Exercise walk-through

6.1 Gas models and absolute temperature

International Baccalaureate · IB Diploma · Physics · SL

INTERNATIONAL BACCALAUREATE · IB DIPLOMA · PHYSICS · SL • EXERCISE SHEET

6.1 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 SL; not an official IB paper.

1 Key knowledge and worked examples

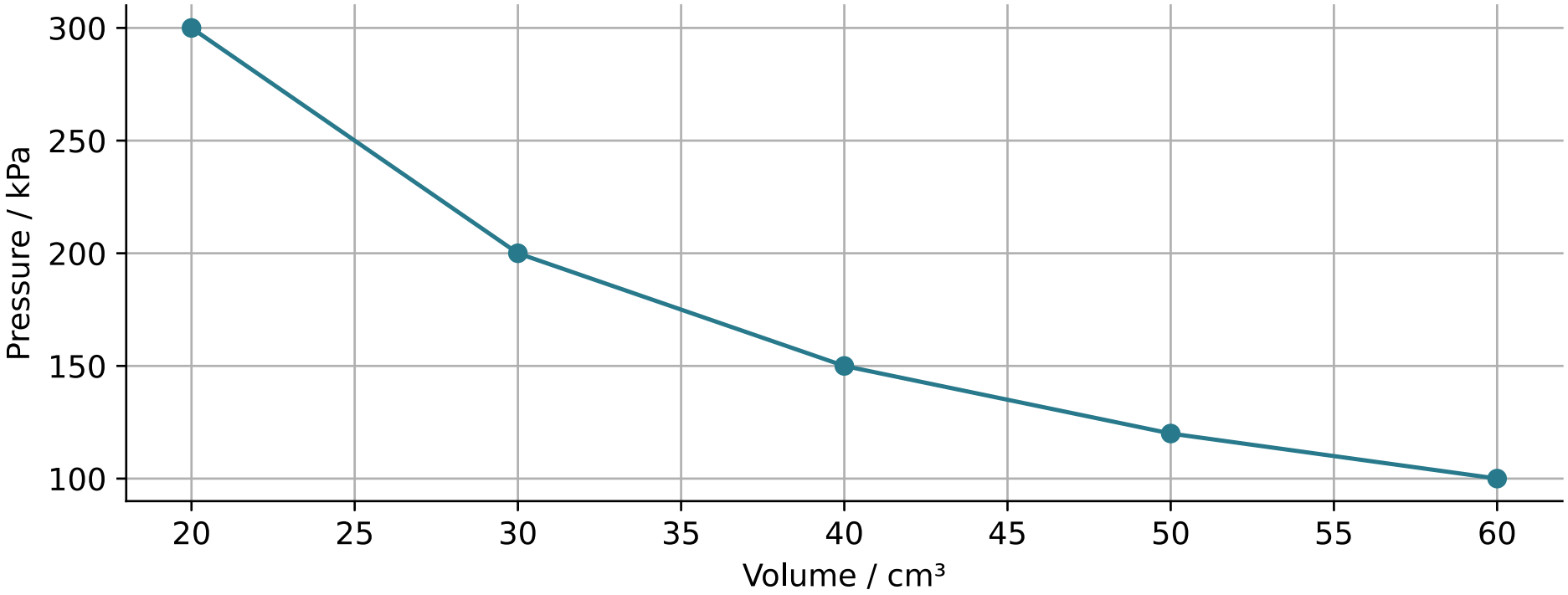
What would explain this observation?

- 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, $p_2/p_1 = T_2/T_1$. $p_2 = p_1\, T_2/T_1 = 100 \times 330/300 = 110$ kPa.

- A 30 °C rise is a 30 K change, but the temperature ratio must use kelvin.

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 96 kPa

- At fixed volume, the pressure is 80 kPa at 250 K.
- Find the pressure at 300 K. The ratio must use kelvin.

Exercises 2.1·2.3

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]

Exercises 2.1·2.3

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

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

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

2.2 At fixedV,n:$p_2=p_1T_2/T_1=(120\text{ kPa})\times350/300=140\text{ kPa}$.

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

2.3 False. 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.

Exercises 2.4·3.1

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

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]

Exercises 2.4·3.1

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

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

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]

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