

國立清華大學 101 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)：環境化學 (2305)

共 2 頁，第 1 頁 *請在【答案卷、卡】作答

1. Please define or explain the following terms: (25%)
 - (a) micelles
 - (b) coagulation
 - (c) flocculation
 - (d) chemiluminescence
 - (e) biological pump

2. The following gaseous species can be found in the troposphere. Identify which are primary and which are secondary pollutants.
(1) O₃, (2) NO, (3) HNO₃, (4) CH₄, (5) PAN, (6) H₂C=O, (7) H₂C=CH₂, (8) VOC, (9) HOO, (10) NO₂, (11) H₂SO₄, (12) SO₂ (5%)

3. (a) Why are chlorofluorocarbons (CFCs) such as CF₂Cl and CFCl₃ such effective greenhouse gases? (5%)
(b) Please explain "Positive feedback" in greenhouse gas. (5%)

4. Carbon dioxide has a large standard free energy of formation, providing a very strong driving force for oxygen to react with organic compounds. Yet the biosphere houses a vast store of organic compounds in contact with an atmosphere that is 21% O₂. How is this possible? (10%)

5. Why the streams in the coal mining areas are often highly polluted by sulfuric acid? (10%)

6. Consider a vehicle powered by hydrogen gas.
 - a. About 3.10 kg of H₂ is required for a vehicle to have a 500 km range. Assume ideal gas behavior and a storage tank of 60 L (a comparable size to conventional gasoline vehicles). What tank pressure might one expect at 25 °C? (5%)
 - b. Since their discovery in 1991, tiny graphite-like cylinders known as nanotubes have been widely researched. These nanotubes (1-3 nm in diameter) have high tensile strength, high electrical conductivity, and a high surface area. Hydrogen can readily adsorb onto these carbon fibers. These nanotubes can absorb three times their weight in H₂. What minimum amount of this carbon allotrope would be needed to reduce the tank pressure in the above hydrogen-powered vehicle to 20.0 atm? (5%)

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7. Water coming into a purification plant has a hardness of 100 mg L^{-1} of calcium carbonate equivalent.
- What is the total concentration of Ca^{2+} and Mg^{2+} in mol L^{-1} ? (5%)
 - Assuming $[\text{Ca}^{2+}] = [\text{Mg}^{2+}]$ and available bicarbonate ions, what minimum mass of sodium hydroxide must be added to precipitate Ca^{2+} and Mg^{2+} in this water? (5%)
8. Polyethylene $[\text{CH}_2\text{CH}_2]$ has a repeating ethane unit. Assume the following average bond energies in kJ mol^{-1} : C–C (348), C–H (412), O=O (495), O–H (463), C=O (799), $\text{C}\equiv\text{O}$ (1072), and H–H (436).
- Write the balanced chemical equation for the gasification of polyethylene by oxygen and steam to produce synthesis gas. (2%)
 - Write the balanced chemical equation for the combustion of polyethylene to produce carbon dioxide and water. (2%)
 - Calculate the heat generated by each of these reactions. Which process is more efficient for “energy recycling”? (3%)
 - Is polyethylene a good candidate for chemical depolymerization? Explain. (3%)
9. A lake is stratified so that it has both aerobic and anaerobic conditions are present. The lake water contains several trace metals including copper. Copper(II) has a standard reduction potential of 0.16 V when reduced to copper (I).
- Calculate the ratio of Cu^{2+} to Cu^+ ions available at a pE of -4 and at a pE of +14. (2%)
 - What oxidation state of copper ions would you expect to dominate under anaerobic conditions? (2%)
 - Assuming that oxygen determines the electron availability near the surface of a lake, how would the decrease in pH affect pE? (3%)
 - Calculate the ratio of Cu^{2+} to Cu^+ ions available at a pH of 5 near the surface. (3%)

Note: The atomic masses of elements are as follows:

H = 1.0	C = 12.0	N = 14.0	O = 16.0	Ca = 40.0	Na = 23.0
Mg = 24.3	S = 32.1	Cl = 35.5	K = 39.1	Cu = 64.0	F = 19.0