AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 6.3.1.1

Density of materials

Mark schemes and examiner comments

Tier	**Foundation**
Question groups	**5**
Available paper years	**2018–2024**

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.

6.3.1.1 Density of materials

Answer 01 · Mark scheme June 2018 | 8464/P/1F | Original Q7

Question	Answers	Mark	AO / Spec. Ref.
07.1	**Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6	AO1 6.3.1.1
	Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.	3–4	
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	
	No relevant content	0	
	Indicative content • measure mass • use a top pan balance or scales • part fill a measuring cylinder with water • measure initial volume • place object in water • measure final volume • volume of object = final volume − initial volume • fill a displacement / eureka can with water • water level with spout • place object in water • collect displaced water • measuring cylinder used to determine volume of displaced water • use of: $\text{density} = \frac{\text{mass}}{\text{volume}}$		

6.3.1.1 Density of materials

Answer 01 · Mark scheme

June 2018 | 8464/P/1F | Original Q7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	all *y*-axis values correct (minimum of 3)	allow **1** mark for two correct values	2	AO2 6.3.1.1
	all bars drawn to the correct height	allow **1** mark for two correct bars allow ± ½ small square	2	
07.3		an answer of 80 scores **2** marks		AO3 6.3.1.1
	$\frac{(1120 - 960)}{2}$	ignore + and / or − signs	1	
	= 80 (kg/m^3)	an answer of 160 scores **1** mark	1	
Total			**12**	

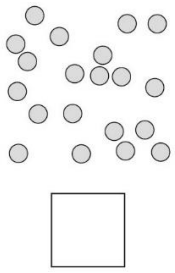
6.3.1.1 Density of materials

Answer 02 · Mark scheme November 2021 | 8464/P/1F | Original Q1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	the piece of limestone has an irregular shape		1	AO1 6.3.1.1 RPA17
01.2	**Level 2:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.		3–4	AO1 6.3.1.1 RPA17
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.		1–2	
	No relevant content		0	
	Indicative content • add water to the displacement can until level with the spout • place the limestone in the water • avoid splashing water out of the displacement can • collect the displaced water in the beaker or measuring cylinder • measure the volume of the displaced water • using a measuring cylinder OR • use the large measuring cylinder • part fill the measuring cylinder water • measure the initial volume on the measuring cylinder • submerge the limestone in the water • measure the final volume on the measuring cylinder • volume of limestone = final volume − initial volume To access level 2 the answer must refer to submerging the limestone in water and using the measuring cylinder.			
01.3	density = $\frac{155}{62}$ density = 2.5 (g/cm^3)		2	AO2 6.3.1.1 RPA17

6.3.1.1 Density of materials

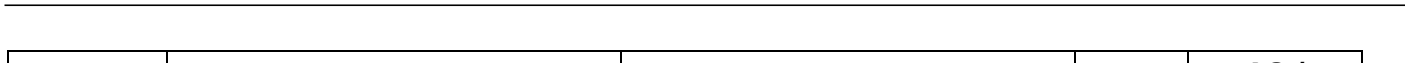
Answer 02 · Mark scheme

01.4	kg/m^3		1	AO1 6.3.1.1 RPA17
01.5	bar drawn to 2.4 g/cm^3		1	AO2 6.3.1.1 RPA17
01.6	obsidian		1	AO3 6.3.1.1 RPA17
01.7	other types of rock may have the same density as obsidian	allow not all rock types are plotted on the bar chart	1	AO3 6.3.1.1 RPA17
01.8	4th box ticked 		1	AO1 6.3.1.1
01.9	less than		1	AO3 6.3.1.1
Total			**13**	

6.3.1.1 Density of materials

Answer 02 · Mark scheme

November 2021 | 8464/P/1F | Original Q1



6.3.1.1 Density of materials

Answer 03 · Mark scheme

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

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	$\Delta\theta = \frac{7.5}{30}$ $\Delta\theta$ = 0.25 (°C)		1 1	AO2 6.1.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	bar Y drawn to 16 **and** bar Z drawn to 12 *y*-axis labelled 'temperature in °C'	allow ± half a small square unit must be present	1 1	AO2 6.1.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	Y because it showed the smallest change in temperature	 reason only scores if Y is chosen	1 1	AO3 6.1.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	less than 12.0 °C		1	AO3 6.1.2.1

6.3.1.1 Density of materials

Answer 03 · Mark scheme June 2022 | 8464/P/1F | Original Q4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	$E = 0.0150 \times 334\,000$ $E = 5010$ (J)		1 1	AO2 6.3.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.6	resolution		1	AO3 6.3.1.1 RPA17

