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

$$Ag|AgCl(s)|Cl^-(0.02\ mol\ kg^{-1})\ ||\ Cl^-(0.10\ mol\ kg^{-1})|AgCl(s)|Ag$$

(a) Write the half-cell reactions and the cell reaction.

(b) Calculate the electromotive force of the concentration cell at 25 ℃, assuming zero junction potention 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 ℃ 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

$$\mu_{JT} = \frac{(2a/RT) - b}{C_P}$$

(b) Calculate ΔH for an isothermal compression of 1 mol N_2 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 ℃, 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

$$2\,NO + Cl_2 \rightarrow 2\,NOCl$$

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 Cl_2 are 0.04 mol L^{-1} and 0.02 mol L^{-1}, respectively. Calculate the half-life and the concentration of Cl_2 at $t = 100$ s. (20%)

6. Describe the following terms briefly

(a) Boyle temperature (3%)

(b) Inversion temperature (3%)

(c) Relaxation time (3%)

(d) Phase rule (3%)

(e) Osmosis and osmotic pressure (3%)

(f) Assumptions for Langmuir adsorption isotherm (5%)