AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 6.3.1.2

Changes of state

Past-paper questions

Tier	**Higher**
Question groups	**6**
Available paper years	**2019–2025**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

6.3.1.2 Changes of state

Question 01

June 2019 | 8464/P/1H | Original Q2

0 2 A scientist cooled the air inside a container.

0 2 . 1 The temperature of the air changed from 20 °C to 0 °C

The volume of the container of air stayed the same.

Explain how the motion of the air molecules caused the pressure in the container to change as the temperature decreased.

[3 marks]

0 2 . 2 The air contained water that froze at 0 °C

The change in internal energy of the water as it froze was 0.70 kJ

The specific latent heat of fusion of water is 330 kJ/kg

Calculate the mass of ice produced.

Use the Physics Equations Sheet.

[3 marks]

Mass of ice = _____ kg

6.3.1.2 Changes of state

Question 01 · continued

0 2 . 3 The air also contained oxygen, nitrogen and carbon dioxide.

Oxygen boils at –183 °C and freezes at –218 °C
Nitrogen boils at –195 °C and freezes at –210 °C
Carbon dioxide sublimates at –78 °C

The scientist continued to cool the air to a temperature of –190 °C

What is the state of each substance at –190 °C?

[2 marks]

Tick (✓) **one** box for **each** row of the table.

Substance	Solid	Liquid	Gas
Oxygen			
Nitrogen			
Carbon dioxide			

Question 2 continues on the next page

6.3.1.2 Changes of state

Question 01 · continued

0 2 . 4 The air also contained a small amount of argon.

As the temperature of the air decreased from 20 °C to –190 °C the argon changed from a gas to a liquid to a solid.

Explain the changes in the arrangement and movement of the particles of the argon as the temperature of the air decreased.

[6 marks]

14

6.3.1.2 Changes of state

Question 02

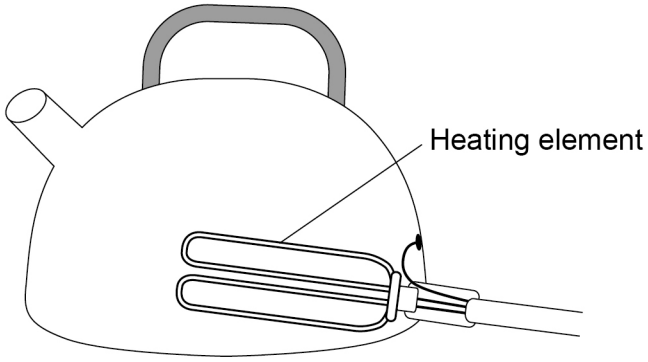
June 2019 | 8464/P/1H | Original Q5

0 5 A student investigated how the mass of water in an electric kettle affected the time taken for the water to reach boiling point.

The kettle switched off when the water reached boiling point.

Figure 4 shows the kettle.

Figure 4



0 5 . 1 The heating element of the kettle was connected to the mains supply.

Explain why the temperature of the heating element increased.

[2 marks]

0 5 . 2 Give **one** variable that the student should have controlled.

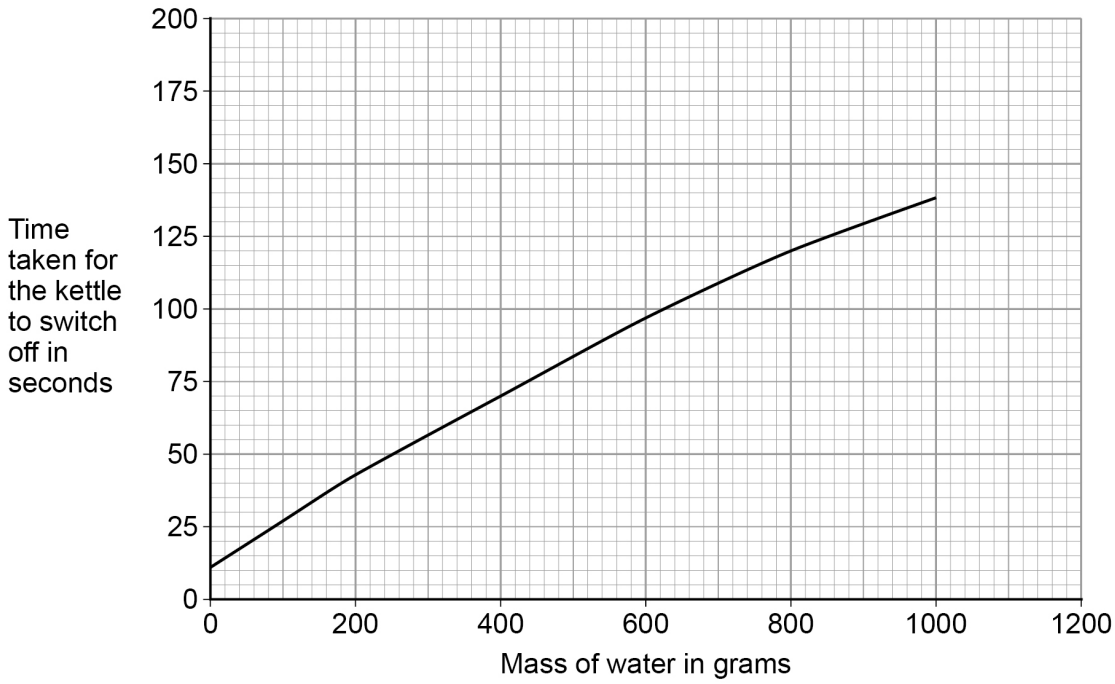
[1 mark]

