8.1 Gas models and absolute temperature

Name: _____ Class: _____ Date: _____ **Total: 10 marks**

KEY WORDS absolute temperature • ideal gas

Objective

Gas models and absolute temperature. Original classroom practice for IB HL; not an official IB paper.

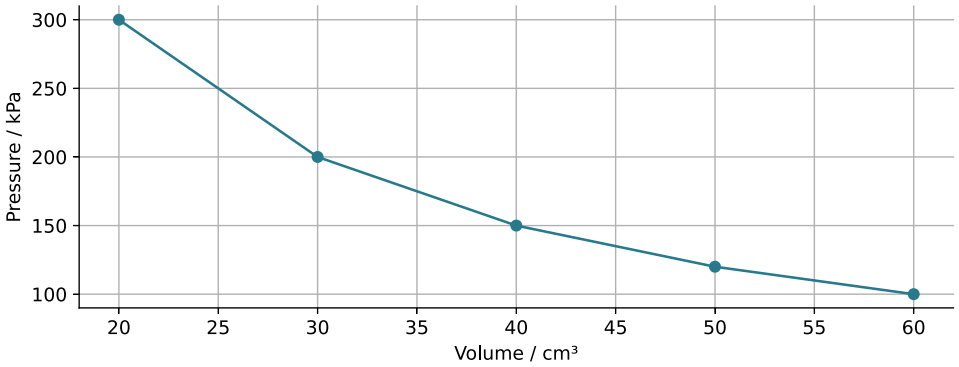
1 Key knowledge and worked examples

■ What would explain this observation?

- A sealed gas container changes pressure when heated. Celsius ratios cannot predict the pressure change because the gas model uses **absolute temperature** .

■ Build the model

- In a gas model, particles move randomly and pressure results from momentum transfer at walls.
- The **ideal gas** equation connects pressure, volume, amount and absolute temperature.
- absolute temperature: Temperature on the kelvin scale.
- ideal gas: A gas model with specified simplifying assumptions.



■ Choose evidence that can test it

- At fixed amount and volume, pressure is proportional to kelvin temperature.
- At fixed temperature and amount, pressure is inversely proportional to volume.
- State which quantities are fixed before choosing a relationship.

In the lab: Use approved apparatus with a temperature range and pressure limit set by the teacher. Allow thermal equilibrium and record pressure against kelvin temperature. Never heat an improvised sealed vessel.

■ Work from known quantities

- Known: pressure is 100 kPa at 300 K, with fixed volume and amount.
- At 330 K, p2/p1=T2/T1. p2=p1 T2/T1=100×330/300=110 kPa.
- A 30 °C rise is a 30 K change, but the temperature ratio must use kelvin.

Your turn: At fixed volume, pressure is 120 kPa at 300 K. Find pressure at 350 K.

■ Check the conclusion and its limits

- An ideal gas is a model with conditions of validity.
- Celsius zero is not zero molecular motion, and internal energy is not determined by pressure alone.

Not true: A gas pressure ratio can always use Celsius temperatures. Ratios of temperatures are meaningful only from absolute zero. 300 K to 350 K is a ratio of 350/300; the same temperatures in Celsius, 27 and 77, give 77/27 - a different, wrong answer.

Key:

- In a gas model, particles move randomly and pressure results from momentum transfer at walls.
- At fixed amount and volume, pressure is proportional to kelvin temperature.
- Watch for: an ideal gas is a model with conditions of validity.

■ Write from a pressure of 135 kPa

- At fixed volume, the pressure is 90 kPa at 200 K.
- Find the pressure at 300 K. The ratio must use kelvin.

2 Practice

2.1 Which scale belongs in a gas-law temperature ratio? Choose one answer.

- **A** Celsius
- **B** Either scale without conversion
- **C** Kelvin [1]

2.2 At fixed volume, pressure is 120 kPa at 300 K. Find pressure at 350 K. Show the relation, substitution and units. [2]

2.3 Decide whether this claim is true and justify: A gas pressure ratio can always use Celsius temperatures. [2]

2.4 Temperature on the kelvin scale: write the technical term. [1]

3 Exam-style questions

3.1 An ideal gas changes from300 K,100 kPa,V to450 K and2V at fixed amount. Find pressure. Explain why using only a temperature ratio would fail. [4]

Solutions

2.1 C Gas-law ratios rest on absolute temperature measured from absolute zero, so kelvin is required. Celsius shifts the zero by 273.15 and breaks every ratio, even though a temperature DIFFERENCE is the same size in both scales.

2.2 At fixedV,n:$p_2 = p_1 T_2/T_1 = (120\ \text{kPa}) \times 350/300 = 140\ \text{kPa}$.

2.3 False. Ratios of temperatures are meaningful only from absolute zero. 300 K to 350 K is a ratio of 350/300; the same temperatures in Celsius, 27 and 77, give 77/27 - a different, wrong answer.

2.4 absolute temperature. absolute temperature means Temperature on the kelvin scale.

3.1 Combined relation$p_2 = p_1(T_2/T_1)(V_1/V_2) = 75\ \text{kPa}$. Volume also changes; the fixed-volume formula does not apply. Use absolute temperature.