AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 6.3.3.1

Particle motion in gases

Past-paper questions

Tier	**Higher**
Question groups	**4**
Available paper years	**2018–2024**

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.

6.3.3.1 Particle motion in gases

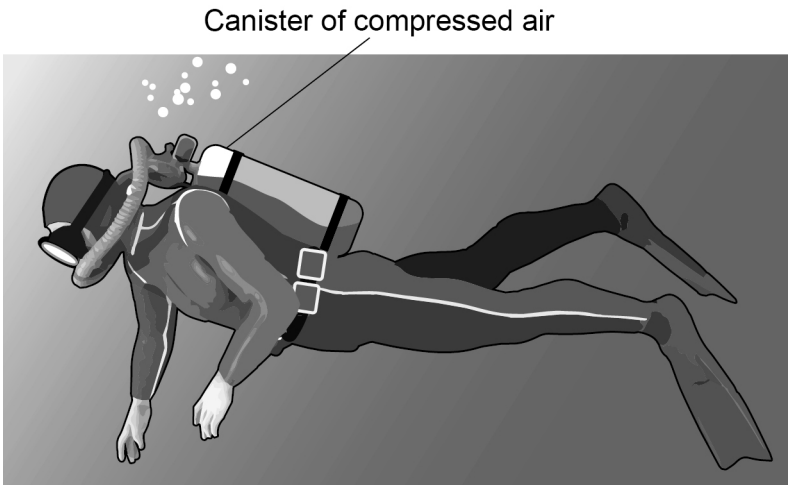
Question 01

June 2018 | 8464/P/1H | Original Q3

0 3 **Figure 5** shows a diver.

The diver is using a canister of compressed air so that he can breathe underwater.

Figure 5



0 3 . 1 Which **two** sentences describe the movement of the air particles in the canister?

[2 marks]

Tick **two** boxes.

- They vibrate about a fixed position. ☐
- They move in random directions. ☐
- The motion of all the particles is predictable. ☐
- They move with a range of different speeds. ☐
- They move in circular paths. ☐

0 3 . 2 The temperature of the air inside the canister increases.

What happens to the movement of the air particles?

[1 mark]

_____

Question 01 · continued

0 3 . 3 It could be dangerous if the temperature of the air inside the canister increased by a large amount.

Explain why.

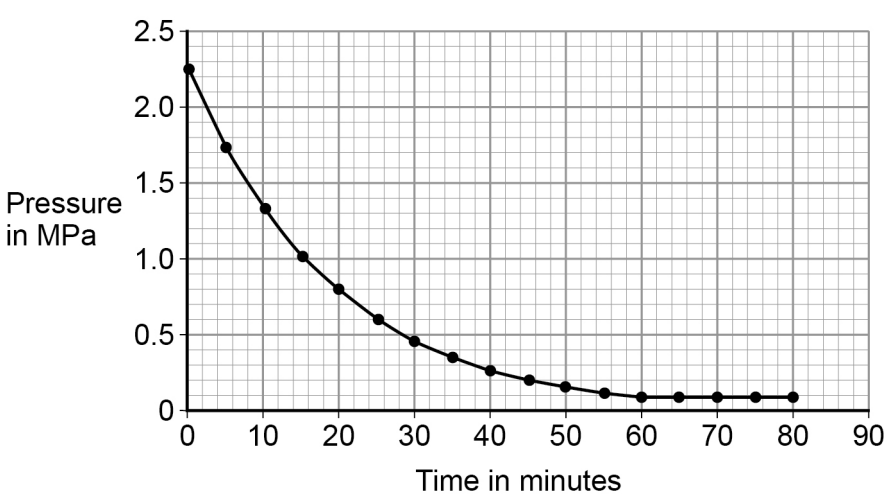
[2 marks]

A canister of air was tested to find out how the pressure changed when it was used by a diver.

- Air was allowed to escape from the canister.
- The pressure of the air in the canister was recorded every 5 minutes for 80 minutes.

Figure 6 shows the results.

Figure 6



0 3 . 4 Estimate the atmospheric pressure.

Use **Figure 6**

[1 mark]

Atmospheric pressure = _____ MPa

6.3.3.1 Particle motion in gases

Question 01 · continued

0 3 . 5 Divers can safely stay underwater until the pressure of the air in the canister has reduced to 25% of its original value.