6.3.1.2 Changes of state

Question 02 · continued

Figure 5 shows how the mass of water in the kettle affected the time taken for the kettle to switch off.

Figure 5



0 5 . 3 Suggest why the line on **Figure 5** does **not** go through the origin.

[1 mark]

0 5 . 4 Suggest why the results give a non-linear pattern.

[1 mark]

Question 5 continues on the next page

6.3.1.2 Changes of state

Question 02 · continued

0 5 . 5 The power of the kettle was 2.6 kW

The kettle took 120 seconds to heat 0.80 kg of water from 18 °C to 100 °C

Calculate the specific heat capacity of water using this information.

Give your answer to 2 significant figures.

[6 marks]

Specific heat capacity = _____ J/kg °C

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6.3.1.2 Changes of state

Question 03

November 2020 | 8464/P/1H | Original Q5

0 5 Ice cream is made by cooling a mixture of liquid ingredients until they freeze.

0 5 . 1 Which statement describes the motion of the particles in solid ice cream?

[1 mark]

Tick (✓) **one** box.

They are stationary. ☐

They move freely. ☐

They vibrate about fixed positions. ☐

0 5 . 2 How do the kinetic energy and the potential energy of the particles change as a liquid is cooled and frozen?

[1 mark]

Tick (✓) **one** box.

Kinetic energy	**Potential energy**	
Decreases	Decreases	☐
Decreases	Does not change	☐
Does not change	Decreases	☐
Does not change	Does not change	☐

Question 03 · continued

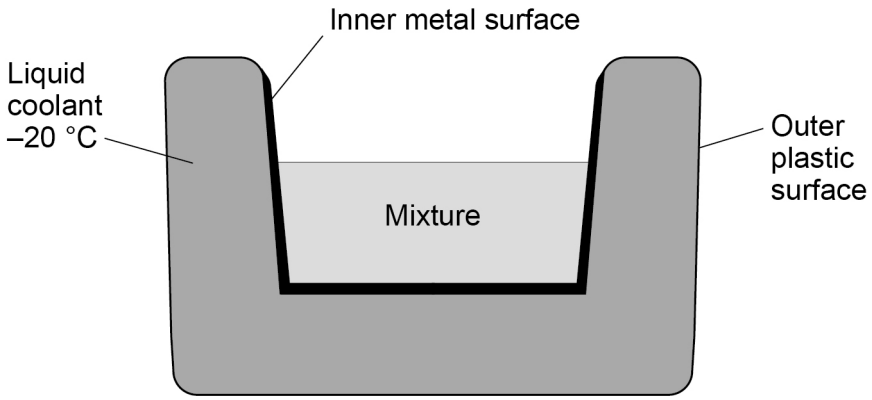
Figure 6 shows a bowl used for making ice cream.

The walls of the bowl contain a liquid coolant.

The bowl is cooled to –20 °C before the mixture is put in the bowl.

The bowl causes the mixture to cool down and freeze.

Figure 6



0 5 . 3 Explain why the different thermal conductivities of metal and plastic are important in the design of the bowl.

[4 marks]

Metal _____

_____

_____

_____

Plastic _____

_____

_____

_____

Question 5 continues on the next page

6.3.1.2 Changes of state

Question 03 · continued

0 5 . 4 The liquid coolant has a freezing point below –20 °C

Explain **one** other property that the liquid coolant should have.

