

Gas pressure, volume and the kelvin scale

Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Worksheet

Name: _____ Date: _____ Class: _____

These twenty problems build your understanding of gases step by step: explaining pressure with moving particles, using $pV = \text{constant}$, converting temperatures to kelvin and applying the pressure law. Several problems use graphs and diagrams.

They suit GCSE, IGCSE, O Level and Class 9-10 students. Assume atmospheric pressure is 100 kPa and use $T = \theta + 273$ unless told otherwise.

Level: Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** IGCSE 2.1, HS-PS3-2

Problem 1 Ideas of kinetic theory (easy)

State three ideas of the kinetic theory of gases.

Problem 2 Celsius to kelvin (easy)

Convert:

1. 0 °C to kelvin
2. 25 °C to kelvin
3. -196 °C (liquid nitrogen) to kelvin
4. 300 K to degrees Celsius

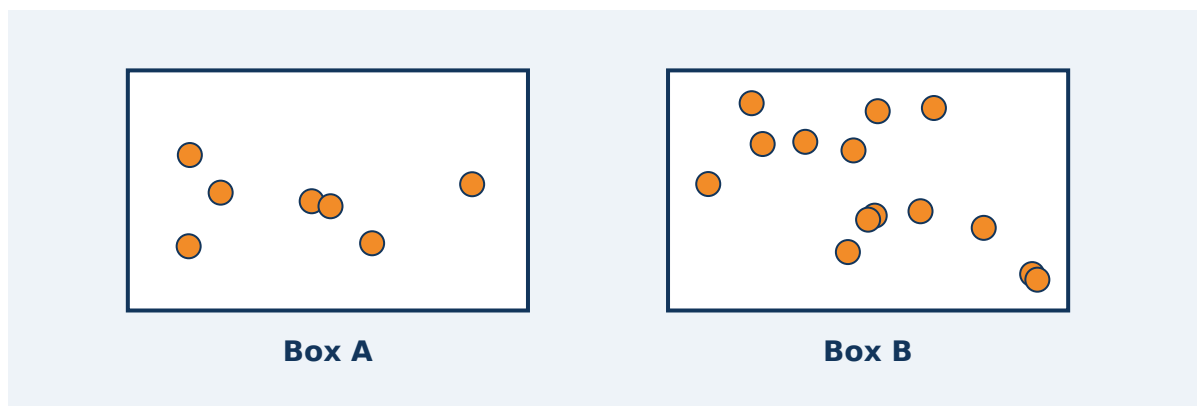
Problem 3 What raises the pressure? (easy)

State whether the pressure of a gas in a closed container increases or decreases when (a) the temperature rises, (b) the volume of the container is made smaller, (c) more gas is pumped in.

Problem 4 Halving the room (easy)

A gas at 100 kPa and 4.0 L is compressed to 2.0 L at constant temperature. Find the new pressure.

Problem 5 Two boxes (easy)



Same volume, same temperature, different numbers of particles.

Boxes A and B are at the same temperature.

1. State which box has the higher pressure.
2. Explain your answer using collisions.

Problem 6 Squeezing a syringe (medium)

A syringe traps 40 cm^3 of air at 100 kPa. The plunger is pushed in until the volume is 25 cm^3 . Calculate the pressure. Temperature is constant.

Problem 7 Filling a tyre (medium)

Kofi in Accra squeezes 600 cm^3 of air at 100 kPa into a small chamber until the pressure is 300 kPa. Calculate the volume of the chamber.

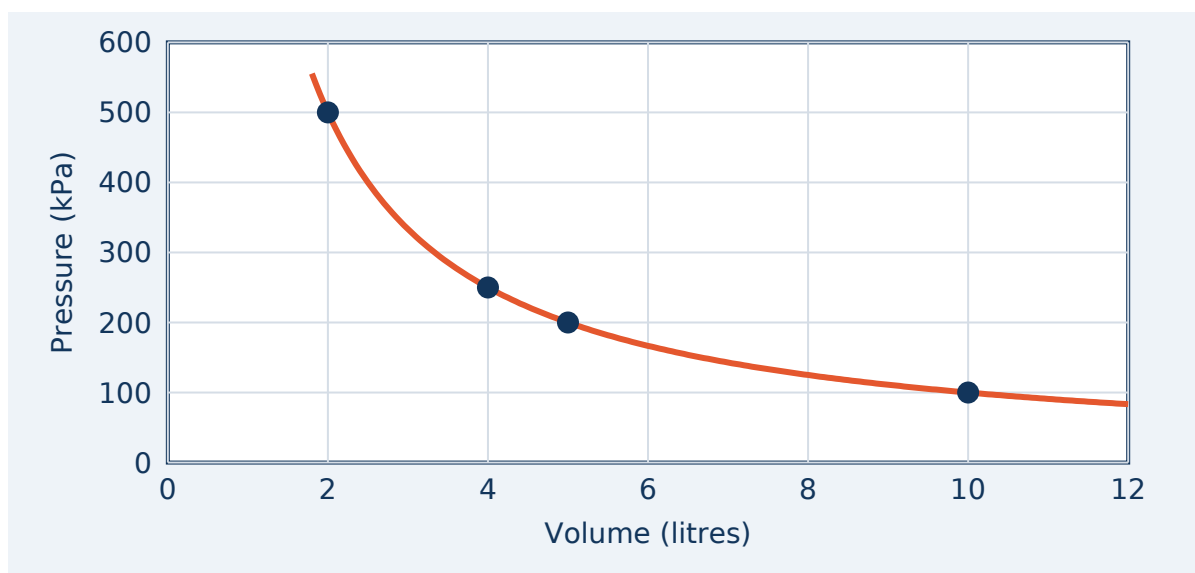
Problem 8 Heating a rigid cylinder (medium)

A rigid steel cylinder holds gas at 150 kPa and 20°C . It is heated to 100°C . Calculate the new pressure.

