

GCSE Combined Science: Trilogy

Worksheet: Internal energy

TIME 30 min	TOTAL 30 marks	CALCULATOR Allowed	DIFFICULTY Easy, Medium
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Topics: Internal energy

NAME	CLASS	DATE
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- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Answer all questions in the spaces provided.
- In all calculations, show clearly how you work out your answer.
- The marks for questions are shown in brackets.

0 1

0 1 . 1

Which of these increases when the internal energy of a gas in a sealed, rigid container increases?

Tick (✓) **one** box.

The mass of the gas

☐

The average kinetic energy of the particles

☐

The number of particles in the gas

☐

The volume of the container

☐

[1 mark]

0 1 . 2

Complete the sentence.

The internal energy of a system is the total energy and energy of all the particles that make up the system.

[2 marks]

0 2

0 2 . 1

Which statement describes the internal energy of a system?

Tick (✓) **one** box.

The total kinetic energy of all the particles in the system ☐

The total kinetic energy and potential energy of all the particles in the system ☐

The total potential energy of all the particles in the system ☐

The average kinetic energy of the particles in the system ☐

[1 mark]

0 2 . 2

Heating a system increases the energy of the particles in the system.

Give the **two** possible effects of heating a system.

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[2 marks]

0 2 . 3

A saucepan of water is heated on a cooker.

What happens to the internal energy of the water?

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[1 mark]

0 3

A pure substance is heated steadily, starting as a solid well below its melting point and finishing as a gas well above its boiling point.

0 3 . 1

Explain, in terms of the particle model, what happens to the substance's temperature and energy as it is heated through this whole process, including what happens during melting and boiling themselves.

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[6 marks]

0 4

An immersion heater transfers energy to a block of stearic acid (a waxy solid) at its melting point. The stearic acid is well insulated, so all of the transferred energy heats it. The temperature of the stearic acid does not change while it is melting.

0 4 . 1

State what happens to the internal energy of the stearic acid while it is melting.

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[1 mark]

0 4 . 2

Explain, in terms of the particles, why the temperature of the stearic acid does not change while it is melting, even though its internal energy increases.

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[2 marks]

0 4 . 3

A second, identical block of stearic acid is heated so that it melts twice as quickly, using a more powerful heater.
Compare the total increase in internal energy needed to completely melt the two blocks.

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[1 mark]

0 5

Steam at 120 °C is passed into cold water. The steam cools to 100 °C, then condenses into water at 100 °C, and the water formed then cools further.

0 5 . 1

Describe what happens to the average kinetic energy of the particles (i) as the steam cools from 120 °C to 100 °C and (ii) as it condenses at 100 °C.

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[2 marks]

0 5 . 2

Describe what happens to the potential energy of the particles as the steam condenses at 100 °C, and explain why energy is transferred to the surroundings even though the temperature does not change.

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[2 marks]

0 6

Two blocks of the same metal are heated by identical heaters for the same time and each receives the same amount of energy. Block A has a mass of 200 g and its temperature rises from 20 °C to 60 °C. Block B has a mass of 400 g and starts at 20 °C.

0 6 . 1

Predict the final temperature of block B.

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Final temperature = °C

[1 mark]

0 6 . 2

Explain why block B’s temperature rise is smaller than block A’s, even though they receive the same amount of energy.

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[2 marks]

0 6 . 3

Compare the increase in the internal energy of block A with the increase in the internal energy of block B.

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[1 mark]

0 7

A block of ice at $-10\text{ }^{\circ}\text{C}$ was taken out of a freezer and put in a warm room. The ice warmed up to $0\text{ }^{\circ}\text{C}$ and then melted.

0 7 . 1

Describe what happens to the particles in the ice as its temperature increases from $-10\text{ }^{\circ}\text{C}$ to $0\text{ }^{\circ}\text{C}$.

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[2 marks]

0 7 . 2

While the ice is melting, its temperature stays at $0\text{ }^{\circ}\text{C}$ even though energy is still being transferred to it.
Explain what happens to the internal energy of the ice while it melts.

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[3 marks]

END OF QUESTIONS

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Mark scheme

GCSE Combined Science: Trilogy · Worksheet: Internal energy · 30 marks

Question 1 (3 marks)

01.1 [1 mark]

Correct: The average kinetic energy of the particles

01.2 [2 marks]

Answer: kinetic; potential

- kinetic (1)
- potential (1)

Notes: The two words may be given in either order.

Question 2 (4 marks)

02.1 [1 mark]

Correct: The total kinetic energy and potential energy of all the particles in the system

02.2 [2 marks]

Answer: Its temperature rises, or it changes state.

- the temperature of the system increases (1)
 - the system changes state (e.g. melts or boils) (1)
-

02.3 [1 mark]

Answer: It increases.

