

- 說明： 一、答案一律寫在試卷(答案卷)上。  
二、請依序作答，並必須標明題號，否則不計分。  
三、計算題務必列出相關公式及計算過程，只寫答案不計分。  
四、試題共二頁，請隨試卷交回。

- Write the formula for: (10%)
  - calcium sulfate
  - sodium dichromate
  - aluminum hydroxide
  - iron(III) oxide
  - ammonium nitrate
- Calculate the average kinetic energies of the  $\text{CH}_4$  and  $\text{N}_2$  molecules at 273 K. (4%)
  - Calculate the root mean square velocities of the  $\text{CH}_4$  and  $\text{N}_2$  molecules at 273 K. (6%)  
( $R = 8.3145 \text{ J K}^{-1} \text{ mol}^{-1}$ , atomic weight for C = 12.0 g/mol, N = 14.0 g/mol, H = 1.0 g/mol, Avogadro's number  $N_A = 6.022 \times 10^{23}$ )
- At 373 K,  $K_c = 4.5 \times 10^9 \text{ L/mol}$  for the reaction  $\text{CO(g)} + \text{Cl}_2\text{(g)} \rightarrow \text{COCl}_2\text{(g)}$ .
  - Calculate the  $K_p$  at 373 K. (4%)
  - Equal moles of CO and  $\text{Cl}_2$  are reaction at 373 K. If the total pressure at equilibrium is 5.0 atm, calculate the equilibrium partial pressure of all the gases ( $P_{\text{CO}}$ ,  $P_{\text{Cl}_2}$  and  $P_{\text{COCl}_2}$ ).  
( $R = 8.3145 \text{ J K}^{-1} \text{ mol}^{-1}$ )(6%)
- The pH of a 0.016 M aqueous solution of p-tuluidine ( $\text{CH}_3\text{C}_6\text{H}_4\text{NH}_2$ ) is 8.60.  
Calculate the  $K_b$ . (5%)
  - Calculate the solubility of silver acetate in a buffered solution with pH = 3.00.  
( $K_{sp}$  for  $\text{CH}_3\text{COOAg}$  is  $2.5 \times 10^{-3}$ ,  $K_a = 1.8 \times 10^{-5}$  for acetic acid,  $\text{CH}_3\text{COOH}$ ) (5%)
- Calculate  $w$  (work) and  $\Delta E$  when one mole of a liquid is vaporized at its boiling point (353 K) and 1.00 atm pressure.  $\Delta H_{\text{vap}}$  for the liquid is  $3.07 \times 10^4 \text{ J mol}^{-1}$  at 353 K. (10%)  
( $R = 8.3145 \text{ J K}^{-1} \text{ mol}^{-1}$ )
- Calculate the  $\varepsilon^0$ ,  $\Delta G^0$  and  $K$  at 25 °C for the galvanic cell reaction. (10%)  
(the faraday:  $F = 96485 \text{ C/mol}$ ,  $R = 8.3145 \text{ J K}^{-1} \text{ mol}^{-1}$ )  
 $\text{Mn}^{2+} + 2 e^- \rightarrow \text{Mn} \quad \varepsilon^0 = -1.18 \text{ V}$   
 $\text{Fe}^{3+} + 3 e^- \rightarrow \text{Fe} \quad \varepsilon^0 = -0.036 \text{ V}$

(背面仍有題目,請繼續作答)

7. (A) What is the probability of finding an electron in a small region of an atom 1s orbital  $\Psi_{1S} = e^{-2r/a_0}$  at a distance  $a_0$  from the nucleus relative to the probability of finding it in the same small region located at  $3a_0$  from the nucleus? (5%)

(B) From the spectrum of hydrogen atom, the first and second lines are 121.6 nm and 102.6 nm, respectively. What will be wavelength (nm) of the third line? (5%)

8. (A) Predict the molecular structure and the hybrid orbitals used by the sulfur atom in (i)  $\text{SO}_3$  and (ii)  $\text{SF}_4$ . (6%)

(B) Use the molecular orbital model to predict the magnetism and bond order of the  $\text{C}_2$ . (4%)

9. The reaction  $\text{I}^-(\text{aq}) + \text{OCl}^-(\text{aq}) \rightarrow \text{IO}^-(\text{aq}) + \text{Cl}^-(\text{aq})$  was studied and the following data were obtained:

$[\text{I}^-]_0$ (mol/L)	$[\text{OCl}^-]_0$ (mol/L)	Initial rate (mol/L s)
0.12	0.18	$7.91 \times 10^{-2}$
0.06	0.18	$3.95 \times 10^{-2}$
0.03	0.09	$9.88 \times 10^{-3}$

(A) What is the rate law? (2%)

(B) Calculate the value of the rate constant. (3%)

- 10 (A) Calculate the osmotic pressure at  $25^\circ\text{C}$  of 0.50 M solution of  $\text{Ca}(\text{NO}_3)_2$  in water. (5%)  
( $R = 0.08206 \text{ L atm K}^{-1} \text{ mol}^{-1}$ )

(B) Barium has a body-center cubic structure. If the atomic radius of barium is 222 pm, calculate the density of solid barium. (atomic weight of Ba = 137.3 g/mol) (5%)

11. (A) Write the isotactic chain of polypropylene (PP). (3%)

(B) Write the major product for the following reactions. (2%)

