

八十七學年度 原子科學 系(所) 乙 組碩士班研究生入學考試

科目 普通化學 科號 4201 共 2 頁第 1 頁 *請在試卷【答案卷】內作答

1. How many milliliters of 0.10M NaOH should be added to 50 mL of 0.10M formic acid, HCOOH, to obtain a buffer with a pH of 4.0? $K_a = 1.8 \times 10^{-4}$ (acid dissociation constant). (20%)

2. Describe the physical meaning of a and b in the Van der Waals equation.(20%)

$$\left(P + \frac{n^2 a}{V^2}\right)(V - nb) = nRT$$

3. At the normal boiling temperature of water, $\Delta H_{\text{vap}}^{\circ}$ (heat of evaporation) = 40.7 KJ mol⁻¹. By assuming that the volume of 1 mol of liquid water is negligible and that water vapor is an ideal gas, calculate q, w, ΔE and ΔG for the reversible vaporation of 1 mol of water at a constant pressure of 1 atm and at a temperature of 373 K (the universal gas constant, $R=8.314 \text{ J mol}^{-1} \text{ K}^{-1}$) (20%)

4. What is the electron configuration of gaseous

(A) Cr atom (atomic number of Cr =24), and

(B) Zn²⁺ ion (atomic number of Zn = 30)(10%)

5. The concentration of the major ions in backish water are as follows: Na⁺:0.02eq/L, Mg²⁺:0.01eq/L, Ca²⁺:0.01eq/L, K⁺:0.005eq/L, Cl⁻:0.025 eq/L, HCO₃⁻:0.005eq/L, and SO₄²⁻:0.012 eq/L.

(A) What would be the osmotic pressure different across a semipermeable membrane which had backrish water on one side and mineral-free water on the other at 1atm and 25°C.(5%)

(B) If in the above example, a yield of 95 percent fresh water on the other side were desired, what minimum pressure would be required to balance the osmotic pressure difference that will develop.(5%)

6. The carbon in living plants and animals contains enough ¹⁴C to yield about twelve ¹⁴C disintegrations per minute per gram carbon for us to date the history of organisms. A 30 gram fossil bone with an activity of 75 disintergrations per minute was found in an old cave. The element analysis of the fossil bone is C:52%, H:7%, O:38%, S:1.5%, P:0.8%, trace element:0.7%.

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(A) Write the balance equation of the radioactivity ^{14}C decay with beta emission in natural environment. (5%)

(B) Calculate the age of this fossil bone. (5%)

7. Stability constants for the complexes between cadmium (II) and chloride are $\beta_1=21$, $\beta_2=168$, $\beta_3=201.6$, and $\beta_4=70.56$. Calculate the molar concentration of each of the first four cadmium chloride complexes in a solution if $\text{Cd}^{2+}=10^{-8}\text{M}$ and $\text{Cl}^{-}=10^{-3}\text{M}$. Also, please identify the most prevalent cadmium species in the solution. (10%)