

**Essential idea:** The properties of ideal gases allow scientists to make predictions of the behaviour of real gases.

### 3.2 – Modelling a gas

#### Nature of science:

Collaboration: Scientists in the 19th century made valuable progress on the modern theories that form the basis of thermodynamics, making important links with other sciences, especially chemistry. The scientific method was in evidence with contrasting but complementary statements of some laws derived by different scientists. Empirical and theoretical thinking both have their place in science and this is evident in the comparison between the unattainable ideal gas and real gases. (4.1)

#### Understandings:

- Pressure
- Equation of state for an ideal gas
- Kinetic model of an ideal gas
- Mole, molar mass and the Avogadro constant
- Differences between real and ideal gases

#### Applications and skills:

- Solving problems using the equation of state for an ideal gas and gas laws
- Sketching and interpreting changes of state of an ideal gas on pressure–volume, pressure–temperature and volume–temperature diagrams
- Investigating at least one gas law experimentally

#### Guidance:

- Students should be aware of the assumptions that underpin the molecular kinetic theory of ideal gases
- Gas laws are limited to constant volume, constant temperature, constant pressure and the ideal gas law
- Students should understand that a real gas approximates to an ideal gas at conditions of low pressure, moderate temperature and low density

#### Theory of knowledge:

- When does modelling of “ideal” situations become “good enough” to count as knowledge?

#### Utilization:

- Transport of gases in liquid form or at high pressures/densities is common practice across the globe. Behaviour of real gases under extreme conditions needs to be carefully considered in these situations.
- Consideration of thermodynamic processes is essential to many areas of chemistry (see *Chemistry* sub-topic 1.3)
- Respiration processes (see *Biology* sub-topic D.6)

#### Aims:

- **Aim 3:** this is a good topic to make comparisons between empirical and theoretical thinking in science
- **Aim 6:** experiments could include (but are not limited to): verification of gas laws; calculation of the Avogadro constant; virtual investigation of gas law parameters not possible within a school laboratory setting

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**Data booklet reference:**

- $p = \frac{F}{A}$
- $n = \frac{N}{N_A}$
- $pV = nRT$
- $\bar{E}_k = \frac{3}{2}k_B T = \frac{3}{2} \frac{R}{N_A} T$