1-6 題每題有 A 與 B 兩小題，請依序於答案卷內做答

1. A. What tests could you perform to distinguish between the following pairs of compounds? (4%)
   a. $CH_3CH_2CH_2CH_3$, $CH_2=CHCH_2CH_3$
   b. $CH_3CH_2CH_2COOH$, $CH_3CH_2C(O)CH_3$ (2-butanone)
   c. $CH_3CH_2CH_2OH$, $CH_3C(O)CH_3$ (acetone)
   d. $CH_3CH_2NH_2$, CH_3OCH_3

   B. What is wrong with the following names? Give the correct name for each compound. (4%)
   a. 2-ethyl propane
   b. 5-iodo-5,6-dimethylhexane
   c. cis-4-methyl-3-pentene
   d. 2-bromo-3-butanol

2. A. Write the rate law for the following proposed mechanisms for the decomposition of IBr to I_2 and Br_2. And account for your answer. (6%)
   a. $IBr(g) \rightarrow I(g) + Br(g)$ (fast)
      $IBr(g) + Br(g) \rightarrow I(g) + Br_2(g)$ (slow)
      $I(g) + I(g) \rightarrow I_2(g)$ (fast)

   b. $IBr(g) \rightarrow I(g) + Br(g)$ (slow)
      $I(g) + IBr(g) \rightarrow I_2(g) + Br(g)$ (fast)
      $Br(g) + Br(g) \rightarrow Br_2(g)$ (fast)

   B. For the reaction, $O_2(g) + 2NO(g) \rightarrow 2NO_2(g)$, the observed rate law is
      Rate = $k[NO]^2[O_2]$
      Which of the changes list below would affect the value of the rate constant k? Account for your answer. (6%)
      a. increasing the partial pressure of oxygen gas.
      b. changing the temperature.
      c. using an appropriate catalyst.

3. A. How many unpaired electrons are in the following complex ions? The atomic number for Ru, Ni, and V is 44, 28, and 23, respectively. en stands for ethylene diamine. Account for your answer. (6%)
   a. $Ru(NH_3)_6^{2+}$ (low spin case)
   b. $Ni(H_2O)_6^{2+}$
   c. $V(en)_3^{3+}$

   B. Rank the following complex ions in order of increasing wavelength of light absorbed. Account for your answer (4%)
 $Co(H_2O)_6^{3+}$, $Co(CN)_6^{3-}$, CoI_6^{3-}, $Co(en)_3^{3+}$

4. A. The following plot shows a vapor pressure of various solutions of components A and B at some temperature.
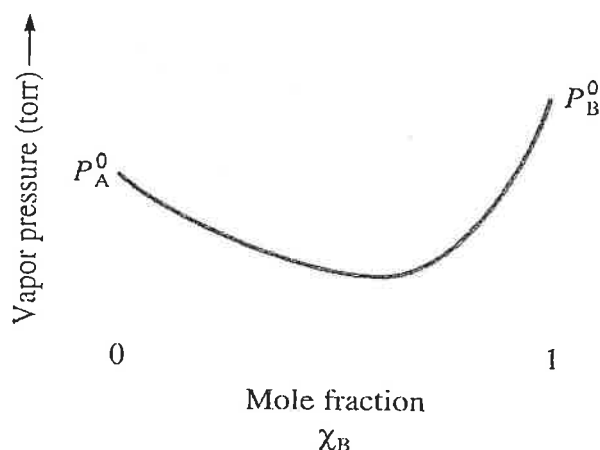
Which of the following statements is false concerning solutions of A and B? If it is false, correct it. (6%)

a. The solutions exhibit negative deviations from Raoult's law.

b. ΔH_{soln} for the solutions should be endothermic.

c. The intermolecular forces are weaker in solution than in either pure A or pure B.

d. Pure liquid B is more volatile than pure liquid A.

e. The solution with $\chi = 0.6$ will have a lower boiling point than either pure A or pure B.