[2 marks]

6.3.1.2 Changes of state

Question 03 · continued

0 5 . 5 The initial temperature of the mixture was +20 °C. The mixture froze at –1.5 °C.

A total of 165 kJ of internal energy was transferred from the mixture to cool and freeze it.

specific heat capacity of the mixture = 3500 J/kg °C

specific latent heat of fusion of the mixture = 255 000 J/kg

Calculate the mass of the mixture.

Give your answer to 2 significant figures.

[6 marks]

Mass (2 significant figures) = _____ kg

14

6.3.1.2 Changes of state

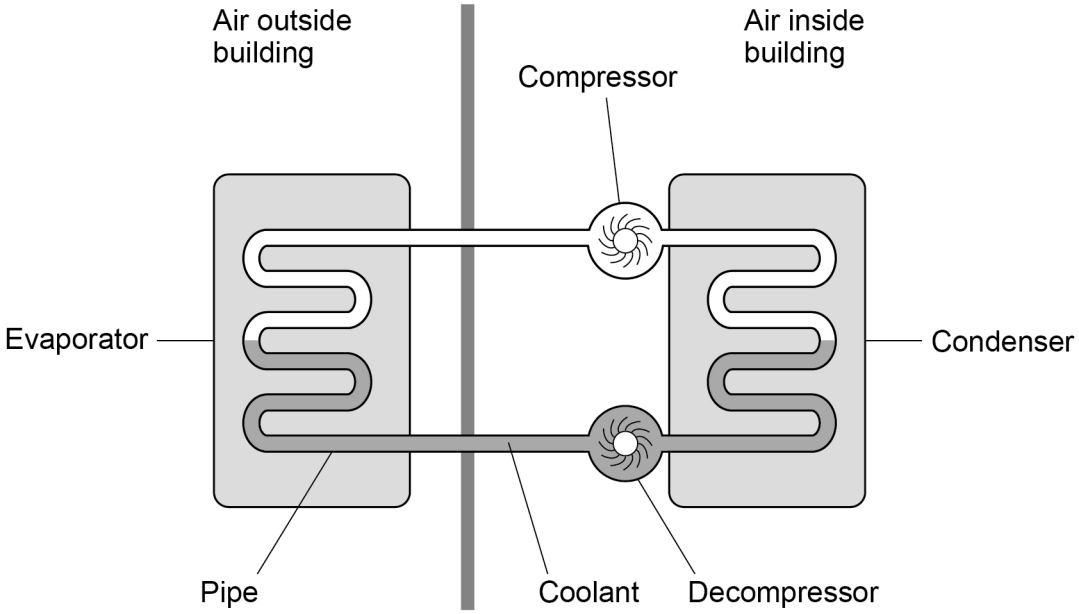
Question 04

November 2021 | 8464/P/1H | Original Q6

0 6 An air source heat pump transfers energy from the air outside a building to increase the temperature of the air inside the building.

Figure 13 shows an air source heat pump.

Figure 13



The compressor is connected to the mains electricity supply.

The pipe in the heat pump contains a substance called coolant.

In the evaporator, energy is transferred from the air outside the building to the liquid coolant.

The temperature of the coolant increases and it evaporates.

0 6 . 1 Explain what happens to the internal energy of the coolant as its temperature increases.

[2 marks]

6.3.1.2 Changes of state

Question 04 · continued

0 6 . 2 What name is given to the energy needed to change the state of the liquid coolant?

[1 mark]

0 6 . 3 What happens to the mass of the coolant as it evaporates and becomes a vapour?

[1 mark]

Tick (✓) **one** box.

- Decreases ☐
- Stays the same ☐
- Increases ☐

0 6 . 4 The compressor increases the density and temperature of the coolant vapour inside the pipe.

Explain why the pressure in the pipe increases.

[2 marks]

Question 6 continues on the next page

6.3.1.2 Changes of state

Question 04 · continued

0 6 . 5 The condenser transfers energy from the coolant to the air in the building.

When the total energy input to the heat pump system is 1560 kJ the temperature of the air in the building increases from 11.6 °C to 22.1 °C.

The efficiency of the heat pump system is 87.5%.

The mass of the air inside the building is 125 kg.

Calculate the specific heat capacity of the air in the building.

Give your answer in standard form.