Determine the maximum time the diver can safely stay underwater.

Use **Figure 6**

[3 marks]

Time = _____ minutes

0 3 . 6 What happens to the volume of the air when it is released from the canister?

[1 mark]

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Turn over for the next question

6.3.3.1 Particle motion in gases

Question 02

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

6.3.3.1 Particle motion in gases

Question 02 · 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

6.3.3.1 Particle motion in gases

Question 02 · 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]

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6.3.3.1 Particle motion in gases

Question 03

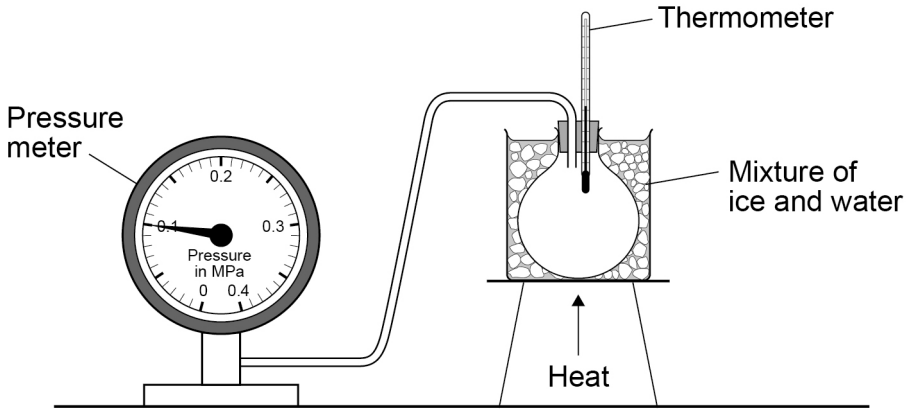
June 2022 | 8464/P/1H | Original Q4

0 4 A student investigated how the pressure of a gas depends on its temperature.

The volume of the gas did **not** change.

Figure 6 shows the equipment used.

Figure 6



0 4 . 1 Pressure is sometimes measured in units called atmospheres.

1 atmosphere is 10^5 pascals (Pa).

What is 1 atmosphere in kilopascals (kPa)?

[1 mark]

1 atmosphere = _____ kPa

Question 03 · continued

0 4 . 2 The student took four pressure readings for each temperature.

Table 1 shows the pressure readings when the temperature was 50.0 °C

Table 1

Temperature in °C	Pressure in MPa			
	1	2	3	4
50.0	0.115	0.120	0.121	0.116

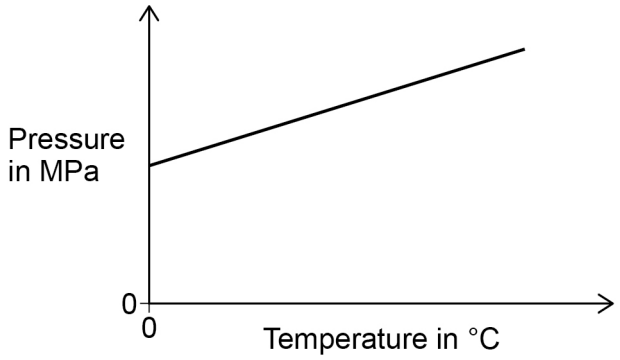
Calculate the uncertainty in the mean pressure.

[2 marks]

Uncertainty = ± _____ MPa

0 4 . 3 **Figure 7** shows a sketch graph of the results.

Figure 7



The student said that as the temperature increases the pressure increases.

Give a better description of the relationship between temperature and pressure.

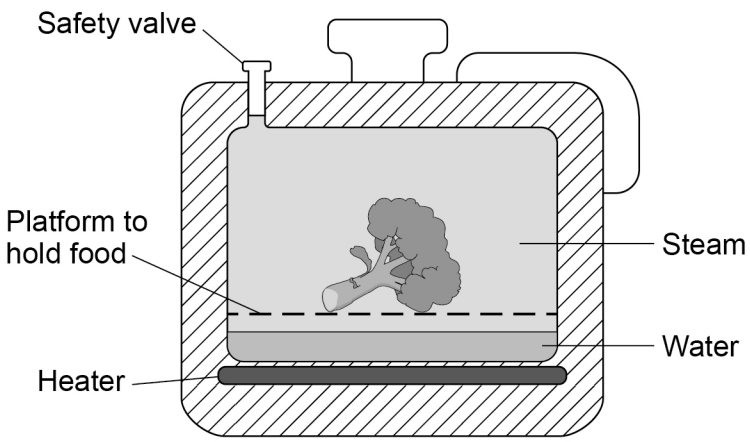
[1 mark]

Question 03 · continued

A pressure cooker is a sealed pot that uses steam to cook food.

