國立臺灣師範大學 106 學年度碩士班招生考試試題
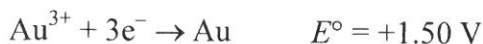
科目：普通化學   適用系所：科學教育研究所

注意：1.本試題共 2 頁，請依序在答案卷上作答，並標明題號，不必抄題。2.答案必須寫在指定作答區內，否則依規定扣分。

1. What concentration of HF ($K_a = 7.2 \times 10^{-4}$) has the same pH as that of 0.069 M HCl? (5 points)

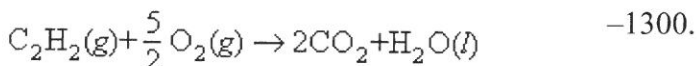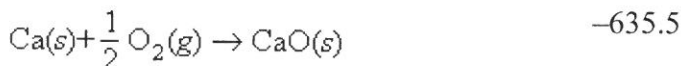2. The reduction potentials for Au^{3+} and Ni^{2+} are as follows:

$Au^{3+} + 3e^- \rightarrow Au$ $E° = +1.50$ V

$Ni^{2+} + 2e^- \rightarrow Ni$ $E° = -0.23$ V

Calculate $\Delta G°$ (at 25°C) for the reaction: $2Au^{3+} + 3Ni \rightarrow 3Ni^{2+} + 2Au$ (5 points)

3. Write the simple <u>explanations</u> or <u>definitions</u> of the following terms: (15 points)

a. Standard states.   b. Second Law of thermodynamics.   c. State function.
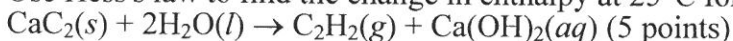
d. Photoelectric effect   e. Spectator ions.

4. Consider the following data:

	ΔH (kJ)
Standard enthalpy of formation of $CaC_2(s)$	-62.8
$Ca(s) + \frac{1}{2} O_2(g) \rightarrow CaO(s)$	-635.5
$CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(aq)$	-653.1
$C_2H_2(g) + \frac{5}{2} O_2(g) \rightarrow 2CO_2 + H_2O(l)$	$-1300.$
Standard enthalpy of formation of $CO_2(g)$	-393.51

Use Hess's law to find the change in enthalpy at 25°C for the following equation:
$CaC_2(s) + 2H_2O(l) \rightarrow C_2H_2(g) + Ca(OH)_2(aq)$ (5 points)

5. Consider the ammonia synthesis reaction ($N_2 + 3H_2 \rightarrow 2NH_3$) where $\Delta G° = -33.3$ kJ/mole of N_2 consumed at 25 °C. For each of the following mixtures of reactants and products at 25 °C, calculate ΔG for each of them and predict the direction of reactions.   (10 points)

a. $P_{NH3} = 1$ atm, $P_{N2} = 1.47$ atm, $P_{H2} = 1.00 \times 10^{-2}$ atm

b. $P_{NH3} = 1$ atm, $P_{N2} = 1$ atm, $P_{H2} = 1$ atm

6. Consider the following Lewis structure. (Next page, lone pairs are not drawn in.)

(i) What is the hybridization of each of oxygen atom, nitrogen atom, and of carbon atoms 1, 2, and 4, respectively. (10 points)

(ii) Predicate the bond angles for above atoms. (10 points)

$$H-\underset{\underset{H}{|}}{\overset{\overset{H}{|}}{C}}-O-\underset{\underset{1}{\overset{H}{|}}}{\overset{\overset{H}{|}}{C}}-\underset{2}{C}\equiv\underset{3}{C}-\underset{4}{\overset{\overset{H}{|}}{C}}=N-H$$

7. A compound contains 47.08% C, 6.59% H and 46.33% Cl by mass; the molar mass of the compound is 153 g/mol. What are the empirical and molecular formulas of the compound. (5 points)

8. The following questions are about transition metal complexes: (10 points)

(a) $[Fe(CN)_6]^{3-}$ is paramagnetic but $[Fe(CN)_6]^{4-}$ is diamagnetic, why? (Draw the crystal field splitting of d orbitals and fill in d electrons for these two complexes to explain).

(b) What molecular shape do you expect these two complexes to be? What is the hybridization of Fe ions?

9. Silver (atomic mass = 107.9) metal crystalizes into a cubic closet packed structure. The radius of Ag atom is 144 pm (pm: 10^{-12}m). Determine: (15 points)

(a) the coordination number of the lattice

(b) the lattice constant of the unit cell

(c) the density (in g/cm^3) of the Ag metal

10. The following mechanism has been proposed to account for the rate law of the decomposition of ozone to oxygen: (10 points)

$$O^3 + M \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} O_2 + O + M$$

$$O + O_3 \xrightarrow{k_2} 2O_2$$
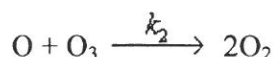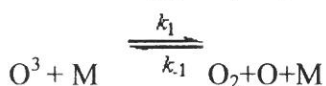
(a) Apply the steady-state hypothesis to the concentration of atomic oxygen, and derive the rate law for the decomposition of ozone. (M stands for an atom or molecule that can exchange kinetic energy with the particles undergoing the chemical reactions.

(b) Assume the second step is the rate determine step. Derive the rate law.