[6 marks]

Specific heat capacity (standard form) = _____ J/kg °C

6.3.1.2 Changes of state

Question 04 · continued

0 6 . 6 The air in the building gains 400 J for every 100 J of energy transferred from the mains electricity supply to the compressor.

An advertisement claims that the heat pump system has an efficiency of 400%.

Explain why the advertisement is **not** correct.

[3 marks]

15

6.3.1.2 Changes of state

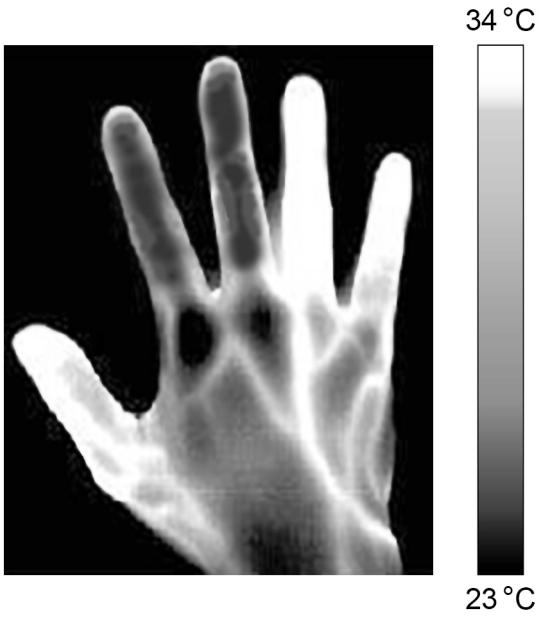
Question 05

November 2021 | 8464/P/2H | Original Q5

0 5 Different parts of the electromagnetic spectrum are used in medical imaging.

Figure 8 shows an image of a person's hand taken with an infrared camera.

Figure 8



0 5 . 1 Explain why the infrared camera is able to show that parts of the hand are at different temperatures.

[2 marks]

Question 5 continues on the next page

6.3.1.2 Changes of state

Question 05 · continued

0 5 . 2 Infrared has a range of wavelengths from 700 nm to 1 mm.

Which part of the electromagnetic spectrum would have waves with a wavelength of 6.5×10^{-7} m?

[1 mark]

Tick (✓) **one** box.

- Infrared ☐
- Microwaves ☐
- Radio waves ☐
- Visible light ☐

0 5 . 3 **Figure 9** shows X-rays and gamma rays being used for medical imaging.

Figure 9

X-rays **Gamma rays**



To use X-rays for medical imaging, a machine produces a very brief burst of X-rays.

To use gamma rays for medical imaging, a radioactive isotope is injected into the patient's blood. The isotope is circulated around the body in the blood. The isotope emits gamma rays.

Compare the potential risks to a patient of using X-rays and gamma rays for medical imaging.

[4 marks]

Question 5 continues on the next page

6.3.1.2 Changes of state

Question 05 · continued

X-rays are produced by colliding high-energy electrons into a metal target.

The electrons have high energy because they are accelerated to high speeds.

Only a small proportion of the kinetic energy of an electron is converted into an X-ray when it collides with the metal target.

0 5 . 4 An electron is accelerated through a distance of 15 mm.

The work done on the electron is 1.2×10^{-13} J.

Calculate the force on the electron.

[3 marks]

Force = _____ N

0 5 . 5 The metal target is made from tungsten.

Tungsten has the highest melting point of any metal.

Explain why using tungsten as the metal target enables the X-ray machine to be more powerful.

[3 marks]

13

6.3.1.2 Changes of state

Question 06

0 5 A student used a temperature probe to measure the temperature of melting ice.

This is the method used.

1. Place the temperature probe in iced water and record the temperature.
2. Remove the probe from the iced water and allow the probe to return to room temperature.
3. Repeat steps 1 and 2 four more times.

The measurements were:

–0.5 °C +0.2 °C –0.3 °C +0.5 °C +0.1 °C

0 5 . 1 What type of error is shown by the measurements?

[1 mark]

0 5 . 2 Determine the uncertainty in the measurements.

[2 marks]

Uncertainty = ± _____ °C

Question 5 continues on the next page

6.3.1.2 Changes of state

Question 06 · continued

The student investigated how the colour of an object affects the rate of change of temperature of the object.

This is the method used.

1. Make two identical cubes using clay.

2. Paint one cube black and paint one cube white.

3. Push a temperature probe into the centre of each cube.

4. Place the cubes 10 cm from an infrared heater.

5. Record the temperature of each cube every two minutes.

Table 1 shows the results for the white cube.