Problem 9 Warning on an aerosol can (medium)

A can says: do not heat above 50°C . Explain in terms of particles why the warning is needed.

Problem 10 Reading a pressure-volume graph (medium)



Pressure and volume of a trapped gas at constant temperature.

The graph shows the pressure of a trapped gas at constant temperature.

1. Read the pressure when the volume is 4 L.
2. Calculate $p \times V$ at three points and say what this shows.
3. Predict the pressure at 8 L.

Problem 11 Weather balloon (medium)

A weather balloon of volume 2.0 m^3 leaves the ground at 100 kPa. At a high altitude the pressure is 25 kPa. Assuming constant temperature, calculate its volume there.

Problem 12 Crisp packet on a hill (medium)

A sealed crisp packet from Wanjiru's school trip looks puffed up at the top of a mountain. Explain why.

Problem 13 Spot the error (medium)

A student uses $p_1 / T_1 = p_2 / T_2$ for gas at 120 kPa and 20°C heated to 80°C and writes $p_2 = 120 \times 80 / 20 = 480 \text{ kPa}$. Find the error and give the correct value.

Problem 14 Units first (medium)

A gas has a volume of 800 cm^3 at 100 kPa.

1. Convert 800 cm^3 to litres.
2. Convert 100 kPa to pascals.
3. Calculate the pressure if the volume is reduced to 0.50 L at constant temperature.

Problem 15 Force on a piston (medium)

A gas at 200 kPa pushes on a piston of area 0.0030 m^2 . Calculate the force on the piston.

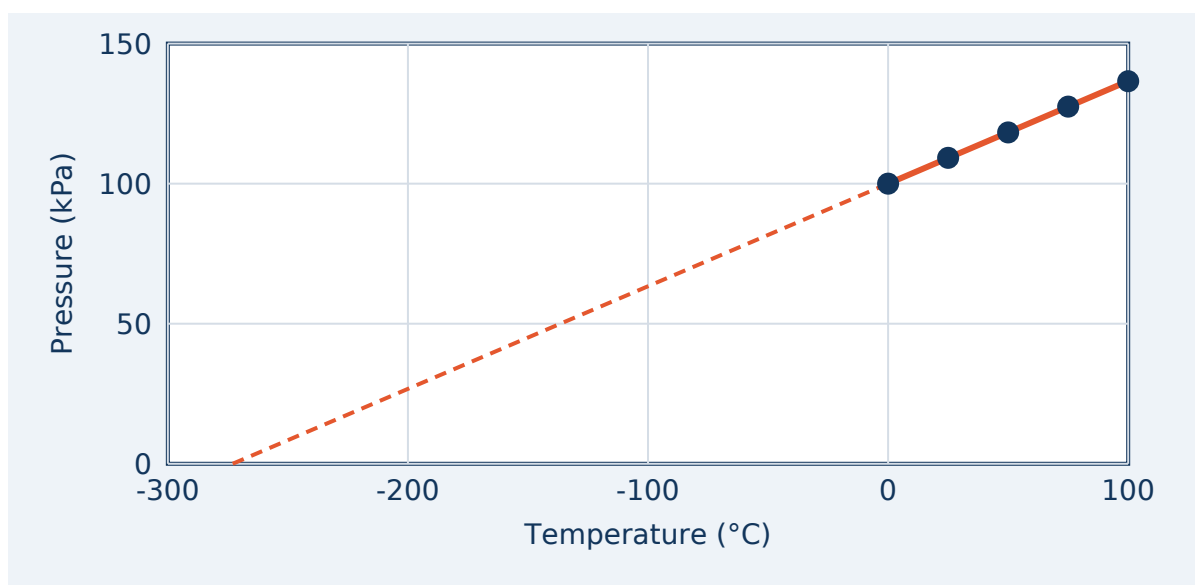
Problem 16 Pumping a bicycle tyre (hard)

A tyre has a fixed volume of 1.5 L and contains air at 100 kPa. A pump pushes in 0.50 L of air at 100 kPa on each stroke. After 6 strokes, calculate the pressure in the tyre. The temperature does not change.

Problem 17 Rising bubble (hard)

A bubble of volume 5.0 cm^3 is released by a diver where the pressure is 300 kPa. The surface pressure is 100 kPa. The water temperature is constant.

1. Calculate the volume of the bubble at the surface.
2. Explain why divers must never hold their breath while rising.

Problem 18 Extrapolating to absolute zero (hard)

Pressure of a fixed volume of gas, with the line extended backwards.

A fixed volume of gas has pressure 100 kPa at 0 °C. The pressure at 100 °C is 136.6 kPa.

1. Show that p / T is the same at both temperatures.
2. Use the graph to say at what Celsius temperature the pressure would reach zero, and what this temperature means.

Problem 19 Jar in the freezer (hard)

A 1.5 L jar is sealed at 27 °C and 100 kPa and placed in a freezer at -18 °C .

1. Calculate the pressure inside the jar after it cools.
2. The lid has an area of $6.0 \times 10^{-4} \text{ m}^2$ and the outside pressure is 100 kPa. Calculate the net force on the lid.

Problem 20 Compress then heat (hard)

A sealed gas starts at 100 kPa, 3.0 L and 300 K. It is compressed slowly to 1.0 L at constant

temperature, then the volume is held fixed while it is heated to 450 K. Calculate the final pressure.