AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 6.3.3.1

Particle motion in gases

Mark schemes and examiner comments

Tier	**Foundation**
Question groups	**2**
Available paper years	**2019–2024**

Using this booklet

1. Booklet answer numbers match the question booklet.
2. Use the original question number within marking tables.
3. Examiner comments are included where available.

Name: _____ **Date:** _____

Where a precise marking extract is unavailable, the full source document is included in an appendix. Any missing mark scheme is explicitly identified.

6.3.3.1 Particle motion in gases

Answer 01 · Mark scheme June 2019 | 8464/P/1F | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
07.1	pressure decreased		1	AO2.1	E
	because molecules have less (kinetic) energy	allow less speed/velocity	1	6.3.3.1	
	so fewer collisions (with the wall/container each second)	allow collide with less force allow less force on the walls	1		
07.2		an answer of 0.0021(212121…) scores **3** marks		AO2.1 6.3.2.2	E
	0.70 = m × 330 **or** 700 = m × 330 000		1	6.1.1.3	
	$m = \frac{0.70}{330}$ **or** $m = \frac{700}{330\,000}$	allow correct rearrangement using converted value(s) of E to J and/or L to J/kg	1		
	m = 0.0021 (kg)	allow 0.0021(212121…) allow correct calculation using converted value(s) of E and/or L **3** marks can only be awarded for m = 0.0021(212121…) (kg)	1		
07.3			2	AO3/2b 6.3.1.1	E

Substance	Solid	Liquid	Gas
Oxygen		✓	
Nitrogen			✓
Carbon dioxide	✓		

2 correct answers scores **1** mark.
if more than one tick in a row, neither can score a mark

6.3.3.1 Particle motion in gases

Answer 01 · Mark scheme

June 2019 | 8464/P/1F | Original Q7

07.4	**Level 3:** Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.	5–6	AO1.1 6.3.1.2	E
	Level 2: Relevant points (reasons/causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	3–4		
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2		
	No relevant content	0		
	Indicative content cooling • as the argon cools the particles slow down • particles in a liquid move slower than particles in a gas • particles in a solid move slower than particles in a liquid • as the liquid/solid cools the particles get closer together • as the liquid/solid cools the density increases gas to liquid • particles change from being spread apart to touching each other • particles will (collide with other particles more often and) change direction more often liquid to solid • particles change from a random arrangement to a regular pattern • particles change from moving freely to fixed positions • particles change from moving freely/randomly to vibrating explanation • (internal) energy (of the argon) decreases • (kinetic) energy (of the particles) decreases with temperature • (potential) energy (of the particles) changes with change of state (of the argon) • forces between particles in a gas are negligible/zero • attractive forces act between atoms when they are close to each other • attractive forces between particles are stronger in a solid than in a liquid to access level 3 there must be an explanation of changes to arrangement and movement of particles during either cooling or a change of state			

Total			**14**

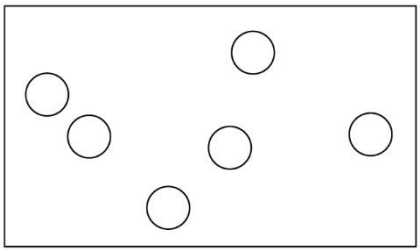
6.3.3.1 Particle motion in gases

Answer 02 · Mark scheme

June 2024 | 8464/P/1F | Original Q5

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	metal has a high thermal conductivity		1	AO1 6.1.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	6 particles all spread apart irregularly within the box e.g. 		1	AO1 6.3.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	air particles collide with the walls of the container		1	AO1 6.3.3.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	decreases		1	AO1 6.3.3.1

Answer 02 · Mark scheme

June 2024 | 8464/P/1F | Original Q5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	(the pressure) decreased as temperature decreased (the pressure) increased as temperature increased	 allow **2** marks for it decreased then increased	1 1	AO1 6.3.3.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.6	90 (m^3)		1	AO2 6.3.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.7	density = $\frac{\text{mass}}{\text{volume}}$ **or** $\rho = \frac{m}{V}$		1	AO1 6.3.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.8	$1100 = \frac{m}{90}$ mass = 90 × 1100 99 000 (kg)	allow ecf from question **05.6**	1 1 1	AO2 6.3.1.1