Table 1

Time in minutes	Temperature in °C
0	18
2	55
4	68
6	73
8	65
10	76
12	76

6.3.1.2 Changes of state

Question 06 · continued

0 5 . 3 Complete **Figure 7**.

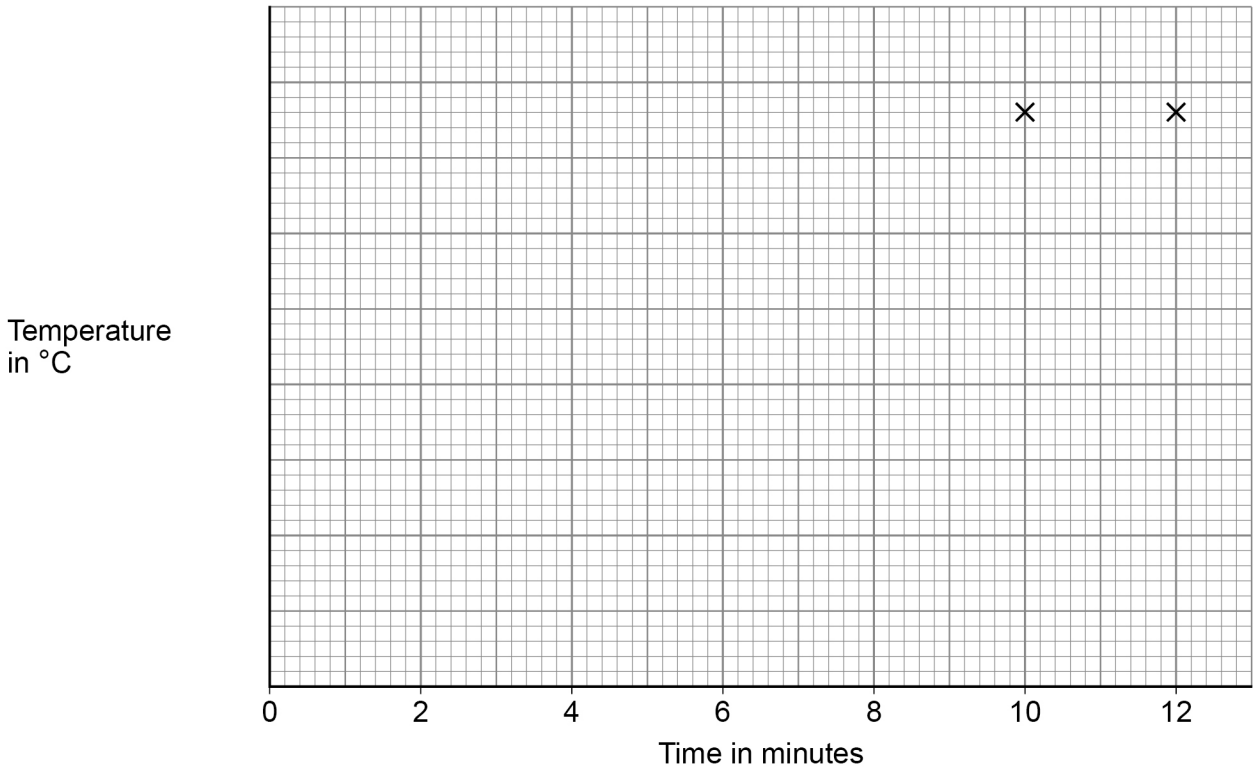
You should:

- use a suitable scale for the *y*-axis
- plot the data from **Table 1**
- draw a line of best fit.

The data for 10 minutes and 12 minutes have been plotted for you.

[4 marks]

Figure 7



Question 5 continues on the next page

6.3.1.2 Changes of state

Question 06 · continued

0 5 . 4 The temperature of the black cube increased from 18 °C to 63 °C in the first 2.0 minutes.

Calculate the average rate of change of temperature of the black cube in the first 2.0 minutes.

Give your answer in °C/s.

[3 marks]

Average rate of change of temperature = _____ °C/s

6.3.1.2 Changes of state

Question 06 · continued

0 5 . 5 The student made two observations:

1. The rate of change of temperature was initially greater for the black cube than for the white cube.

2. After a few minutes, both cubes stopped changing temperature.

Explain the student's observations.

You should refer to the absorption and emission of radiation from the surfaces of the cubes.

[4 marks]

Extra space

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