- it increases (1)
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Question 3 (6 marks)

03.1 [6 marks]

Answer: Level-of-response answer: while solid, energy raises the particles' kinetic energy (temperature rises); at the melting point, energy instead breaks/weakens bonds between particles (potential energy increases, temperature constant); once liquid, kinetic energy (and temperature) rises again; at the boiling point, energy separates the particles completely (temperature constant again); once gas, kinetic energy (and temperature) rises further. Throughout, the internal energy of the substance increases.

Levels of response

- **Level 3 (5–6)** A detailed, coherent answer. Relevant points are accurate, linked in a logical sequence and use correct scientific terms.
- **Level 2 (3–4)** Several relevant points with some linking, but the answer has gaps, errors or lacks detail.
- **Level 1 (1–2)** Simple statements making one or two relevant points, with little or no linking.
- **No marks (0)** Nothing relevant or worthy of credit.

Indicative content

- while heating the solid (below its melting point), the energy supplied increases the kinetic energy of the particles, so the temperature rises
- at the melting point, the energy supplied is used to break or weaken the bonds between particles (increasing their potential energy), not to increase their kinetic energy, so the temperature stays constant during melting
- once melted, the energy supplied again increases the kinetic energy of the (liquid) particles, so the temperature rises
- at the boiling point, the energy supplied is used to overcome the bonds between particles so they can separate completely, so the temperature stays constant during boiling
- once all the liquid has become gas, further energy again increases the kinetic energy of the (gas) particles, so the temperature rises further
- throughout the whole process the energy supplied increases the internal energy of the substance (the total kinetic and potential energy of its particles)

Notes: Level 1 (1–2 marks): isolated correct statements, e.g. that temperature stays constant during melting or boiling, without a clear explanation. Level 2 (3–4 marks): describes the correct pattern of rising and constant temperature through the stages, in the right order, but does not fully explain the energy changes involved (kinetic vs potential/bond energy) at each stage. Level 3 (5–6 marks): a full, logically ordered account that correctly links energy input to kinetic energy (temperature rising) or to breaking/forming bonds (temperature constant) at every stage from solid to gas.

Question 4 (4 marks)

04.1 [1 mark]

Answer: It increases.

- it increases (1)

04.2 [2 marks]

Answer: The energy increases the particles' potential energy as the bonds holding them in place are broken; their average kinetic energy (and so the temperature) is unchanged.

- the energy increases the potential energy of the particles, as the bonds/forces holding them in a solid arrangement are overcome (1)
- the average kinetic energy of the particles, and so the temperature, does not change (1)

04.3 [1 mark]

Answer: The same: melting a given mass of the same substance always needs the same total increase in internal energy, regardless of how quickly the energy is supplied.

- the total increase in internal energy needed is the same for both blocks — melting a given mass of a given substance always needs the same amount of energy, however quickly it is supplied (1)

Question 5 (4 marks)

05.1 [2 marks]

Answer: (i) It decreases as the temperature falls. (ii) It stays the same, because the temperature is constant while condensing.

- (i) the average kinetic energy of the particles decreases as the temperature falls (1)
- (ii) the average kinetic energy does not change, because the temperature stays at 100 °C while it condenses (1)

05.2 [2 marks]

Answer: The particles lose potential energy as they move together and bonds form; this lost energy is transferred to the surroundings, even though the temperature stays the same.

- the potential energy of the particles decreases as they move much closer together and bonds form between them (1)
 - this decrease in the particles' energy is transferred to the surroundings (by heating), even though the kinetic energy and temperature are unchanged (1)
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Question 6 (4 marks)

06.1 [1 mark]

Answer: 40 °C

- 40 (°C) — twice the mass, so half the temperature rise (20 °C) (1)

06.2 [2 marks]

Answer: Block B has twice the mass, so the same energy is shared between twice as many particles — the average kinetic energy (and so the temperature) rises less.

- the same energy is shared between twice as many particles in block B (twice the mass) (1)
- so the increase in the average kinetic energy per particle, and hence the temperature rise, is smaller for block B (1)

06.3 [1 mark]

Answer: The increase in internal energy is the same for both blocks.

- the increase in internal energy is the same for both blocks, because they were both given the same amount of energy (1)

Question 7 (5 marks)

07.1 [2 marks]

Answer: The particles vibrate more vigorously about their fixed positions: their average kinetic energy, and so the internal energy of the ice, increases.

- the particles vibrate faster / with a larger amplitude (about their fixed positions) (1)
- the (average) kinetic energy of the particles increases (1)
- the internal energy of the ice increases (1)

Any 2 of the points above.

Notes: Do not accept 'the particles start to move around' or 'the particles expand'.

07.2 [3 marks]

Answer: The internal energy increases. The energy increases the potential energy of the particles as the bonds holding them in place are broken, but their kinetic energy stays the same, so the temperature stays at 0 °C.

- the internal energy (of the ice) increases (1)
 - the (average) kinetic energy of the particles does not change because the temperature is constant (1)
 - the potential energy of the particles increases (as the forces / bonds holding the particles in place are overcome) (1)
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