註：本次考試 ☒不可 參考自己的書籍及筆記 ☒不可 查字典 ☑可 ☒不可 使用計算器

1. Define the following terms: (18%)
   (a) isotope　　　　　(b) precision　　　　(c) isoelectronic
   (d) lattice energy　(e) electronaffinity　(d) Lewis acid

2. Give the symbol, including the correct charge, for each of the following
   ions: (6%)
   (a) permanganate ion　(b) dihydrogen phosphate ion　(c) sulfide ion
   (d) nitrite ion　　　　(e) sulfate ion　　　　　　　(f) perchlorate ion

3. Define redox reaction in terms of oxygen; electrons; and oxidation number?
   (6%)

4. A piece of nickel foil, 0.550 mm thick and 1.25 cm square, is allowed to
   react with fluorine, F_2, to give a nickel fluoride. (a) How many moles
   of nickel foil were used? (The density of nickel is 8.908 g/cm³.) (b) If
   you isolated 1.261 g of the nickel fluoride, what is its formula? (c)
   What is the percent composition by mass of the nickel fluoride? (9%)
   (atomic mass: Ni: 58.693; F: 18.9984)

5. The cancer chemotherapy agent, cisplatin, is made by the following reaction
   $(NH_4)_2PtCl_{4(s)} + 2\ NH_{3(aq)} \longrightarrow 2\ NH_4Cl_{(aq)} + Pt(NH_3)_2Cl_{2(s)}$
   Assume that 15.5 g of $(NH_4)_2PtCl_{4(s)}$ is combined with 225 ml of 0.75 M NH_3 to
   make cisplatin.
   (a) Which reactant is in excess and which is the limiting reactant?
   (b) How many grams of cisplatin can be formed?
   (c) After all the limiting reactant has been consumed and the maximum
       quantity of cisplatin has been formed, how many grams of the other
       reactant remain? (9%)
       (atomic weight: H: 1.0079; N: 14.0067; Cl: 35.4527; Pt: 195.08)

6. What is Heisenberg's uncertainty principle? Explain how it applies to our
   modern view of atomic structure. (8%)

7. Consider the ionic compound MX. How does the enthalpy of formation change
   if (a) the size of M^+ increases, (b) the size of X^- increases, (c) the
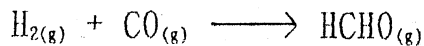   electron affinity of X decreases, or (d) the ionization energy of M
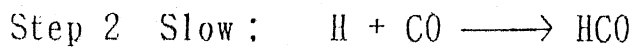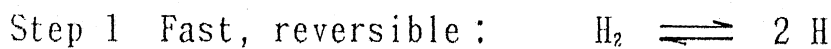   decreases? (8%)

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8. Sketch the phase diagram for water. Label the normal boiling point, melting point, and triple point, and show what regions of temperature and pressure are appropriate to solid, liquid, and vapor. Explain why the special properties of ice allow you to skate on ice.　(8%)

9. Hydrogen and carbon monoxide react to give formaldehyde under certain conditions.　　　$H_{2(g)} + CO_{(g)} \longrightarrow HCHO_{(g)}$
   The mechanism proposed for this reaction is
   Step 1　Fast, reversible :　　$H_2 \rightleftharpoons 2\ H$
   Step 2　Slow :　$H + CO \longrightarrow HCO$
   Step 3　Fast :　$H + HCO \longrightarrow HCHO$
   What rate law is derived from this mechanism?　　(4%)

10. The equilibrium reaction　$N_2O_{4(g)} \rightleftharpoons 2\ NO_{2(g)}$ has been thoroughly studied. If the total pressure in a flask containing NO_2 and N_2O_4 gas at 25°C is 1.50 atm, and the value of K_p at this temperature is 0.148, what fraction of the N_2O_4 has dissociated to NO_2? What happens to the fraction dissociated if the volume of the container is increased so that the total equilibrium pressure falls to 1.00 atm?　(8%)

11. Sulfurous acid, H_2SO_3, is a weak acid capable of providing two H^+ ions.
    (a) What is the pH of a 0.45 M solution of H_2SO_3?
    (b) What is the equilibrium concentration of the sulfite ion, SO_3^{2-}, in the 0.45 M solution of H_2SO_3?　(8%)
    (H_2SO_3 :　$K_{a1} = 1.2 \times 10^{-2}$,　　$K_{a2} = 6.2 \times 10^{-8}$)

12. You dissolve 1.00 mol of propanoic acid ($CH_3CH_2CO_2H$, $K_a = 1.3 \times 10^{-5}$) and 0.40 mol of NaOH in enough water to make 1.00 L of solution.
    (a) Write a balanced equation to depict the reaction that can occur.
    (b) How many moles of acid and of its conjugate base are present after the reaction?
    (c) Calculate the pH of the solution.
    (d) Does the pH increase, decrease, or remain the same of 0.40 g if NaOH is added to the solution?　(8%)