

國立清華大學 100 學年度碩士班入學考試試題

系所班組別：生醫工程與環境科學系 乙組(環境分子科學組)

考試科目 (代碼)：普通化學 (2601)

共 3 頁，第 1 頁 *請在【答案卷、卡】作答

- (10%) Write out the structural formula of each of the following compounds.
(a) hypochlorous acid (b) potassium bromate (c) dinitrogen tetroxide
(d) acetonitrile (e) monomethyl phthalate
- (7%) Because dealing with dental cavities can be expensive and unpleasant, dentists are searching for ways to find budding cavities at the very earliest stages of their development, well before they can be detected by X rays. One method is developed by Chris Longbottom, a dentist in Scotland. The method is using special electrodes that fit over the teeth at points where the teeth touch and are thus most vulnerable to trapped food that stimulates bacterial growth. Explain how this works and propose your opinion.
- (8%) Fruit flies are formidable pests that have the potential to seriously damage several important fruit crops. Because of this, there have been several widely publicized sprayings of residential areas in southern California with the pesticide malathion to try to control fruit flies. Now there may be a better way to kill fruit flies with a blend of two common dyes (red dye no. 28 and yellow dye no.8) long used to color drugs and cosmetics. Explain how this works and propose your opinion.
- (10%) When the galleon *Atocha* was destroyed on a reef by a hurricane in 1622, it was bound for Spain carrying about 47 tons of copper, gold, and silver from the New World. The bulk of the treasure was silver bars and coins packed in wooden chests. When treasure hunter Mel Fisher salvaged the silver in 1985, corrosion and marine growth had transformed the shiny metal into something that looked like coral. Write down all possible chemical reactions in wooden chests that had occurred in 350 years of being submerged in the ocean and propose effective procedures to restore the silver to its original condition.

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5. (15%) The reaction $A \rightleftharpoons B$, where A and B are ideal gases, is studied at constant temperature 298K and constant pressure 1 atm. The standard chemical potential of A at this temperature is 40 kJ/mol and that for B is 37 kJ/mol. The reaction is started with 1 mol of A only, so the amounts of A and B at a later time are given in terms of extent of reaction ξ by $n_A = 1 - \xi$ and $n_B = \xi$, respectively. (a) Derive the Gibbs energy of the reaction and explain how the mixing of reactant A and product B affects the position of chemical equilibrium. (b) Plot G versus ξ . (c) Plot $dG/d\xi$ versus ξ . (d) Plot $d^2G/d\xi^2$ versus ξ .
6. (5%) Please state the reason why AgCl dissolves readily in 2 M NH_3 but is quite insoluble in 2 M NH_4NO_3 .
7. (5%) When an aqueous solution of KCN is added to a solution containing Ni^{2+} ions, a precipitate forms, which redissolves upon addition of more KCN solution. No precipitate forms when H_2S is bubbled into this solution. Write reactions describing what happen in this solution. [Hint: CN^- is a Brønsted-Lowry base; $K_b = 10^{-5}$ and a Lewis base.]
8. (10%) Explain the following on the basis of the behavior of atoms and/or ions.
- (1) Cooking with hot water is faster in a pressure cooker than in an open pan.
 - (2) Salt is used on icy roads.
 - (3) Melted sea ice from the Arctic Ocean produces fresh water.
 - (4) $\text{CO}_2(\text{s})$ (dry ice) does not have a normal boiling point under normal atmosphere conditions, even though CO_2 is a liquid in fire extinguishers.
9. (15%) Acrylic acid ($\text{CH}_2=\text{CHCO}_2\text{H}$) is a precursor for many important plastics. K_a for acrylic acid is 5.6×10^{-5} .
- (1) Calculate the pH of a 0.10 M solution of acrylic acid.
 - (2) Calculate the percent dissociation of a 0.10 M solution of acrylic acid.
 - (3) Calculate the pH of a 0.050 M solution of sodium acrylate ($\text{NaC}_3\text{H}_3\text{O}_2$).

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10. (15%) Considering the titration of a generic weak acid HA with a strong base that give the following titration curve, please indicate the points that correspond to the following questions.

- (1) The maximum buffer region
- (2) pH depends only on [HA]
- (3) pH depends only on [A⁻]
- (4) pH depends only on the amount of excess strong base added
- (5) The pK_a of HA

