

Particle motion in gases

4.3.3.1 · Particle model of matter · revision notes

How the random motion of gas molecules explains the temperature and pressure of a gas. You need to link the temperature of a gas to the average kinetic energy of its molecules, and explain in words (no calculations) why heating a gas in a fixed volume increases its pressure. Questions are mainly 2 to 4 mark explanations in contexts such as tyres, aerosol cans and sealed containers.

Key facts

- Gas molecules are in constant random motion
- Gas pressure is caused by molecules colliding with the walls and exerting a force on them
- Hotter → molecules faster → collide with the walls more often and with more force
- Higher temperature = greater average kinetic energy of the molecules
- Constant volume: temperature up → pressure up
- Cooler → molecules slower → fewer, weaker collisions with the walls → lower pressure

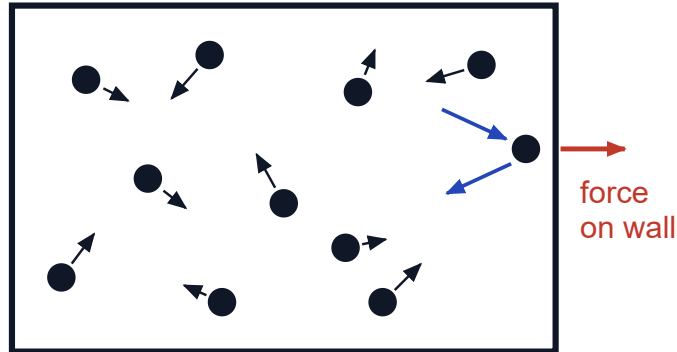
Notes

Gas molecules and temperature

- The molecules of a gas are in **constant random motion**. They move in all directions, at a range of speeds, and keep colliding with each other and with the walls of their container.
- The **temperature** of a gas is related to the **average kinetic energy** of its molecules.
- Heating a gas raises its temperature, so its molecules move faster on average. Cooling a gas slows its molecules down.

How a gas exerts pressure

- Gas molecules constantly collide with the walls of their container.
- In each collision, a molecule exerts a force on the wall. Huge numbers of molecules collide every second, so together they produce a steady force on the wall.
- The **pressure** of the gas is the force that these collisions produce on each unit of area of the wall.

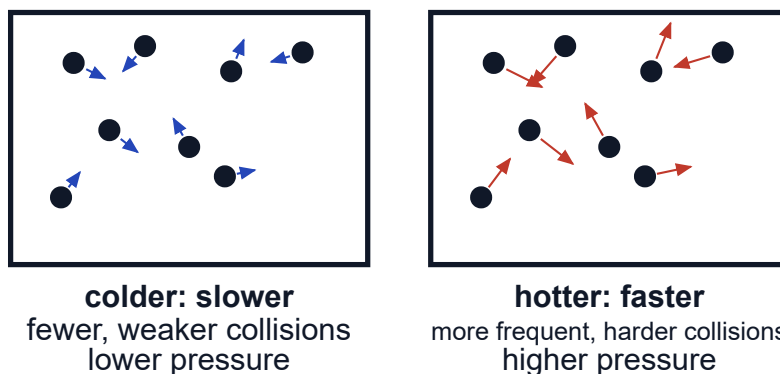


random motion: all directions, a range of speeds

Each collision pushes on the wall. Force per unit area = pressure.

Heating a gas at constant volume

- If a gas is in a sealed container that cannot expand (constant volume), increasing its temperature increases its pressure.
- Why: the molecules gain kinetic energy and move faster on average, so they **collide with the walls more often** (more collisions each second) and **with more force** in each collision. Both effects increase the pressure.



Same volume, higher temperature: faster molecules, higher pressure.

- Cooling the gas does the opposite: the molecules move more slowly, so they hit the walls less often and with less force, and the pressure falls.
- Examples: a sealed aerosol can may burst if it is heated; car tyre pressure rises after a long drive because the air inside warms up.
- You only need to explain this relationship in words; you do not calculate it.

How to answer each type of question

Describe the motion of gas molecules

1 to 2 marks

Grade 3

1. Use the key words: constant (never stops) and random (all directions).
2. If the question mentions temperature, link it to the average kinetic energy (speed) of the molecules.

Example. Describe the motion of the molecules in a gas. (2 marks)

Model answer. The molecules move all the time / constantly (1) in random directions (1).

Explain how a gas exerts a pressure

2 marks

Grade 5

1. Say that the molecules collide with the walls (surface).
2. Say that each collision exerts a force, and the force on each unit area is the pressure.

Example. A balloon is filled with air.

Explain how the air molecules exert a pressure on the inside of the balloon.

Model answer. The air molecules collide with the inside surface of the balloon (1). Each collision exerts a force on the surface; the total force on each unit area is the pressure (1).

Don't lose marks

- ✗ Saying the molecules get bigger or expand when heated. They move faster; their size does not change.
- ✗ Giving only one effect. Say the molecules hit the walls more often AND with more force.
- ✗ Saying the pressure rises because the molecules collide with each other more. Pressure comes from collisions with the walls.
- ✗ Writing just 'more collisions'. Say 'more collisions per second' or 'collide more frequently'.
- ✗ Saying the molecules have 'more energy' without saying which kind: say kinetic energy.

More tips

Memory tricks

- Pressure chain: hotter → faster molecules → hit the walls more often AND harder → higher pressure.
- Constant volume + hotter = higher pressure. That is why aerosol cans warn you not to heat them.
- Temperature = average kinetic energy, so 'hotter gas' always means 'faster molecules on average'.

Exam technique

- Use the key phrases: 'constant random motion', 'average kinetic energy', 'collide with the walls more frequently', 'with greater force'.
- Check what is held constant: these explanations are for a gas whose volume does not change.
- In 3-mark explanations, build a chain: temperature → kinetic energy (speed) → collisions with the walls (frequency and force) → pressure.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3

Describe the motion of gas molecules

They are in constant random motion, moving in all directions.

Grade 4

Link gas temperature to molecules' kinetic energy

The higher the temperature, the greater the average kinetic energy of the molecules, so the faster they move on average.

Grade 5

Explain how a gas exerts pressure

Molecules collide with the walls of the container and exert a force on them; the force on each unit area is the pressure.

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