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.7	$\text{density} = \frac{\text{mass}}{\text{volume}}$ **or** $\rho = \frac{m}{V}$		1	AO1 6.3.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.8	$0.300 = \frac{m}{0.186}$ $m = 0.300 \times 0.186$ $m = 0.0558$ (g)		1 1 1	AO2 6.3.1.1

Total Question 4		14

6.3.1.1 Density of materials

Answer 04 · Mark scheme

June 2023 | 8464/P/1F | Original Q3

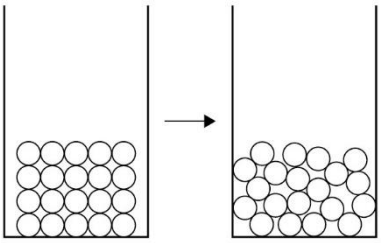
Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	$\Delta E = 4.0 \times 420 \times 50$ $\Delta E = 84\,000$ (J)		1 1	AO2 6.1.1.3 6.3.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	the total kinetic energy and potential energy of the steel particles		1	AO1 6.3.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	the particles are in fixed positions		1	AO1 6.3.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	stays the same		1	AO1 6.3.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5			1	AO1 6.3.1.1

Answer 04 · Mark scheme

June 2023 | 8464/P/1F | Original Q3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.6	(the space between the particles) increases	allow the particles move further apart	1	AO1 6.3.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.7	physical		1	AO1 6.3.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.8	mass per kg = $\frac{18}{4.0}$ mass per kg = 4.5 g medium carbon **OR** mass in 4.0 kg of medium carbon steel = 4.5 × 4.0 (1) mass in 4.0 kg of medium carbon steel = 18 g (1) medium carbon (1)	 dependent on MP2 allow mass in 4.0 kg of low carbon steel = 8 (g) allow mass in 4.0 kg of high carbon steel = 28 (g) dependent on MP1 dependent on MP2	1 1 1	AO3 6.3.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.9	280 000 = 4.0 × *L* $L = \frac{280\,000}{4.0}$ *L* = 70 000 (J/kg)		1 1 1	AO2 6.3.2.3

Total Question 3	**14**

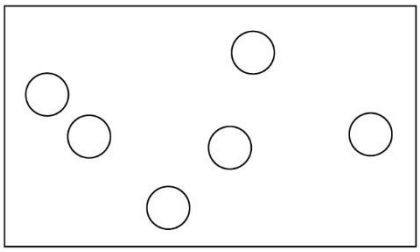
6.3.1.1 Density of materials

Answer 05 · 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

6.3.1.1 Density of materials

Answer 05 · 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**

6.3.1.1 Density of materials

Answer 02 · Examiner comments November 2021 | 8464/P/1F | Original Q1

Question 1 (Low demand)

01.1 Approximately three quarters of all students answered this question correctly.

01.2 Many students were unable to make any progress with this question, with almost 50% of students failing to gain any marks and just under a fifth of students not attempting to answer at all. Some students saw the displacement can and began to describe displacement reactions, which gained no credit. A small minority of students suggested melting the limestone in order to measure its volume, which also gained no marks.

01.3 This calculation was correctly answered by around four fifths of students. A common mistake was for students to substitute the volume 62 cm^3 into the equation as a value of 62^3.

Answer 02 · Examiner comments November 2021 | 8464/P/1F | Original Q1

01.4 Slightly more than 60% of students answered this correctly. About a fifth of students incorrectly chose the first option, cm/g^3.

01.5 This question was well answered, with almost 90% gaining the mark.

01.6 Just under 90% of students gave the correct answer.

01.7 About one in four students gained this mark. Many students appeared to have not read the first line of the question, and instead gave a reason why they had chosen their answer to question **01.6**. Of those who did read the question correctly, a common misconception was that a rock with a different mass would have a different density.

01.8 Slightly over 70% of students selected the right answer.

01.9 Just over three quarters of students scored this mark.

6.3.1.1 Density of materials

Answer 03 · Examiner comments

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

Question 04 (Low demand and standard demand)

04.1 Just under half of all students gained both marks on this question, with very few students gaining just one mark.

Common incorrect answers included attempts to subtract 7.5°C from 30 seconds, or attempts to convert time into minutes, as well as answers dividing 30 seconds by 7.5 °C.

04.2 The vast majority of students correctly drew the bars, but labelling the y-axis was far more problematic for students. A fair number of students labelled the axis, but forgot to include units, or included an incorrect unit. However, a very large proportion of students labelled the vertical axis "Y".

04.3 Nearly 90% correctly identified Y as the best thermal insulator, but only about 15% were able to give the correct reason.

Most students referred in their answer to the final temperature, but did not mention the change in temperature. It was also not uncommon for students to talk about "heat", which did not gain any credit.

04.4 Only about 15% of students selected the correct temperature.

04.5 Slightly more than 85% of students gained both marks for this calculation.

A common mistake was to attempt a spurious conversion of kg to g. Students who did this were awarded a maximum of 1 mark for this question.