Figure 8 shows a pressure cooker.

Figure 8



0 4 . 4 When the water in the pressure cooker starts to boil:

- the amount of steam in the pressure cooker increases
- the temperature of the steam increases above 100 °C

Explain why these changes make the pressure in the cooker increase.

[5 marks]

6.3.3.1 Particle motion in gases

Question 03 · continued

0 4 . 5 If the pressure inside the pressure cooker becomes greater than 200 kPa then some of the steam is released through the safety valve.

The released steam expands as it moves into the atmosphere.

Explain how a change in density of the steam is caused by a change in the arrangement of particles in the steam as it is released.

[3 marks]

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Turn over for the next question

6.3.3.1 Particle motion in gases

Question 04

June 2024 | 8464/P/1H | Original Q6

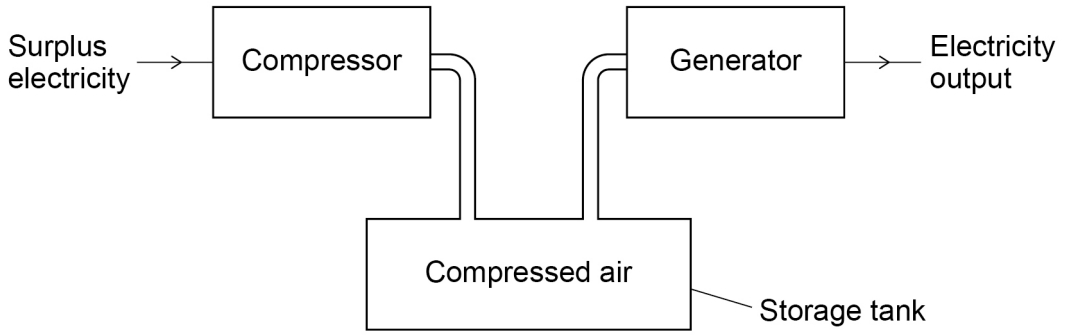
0 6 Energy can be stored using a Compressed Air Energy Storage (CAES) system.

When more electricity is generated than is needed, a CAES system uses the surplus electricity to compress air in a storage tank.

When there is a greater demand for electricity, the CAES system releases the compressed air to generate electricity.

Figure 7 shows a diagram of the CAES system.

Figure 7



0 6 . 1 The CAES system has two processes:

- compressing air to store energy. This process has an efficiency of 0.72
- releasing the air to generate electricity. This process has an efficiency of 0.86

Calculate the efficiency of the CAES system.

Give your answer to 2 significant figures.

[3 marks]

Efficiency of the CAES system (2 significant figures) = _____

6.3.3.1 Particle motion in gases

Question 04 · continued

The generator works when forces from the compressed air cause a turbine to rotate.

When particles of air collide with the turbine they transfer energy to the turbine.

In warm weather the temperature of the compressed air increases, increasing the pressure inside the storage tank.

0 6 . 2 Explain how the motion of the particles in warmer air causes an increase in the power transferred to the turbine.

[4 marks]

Question 6 continues on the next page

6.3.3.1 Particle motion in gases

Question 04 · continued

0 6 . 3 The volume of the storage tank is 5.0×10^5 m^3.

The density of the compressed air is 48 kg/m^3.

specific heat capacity of air = 1100 J/kg °C

The temperature of the compressed air increases from 12 °C to 27 °C.

Calculate the energy transferred to the compressed air in the storage tank.

Use the Physics Equations Sheet.

Give your answer in standard form.

[6 marks]

Energy transferred (in standard form) = _____ J

6.3.3.1 Particle motion in gases

Question 04 · continued

0 6 . 4 The UK government wants the amount of carbon dioxide released into the atmosphere to be reduced.

Explain why efficient energy storage is important in reducing the amount of carbon dioxide released when generating electricity.

[4 marks]

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