Total Question 5	**11**

6.3.3.1 Particle motion in gases

Answer 01 · Examiner comments June 2019 | 8464/P/1F | Original Q7

Question 7

07.1 This question tested students' understanding of the links between temperature and pressure via the motion of the particles in a gas. Over 30% of students scored at least one mark but fewer than 5% scored all three marks. Roughly 20% made no attempt. Many

students wrote about successful collisions, which was condoned here. However, writing about particles moving less was not seen as equivalent to writing about particles moving more slowly. The most common reason for gaining 2 marks rather than three was the omission of any mention of collisions. One common misconception is that, as the particles cool down, the number of particles increases. There were also a number of students who did not mention pressure in their answer, instead discussing how the movement of particles changed as they cooled and how this linked with temperature.

07.2 Just over 25% of students scored at least one mark while around 1 in 5 students scored all three marks; approximately 10% made no attempt at all. Some students did not show an equation and just divided one number by the other – sometimes achieving the correct result. Others multiplied the two numbers and therefore did not score. Some chose the wrong equation, while others multiplied or divided by zero, because it was in the question. Those students who scored 2 marks had usually made an erroneous conversion of either kJ to J or kg to g. Many students tried to answer the question using the equation $E = mc\Delta\theta$, with 20 °C as their change in temperature, gaining 0 marks.

07.3 Slightly over a quarter of students scored on this question, and half of those scored both marks. Many students drew a temperature line, which then enabled them to come to the correct conclusions and gain both marking points. A small number of students chose to fill the boxes with numbers representing temperatures, rather than ticking one box for each row of the table.

07.4 Many students who gained 0 marks on this question failed to talk about particles, instead naming and describing changes of state. Many students were able to get into Level 1 (1 or 2 marks) because they knew something about the arrangement and movement of particles in one state. A common misconception was that particles cease to move at all in the solid state. A large number of students gave a basic description of the change of arrangement such as the particles getting closer together as the change of states occurs or the movement of the particles slowing down, but then gave very little additional detail. Fewer students managed to link the changes to energy changes or forces between particles. Very few students achieved Level 3. Some students referred to the energy decreasing at each change of state and some talked about 'bonding' occurring. However, often the relevant points regarding the changes to arrangement or movement were not effective and prevented them from acquiring Level 3. Around 15% made no attempt at the question, about 20% scored 0 marks, around 30% scored in Level 1, approximately 30% in Level 2, with the remainder reaching Level 3.

6.3.3.1 Particle motion in gases

Answer 01 · Examiner comments

June 2019 | 8464/P/1F | Original Q7

Use of statistics

Statistics used in this report may be taken from incomplete processing data. However, this data still gives a true account on how students have performed for each question.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.

Answer 02 · Examiner comments

June 2024 | 8464/P/1F | Original Q5

Question 5 (low and standard demand)

