

Exercise walk-through

8.1

Gas models and absolute temperature

International Baccalaureate · IB Diploma · Physics · HL

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. Supported HL concept preparation; original classroom practice, not an official IB paper or assessed learner work.

1 Key knowledge and worked examples

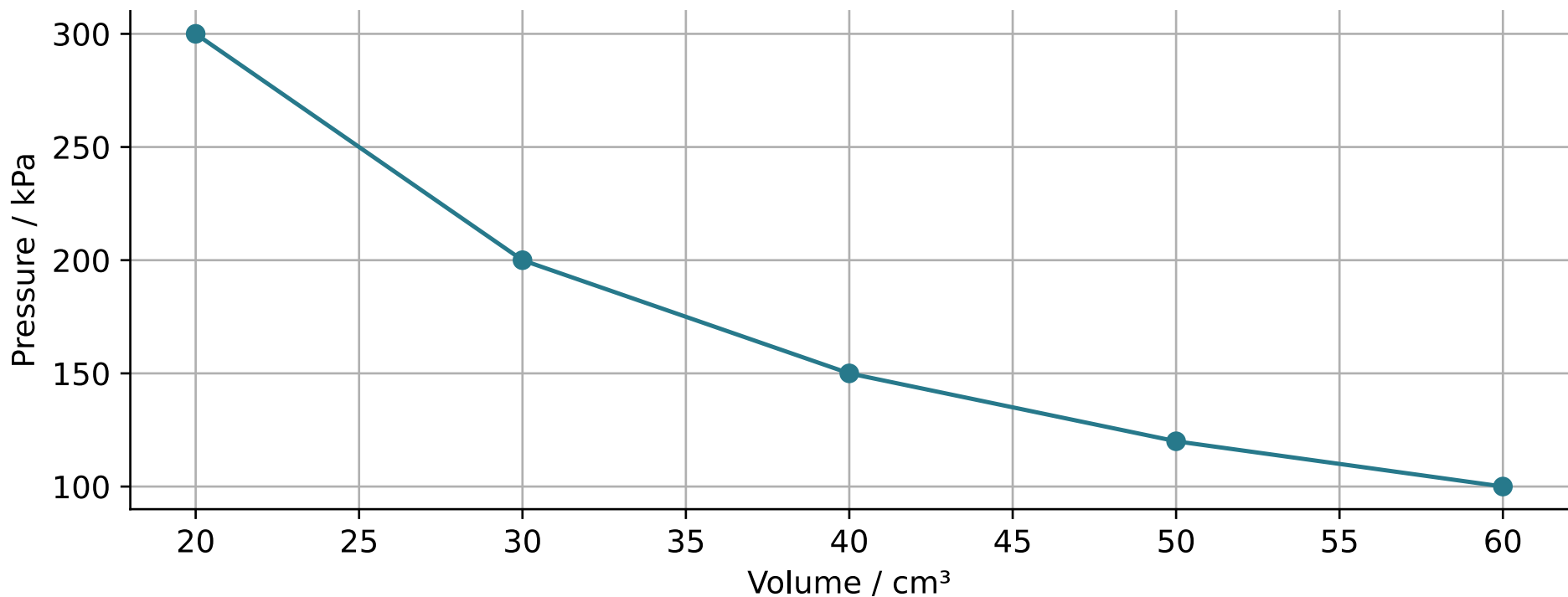
■ What would explain this observation?

- A sealed gas container changes pressure when heated. Celsius ratios cannot predict the pressure change because the gas model uses **absolute temperature**.
- Start with a prediction. State the quantities or features you would compare, then decide what evidence could distinguish two explanations.

■ 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.
- 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

- State the known values and their units. Choose the relation because its assumptions

fit this case, then rearrange before substitution.

- Known: pressure is 100 kPa at 300 K, with fixed volume and amount. At 330 K, $p_2/p_1 = T_2/T_1$. $p_2 = p_1 T_2/T_1 = 100 \times 330/300 = 110$ kPa. A 30 °C rise is a 30 K change, but the temperature ratio must use kelvin.

Example:

At fixed volume, pressure is 120 kPa at 300 K. Find pressure at 350 K. Use the same sequence: known quantities $\rightarrow$ model $\rightarrow$ relation $\rightarrow$ substitution $\rightarrow$ unit and interpretation.

■ 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.

- Return to the original observation. Explain what the result supports, which conditions it assumes, and one way to test a competing explanation.

Warn:

A gas pressure ratio can always use Celsius temperatures. This claim is false: 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.

Key:

Gas models and absolute temperature: 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.

Exercises 2.1·2.3

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

- **A** Celsius
- **B** Kelvin
- **C** Either scale without conversion

[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]

Exercises 2.1-2.3

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

- **A** Celsius
- **B** Kelvin
- **C** Either scale without conversion

[1]

2.1 B 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.

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

[2]

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

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

[2]

2.3 False. 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.

Exercises 2.4-3.1

2.4 Temperature on the kelvin scale: write the technical term.

[1]

3 Exam-style questions

3.1 An ideal gas changes from 300 K, 100 kPa, V to 450 K and $2V$ at fixed amount. Find pressure. Explain why using only a temperature ratio would fail.

[4]

Exercises 2.4·3.1

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

3 Exam-style questions

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

3.1 An ideal gas changes from 300 K, 100 kPa, V to 450 K and $2V$ at fixed amount. Find pressure. Explain why using only a temperature ratio would fail. [4]

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.