AQA GCSE Physics | 8463

SPECIFICATION POINT 4.3.3.1

# Particle motion in gases

## Mark schemes and examiner comments

| | |
|---|---|
| Tier | **Higher** |
| Question groups | **7** |
| Available paper years | **2018–2025** |

## 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.

### 4.3.3.1 Particle motion in gases

**Answer 01 · Mark scheme** June 2018 | 8463/1H | Original Q7

| Question | Answers | Extra information | Mark | AO/ Spec. Ref |
|---|---|---|---|---|
| **07.1** | any **two** from:<br><br>• calculate a mean<br>• reduces the effect of random errors<br><br>• identify / remove anomalies | <br><br><br>reduces human error is insufficient<br><br>allow to assess the repeatability of the data | 2 | AO3<br>4.3.3.2 |
| **07.2** | random error<br><br>(because) eye position would not be the same each time (relative to the liquid) | allow a parallax error<br>human error is insufficient<br><br>allow systematic error only if it is clear that the student always viewed liquid level from above meniscus (or below) | 1<br><br>1 | AO3<br>4.3.3.2 |
| **07.3** | (a temperature increase would) increase the pressure in the tube<br>(even if the volume was constant)<br><br>(because a higher temperature would mean) higher (average) kinetic energy of molecules / particles | <br><br><br>allow higher (average) speed for higher (average) kinetic energy | 1<br><br><br>1 | AO1<br>4.3.3.3 |

### 4.3.3.1 Particle motion in gases

**Answer 01 · Mark scheme**

June 2018 | 8463/1H | Original Q7

| Question | Answers | Extra information | Mark | AO/ Spec. Ref |
|---|---|---|---|---|
| **07.4** | | an answer of 8.0 ($cm^3$) scores **3** marks | | AO2 4.3.3.2 |
| | $1.6 \times 10^5 \times 9.0$ (= $1.44 \times 10^6$) | | 1 | |
| | $1.44 \times 10^6 = 1.8 \times 10^5 \times V$ **or** $V = \frac{1.44 \times 10^6}{1.8 \times 10^5}$ | allow for **2** marks $V = \frac{1.6 \times 10^5 \times 9.0}{1.8 \times 10^5}$ | 1 | |
| | $V = 8.0$ ($cm^3$) | | 1 | |
| **07.5** | work is done on the air (in the tyre) | | 1 | AO1 4.3.3.3 |
| | so the temperature (of the air) increases | allow the (average) kinetic energy of the particles increases | 1 | |
| **Total** | | | **11** | |

4.3.3.1 Particle motion in gases

Answer 02 · Mark scheme

June 2019 | 8463/1H | Original Q11

## Question 11

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 11.1 | the (mean) kinetic energy of the particles increases | allow the (mean) speed of the particles increases<br>'kinetic energy increases' is insufficient by itself<br>do not accept particles vibrating | 1 | 4.3.2.1 AO1 |
| | which increases the (internal) energy of the water | ignore description of evaporation | 1 | |
| 11.2 | Particles in a gas have more potential energy than particles in a liquid. | | 1 | 4.3.1.1 AO1 |
| 11.3 | Energy given to water E = mL with quantities defined | | 1 | 4.3.3.1 AO1 |
| | power output (of Bunsen burner) $= \frac{\text{energy transferred (to water)}}{\text{time}}$ | allow $P = \frac{E}{t}$ with quantities defined | 1 | |
| | power output $= \frac{\text{change in mass} \times \text{specific latent heat}}{\text{time}}$ | allow E = Pt equated with E = mL or stated in words<br>**or**<br>$P = \frac{mL}{t}$ with quantities defined | 1 | |
| | time should be converted to seconds<br>**or**<br>use a time of 300 seconds | | 1 | |
| **Total** | | | **7** | |

