Particle Motion in Gases

Gas particles fly around, bump into things and exert forces on them. This is happening to you right now — the air around you is exerting pressure on you (unless you're somehow reading this in space).

Colliding Gas Particles Create Pressure

1) According to kinetic theory, all matter is made up of very small, constantly moving particles.
2) In a gas, these particles are free to move around in completely random directions. Particles in a gas hardly take up any space. Most of the gas is empty space.
3) As gas particles move about, they randomly bang into each other and whatever else gets in the way, like the walls of their container.
4) Gas particles are very small, but they still have a mass. When they collide with something, they exert a force on it.
5) All these collisions cause a net force acting outwards on the inside surface of the container. The force acting per unit area is the pressure.
6) The more particles there are in a given volume, the more often they'll collide with the walls of the container, and with each other, so the higher the pressure will be.

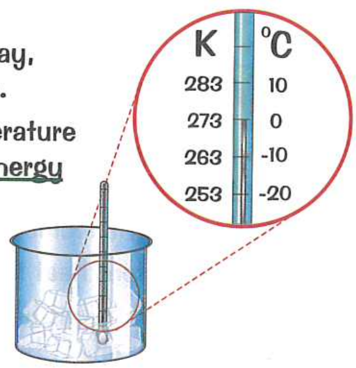
Increasing the Temperature Increases the Pressure

A sealed container is an example of a closed system — no matter can get in or out.

1) The pressure a gas exerts on its container also depends on how fast the particles are going and how often they hit the walls.
2) If you hold a gas in a sealed container with a fixed mass and volume and heat it, energy is transferred to the kinetic energy stores of the gas particles and they move faster. This means the particles hit the container walls harder and more often, creating more pressure.
3) If the gas is cooled, the particles have less energy and move less quickly. The particles hit the walls with less force and less often, so the pressure is reduced.

Absolute Zero is as Cold as Stuff Can Get — 0 kelvin

1) If you increase the temperature of something, you give its particles more energy — they move about more quickly or vibrate more. In the same way, if you cool a substance down, you're reducing the energy of the particles.
2) In theory, the coldest that anything can ever get is -273 °C — this temperature is known as absolute zero. At absolute zero, the particles have as little energy in their kinetic stores as it's possible to get — they're pretty much still.
3) Absolute zero is the start of the Kelvin scale of temperature.
4) A temperature change of 1 °C is also a change of 1 kelvin. The two scales are pretty similar — the only difference is where the zero occurs.
5) To convert from degrees Celsius to kelvins, just add 273. And to convert from kelvins to degrees Celsius, just subtract 273.



	Absolute zero	Freezing point of water	Boiling point of water
Celsius scale	–273 °C	0 °C	100 °C
Kelvin scale	0 K	273 K	373 K

There's no degree symbol when you write a temperature in kelvins. Just write K, not °K. OK.

Gas particles need to watch where they're going...

Remember, the more gas particles there are, and the faster they travel, the higher the pressure. Simple...

Q1 Find the value of 25 °C in kelvin. [1 mark]

Q2 Explain how a gas exerts pressure on its container. [2 marks]

Particle Motion in Gases

Warm-Up

Circle the correct words or phrases below so that the sentences are correct.

The particles in a gas are always moving in the same direction / random directions.

A gas exerts a force on a container due to collisions / radioactivity.

The total force exerted by the particles per unit area is the gas energy / pressure.

1 Describe, in terms of particles, what is meant by the term absolute zero. Grade 4-6

....

....

....

[Total 1 mark]

2 Two sealed containers, A and B, contain the same quantity of gas at the same temperature. The volume of container A is twice the volume of container B. Grade 6-7

Explain, in terms of particles, why the pressure of the gas in container A is lower than the pressure of the gas in container B.

....

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....

[Total 2 marks]

3 A gas is held in a sealed container with a fixed volume. The initial temperature of the gas is 295 K. Grade 6-7

a) Give the initial temperature of the gas in degrees Celsius.

.... °C

[1]

b) The container is heated over a Bunsen burner. Describe and explain how this affects the pressure of the gas inside the container.

....

....

....

[3]

[Total 4 marks]

4 **Figure 1** shows four sealed containers. Each contains the same mass of a gas. In which container is the pressure of the gas the highest?

Grade 6-7

Figure 1

Volume = 0.04 m³	Volume = 0.04 m³	Volume = 40 000 cm³	Volume = 40 000 cm³
Temperature = 10 °C	Temperature = 20 °C	Temperature = 283 K	Temperature = 30 °C
☐ **A**	☐ **B**	☐ **C**	☐ **D**

[Total 1 mark]

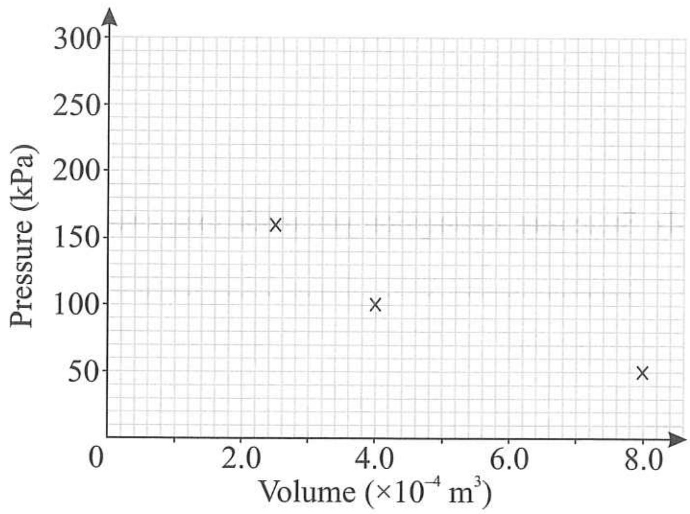
5 A student investigates how varying the volume of a container full of a fixed mass of gas at a constant temperature affects the pressure of the gas. **Figure 2** is an incomplete table of his results.

Grade 6-7

Figure 2

Volume (m^3)	Pressure (kPa)
8.0×10^{-4}	50
4.0×10^{-4}	100
2.5×10^{-4}	160
1.6×10^{-4}	....

Figure 3



a) Complete **Figure 2** by calculating the missing pressure measurement.

[3]

b) Using information from **Figure 2**, complete the graph in **Figure 3** by plotting the missing data and drawing a line of best fit.

[2]

[Total 5 marks]

Exam Practice Tip

Remember, one degree on the Kelvin scale is the same size as one degree on the Celsius scale, but 0 K is much, much colder than 0 °C. A temperature in Kelvin will always have a higher value than the same temperature in Celsius.