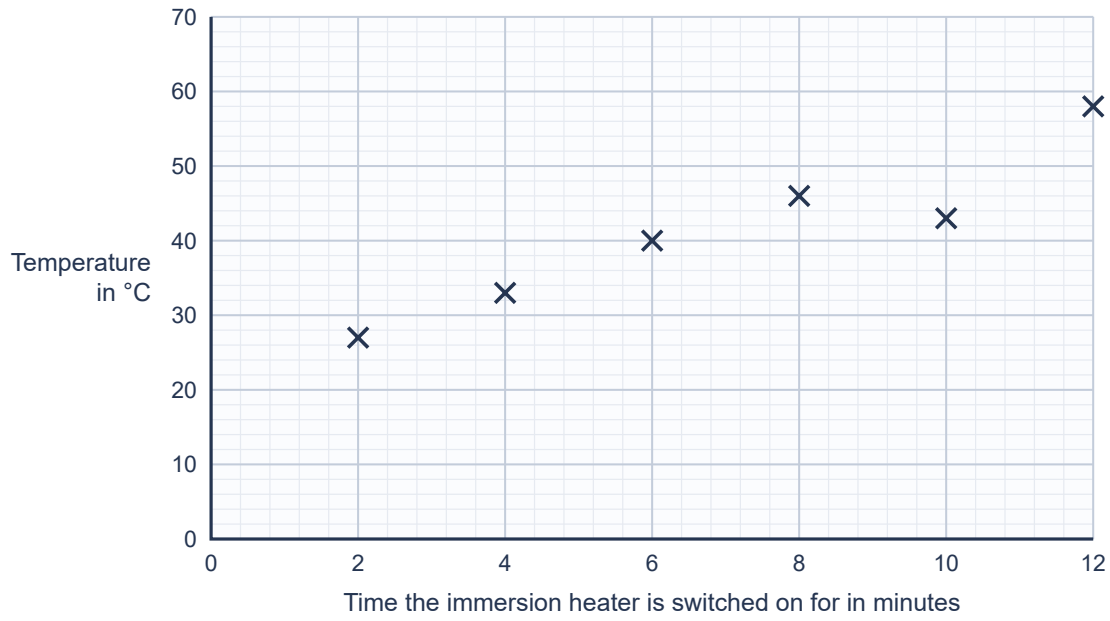
Calculate the energy transferred by the heater to increase the temperature of the iron block by 10 °C. Use the correct equation from the equations at the end of the test. Give your answer to two significant figures.

Energy transferred = _____ **J**

(3)

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 5**.

Figure 5



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

Time = _____ **minutes**

(1)

3.4 Draw the line of best fit for the points plotted in **Figure 5**.

(1)

3.5 What was the temperature of the room?

Temperature = _____ **°C**

(1)

3.6 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.

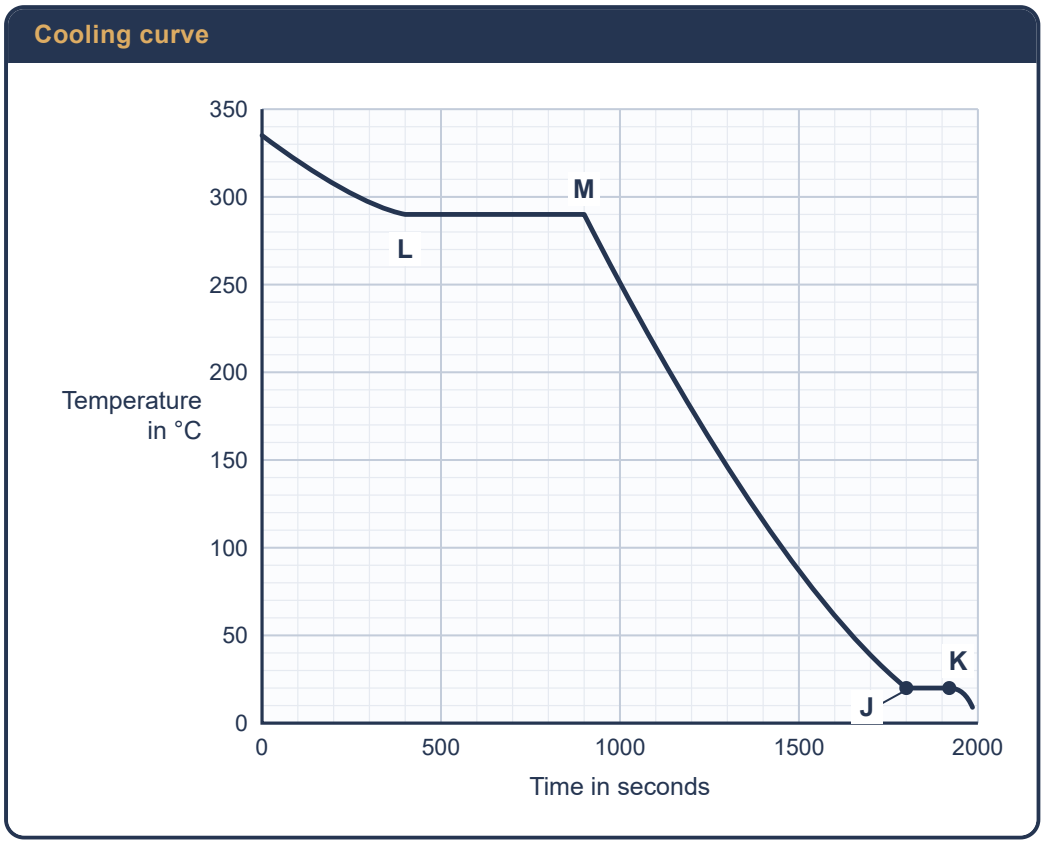
(3)

