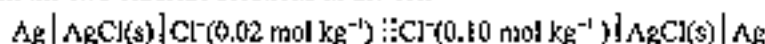


1. The cell potential of the following concentration cell is caused by the concentration gradient between the two chloride solutions in the cell



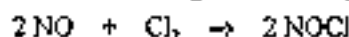
- (a) Write the half-cell reactions and the cell reaction.
 (b) Calculate the electromotive force of the concentration cell at 25 °C, assuming zero junction potential for the salt bridge and the activity coefficients are unity.
 (c) Which is the positive electrode? (15%)
2. A sample of ethanol weighing 0.7663 g is burned in a bomb calorimeter for which the heat capacity, including the sample, is 5643 J K⁻¹. A temperature rise from 20.62 to 24.64 °C is observed. (a) What are the values of q , w , and ΔU , all per mole ethanol? (b) What is the change in the number of moles of gaseous reagents per mole of ethanol? (c) What is the value of ΔH for the reaction? (15%)
3. (a) Starting from the definition of Joule-Thomson coefficient, $\mu_{JT} = (\partial T / \partial P)_H$, show that

$$\mu_{JT} = \frac{T(\partial V / \partial T)_P - V}{C_p}$$

and for a van der Waals gas

$$\mu_{JT} = \frac{(2a/RT)}{C_p}$$

- (b) Calculate ΔH for an isothermal compression of 1 mol N₂ from 0.1 to 25 MPa at 300 K. Take C_p to be 4.5R, independent of temperature. (15%)
4. For oxygen at 1 bar and 25 °C, the collision diameter is 0.361 nm. Calculate the mean free path, the most probable speed, mean speed, root-mean-square speed, and the average time between collisions. (15%)
5. Assume the following data for the gas-phase reaction



at 298 K

[NO] / mol L ⁻¹	[Cl ₂] / mol L ⁻¹	Initial Rate / mol L ⁻¹ s ⁻¹
0.02	0.02	7.1 × 10 ⁻⁵
0.04	0.02	2.8 × 10 ⁻⁴
0.02	0.04	1.4 × 10 ⁻⁴

- (a) Find the order with respect to each reactant and find the rate constant.
 (b) The initial concentrations of NO and Cl₂ are 0.04 mol L⁻¹ and 0.02 mol L⁻¹, respectively. Calculate the concentration of Cl₂ at $t = 100$ s. (17%)
6. What is the uncertainty in the velocity of an electron if the uncertainty in its position is 100 pm? (Planck constant $h = 6.626 \times 10^{-34}$ J s; mass of an electron = 9.109×10^{-31} kg) (12%)
7. Describe the following terms briefly
 (a) Boyle temperature (3%)
 (b) Phase rule (3%)
 (c) Assumptions for Langmuir adsorption isotherm (5%)