

八十六學年度 原子科學 系(所) 乙 組碩士班研究生入學考試

科目 普通化學 科號 4301 共 4 頁第 1 頁 *請在試卷(答案卷)內作答

- (a) When metal ions were burned in a flame, a lot of them always show various colors. Therefore, various metal complexes were used in firework. Why do metal ions show colors when they were burned in a flame? (5%)

(b) Explain why most of transition metals show magnetic properties. (5%)
- | | | | |
|------------------|---------------|-------------------|------|
| ^{60}Co | $t_{1/2} = ?$ | mode of decay = ? | (5%) |
| ^{32}P | $t_{1/2} = ?$ | mode of decay = ? | |
- A piece of human skeleton was found in an old cave. Radioactivity measurement shows that the ^{14}C radioactivity is 10 disintegration per gram per min. How old is the skeleton? Given that the current steady state ^{14}C radioactivity is 15.3 disintegration per gram per min. (10%)
- What is the Hess's law? (5%)

5-14 題，每題二分

- Consider the rate data for the reaction, $2\text{A} + 3\text{B} \rightarrow \text{products}$.

Initial [A]	Initial [B]	$-\Delta[\text{A}]/\Delta t$
0.025 M	0.025 M	0.0012 mol min ⁻¹
0.050 M	0.025 M	0.0024 mol min ⁻¹
0.050 M	0.050 M	0.0024 mol min ⁻¹

What is the rate equation for this reaction?

- A. $k[\text{A}]$ B. $k[\text{A}][\text{B}]$ C. $k[\text{A}]^2[\text{B}]^3$ D. $k[\text{B}]$
 E. none of the above

- The gas phase reaction between hydrogen bromide and oxygen is proposed to take place by the following steps. 1. $\text{HBr} + \text{O}_2 \rightarrow \text{HO}_2\text{Br}$
 2. $\text{HO}_2\text{Br} + \text{HBr} \rightarrow 2\text{HOBr}$ 3. $\text{HOBr} + \text{HBr} \rightarrow \text{H}_2\text{O} + \text{Br}_2$ If the first step is the slowest, what is the rate equation for the reaction?
 A. $k[\text{HOBr}][\text{HBr}]$ B. $k[\text{HBr}][\text{O}_2]$ C. $k[\text{HO}_2\text{Br}][\text{O}_2]$
 D. $k[\text{HOBr}]^2$ E. none of the above

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科目 普通化學 科號 4301 共 4 頁第 2 頁 *請在試卷【答案卷】內作答

7. The rate equation for the reaction, $A + 2B \rightarrow \text{products}$, is found to be $\text{rate} = k[A][B]^2$. What is the molecularity of the slow step for this reaction?
 A. unimolecular B. bimolecular C. termolecular
 D. tetramolecular E. none of the above
8. Consider the reaction, $A + B \rightarrow \text{products}$, which has the rate equation, $\text{rate} = k[A]$. The concentration of A falls from 0.050 M to 0.015 M after a period of 20 minutes. What is the value of the rate constant, k , for this reaction?
 A. 17 min^{-1} B. 380 min^{-1} C. $2.6 \times 10^{-6} \text{ min}^{-1}$ D. 0.060 min^{-1}
 E. none of the above
9. Consider the reaction, $A + B \rightarrow \text{products}$, which has the rate equation, $\text{rate} = k[A]$. The value of the rate constant, k , is 0.079 min^{-1} . How long will it take for the concentration of A to fall from 0.050 M to 0.015 M?
 A. 32 min B. 23 min C. 15 min D. 11 min
 E. none of the above
10. Consider the reaction, $A + B \rightarrow \text{products}$, which has the rate equation, $\text{rate} = k[A]$. The half-life, $t_{1/2}$, is 43 minutes. What is the value of the rate constant, k , for the reaction?
 A. 0.80 min^{-1} B. 0.42 min^{-1} C. $.016 \text{ min}^{-1}$ D. 62 min^{-1}
 E. none of the above
11. The equilibrium constant for the vapor phase reaction, $\text{PCl}_3 + \text{Cl}_2 \leftrightarrow \text{PCl}_5$, is 49. If the rate constant for the reverse reaction is 1.5 s^{-1} , what is the rate constant for the forward process?
 A. $33 \text{ L mol}^{-1} \text{ s}^{-1}$ B. $0.87 \text{ mol s L}^{-1}$ C. $73.5 \text{ L mol}^{-1} \text{ s}^{-1}$
 D. 6.8 s^{-1} E. none of the above

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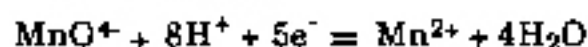
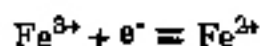
12. Which of the following is true?
- As the temperature is increased, the primary factor causing an increase in reaction rate is the increase in the number of collisions.
 - As the temperature is increased, the number of collisions that reach the transition state increases.
 - For an exothermic reaction, the products always contain more potential energy than the reactants.
 - The energy of activation is thought to undergo large changes as the temperature is changed.
 - none of the above
13. Which of the following is true?
- A catalyst speeds the approach of a reaction to equilibrium but does not change the equilibrium position.
 - Homogeneous catalysts exist in a separate phase from the reaction medium.
 - Heterogeneous catalysts are in the same phase as the reaction medium.
 - An enzyme in solution behaves as a heterogeneous catalyst.
 - none of the above
14. What is the missing particle for the radioactive decay reaction, $^{15}\text{O} \rightarrow ^{15}\text{N} + \underline{\quad}$?
- neutron
 - beta particle
 - alpha particle
 - positron
 - none of the above
15. In the hydrogen atom, sketch the radial wavefunction $4\pi r^2 R^2(r)$ versus r for the following atomic orbitals. (a) 5p (b) 5d (c) 6f (7) 6s (8%)
16. Show the splittings of the d-orbitals and the filling of d-electrons for the following complexes (a) NiCl_4^{2-} (b) PdCl_4^{2-} (c) $\text{Ni}(\text{CN})_4^{2-}$ (d) CoF_6^{3-} (8%) (no atomic number will be provided here)

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17. For a single crystals with the following unit cells $a=b=2\text{\AA}$, $c=3\text{\AA}$, $\alpha=\beta=90^\circ$, $\gamma=120^\circ$. Each unit cell contains six molecules. If the molecular weight is 60.0g/mole. Please find the density of this crystal. (8%)

18. In the titration of MnO_4^- with Fe^{2+} in the acidic medium, show the electric potential at the equivalent point $E = (A\varepsilon_{\text{Fe}}^0 + B\varepsilon_{\text{Mn}}^0)/C + (0.059/D)\log[\text{H}^+]^E$. $\varepsilon_{\text{Fe}}^0$ and $\varepsilon_{\text{Mn}}^0$ represents the half-cell potentials for the following reactions. Where are the values of A, B, C, D, E? (12%)



19. Show the idealized structures for the following compounds. (a) BrF_3
(b) ICl_2^- (c) SOF_2Cl_2 (d) IO_2F_2^- (8%)

20. calculate the mean free path of N_2 at 1 atm at 23°C , the molecular diameter of N_2 is about 3\AA . (6%)