AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 6.3.2.1

Internal energy

Past-paper questions

Tier	**Higher**
Question groups	**4**
Available paper years	**2019–2023**

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.

6.3.2.1 Internal energy

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

6.3.2.1 Internal energy

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

6.3.2.1 Internal energy

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

6.3.2.1 Internal energy

Question 02

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 02 · continued

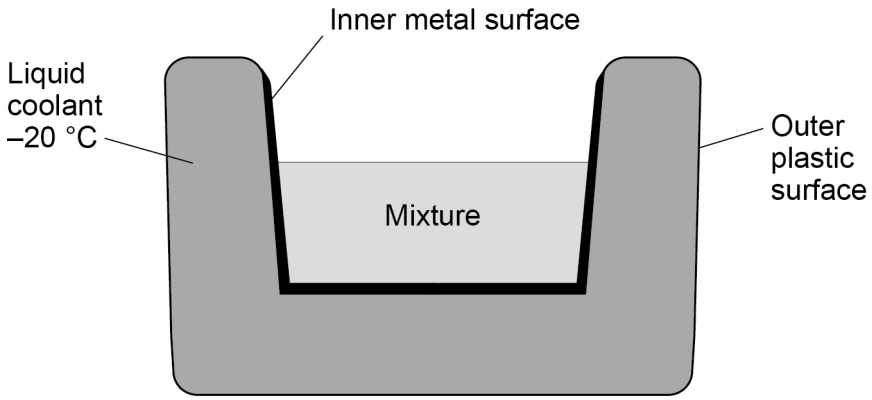
Figure 6 shows a bowl used for making ice cream.

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

6.3.2.1 Internal energy

Question 02 · 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]

6.3.2.1 Internal energy

Question 02 · 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

6.3.2.1 Internal energy

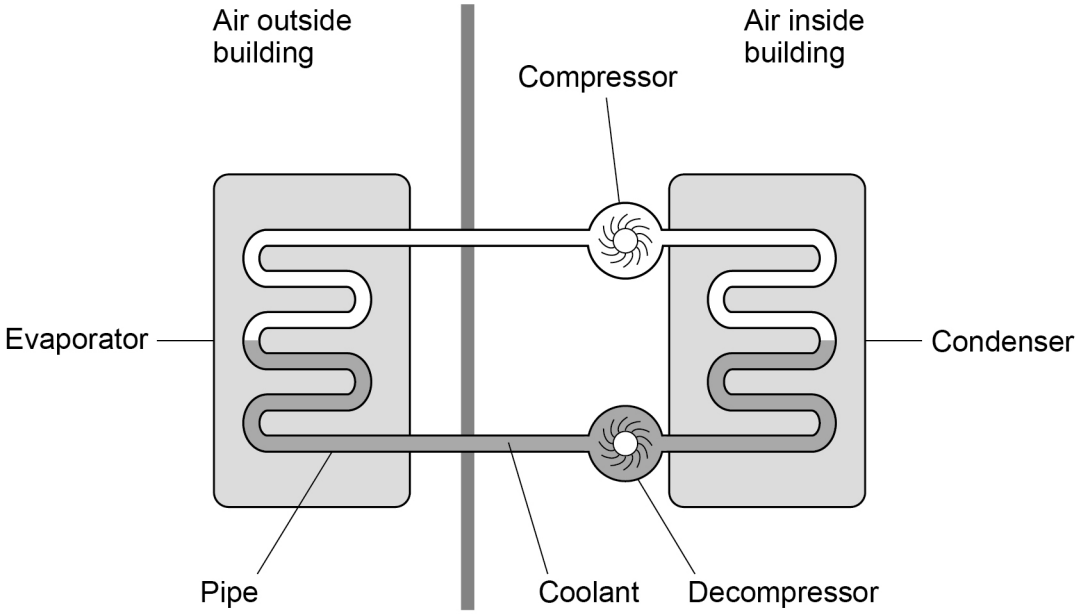
Question 03

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]

6.3.2.1 Internal energy

Question 03 · 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

6.3.2.1 Internal energy

Question 03 · 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

6.3.2.1 Internal energy

Question 03 · 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]

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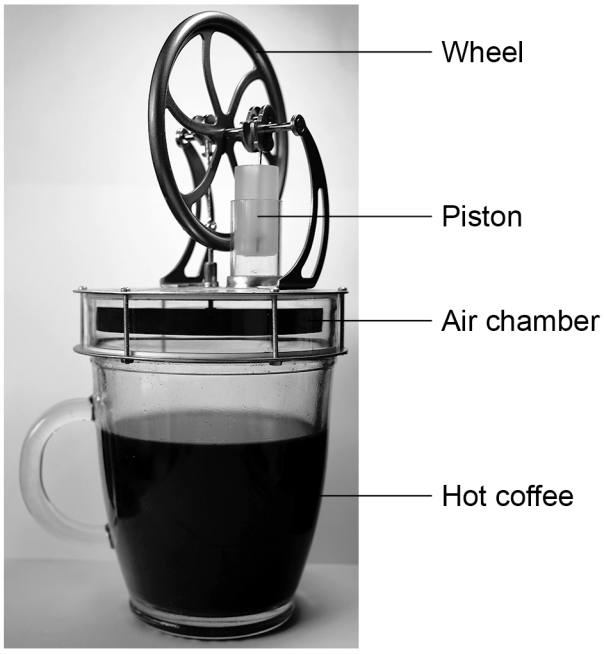
6.3.2.1 Internal energy

Question 04

June 2023 | 8464/P/1H | Original Q6

0 6 **Figure 12** shows a device that uses a mug of hot coffee to turn a wheel.

Figure 12



0 6 . 1 The hot coffee increases the temperature of the air in the chamber.

Explain how the pressure in the chamber changes.

[3 marks]

Question 6 continues on the next page

6.3.2.1 Internal energy

Question 04 · continued

0 6 . 2 For the device to work, the air in the chamber must increase in temperature quickly.

Explain why the bottom of the air chamber is made of metal rather than plastic.

[2 marks]

0 6 . 3 The mass of air in the chamber is constant.

What property of air allows a small change in internal energy to cause a large temperature change to the air in the chamber?

[1 mark]

0 6 . 4 The changes in pressure in the air chamber cause the wheel to turn.

Suggest **one** way to increase the speed at which the wheel turns.

[1 mark]

6.3.2.1 Internal energy

Question 04 · continued

0 6 . 5 The temperature of the coffee decreases as the device is used.

The initial temperature of the coffee was 76 °C.

The internal energy of the coffee decreased by 15 kJ.

density of coffee = 1.1×10^{3} kg/m^{3}

volume of coffee = 1.9×10^{-4} m^{3}

specific heat capacity of coffee = 4200 J/kg °C

Calculate the final temperature of the coffee.

Use the Physics Equations Sheet.

[6 marks]

Final temperature of the coffee = _____ °C

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