Course: CHM202

Energetics and dynamics of chemical reactions

Assignment – I

Q.1. van der Waals constants for gases A, B and C are as follows-

Gas	a (litre^2 atm.mole^{-2})	b (litre.mole^{-1})
A	4.0	0.027
B	12.0	0.030
C	6.0	0.032

Which gas has (a) highest critical temperature? (b) largest molecular volume, (c) most ideal behavior at STP?

Q.2. Using van der Waals equation calculate the pressure developed by 100 gm CO_2 contained in a volume of 5 litres at 40 ºC. Compare this value with that calculated from ideal gas laws. [a = 3.59 litre^2 atm.mole^{-2} , b = 0.0427 litre.mole^{-1}.]

Q.3. If the temperature above which a van der Waals gas cannot be liquified is 32.8 ºC and minimum pressure to be applied at this temperature for liquefication is 48.2 atm.

(a) Find the minimum distance of approach between the centres of two molecules?

(b) Calculate the Boyle temperature.

[Hint: b $\propto$ radius (r)]

Q.4. If compressibility factor Z for a van der Waals gas is 1.000054 at 0 ºC and 1 atm. Boyle temperature of the gas is 107 K, neglecting higher terms of P, calculate the values of a, b and molecular diameter.

Q.5. Gases A and B obeying van der Waals equation have following p_C and T_C values.

Gases	T_C (K)	p_C (atm)
A	44	26
B	304	72

Which gas (i) has higher $\overline{V_C}$ value and (ii) shows more nearly ideal behavior at 25 ºC and pressure of 1000 torr? [1 torr = 1 mm].

Q.6 (a) The molar volume of a perfect gas at 500 K and 100 bar is V_m^o = 0.416 dm^3mol^{-1}. The mean molar volume of air at 60 bar and 400 K is V_m = 0.9474 dm^3 mol^{-1}. In these conditions, which force dominant, attractions or repulsions? (Hint: compression factor).

(b) Calculate the critical compression factor (Z_C) for the van der Waals equation.

Q.7 The mass density of phosphorus vapor at 100 ℃ and 16 kPa is 0.6388 kg m^{-3}. What is the formula under these conditions?

Q.8 A specimen of H_2 gas was found to have a pressure of 125 kPa at the room temperature (i.e. 25 ℃). What can its pressure be expected to be when the temperature is 12 ℃?

Q.9. The critical constants of methane are p_C = 45.6 atm, $\overline{V_C}$ = 98.7 cm^3mol^{-1}, and T_C = 190.6 K. Evaluate the van der Waals coefficients of the methane and determine the radius of the molecules.

Q.10 Estimate the molar volume of chlorine gas on the basis of the van der Waals equation of state at 250 K and 150 kPa. Also calculate the percentage difference from the value predicted by the perfect gas equation. [$a = 6.260$ atm dm^6mol^{-2} ; $b = 5.42 \times 10^{-2}$ dm^3mol^{-1}; 1 Pa = 1.01×10^{-5} atm].