B. Use the accompanying phase diagram for sulfur to answer the following questions. (The diagram is not to scale). (4%)
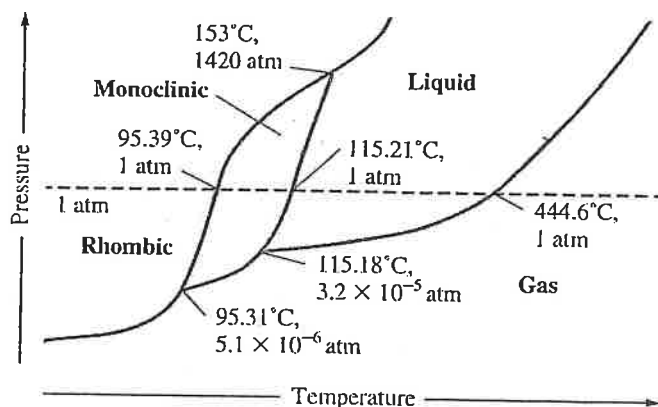
a. What phases are in equilibrium at each of the triple point?

b. What phase is stable at room temperature and 1.0 atm?

c. What are the normal melting point and normal boiling point of sulfur?

d. Which is the denser solid phase, monoclinic or rhombic sulfur?

背面有題，請繼續作答。

5. A. For the species O_2, O_2^+, and O_2^-, give the electron configuration and the bond order for each. Which has the strongest bond? (6%)

B. Consider the following Lewis structure, where E is an unknown element:

What are the possible identities for element E? Predict the molecular structure for this ion. (6%)

6. A. The titration of Na_2CO_3 with HCl has the following qualitative profile:
   Please identify the major species in solution as points B, D, and F (6%)

B. The salt BX, when dissolved in water, produces an acidic solution. Which of the following could be true? Account for your answer. (There may be more than one correct answer.) (6%)

   a. The acid HX is a weak acid.

   b. The acid HX is a strong acid.

   c. The cation B^+ is a weak acid

7. You have 2.4 moles of gas contained in a 4.0-L bulb at a temperature of 32 °C. This bulb is connected to a 20.0-L sealed, initially evacuated bulb via a valve. Assume the temperature remains constant. Please answer the followings. (10%)

   a. What should happen to the gas when you open the valve? Calculate any changes of the conditions.

   b. Calculate ΔH, ΔH, q, and w for the process you describe in part a.

   c. Given your answer to part b, what is the driving force for the process?

8. Please answer the followings regarding the buffer solution. (10%)

   a. If you want to prepare a buffer solution at pH = 4.0 or pH = 10.0, how would you decide which weak acid-conjugate base or weak base-conjugate acid pair to use?

   b. Consider a buffered solution where [weak acid] > [conjugate bae]. How is the pH of the solution related to the pKa value of the weak acid?

   c. A good buffer possess a good buffering capacity. What is the buffering capacity? How do the following buffers differ in capacity? How do they differ in pH?

   $$0.01 \ M \ \text{acetic acid}/0.01 \ M \ \text{sodium acetate}$$
   $$0.1 \ M \ \text{acetic acid}/0.1 \ M \ \text{sodium acetate}$$
   $$1.0 \ M \ \text{acetic acid}/1.0 \ M \ \text{sodium acetate}$$

9. You have a concentration cell with Cu electrodes and $[Cu^{2+}] = 1.00 \ M$ (right side) and $1.0 \times 10^{-4} \ M$ (left side). Please answer the followings. (10%)

   a. Draw this concentration cell labelling the anode and the cathode, and describing the direction of the electron flow.

   b. Calculate the potential for this cell at 25 °C.

   c. What will happen (increase or decrease) to the cell potential after enough NH_3 is added to the left cell compartment. Account for your answer.

10. Consider the following graph of binding energy per nucleon as a function of mass number. The graph is shown in the next page. Please answer the following questions. (6%)

    a. What does this graph tell us about the relative half-lives of the nuclides? Explain your answer.

    b. Which nuclide shown is the most thermodynamically stable? Which is the least thermodynamically stable?

    c. What does this graph tell us about which nuclides undergo fusion and which undergo fission to become more stable? Support your answer.