Total for this question: 11 marks

4 Question 4

8 marks

The graph shows how the temperature of a pure substance changes as it cools from 330 °C.



4.1 Explain why the temperature of the substance is constant between the points marked **J** and **K**.

(2)

4.2 A book of scientific data contains the statement:

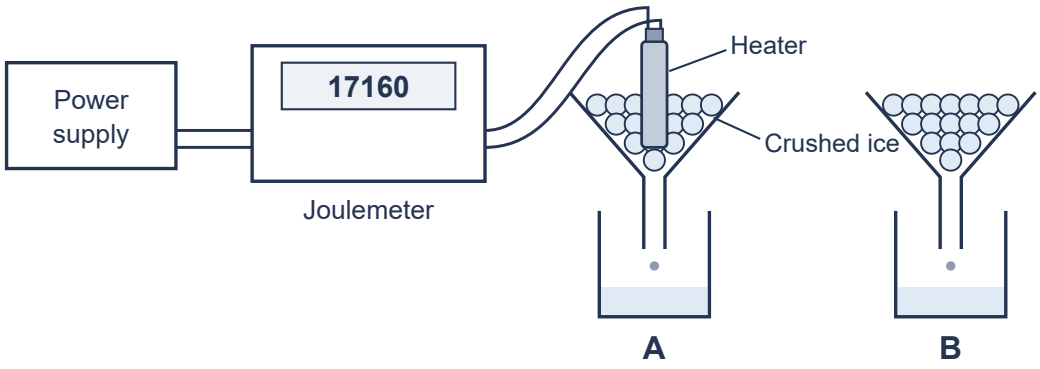
'The specific latent heat of fusion of pure ice is 3.3 × 10^5 J/kg.'

What does this statement mean?

(1)

The diagram shows one method of measuring the specific latent heat of fusion of ice in a laboratory where the temperature is 20 °C. Two funnels, **A** and **B**, contain equal amounts of crushed ice at 0 °C. The mass of melted ice from each funnel is measured after 12 minutes. The joulemeter measures the energy supplied to the heater.

Measuring the specific latent heat of fusion of ice



4.3 Why is it necessary to set up funnel **B** to obtain accurate results?

(2)

4.4 The measurements taken are given in the table.

Mass of melted ice collected from funnel A	63 g
Mass of melted ice collected from funnel B	24 g
Joulemeter reading	17 160 J

Use the data in the table to calculate the specific latent heat of fusion of ice.

Specific latent heat of fusion = _____ **J/kg**

(2)

4.5 Suggest **one** reason why the value obtained by this method and the value given in the data book are not the same.

(1)

Total for this question: 8 marks

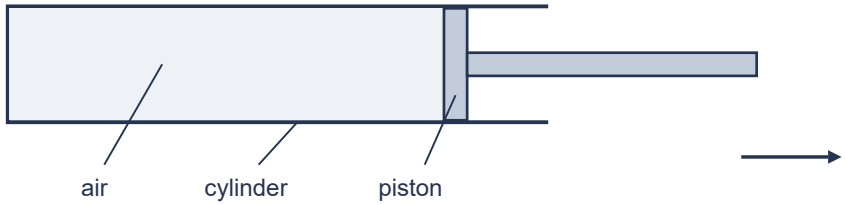
5 Question 5

Physics (triple) only | 7 marks

Physics (triple) only. Combined Science students: skip this question. 5.4 is Higher tier.