4.3.3.1 Particle motion in gases

Answer 03 · Mark scheme

November 2020 | 8463/1H | Original Q10

## Question 10

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **10.1** | The particles move in random directions.<br><br>The particles move with a range of speeds. | | 1<br><br>1 | AO1<br>4.3.3.1 |
| **10.2** | 100 000 × 0.030 = 3000<br><br>p × 0.025 = 3000<br><br>$p = \frac{3000}{0.025}$<br><br>p = 120 000 (Pa) | <br><br>allow a correct substitution using an incorrectly calculated value using pV = constant<br><br>allow a correct rearrangement using an incorrect value of the constant<br><br>allow a correct calculation using an incorrect value of the constant<br><br>allow correct substitution into $p_1V_1 = p_2V_2$ for first 2 marking points | <br>1<br><br>1<br><br>1<br><br>1 | AO2<br>4.3.3.2 |
| **10.3** | particles would have a higher (mean) kinetic energy<br><br>(so) increased number of collisions with the walls of the balloon per second<br><br>greater forces exerted in collisions (between particles and balloon walls)<br><br>greater force exerted on same area | allow particles would have a higher (mean) speed<br>do not accept particles vibrate more<br><br>allow greater frequency of collisions with the walls of the balloon<br><br>allow greater rate of change of momentum (of particles)<br><br>allow description using p=F/A | 1<br><br>1<br><br>1<br><br>1 | AO1<br>4.3.3.1 |
| **Total** | | | **10** | |

4.3.3.1 Particle motion in gases

Answer 04 · Mark scheme

November 2021 | 8463/1H | Original Q9

## Question 9

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **09.1** | 0(.0) to 12(.0) | allow 2(.0) to 12(.0) (N) | 1 | AO1 4.3.3.2 |
| **09.2** | mass of gas (in the syringe)<br>**or**<br>temperature (of the gas) | | 1 | AO3 4.3.3.2 |
| **09.3** | constant = 60 × 45<br>**or**<br>constant = 2700<br><br>2700 = p × 40<br><br>$p = \frac{2700}{40}$<br><br>p = 67.5 (kPa) | <br><br><br><br><br><br>allow 68 (kPa) | 1<br><br><br>1<br><br>1<br><br>1 | AO2 4.3.3.2 |

4.3.3.1 Particle motion in gases

Answer 04 · Mark scheme

November 2021 | 8463/1H | Original Q9

| | | | | |
|---|---|---|---|---|
| **09.4** | there is more time between collisions of particles and the walls of the syringe<br>**or**<br>there are less frequent collisions between the particles and the walls of the syringe<br><br>(causing) a lower (average) force on the walls of the syringe<br><br>(and) pressure is the total force per unit area | | 1<br><br>1<br><br>1 | AO1<br>4.3.3.2 |
| **Total** | | | **9** | |

4.3.3.1 Particle motion in gases

Answer 05 · Mark scheme

June 2023 | 8463/1H | Original Q9

## Question 9

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **09.1** | random | allow all / any<br>ignore many different | 1 | AO1<br>4.3.3.1 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **09.2** | more (air) particles (in the tyre)<br><br>greater number of collisions with tyre (walls) per second | <br><br>allow collisions with tyre (walls) are more frequent<br>allow greater rate of collisions with tyre (walls)<br><br>do **not** credit MP2 if linked to an increased air temperature or increased speed / $E_k$ of particles<br><br>ignore greater force per $m^2$ | 1<br><br>1 | AO1<br>4.3.3.1<br>4.3.3.2 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **09.3** | (as temperature increases the) air particles have greater (mean) kinetic energy<br><br>(so) more collisions with tyre (walls) per second<br><br>(and) greater force in each collision<br><br>greater (mean) force per square metre causes greater pressure (on wall of tyre) | allow particles move with greater speeds (on average)<br><br>allow collisions with tyre (walls) are more frequent<br>allow greater rate of collisions with tyre (walls)<br><br>allow greater rate of change of momentum in each collision<br><br>allow ‘on a given area’ for ‘per square metre’ | 1<br><br>1<br><br>1<br><br>1 | AO1<br>4.3.3.1 |

| **Total Question 9** | **7** |
|---|---|

4.3.3.1 Particle motion in gases

Answer 06 · Mark scheme

June 2024 | 8463/1H | Original Q8

## Question 8

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 08.1 | (air) particles are closer together | ignore reference to kinetic energy of particles<br>ignore reference to concentration of air particles | 1 | AO1<br>4.3.3.2 |
| | (so) frequency of collision between air particles and syringe walls increased | do not credit MP2 if linked to an increase in kinetic energy | 1 | |
| | larger (total) force on a smaller (surface) area | allow larger force per unit area | 1 | |
| | | if no other marks score allow 1 mark for pressure increases because volume decreases and pV = constant | | |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 08.2 | the mean kinetic energy of the particles increases | | 1 | AO1<br>4.3.3.1 |

