科目 普通化學 類組別 A1 025 共 2 頁 第 1 頁

＊請在試卷答案卷（卡）內作答

1. (6 pts) For the following two pairs of chemical species (a) $MgCl_2$ and PCl_3 (b) CH_3NH_2 and CH_3F. Identify the dominant forces for these chemical species and select the ones with higher boiling points in each pair.

2. (8 pts) Predict the geometries of (a) NH_2^- (b) ICl_2^- (c)ICl_4^- (d) $CdCl_4^{2-}$. Answer in text (Chinese or English), but not in drawings.

3. (8 pts) (a) Balance the following reaction.

$$MnO_4^- + CN^- \rightarrow MnO_2 + CNO^-$$

(b) Which species is the reducing agent?
(c) From which species to which species does electron transfer occur?
(d) How does pH of the medium affect this reaction? For example, is this redox reaction as written is favorable in acidic solution? Explain.

4. (6 pts) Write reactions to predict whether aqueous solutions of the following salts are acidic, basic, or neutral. (a) $CrCl_3$ (b) $KClO_4$ (c) C_6H_5COONa.
5. (8 pts) For the face-centered cubic structure (a) how many atoms exist in the unit cell? (b) what is the coordination number? (c) what is the relationship between a (edge length of the unit cell) and r (atomic radius)?
6. (6 pts) Rank the following in order of increasing surface tension at a given temperature, and explain your ranking. (a) $CH_2CH_2CH_2OH$ (b) $HOCH_2CH(OH)CH_2OH$ (c) $HOCH_2CH_2OH$.
7. (8 pts) Name the following compounds in English.
   (a) B_2H_6 (b) N_2O_4 (c) PH_3 (d) $H_2PO_4^-$.
8. (10 pts) Consider the following equilibrium process:
   $PCl_5(g) = PCl_3(g) + Cl_2(g)$ $\Delta H^\circ = 92.5$ kJ/mol
   Predict the direction of the shift in equilibrium when
   (a) the temperature is raised,
   (b) more chlorine gas is added to the reaction mixture,
   (c) some PCl_3 is removed from the mixture,
   (d) the pressure on the gases is increased,
   (e) a catalyst is added to the reaction mixture.

注意:背面有試題

9. (8 pts) Sulfur undergoes a phase transition from the rhombic crystal structure to the monoclinic crystal form at 95°C. The process is shown below.

S_8(rhombic) → S_8(monoclinic)

(a) Predict the signs of ΔG, ΔH, and ΔS for the above process.
(b) Which form of sulfur has the more ordered crystalline structure?

10. (10 pts) One mechanism for the destruction of ozone in the upper atmosphere is

$O_3(g) + NO(g) \rightarrow NO_2(g) + O_2(g)$ (Slow)
$NO_2(g) + O(g) \rightarrow NO(g) + O_2(g)$ (Fast)

(a) Write down the overall reaction.
(b) Which species is a catalyst?
(c) Which species is an intermediate?
(d) The activation energy Ea for the "uncatalyzed" overall reaction is 14.0 kJ. Ea for the same reaction catalyzed is 11.9 kJ. What is the ratio of the rate constant for the catalyzed reaction to that for the uncatalyzed reaction at 27°C? Assume that the frequency factor A is the same for each reaction. (You only need to write down the necessary equation with numbers)

11. (8 pts) Air bags are activated when a severe impact causes a steel ball to compress a spring and electrically ignite a detonator cap. This causes sodium azide, a major component in the air bag, to decompose explosively and to produce nitrogen. Please answer the following questions.
(a) Write down the chemical formula for sodium azide.
(b) Write down the decomposition reaction of sodium azide.
(c) How many moles of sodium azide must be reacted to inflate an air bag to 70.0 L at STP.

12. (10 pts) Please use *Molecular Orbital Theory* to answer the following questions:
(a) Why O_2 is paramagnetic? (3%)
(b) Bond orders for O_2^- (superoxide ion) and O_2^{2-} (peroxide ion). (4%)
(c) Oxygen-oxygen bond length order for O_2, O_2^- and O_2^{2-}. (3%)

13. (4 pts) An unknown element is a nonmetal and has a valence electron configuration ns^2np^4.
(a) How many valence electrons does this element have?
(b) What is the formula of the compound this element would form with lithium?
(c) Would this element have a larger or smaller radius than barium?
(d) Would this element have a greater or smaller ionization energy than fluorine?