注意事項：1. 答案一律寫在答案卷上，否則不予計分。
2. 請標明題號依序作答，不必抄題。
3. 試題應隨同試卷繳回，不得攜出試場。

1. Write formulas for the following compounds. (8%)
(a) magnesium phosphate (b) hypochlorous acid
(c) tetraborane (d) potassium hexacyanoferrate(III)

2. Determine the point group for each of the following species. (8%)
(a) NO_2^+ (b) SOF_4 (c) $B(OH)_3$ (d) $PtCl_4^{2-}$

3. Explain the following with an example: (16%)
(a) aprotic solvents (b) n-type semiconductor
(c) S_N1CB mechanism (d) spin-orbit coupling

4. Suggest explanations for the following facts: (24%)
(a) The first ionization energy of atomic fluorine is greater than the first ionization energy of F_2.
(b) Although both the Br_3^- and I_3^- ions are known, the F_3^- ion does not exist.
(c) The conductivity of ICl is enhanced by adding either $AlCl_3$ or NaCl.
(d) I_2 is purple in color as are its solutions in CCl_4 and benzene. Solutions of I_2 in acetone and diethyl ether are brown.

5. Find the number of unpaired electrons, ground state term symbols and ligand field stabilization energy for each of the following complexes. (6%)
(a) $[Fe(H_2O)_6]^{2+}$ (b) $[Cr(CN)_6]^{4-}$

6. Answer the followings:
(a) In acid solution chromate (CrO_4^{2-}) dimerizes to form the red-orange dichromate ion. Write a balanced net ionic equation for the reaction. (2%)
(b) Given:

$$Cr3+ + e- \longrightarrow Cr2+ \qquad \varepsilon^0 = -0.41\ V$$
$$O_{2(g)} + 4H^+_{(aq)} + 4e^- \longrightarrow 2H_2O_{(l)} \qquad \varepsilon^0 = 1.23\ V$$

Will acidic solutions of Cr^{2+} be stable if exposed to air, or will O_2 oxidize Cr^{2+} to Cr^{3+}? Show all calculation required to prove your answer. (6%)
(c) CrO_4^{2-} has T_d symmetry. Using the group theory method, predict the possible hybridization schemes for the Cr atom in CrO_4^{2-}. Which of these schemes would you expect to be most likely? Explain your answer. (8%)

T_d	E	$8C_3$	$3C_2$	$6S_4$	$6\sigma_d$		
A_1	1	1	1	1	1		$x^2 + y^2 + z^2$
A_2	1	1	1	−1	−1		
E	2	−1	2	0	0		$(2z^2 - x^2 - y^2,$ $x^2 - y^2)$
T_1	3	0	−1	1	−1	(R_x, R_y, R_z)	
T_2	3	0	−1	−1	1	(x, y, z)	(xy, xz, yz)

(d) CrO_4^{2-} ions are intense yellow but $Cr(OH)_6^{3+}$ ion is a pale-green. Characterize the origins of the transitions and explain the relative intensities. (8%)

7. What are Wilkinson and Ziegler-Natta catalysts, respectively? Give an example for the reactions it catalyzes for each catalyst. (8%)

8. Explain why $Mo(PMe_3)_5H_2$ is a dihydride (contains two separate H ligands), but $Mo(CO)_3(PR_3)_2(H_2)$ contains the dihydrogen ligand. (Me = methyl, R = isopropyl). (6%)