| Question | Answers | Extra information | Mark | AO / Spec. |
|---|---|---|---|---|
| 08.3 | $c$ = 1010 (J/kg °C) | allow full credit for a correct method using $E$ = 0.0000130 (kJ) | 1 | AO2<br>4.1.1.3<br>4.3.2.2 |
| | $0.0130 = 2.60\times10^{-8} \times 1010 \times \Delta\theta$ | allow a correct substitution of an incorrectly / not converted value of $c$ | 1 | |
| | $\Delta\theta = \dfrac{0.0130}{(2.60 \times 10^{-8} \times 1010)}$ | allow a correct rearrangement of an incorrectly / not converted value of $c$ | 1 | |
| | $\Delta\theta$ = 495 (°C) | allow an answer consistent with an incorrectly / not converted value of $c$<br>allow a correct answer given to more than 3 sig figs | 1 | |

| Total Question 8 | 8 |
|---|---|

4.3.3.1 Particle motion in gases

Answer 07 · Mark scheme

June 2025 | 8463/1H | Original Q8

## Question 8

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 08.1 | $m$ = 0.050 (kg) | all subsequent marks can score using an incorrectly / not converted value of $m$ | 1 | AO2 4.3.2.3 |
| | 9950 = 0.050 × $L$ | | 1 | |
| | $L = \frac{9950}{0.050}$ | | 1 | |
| | $L$ = 199 000 (J/kg) | | 1 | |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 08.2 | the potential energy of the particles increases | | 1 | AO1 4.3.2.1 |
| | (but) the kinetic energy of the particles does not change (as temperature does not change) | | 1 | |
| | (so the) internal energy increases | MP3 dependent on MP1 **and** MP2 | 1 | |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| 08.3 | the *(mean)* kinetic energy of the gas particles increased | allow the *(mean)* speed of the gas particles increased | 1 | AO1 4.3.3.1 |
| | (so) particles exert a greater force on the walls of the container during each collision | | 1 | |
| | (and) the frequency of collisions of the particles and the walls of the container increases | allow 'rate of' for 'frequency' | 1 | |
| | (so) pressure increases | this mark is dependent on scoring at least 1 other mark | 1 | |

| Total Question 8 | 11 |
|---|---|

4.3.3.1 Particle motion in gases

Answer 03 · Examiner comments

November 2020 | 8463/1H | Original Q10

**Question 10 (High demand)**

**10.1** 75% of students correctly identified two correct statements, while 23% of students identified one.

**10.2** 65% of students scored 4 marks. Students who understood that 'pressure × volume = a constant' were usually able to perform the calculation correctly. A few students made mistakes in copying down the quantities, eg missing off a 0 from, or adding an extra 0 to, the pressure. Many students who did not score marks thought that the relationship between the quantities was pressure/volume = a constant.

**10.3** A good range of answers were seen and the question discriminated well between students. 1% of students scored all 4 marks, while 10% scored 3 marks, 25% scored 2 marks and 40% scored 1 mark. Most students realised that the answer involved the helium particles, and many referred correctly to the increase in kinetic energy or speed of these particles. However, few students were able to provide a coherent explanation beyond this. Whilst many referred to particle collisions, few indicated that the collisions were with the walls of the balloon and that the collisions would be more frequent. Many students seem to think that pressure is caused by particles colliding amongst themselves. A minority of answers went on to state that a greater force would be exerted on the balloon walls, but then failed to link this idea with the definition of pressure.

4.3.3.1 Particle motion in gases

Answer 03 · Examiner comments



**Mark Ranges and Award of Grades**

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

### 4.3.3.1 Particle motion in gases

**Answer 04 · Examiner comments** November 2021 | 8463/1H | Original Q9

**Question 9**

Questions **09.1** and **09.3** were well answered with 45% of students scoring 4 marks on **09.3**. Less than 10% of students scored a mark on **09.2,** with many students stating that either the volume or the equipment was kept the same, neither of which were creditworthy. Question **09.4** was poorly answered with few students demonstrating sufficient technical accuracy in their explanation. Common errors were to refer simply to ‘more collisions’ rather than the ‘frequency of collisions’ and not referring to the force exerted on the container walls.

