What is the Van der Waals Equation?

Worksheet

The Van der Waals equation is (P + a/V_m)(V_m b) = RT, where a accounts for intermolecular forces and b for molecular volume. It predicts real gas behavior more accurately than the ideal gas law.

$$(P + \frac{a}{V_m^2})(V_m - b) = RT$$

Questions

1. Which factor makes pressure lower in real vs ideal gas?

A) Molecular volume b
B) Intermolecular attractions a
C) Higher temperature
D) Larger container

2. In the Van der Waals term (P + a/V_m), why add a/V_m to P?

A) To correct volume
B) To account for lost pressure due to attractions
C) To increase temperature
D) To calculate entropy

3. Which condition makes ideal gas law most accurate?

A) High pressure, low temperature
B) Low pressure, high temperature
C) High density
D) Strong intermolecular forces

4. If a = 0 and b = 0 in Van der Waals, what remains?

A) PV = nRT (ideal gas law)
B) P = RT/V_m
C) No equation
D) P + aV_m = 0

5. Calculate pressure for CO at 25C with V_m = 1 L/mol. Use a = 3.64 atmL/mol and b = 0.04267 L/mol.

6. N gas at 20C, V_m = 2 L/mol. Constants: a = 1.408, b = 0.0391 L/mol. Find P.

7. Compare ideal vs real for O: at 1 L/mol, 300 K, a = 1.378, b = 0.03183 L/mol.

8. Define: What is the Van der Waals equation?

9. Define: What does constant 'a' represent?

10. Define: What does constant 'b' represent?

Answer Key

1. B) Intermolecular attractions a - Attractions between molecules reduce observed pressure compared to ideal prediction.

2. B) To account for lost pressure due to attractions - Attractions reduce pressure; we add this correction to find the ideal pressure that would exist without attractions.

3. B) Low pressure, high temperature - At low pressure and high temperature, gases behave ideally (b negligible, attractions weak).

4. A) PV = nRT (ideal gas law) - Setting both constants to zero recovers PV = nRT.

5. T = 25 + 273 = 298 K RT = 0.08206 298 = 24.45 Latm/mol (P + 3.64/1)(1 0.04267) = 24.45 (P + 3.64)(0.95733) = 24.45 P + 3.64 = 25.55 P = 21.91 atm

6. T = 20 + 273 = 293 K RT = 0.08206 293 = 24.04 Latm/mol (P + 1.408/4)(2 0.0391) = 24.04 (P + 0.352)(1.9609) = 24.04 P + 0.352 = 12.25 P 11.9 atm

7. Ideal: P = RT/V_m = 24.618/1 = 24.62 atm Real: (P + 1.378/1)(1 0.03183) = 24.618 (P + 1.378)(0.96817) = 24.618 P + 1.378 = 25.43 P = 24.05 atm (lower due to attractions)

8. (P + a/V_m)(V_m b) = RT. It corrects ideal gas law for real gas deviations.

9. Intermolecular attractive forces. Larger a = stronger attractions = lower pressure.

10. Molecular volume (excluded volume). Accounts for finite size of gas molecules.