Exercise walk-through

Deviation from Ideal Gas Law ▪ 3.6

eXercise

You must be able to

- state when real gases deviate (**high pressure, low temperature**)
- explain the two causes (particle **volume** and **attractions**)
- predict which gas is more ideal

Method — When deviations matter

Real gases behave most **ideally** at **high temperature** and **low pressure**. They deviate most at **low temperature** and **high pressure**, where the ideal assumptions break down.

Method — The two causes

The ideal law assumes zero particle volume and no attractions. In reality:

- particles **do** take up volume — matters at high pressure (crowded);
- particles **do** attract — matters at low temperature (slow-moving, so attractions pull them together).

Method — Effect on pressure

Attractions make real particles hit the walls a little **less** hard, so the real pressure is slightly **lower** than ideal. Particle volume makes the available space smaller, raising pressure at very high compression.

Method — Which gas is more ideal

Small, nonpolar gases with weak IMFs (like He, H_2) behave most ideally. Large or polar gases (with strong attractions) deviate more.

Practice 2.1 ▪ 1 mark

Under what conditions do real gases behave most ideally?

Solution 2.1

Method: When deviations matter

Worked steps

High temperature and low pressure B1.

Practice 2.2 ▪ 2 marks

Name the two properties of real particles that the ideal law ignores.

Solution 2.2

Method: Effect on pressure

Worked steps

The volume of the particles; the attractions between particles B1 B1.

Practice 2.3 ▪ 2 marks

Which behaves more ideally: He or NH_3? Give a reason.

Solution 2.3

Method: Which gas is more ideal

Worked steps

He — it is small and nonpolar with only weak dispersion forces, so it deviates less than the polar, hydrogen-bonding NH_3 M1 A1.

Exam-style 3.1 ▪ 1 mark

Real gases deviate most from ideal behavior at

A high temperature and low pressure

B low temperature and high pressure

C standard conditions

D any temperature

Solution 3.1

Method: When deviations matter

A high temperature and low pressure

B low temperature and high pressure ✓

C standard conditions

D any temperature

Worked steps

B — low temperature and high pressure.

Exam-style 3.2 ▪ 1 mark

A gas is cooled to near its boiling point at high pressure.
(a) State whether it behaves more or less ideally.
(b) Explain the role of intermolecular attractions at low temperature.

Solution 3.2

Worked steps

(a) Less ideally B1. (b) At low temperature the particles move slowly, so intermolecular attractions pull them together, reducing the pressure below the ideal prediction M1 A1.

Exam-style 3.3 ▪ 2 marks

Explain why He behaves more ideally than H_2O vapor, in terms of intermolecular forces.

Solution 3.3

Method: Which gas is more ideal

Worked steps

He has only weak dispersion forces, while H_2O has strong hydrogen bonding; stronger attractions cause larger deviations, so He is more ideal **M1** **A1**.