05.1 Just under half of students correctly identified that metal has a high thermal conductivity.

05.2 The vast majority of students were able to draw a diagram to represent the arrangement of particles in a gas.

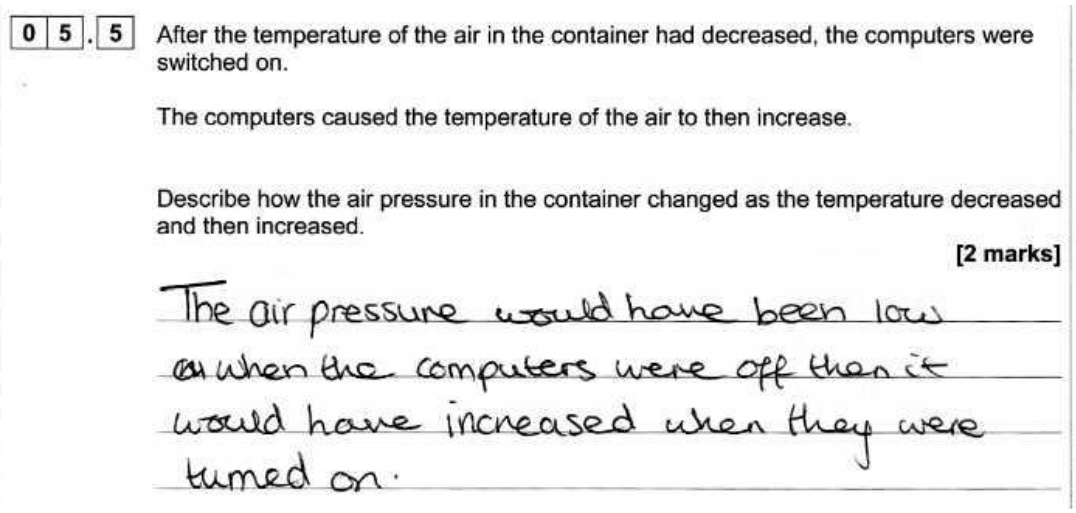
05.3 Just over 55% of students recalled that pressure on the walls of a container is caused by air particles colliding with the walls. Almost 30% of students showed the misconception that particles in a gas expand to fill the container, causing pressure on the walls.

05.4 Slightly less than two-thirds of students recalled that at lower temperatures the average speed of particles is less.

05.5 Roughly 20% of students gained both marks on this question, with about a third of students scoring one mark.

A sizeable proportion of students appeared not read the question correctly and, instead of describing how the pressure changed, gave explanations of why the pressure changed. In doing so, many of these responses did not include a description of how the pressure was affected and so scored no marks.

Misconceptions included the idea of air particles expanding as temperature increases, and the idea of pressure being caused by 'pressure particles'.



0 5 . 5 After the temperature of the air in the container had decreased, the computers were switched on.

The computers caused the temperature of the air to then increase.

Describe how the air pressure in the container changed as the temperature decreased and then increased.

[2 marks]

The air pressure would have been low as when the computers were off than it would have increased when they were turned on.

Although an ideal answer would have indicated that the pressure would initially decrease, for this question the idea that the pressure was initially low was sufficient to score the first marking point. This response scored both marks.

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6.3.3.1 Particle motion in gases

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The computers caused the temperature of the air to then increase.

Describe how the air pressure in the container changed as the temperature decreased and then increased.

[2 marks]

When the tempreature decreased → less energy → less collitions.
When increased → more energy → more collitions.

This student appears to understand what is happening inside the container, but does not describe how this affects the pressure. The response scored no marks.

05.6 This question was generally well answered, with more than three-quarters of students calculating the correct volume.

For those who did not answer correctly, by far the most common error was to treat 7.5 m^2 as 7.5^2 m^2, which led to an incorrect answer of 675 m^3.

05.7 Given that students had an equation sheet, this question was well answered, with slightly less than 90% of students answering correctly.

Of those who answered incorrectly, the most common answer was caused by students who misread ρ as p, and misread V as v. This led them to the equation linking mass, momentum and velocity rather than the equation linking density, mass and volume.

05.8 The error carried forward from question 05.6 meant that even those who had incorrectly calculated the volume of the container could still score all 3 marks on this question. However, a small minority of students used the number 5.6 in their calculation instead of using their answer from question 05.6.

Rather than showing an initial substitution into the equation (eg $1100 = m \div 90$), the majority of students have a tendency to start questions such as this by writing down the calculation they intend to carry out (eg 90×1100). If they did this correctly, these students tended to score all 3 marks, but if they had rearranged incorrectly their responses tended to score 0. On this question about 50% earned 3 marks, while roughly 45% did not gain any marks. Students who substituted into the equation first, and then rearranged, were able to earn some credit even if they made a mistake somewhere along the way.

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