Figure 6 shows air inside a cylinder with a movable piston.

Figure 6



5.1 The piston is pulled a little way in the direction of the arrow, but stays inside the cylinder. Which of these increases?

Tick (✓) **one** box.

- [ ] The mass of the air inside the cylinder.
- [ ] The rate at which air particles collide with the walls of the cylinder.
- [ ] The volume of the air inside the cylinder.
- [ ] The pressure of the air inside the cylinder.

(1)

Figure 7 shows a rubber tube that is used inside a bicycle tyre. The tube is inflated with a bicycle pump.

Figure 7



before being inflated

after being inflated

5.2 The air inside the tube exerts an outward force on the wall of the tube. State the angle that this outward force makes with the wall of the tube.

(1)

5.3 It takes 4.8 litres of air from the atmosphere to inflate the empty tube to a pressure of 400 000 Pa. Atmospheric pressure is 100 000 Pa.

Calculate the volume of air inside the tube. Assume the temperature of the air inside the tube is the same as the temperature of the air outside the tube.

Volume = _____ **litres**

(3)

5.4 When a bicycle pump is used to inflate the tube, the air in the pump gets warm. Ignore any effects of friction in the pump. Explain why the air in the bicycle pump gets warm.

(2)

Total for this question: 7 marks

Equations

Word equation	Symbol equation
change in thermal energy = mass × specific heat capacity × temperature change	$\Delta E = m\,c\,\Delta\theta$
thermal energy for a change of state = mass × specific latent heat	$E = m\,L$
for a gas: pressure × volume = constant *(Physics only)*	$p\,V$ = constant

END OF TEST

Now mark your answers using the mark scheme that follows.

MARK SCHEME

Particle Model of Matter · Topic Test

[1] in the Mark column means one mark for that line.

accept / allow notes (gold) are other answers that also score.

reject / do not accept notes (red) are answers that do not.

1 Question 1 — mark scheme — 9 marks

PART	ANSWER	MARK
1.1	solid	1
1.2	liquid	1
1.3	boiling *if more than two boxes are ticked, lose 1 mark for each extra tick*	1
	evaporation	1
1.4	the average kinetic energy of the particles	1
1.5	the motion is random	1
	a range of speeds **or** a range of directions	1
1.6	$\rho = 0.032 \div 0.025$	1
	$\rho = 1.28$ kg/m^3 *allow 1.3 kg/m^3* *allow 1.28 or 1.3 kg/m^3 with no working for 2 marks*	1

Total: 9 marks

2 Question 2 — mark scheme — 6 marks

PART	ANSWER	MARK

Level	Description	Marks
3	A detailed and coherent description of both the arrangement and the motion of the particles in the different states of matter.	5–6
2	A coherent description of both the arrangement and the motion of the particles in the different states of matter.	3–4
1	A simple description of the arrangement and / or the motion of the particles in the different states of matter.	1–2
	No relevant content	0

Indicative content

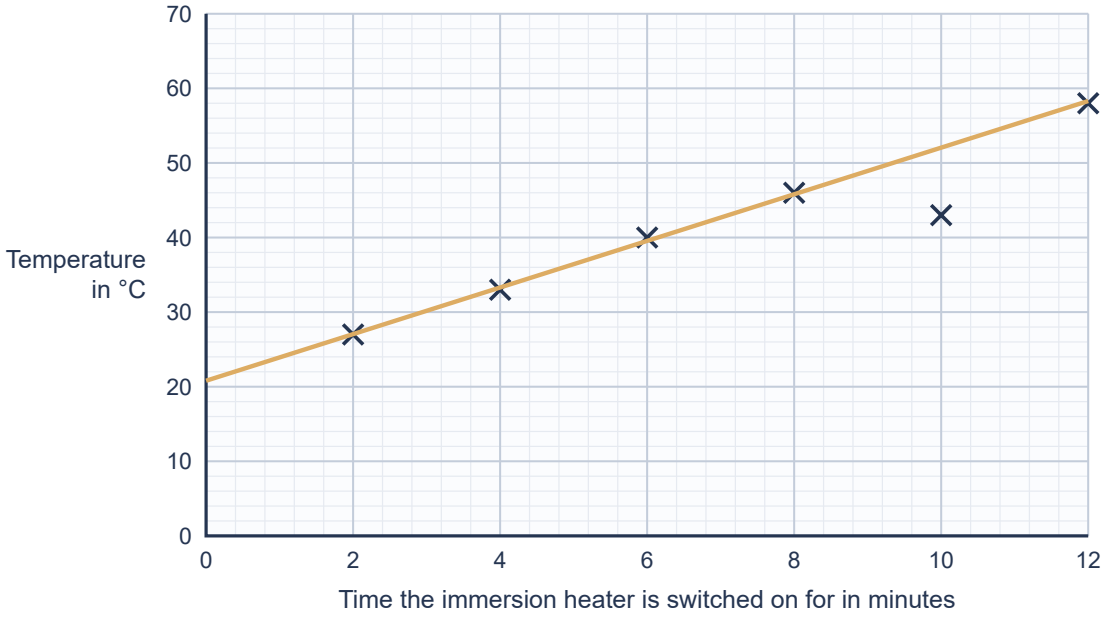
- **Solid:** particles closely packed in a regular pattern; the particles vibrate about fixed positions
- **Liquid:** particles closely packed in an irregular pattern; the particles are able to move past each other
- **Gas:** particles widely spread out with no pattern; the particles move randomly and rapidly

