國立臺北科技大學

九十九學年度研究所碩士在職專班入學考試

化學工程研究所

乙組：物理化學試題

填准考證號碼

注意事項：

1. 本試題共 5 題，配分共 100 分。第 1~5 題各 20 分。
2. 請按順序標明題號作答，不必抄題。
3. 全部答案均須答在試卷答案欄內，否則不予計分。

1. Two moles of an ideal gas, for which $C_{v,m} = 3R/2$, is subjected to two successive changes in state: (1) From 40 ℃ and 100 kPa, the gas is expanded isothermally against a constant pressure of 20 kPa to twice the initial volume. (2) At the end of the previous process, the gas is cooled at constant volume from 40 ℃ to −20 ℃. Calculate q, w, ΔU, and ΔH for each of the stages. Also calculate q, w, ΔU, and ΔH for the complete process.

2. Harnet and Hamer report values for the potential of the cell

$$\mathrm{Pt}(s) \mid \mathrm{PbSO_4}(s) \mid \mathrm{H_2SO_4}(aq, a) \mid \mathrm{PbSO_4}(s) \mid \mathrm{PbO_2}(s) \mid \mathrm{Pt}(s)$$

over a wide range of temperature and H_2SO_4 concentrations. In 1 m H_2SO_4, their results were described by

$$E(\mathrm{V}) = 1.91737 + 56.1 \times 10^{-6}\, t + 108 \times 10^{-8}\, t^2$$

where t is temperature on the Celsius scale. Calculate ΔG, ΔH, and ΔS for the cell reaction at 10 ℃ and 35 ℃.

3. An electrical motor is used to operate a Carnot refrigerator with an interior temperature of 0 ℃. Liquid water at 0 ℃ is placed into the refrigerator and transformed to ice at 0 ℃. If the room temperature is 30 ℃, what mass of ice can be produced in one hour by a 0.5-hp motor that is running continuously? Assume that the refrigerator is perfectly insulated and operates at the maximum theoretical efficiency.

4. The partial molar volumes of water and ethanol in a solution with $x_{H2O} = 0.60$ at 25 ℃ are 17.0 and 57.0 $\mathrm{cm^3\ mol^{-1}}$, respectively. Calculate the volume change upon mixing sufficient ethanol with 2.00 mol of water to give this concentration. The densities of water and ethanol are 0.997 and 0.7893 $\mathrm{g\ cm^{-3}}$, respectively, at this temperature.

5. $\mathrm{Ca(HCO_3)_2}(s)$ decomposes at elevated temperatures according to the stoichiometric equation

$$\mathrm{Ca(HCO_3)_2}(s) \rightarrow \mathrm{CaCO_3}(s) + \mathrm{H_2O}(g) + \mathrm{CO_2}(g)$$

If pure $\mathrm{Ca(HCO_3)_2}(s)$ is put into a sealed vessel, the air is pumped out, and the vessel and its contents are heated, the total pressure is 0.235 bar. Determine K_p under these conditions. If the vessel initially also contains 0.101 bar $\mathrm{H_2O}(g)$, what is the partial pressure of $\mathrm{CO_2}(g)$ at equilibrium?