大同大學 101 學年度研究所碩士班入學考試試題

考試科目:物理化學　　所別:化學工程研究所　　

註:本次考試 不可以參考自己的書及筆記； 不可以使用字典； 可以使用計算器。

1. (10%) (a) Plot the P-T phase diagrams for H_2O and CO_2. The triple point and critical point of H_2O and CO_2 are

H_2O	$T_{t,p} = 0.01\ ^oC$	$P_{t,p} = 0.00611$ bar
	$T_{c,p} = 374\ ^oC$	$P_{c,p} = 215$ bar
CO_2	$T_{t,p} = -56.4\ ^oC$	$P_{t,p} = 5.11$ bar
	$T_{c,p} = 31.1\ ^oC$	$P_{c,p} = 73$ bar

(b) How to use the Clapeyron equation to the phase transition?

2. (10%) State briefly the zero law, the first law, the second law and the third law of the thermodynamics.

3. (15%) Detrmine ΔH_{500K} for the following reaction at 500K and constant pressure:

$$CO(g) + H_2O(g) \rightarrow CO_2(g) + H_2(g)$$

The following data are necessary:

Substance	C_p (J/mol K)	$\Delta_f H_{298K}$ (kJ/mol)
CO	29.12	–110.5
H_2O	33.58	–241.8
CO_2	37.11	–393.5
H_2	29.89	0

4. (10%) The expansion coefficient of a gas, α, is defined as $\alpha = \frac{1}{V}\left(\frac{\partial V}{\partial T}\right)_p$ and the isothermal compressibility of a gas, κ, is defined as $\kappa = -\frac{1}{V}\left(\frac{\partial V}{\partial P}\right)_T$

(a) Find the values of α and κ for an ideal gas at STP.

(b) Using the cyclic rule to show that $\left(\frac{\partial P}{\partial T}\right)_V = \frac{\alpha}{\kappa}$

5. (15%) The following data relate to the adsorption of nitrogen at 77K on a 1.00 g sample of silica gel:

P/kPa	15.2	54.8
V/cm^3(STP)	135	247

At 77K the saturation vapor pressure P_0 of nitrogen is 101.3 kPa. Estimate the surface area of the gel by BET isotherm given below by taking the molecular area of nitrogen to be $1.62 \times 10^{-19} m^2$.

$$\frac{PP_0}{V(P_0 - P)} = \frac{1}{V_0 K} + \frac{P}{V_0}$$

6. (13%) A second order reaction in solution has a rate constsant of $5.70 \times 10^{-5}\ dm^3 mol^{-1} s^{-1}$ at 25 °C and of $1.60 \times 10^{-4}\ dm^3 mol^{-1} s^{-1}$ at 40 °C. Assume a proper equation to apply and calculate the activation energy and preexponential factor. What is the unit for this reaction rate?

7. (15%) A homogeneous reaction of stoichiometry A + B ←→ Y + Z is found to be second order in A and zero order in B. Please propose a mechanism and show it is consistent with this behavior.

8. (12%) Explain the meaning of following terms in Chinese.
   (a) Catalysis
   (b) Initial rate method
   (c) Adsorption isotherm
   (d) Fuel cells