**Answer 05 · Examiner comments** June 2023 | 8463/1H | Original Q9

**Question 9 (High Demand)**

**09.1** 80% of students correctly stated that the particels move in  random directions.

4.3.3.1 Particle motion in gases

Answer 05 · Examiner comments

June 2023 | 8463/1H | Original Q9

**09.2** 18% of students scored 2 marks, while 60% of students scored 1 mark.
If a student stated that there are a greater number of collisions with the tyre per second, but linkedthis to a spurious reason e.g .because the particles are moving faster, they did not score the score the 2nd mark. For the 2nd mark a microscopic description was needed, which is why 'greater force per $m^2$' was ignored.

**09.3** This question was well attempted, but most students' explanations lacked the detail needed to score marks. 45% of students scored 1 mark. 26 % of students scored 2 marks. Only 10 % of students scored 3 or 4 marks.
The first 3 marking points were microscopic explanations, whereas the 4th marking point is a macroscopic explanation. Students who stated 'the particles vibrate more/faster' could not score the 1st marking point. For the 2nd marking point students needed to refer to more collisions with the tyre 'per second' or 'more frequently' or 'greater rate', the dependence on time is important. For the 3rd marking point te force referred to is the individual force experienced in a collision by a particle with the tyre wal, Students needed to state this so that it was clear whether they were talking about the total force or the individual force exerted by a particle. For the 4th marking point students needed to say both that the pressure is greater **and** why – that the force per square metre is greater. If a student said 'greater force and as pressure = force / area, greater pressure' that was just enough to score.

4.3.3.1 Particle motion in gases

Answer 05 · Examiner comments

June 2023 | 8463/1H | Original Q9

**Mark Ranges and Award of Grades**

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

4.3.3.1 Particle motion in gases

**Answer 06 · Examiner comments** June 2024 | 8463/1H | Original Q8

**Question 8 (High Demand)**

**08.1** Questions about the microscopic causes of pressure are difficult for GCSE students and this question was no exception. Many students repeated information given in the question which did not score any marks. A minority of students scored the first mark point, many students simply stating that the volume decreased which was insufficient. Students made a good attempt at explaining that there were more collisions between the particles and the container walls, but failed to score because they didn't refer to a specified time period e.g. per second, or rate or more frequent, etc. Some students stated that the kinetic energy of the particles had increased, which stopped them from scoring the second mark point. Very few students scored the third mark point which was the most demanding of the three. 9% of students scored 2 or 3 marks, while 43% of students scored 1 mark.

**08.2** 94% of students scored this mark, linking temperature increase to mean kinetic energy of particles.

**08.3** A grade 6-7 calculation question which discriminated well between students. Many students failed to convert the specific heat capacity so scored 3 marks instead of 4. Some students tried to convert the energy into kJ but very few did this successfully, usually ending with a 'power of 10' error. 22% of students scored 3 marks while 62% of students scored 4 marks.

**Answer 07 · Examiner comments** June 2025 | 8463/1H | Original Q8

## 08.1

Just fewer than 90 % of the students scored 4 marks on this calculation of specific latent heat. Students who did not convert or incorrectly converted the mass could score a maximum of 3 marks.

## 08.2

Most students did not refer to the energy of the particles in terms of kinetic and potential energy, so scoring no marks. Many students thought the kinetic energy of the particles changed which limited them to scoring only the first marking point. Only about 3 % of the students scored 2 or 3 marks, while just over 10 % of the students scored 1 mark.

## 08.3

Students made good attempts at answering this challenging question about gas pressure. Technical accuracy was important for the second and third marking points, so it needed to be clear that particle collisions with the container walls were more frequent, more often or at a greater rate of collision. More frequent collisions between particles was insufficient for the second mark. The third marking point needed to reference the forces involved in collisions with the container walls, an implied greater force per collision was acceptable, but not a macroscopic force linked to force and area as that was not being tested. Almost half of the students scored 3 or 4 marks, while almost 40 % of the students scored 1 or 2 marks.