

Exercise walk-through

9.2

The Ideal Gas Law

AP Physics 2

The ideal gas law

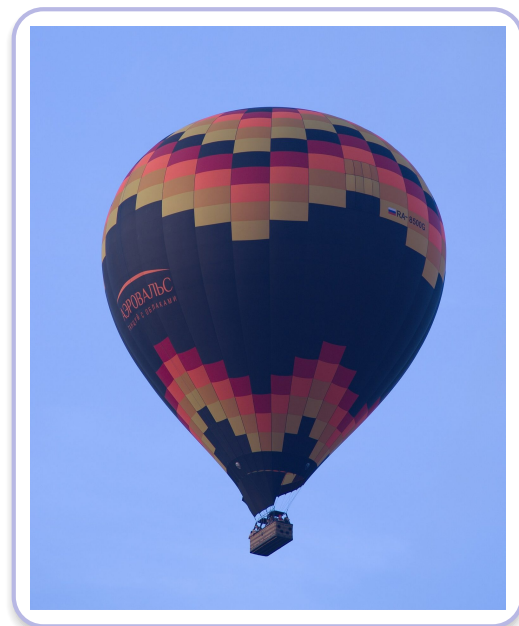
Two forms of the same law

$$PV = Nk_B T \quad PV = nRT$$

N particles, or n **moles** ; $R = N_A k_B$.

Comparing two states

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$



Heating a gas expands it and can do work

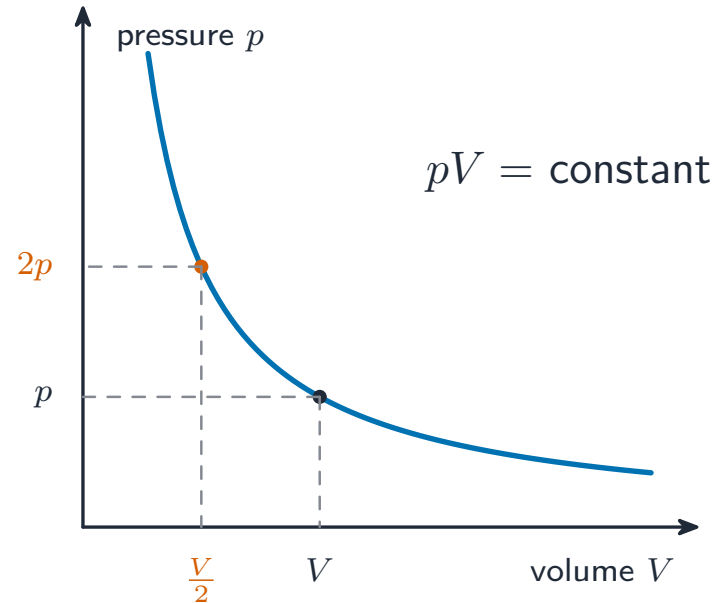
Worked example – heating a rigid container

A sealed container of gas is at 1.0×10^5 Pa and 300 K. It is heated to 450 K. Find the new pressure.

- an **ideal gas** obeys $PV = nRT$,
or $PV = Nk_B T$
- rigid and sealed, so V and n are fixed:
$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$
- $P_2 = 1.0 \times 10^5 \times \frac{450}{300} = 1.5 \times 10^5$ Pa

Always identify **what is held constant** before choosing the form of the law – and always use **kelvin**, since the ratio is meaningless in Celsius.

Boyle's law



Boyle's law: at constant temperature, pressure times volume is constant

Exercises 2.1-2.3

2.1 A gas at constant temperature has its pressure doubled. State what happens to its volume. [1]

2.2 Find the volume of 2.0 mol of gas at 300 K and 1.0×10^5 Pa (take $R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$)

2.3 State two conditions under which a real gas behaves like an ideal gas. [2]

Exercises 2.1·2.3

2.1 A gas at constant temperature has its pressure doubled. State what happens to its volume. [1]

2.1

- it halves (Boyle's law, PV constant at fixed T)
-

2.2 Find the volume of 2.0 mol of gas at 300 K and 1.0×10^5 Pa (take $R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$)

2.2

- $$V = \frac{nRT}{P} = \frac{2.0 \times 8.31 \times 300}{1.0 \times 10^5} = 0.050 \text{ m}^3$$

2.3 State two conditions under which a real gas behaves like an ideal gas. [2]

2.3

- low pressure; high temperature

Exercises 3.1-3.2

3.1 The ideal gas law is

[1]

☐

A $PV = nRT$

B $P = \rho gh$

C $PV = \frac{1}{2}mv^2$

D $V = IR$

3.2 A fixed amount of gas is heated at constant volume. Its pressure

[1]

☐

A falls

B rises

C stays constant

D halves

Exercises 3.1·3.2

3.1 The ideal gas law is

[1]

☐

A $PV = nRT$

B $P = \rho gh$

C $PV = \frac{1}{2}mv^2$

D $V = IR$

3.1 A

- $PV = nRT$.

3.2 A fixed amount of gas is heated at constant volume. Its pressure

[1]

☐

A falls

B rises

C stays constant

D halves

3.2 B

- rises.

Exercise 3.3 (a)

3.3 A sealed rigid 0.020 m^3 container holds gas at $2.0 \times 10^5 \text{ Pa}$ and 300 K . It is heated to 450 K .

(a) Find the new pressure.

[3]

Exercise 3.3 (a)

3.3 A sealed rigid 0.020 m^3 container holds gas at $2.0 \times 10^5 \text{ Pa}$ and 300 K . It is heated to 450 K .

(a) Find the new pressure.

[3]

(a)

- $$\frac{P_1}{T_1} = \frac{P_2}{T_2} \Rightarrow P_2 = 2.0 \times 10^5 \times \frac{450}{300} = 3.0 \times 10^5 \text{ Pa}$$

Exercise 3.3 (b)

3.3 A sealed rigid 0.020 m^3 container holds gas at $2.0 \times 10^5 \text{ Pa}$ and 300 K . It is heated to 450 K .

(b) State the assumption you made about the volume.

[1]

Exercise 3.3 (b)

3.3 A sealed rigid 0.020 m^3 container holds gas at $2.0 \times 10^5 \text{ Pa}$ and 300 K . It is heated to 450 K .

(b) State the assumption you made about the volume.

[1]

(b)

- the volume stays constant (the container is rigid)