UNIVERSITY OF MALTA

DEPARTMENT OF CHEMISTRY

CH237 - Chemical Thermodynamics and Kinetics

Tutorial Sheet 1

1. (a) A chemical reaction takes place in a container of cross-sectional area 100 cm^2. As a result of the reaction, a piston is pushed out through 10 cm against an external pressure of 1.0 atm. Calculate the work done by the system.

(b) A sample of 4.50g of methane gas occupies 12.7 L at 310 K. (i) Calculate the work done when the gas expands isothermally against a constant external pressure of 200 Torr until its volume has increased by 3.3 L. (ii) Calculate the work that would be done if the same expansion occurred reversibly.
(Note: 1 torr = 133.3 Pa)

(c) In an isothermal reversion compression of 52.0 mmol of a perfect gas at 260 K, the volume of the gas is reduced to one-third its initial value. Calculate the work done in this process.

(d) A sample consisting of one mole of Argon is expanded isothermally at 0°C from 22.4 L to 44.8 L (i) reversibly, (ii) against a constant external pressure equal to the final pressure of the gas, and (iii) freely (against zero external pressure). For the three processes calculate q, w, DU, and DH.

2. (a) A strip of magnesium of mass 15 g is dropped into a beaker of dilute hydrochloric acid. Calculate the work done by the system as a result of the reaction. The atmospheric pressure is 1.0 atm and the temperature 25°C.

(b) A piece of zinc of mass 5.0 g is dropped into a beaker of dilute hydrochloric acid. Calculate the work done by the system as a result of the reaction. The atmospheric pressure is 1.1 atm and the temperature 23^{o}C.

3. (a) A sample consisting of one mole of monatomic perfect gas with a molar heat capacity at constant volume is 5R/2, initially at a pressure of 1.00 atm and a temperature of 300 K, is heated reversibly to 400 K at constant volume. Calculate the final pressure, and the change in internal energy, heat transfer, and work done in the process.

(b)When 229 J of energy is supplied as heat at constant pressure to 3.0mol $Ar_{(g)}$, the temperature of the sample increases by 2.55 K. Calculate the molar heat capacities at constant volume and constant pressure of the gas.

(c) The value of the molar heat capacity at constant pressure, $c_{p,m}$, for a sample of a perfect gas was found to vary with temperature according to the expression $c_{p,m}/(\mathrm{J\ K^{-1}mol^{-1}}) = 20.17 + 0.3665T$. Calculate q, w, ΔU, and ΔH for 1.00 mol when the temperature of 1.00 mol of gas is raised from 25°C to 200°C (i) at constant pressure, (ii) at constant volume.

(d) A sample consisting of 1.0 mol of perfect gas with $c_{v,m} = 20.8\ \mathrm{JK^{-1}}$ is initially at 3.25 atm and 310K. This sample then undergoes reversible adiabatic expansion until its pressure reaches 2.50 atm. Calculate the final volume and temperature and the work done.

(e) With reference to the figure below (Fig 1), and assuming perfect gas behavior, with $C_V = 3R/2$ and T = 313 K. calculate: (i) the amount of gas molecules (in moles) in this system and its volume in states B and C, (ii) the work done on the gas along the paths ACB and ADB, (iii) the work done on the gas along the isotherm AB, (iv) q and ΔU for each of the three paths.

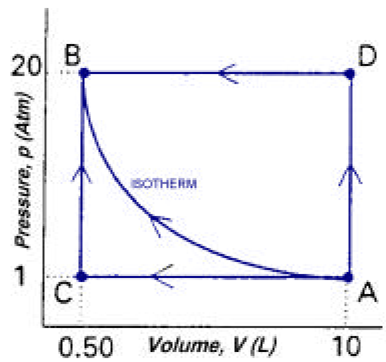

Fig. 1