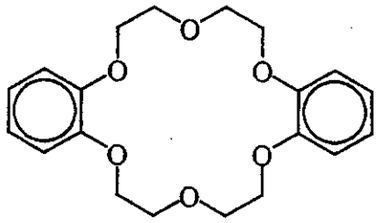
*注意事項：1.請標明題號依序作答。
2.計算題必須列出計算過程，否則不予計分。

1. Write formulas for the following compounds. (10%)
(a) perchloric acid (b) ammonium sulfate (c) sodium bromate
(d) methylamine (e) potassium hexacyanoferrate(III)

2. Ionic compounds, such as $KMnO_4$, can be dissolved in nonpolar solvents by adding crown ethers. The structure of typical crown ether is as follows:



Suggest how crown ethers make $KMnO_4$ soluble in nonpolar solvents. (8%)

3. (a) Will a crystalline solid or an amorphous solid give a simpler X-ray diffraction pattern? Why? (4%)
(b) Is it possible to generalize that amorphous solids always have weaker or stronger interparticle forces than crystalline solids? Explain your answer. (4%)

4. Calculate the final concentration of Pb^{2+} by mixing 100.0 mL of 0.0500 M $Pb(NO_3)_2$ and 200.0 mL of 0.100 M NaI (K_{sp} of $PbI_2=1.4\times10^{-8}$) (10%)

5. (a) When 2.00 mol of $SO_{2(g)}$ reacts completely with 1.00 mol of $O_{2(g)}$ to form 2.00 mol of $SO_{3(g)}$ at 25℃ and a constant pressure of 1.00 atm, 198 kJ of energy is released as heat. Calculate ΔH and ΔE for this process. ($R=8.3145$ J $K^{-1}mol^{-1}$) (6%)
(b) At what temperatures is the following process spontaneous at 1 atm?

$$Br_2(l) \rightarrow Br_2(g)$$

where $\Delta H^0 = 31.0$ kJ/mol and $\Delta S^0 = 93.0$ J K^{-1} mol^{-1}
What is the normal boiling point of liquid Br_2? (8%)

(背面仍有題目,請繼續作答)

6. Consider the following galvanic cell at 25℃:

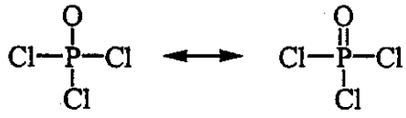
$$Pt \mid Cr^{2+}(0.30\ M), Cr^{3+}(2.0\ M) \parallel Co^{2+}(0.20\ M) \mid Co$$

The overall reaction and equilibrium constant value are

$$2Cr^{2+}_{(aq)} + Co^{2+}_{(aq)} \rightarrow 2Cr^{3+}_{(aq)} + Co_{(s)} \quad K = 2.79\times10^{7}$$

Calculate the cell potential, ε, for this galvanic cell and ΔG for the cell reaction at these conditions. (10%)

7. Complete the following resonance structures for $POCl_3$: (8%)



(A)　　(B)

(a) Would you predict the same molecular structure from each resonance structure?

(b) What is the hybridization of P in each structure?

(c) What orbitals can the P atom use to form the π bond in structure B?

(d) Which resonance structure would be favored on the basis of formal charges?

8. Predict the molecular structure and the bond angles for each of the following.
(a) $XeCl_2$ (b) ClF_3 (c) SF_4 (d) PCl_5 (e) XeO_3 (10%)

9. Using the molecular orbital model to describe the bonding in F_2^+, F_2, and F_2^-, predict the bond orders and the relative bond lengths for these three species. How many unpaired electrons are present in each species? (10%)

10. (a) The complex ion $NiCl_4^{2-}$ contains two unpaired electrons, but $Ni(CN)_4^{2-}$ is diamagnetic. Propose structures for these two complex ions. (6%)
(b) Which of the complex ions CoI_6^{3-}, $Co(H_2O)_6^{3+}$, or $Co(en)_3^{3+}$, will absorb light with the longest wavelength? Explain. (6%)