04.6 Only about a fifth of students gained this mark.

04.7 About 85% of students wrote the correct equation, although the students had an equation sheet listing all equations this year.

For the students who did not gain the mark, many looked at the symbols for resistivity (ρ), mass (m) and volume (V), and then looked at the equation sheet to find the equation linking momentum (p), mass (m) and velocity (v).

04.8 Just over half of all students gained all 3 marks in this calculation, with about 10% gaining 2 marks.

Many of those who made mistakes saw that the unit for volume is cm^3 and therefore decided to calculate 0.186^3 as part of their answer; some calculations also included 0.300^3.
Despite the question asking for the answer in grams, and needing no conversion to achieve this, some students attempted to convert to kg, which led to a maximum possible mark of 2 for this question.

6.3.1.1 Density of materials

Answer 04 · Examiner comments — June 2023 | 8464/P/1F | Original Q3

Question 03 (Low demand and standard demand)

03.1 Nearly 90% of students gained both marks for this calculation. A fairly common incorrect method was to subtract 50°C from 420 J/Kg°C, and give a value for the temperature change of 370°C, which gained no credit.

03.2 Slightly less than 40% of students selected the correct meaning for internal energy. It was (very) slightly more common for students to think that internal energy is the energy added to the steel particles as they are heated than to select the correct answer.

03.3 About 70% of students chose the correct statement describing the particles in a solid.

03.4 Approximately 45% of students knew the mass of steel stays the same.

Answer 04 · Examiner comments — June 2023 | 8464/P/1F | Original Q3

03.5 The correct diagram to show the change in arrangement of the particles was chosen by over 95% of students.

03.6 Roughly two fifths of students answered this correctly. Many students wrote about the motion of particles, which was ignored, rather than the arrangement of particles. Students who stated that the particles spread out but remained in contact with each other scored this mark.

03.7 Just over three quarters of students recognised that melting is a physical change.

03.8 Over half of the students gained full marks on this question. Almost no students gained 1 or 2 marks, but about 10% did not attempt it at all. Evidence of a relevant calculation had to be shown before any credit could be awarded. So, for example, students who calculated the average of 2, 4.5 and 7 and came up with an answer of 4.5 g, and then selected medium carbon did not score any marks.

03.9 Nearly 60% of students gained full marks on this standard demand calculation. A small proportion of students attempted to convert 4.0 kg to g, which limited them to a maximum mark of 2.

Answer 05 · 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.

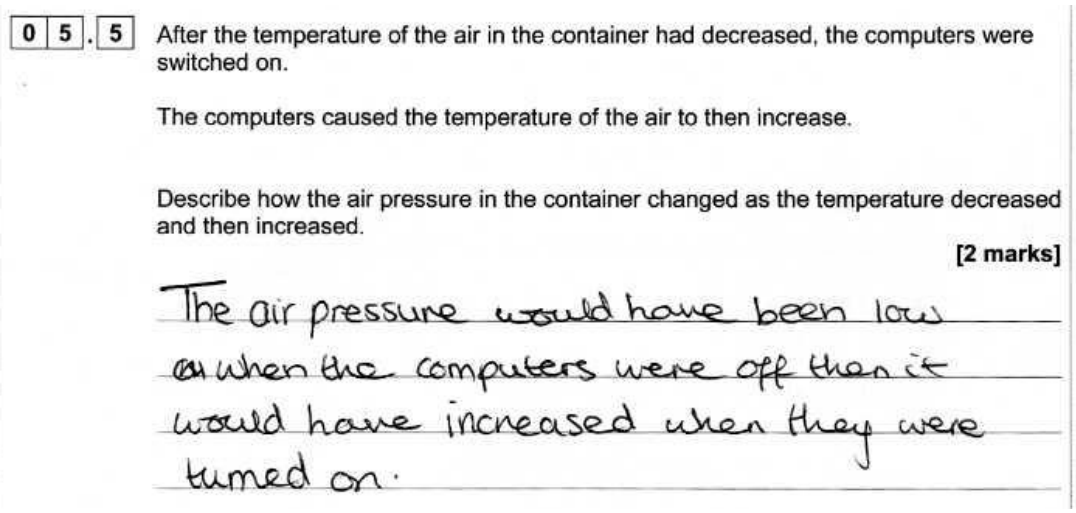
05.3 Just over 55% of students recalled that pressure on the walls of a container is caused by air particles colliding with the walls. Almost 30% of students showed the misconception that particles in a gas expand to fill the container, causing pressure on the walls.

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 then 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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6.3.1.1 Density of materials

Answer 05 · Examiner comments June 2024 | 8464/P/1F | Original Q5

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]

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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