

- 注意事項： 1. 答案一律寫在試卷上，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. The label on a commercially available concentrated hydrochloric acid solution reads "37.4% HCl by weight, density $1.18\text{g}\cdot\text{ml}^{-1}$." Calculate the molality, formality, and mole fraction of HCl in this solution. (formula weight of HCl = $36.46\text{g}\cdot\text{mol}^{-1}$)

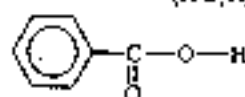
2. Choose and explain: (15%)

(a) Higher first ionization energy: Be or B

(b) Smallest bond angle: NO_2 , NO_2^+ , NO_2^-

(c) Paramagnetic substance: N_2 , O_2 , F_2

3. The solubility of benzoic acid ($\text{HC}_6\text{H}_4\text{O}_2$),



is $0.34\text{g}/100\text{ml}$ in water at 25°C and is $10.0\text{g}/100\text{ml}$ in benzene (C_6H_6) at 25°C . Rationalize this solubility behavior. Would benzoic acid be more or less soluble in a 0.1M NaOH solution than it is in water? Explain. (8%)

4. Solutions of sodium thiosulfate are used to dissolve unexposed AgBr in the developing process for black-and-white film. What mass of AgBr can dissolve in 1.0L of 0.500M $\text{Na}_2\text{S}_2\text{O}_3$? Assume the overall formation constant for $\text{Ag}(\text{S}_2\text{O}_3)_2^{2-}$ is 2.9×10^{13} and K_{sp} for AgBr is 5.0×10^{-13} . (formula weight of AgBr = $187.8\text{g}\cdot\text{mol}^{-1}$) (8%)

5. (a) What is the Bragg equation? What do the symbols in the equation stand for? (6%)

(b) The lattice energy of CuI is $958\text{kJ}\cdot\text{mol}^{-1}$, while that of NaI is $690\text{kJ}\cdot\text{mol}^{-1}$. Account for the difference between them. (6%)

6. One mole of an ideal gas is expanded reversibly from an initial pressure of 6.00 atm to a final pressure of 0.500 atm . The temperature is kept constant at 20°C . Calculate ΔE , ΔH , ΔS , ΔG , q , and w for this process. (10%)

7. Using the relationship

$$\ln(K) = -\frac{\Delta H^\circ}{RT} + \frac{\Delta S^\circ}{R}$$

show that for a system at equilibrium, the equilibrium will shift to the right for an endothermic process when the temperature is increased. (8%)

8. The decomposition of NH_3 to N_2 and H_2 was studied on two surfaces:

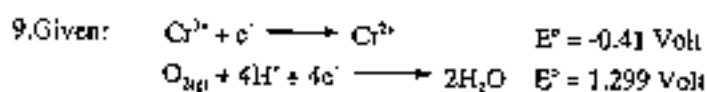
Surface	$E_a(\text{kJ}/\text{mol})$
W	163
Os	197

Without a catalyst the activation energy is $335\text{kJ}/\text{mol}$.

(a) Which surface is the better heterogeneous catalyst for the decomposition of NH_3 ? Why? (2%)

(b) How many times faster is the reaction at 298 K on the W surface compared with the reaction with no catalyst present? (8%)

(背面仍有題目, 請繼續作答)



Will acidic solutions of Cr^{2+} be stable if exposed to air, or will O_2 oxidize Cr^{2+} to Cr^{3+} ? Show all calculations required to prove your answer. (8%)

10. Give brief explanations for the following observations. (12%)

(a) The $\text{Fe}(\text{CN})_6^{4-}$ ion has a magnetic moment of 1.76 BM, while $\text{Fe}(\text{H}_2\text{O})_6^{3+}$ has a magnetic moment of 5.94 BM.

(b) The $\text{Co}(\text{H}_2\text{O})_6^{2+}$ ion is light red (pink), while the CoCl_4^{2-} ion, which has tetrahedral geometry, is blue.