編號： 149

國立成功大學 106 學年度碩士班招生考試試題

系　　所：環境工程學系

考試科目：普通化學　　考試日期：0213，節次：1

※ 考生請注意：本試題不可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. In chemical oxygen demand (COD) measurements, dichromate is used to oxidize pollutants in water samples. Excess dichromate is added to ensure complete oxidation. Residual dichromate is titrated by ferrous ion, forming ferric ion and chromium (III). (Atomic weight of chromium = 52)
   (a) Write the balanced reaction of ferrous ion with dichromate. (7%)
   (b) What is the equivalent weight of dichromate? (5%)
   (c) If the added dichromate is 3 mM and the dichromate concentration determined by ferrous ion titration is 1 mM, what is the COD (as mg/L)? (8%)
2. The ozone layer is about 20 km thick, has an average total pressure of 1.3×10^{-2} atm, and has an average temperature of 230 K. The partial pressure of ozone in the layer is only about 1.6×10^{-9} atm. How many meters thick would the layer be if all the ozone contained in it were compressed into a thin layer of pure O_3 at standard temperature and pressure? (10%)
3. At equilibrium, the solubility of CO_2 in water is 1.6×10^{-2} M at 25°C and 0.5 atm pressure. What is the Henry's law constant (K_H) for CO_2 as (mole/L/atm)? Anthropogenic release of CO_2 has contributed climate change. The atmospheric CO_2 concentration has increased from 300 ppm in the 1920s to 400 ppm in 2017. What is the resulting increase in CO_2 concentration as (mg CO_2/L) in ocean at 25°C (atmospheric pressure is 1 atm)? Assume pH and salt concentration effect can be neglected. (15%)
4. (a)Write the rate expression of $O_{3(g)}$ for the elementary reaction: $O_{3(g)} + O_{(g)} \rightarrow 2\ O_{2(g)}$ with a rate constant of k. What is the overall order of this reaction? (5%)
   (b)Given a reaction of $2NO_{2(g)} + F_{2(g)} \rightarrow 2NO_2F_{(g)}$ with a rate expression of $R = k[NO_2][F_2]$, come up with a possible reaction mechanism. Please also indicate the rate limiting step. (10%)
5. (a)The equilibrium constant K_c for the reaction as follows is 57 at 700 K: (10%)

   $H_{2(g)} + I_{2(g)} \underset{k_r}{\overset{k_f}{\rightleftharpoons}} 2\ HI_{(g)}$, $K_c = 57$ at 700 K.

   Is the rate constant k_f for the formation of HI larger or smaller than the rate constant k_r for the decomposition of HI?
   The value of k_r at 700 K is 1.16×10^{-3} ($M^{-1}s^{-1}$). What is the value of k_f at the same temperature?
   How are the values of k_r, k_f, and K_c affected by the addition of catalyst?
   (b)For the same reaction in (a), if the initial concentrations are $[H_2] = 0.1$ M and $[I_2] = 0.2$ M, what are $[H_2]$, $[I_2]$, and [HI] at equilibrium?(10%)
6. (a)What is the pH in a solution containing 0.5 M NH_4Cl and 0.05 M NH_3 (pK_b for $NH_3 = 4.75$)?(10%)
   (b)How would you prepare an NH_4Cl-NH_3 buffer that has a pH of 9.0?(5%)
   (c)Is NH_4Cl-NH_3 solution a good buffer system for pH = 7? Why?(5%)