Total: 6 marks

3 Question 3 — mark scheme — 11 marks

PART	ANSWER	MARK
3.1	the conclusion is not correct	1
	because 150 ÷ 45 = 3.3, and 3.3 is less than 5 *allow 40–50 s for tin*	1
3.2	ΔE = 1.023 × 450 × 10	1
	ΔE = 4603.5 J	1
	= 4600 J (2 significant figures) *allow 2 marks for a correct answer to the wrong number of significant figures, e.g. 4604 J* *allow 1 mark for an incorrect answer to the wrong number of significant figures if the substitution is correct*	1
3.3	10 minutes	1
3.4	a single straight line of best fit through the points, ignoring the point at 10 minutes *the line should reach the temperature axis at about 20 °C*	1

3.5	20 °C *allow 19–22 °C read from their line where it meets 0 minutes*	1
3.6	the gradient would be greater	1
	because the energy supplied per second would be greater	1
	so the rate of increase of temperature would be greater ***or** more energy is supplied (in 12 minutes), so the final temperature is greater (a greater temperature rise)*	1



3.4: a line like the gold one. The point at 10 minutes is the anomaly.

Total: 11 marks

4 Question 4 — mark scheme

8 marks

PART	ANSWER	MARK
4.1	(the substance is) changing state, from a liquid to a solid	1
	energy (latent heat) is transferred to the surroundings, but the temperature does not change *accept: the energy released as the particles bond (form a solid) balances the energy transferred to the surroundings*	1
4.2	3.3 × 10^5 J (330 000 J) of energy is needed to change 1 kg of pure ice at 0 °C into water at 0 °C *accept: … to melt 1 kg of ice with no change in temperature*	1
4.3	it acts as a control	1

	so the mass of ice melted without the heater (by the warmth of the room) can be measured *and subtracted from the mass melted in funnel A*	1
4.4	uses the correct mass in kg: 63 − 24 = 39 g = 0.039 kg	1
	L = 17 160 ÷ 0.039 = 440 000 J/kg (4.4 × 10^5 J/kg) *allow 2 marks for the correct answer with or without working*	1
4.5	any sensible reason that would make less ice melt from the heater than expected, e.g.: the heater is not totally covered by ice; some energy warms the heater itself; some energy is transferred to the surroundings / the funnel	1

Total: 8 marks

5 Question 5 — mark scheme

Physics (triple) only · 7 marks

PART	ANSWER	MARK
5.1	The volume of the air inside the cylinder. *the mass is unchanged; the rate of collisions and the pressure both decrease*	1
5.2	at right angles / 90° *accept perpendicular / normal to the wall of the tube*	1
5.3	substitutes into $p_1V_1 = p_2V_2$: 400 000 × V = 100 000 × 4.8	1
	rearranges: V = 100 000 × 4.8 ÷ 400 000 *substitution and rearrangement can be in either order*	1
	V = 1.2 litres *award full marks for the correct answer without working* *a power of ten error scores 2 marks*	1
5.4	work is done on the air (in compressing it)	1
	which increases the (kinetic) energy of the air particles / the internal energy, so the temperature increases *accept heat for thermal*	1

Total: 7 marks

END OF MARK SCHEME