

科目 普通化學 類組別 A-1、A-5、B-5、B-6 共 4 頁第 1 頁 \*請在試卷答案卷(卡)內作答

選擇題(每題 2.5 分，答錯不倒扣)

- Which of the following is equivalent to  $4 \times 10^{-6}$  cm?  
(A) 0.4 mm (B)  $4 \mu\text{m}$  (C) 40 nm (D)  $40 \text{ \AA}$  (E) 40 pm
- Express the following operation with the appropriate number of significant figures:  
 $32.4 + 1.325 + 81 =$   
(A) 114.725 (B) 114.7 (C) 115 (D)  $1.1 \times 10^2$  (E)  $1.10 \times 10^2$
- Give the complete chemical symbol for the nuclide that contains 18 protons, 18 electrons, and 22 neutrons.  
(A)  $^{18}_{18}\text{Ar}$  (B)  $^{40}_{18}\text{Ar}$  (C)  $^{40}_{22}\text{Ar}$  (D)  $^{40}_{22}\text{Ca}$  (E)  $^{22}_{18}\text{Ca}$
- Which of the following species has equal numbers of neutrons and protons?  
(Their atomic numbers are shown in the parenthesis.)  
(A)  $^{24}\text{Mg}^{2+}$ (12) (B)  $^{35}\text{Cl}^{-}$ (17) (C)  $^{47}\text{Cr}$ (24) (D)  $^{60}\text{Co}^{3+}$ (27) (E)  $^{90}\text{Sr}$ (38)
- Which of the following is tetraphosphorus decasulfide?  
(A)  $\text{P}_4\text{S}_{10}$  (B)  $\text{P}_4\text{S}_{12}$  (C)  $\text{P}_3(\text{SO}_3)_8$  (D)  $\text{P}_3(\text{SO}_3)_{10}$  (E)  $\text{P}_3(\text{SO}_3)_{12}$
- Which one of the following reactions will have a positive value of  $\Delta H^\circ$ ?  
(A)  $\text{C}(\text{graphite}) \rightarrow \text{C}(\text{diamond})$   
(B)  $3\text{C}(\text{graphite}) + 4\text{H}_2(\text{g}) \rightarrow \text{C}_3\text{H}_8(\text{g})$   
(C)  $\text{C}(\text{graphite}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g})$   
(D)  $\text{C}_6\text{H}_{12}\text{O}_6(\text{s}) + 6\text{O}_2(\text{g}) \rightarrow 6\text{CO}_2(\text{g}) + 6\text{H}_2\text{O}(\text{l})$   
(E) None of the above.
- Among the four quantum numbers,  $n$  and  $l$  together govern  
(A) the shape of an orbital  
(B) the energy of an orbital  
(C) the spin properties of the electron  
(D) the spatial orientation of the orbital  
(E) the magnetic property of the orbital
- Which element in the following has the largest first ionization energy?  
(A) Li (B) Na (C) K (D) Be (E) B
- Which element in the following has the lowest electron affinity (i.e., the easiest in accepting an electron)?  
(A) O (B) S (C) He (D) Ne (E) Ar
- Which element in the following has the largest atomic radius?  
(A) Li (B) Be (C) B (D) Na (E) Mg
- What is the formal charge on the oxygen atom in  $\text{H}_3\text{O}^+$ ?  
(A) +1 (B) 0 (C) -1 (D) -2 (E) -3
- What is the bond order of the  $\text{He}_2^+$  ion?  
(A) -1/2 (B) 0 (C) 1/2 (D) 1 (E) 3/2
- Which of the following interactions is the weakest?  
(A) London forces (B) dipole-dipole forces (C) hydrogen bonding (D) ion-dipole forces (E) ionic bonding
- Which of the following properties is decreasing upon increasing the intermolecular attractive forces?  
(A) Vapor pressure (B) Heat of vaporization (C) Freezing point (D) Surface tension (E) Critical temperature.
- What is the osmotic pressure at  $27^\circ\text{C}$  of a 1.0 mM sucrose ( $\text{C}_{12}\text{H}_{22}\text{O}_{11}$ , fw = 342) solution?  
(A) 0.025 atm (B)  $2.2 \times 10^{-3}$  atm (C) 0.22 atm (D) 8.4 atm (E) 0.76 atm

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16. Which of the following aqueous solutions will have the highest boiling point?  
 (A) 0.040 *m* glycerin (B) 0.030 *m* phenol (C) 0.025 *m* KBr (D) 0.020 *m* BF<sub>4</sub>NH<sub>3</sub> (E) 0.015 *m* PbSO<sub>4</sub>
17. Which of the following will shift the equilibrium to the left?  

$$3\text{Fe}(s) + 4\text{H}_2\text{O}(g) \rightleftharpoons \text{Fe}_3\text{O}_4(s) + 4\text{H}_2(g), \Delta H^\circ = -150 \text{ kJ}$$
 (A) Fe<sub>3</sub>O<sub>4</sub>(*s*) is added to the system.  
 (B) A catalyst is added to the mixture.  
 (C) The volume of the reaction vessel is doubled.  
 (D) Raise the temperature of the mixture.  
 (E) Introduce more H<sub>2</sub>O(*g*).
18. Which of the following aqueous solutions (with the same molarity) will show the strongest basicity?  
 (A) NH<sub>4</sub>NO<sub>3</sub> (B) NH<sub>4</sub>Cl (C) KBr (D) KCl (E) KF
19. Which of the following is the weakest acid?  
 (A) CH<sub>2</sub>ClCOOH (B) CCl<sub>3</sub>COOH  
 (C) CH<sub>3</sub>CH<sub>2</sub>COOH (D) CH<sub>2</sub>ClCH<sub>2</sub>COOH (E) CCl<sub>3</sub>CH<sub>2</sub>COOH
20. If a buffer solution is prepared by carbonic acid (H<sub>2</sub>CO<sub>3</sub>) and its sodium salts. Which pH range shown in the following will have the strong buffer capacity?  
 (The pK<sub>a1</sub>, pK<sub>a2</sub>, and pK<sub>a3</sub> of carbonic acid are 6.352, and 10.329, respectively.)  
 (A) 3.0 ~ 4.0 (B) 4.5 ~ 5.5 (C) 6.0 ~ 7.0 (D) 7.5 ~ 8.5 (E) 9.0 ~ 10.0
21. What compound in the following is a major greenhouse gases?  
 (A) CO (B) CO<sub>2</sub> (C) O<sub>3</sub> (D) SO<sub>3</sub> (E) Chlorofluorocarbons (CFCs)
22. Which of the following reactions is positive in the entropy change?  
 (A) C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>(*s*) + 6O<sub>2</sub>(*g*) → 6CO<sub>2</sub>(*g*) + 6H<sub>2</sub>O(*l*)  
 (B) N<sub>2</sub>(*g*) + O<sub>2</sub>(*g*) → 2NO(*g*)  
 (C) Cooling of nitrogen gas from 20 °C to -50 °C.  
 (D) Ag(*s*) + Cl<sup>-</sup>(*aq*) → AgCl(*s*)  
 (E) 3Fe(*s*) + 4H<sub>2</sub>O(*g*)  $\rightleftharpoons$  Fe<sub>3</sub>O<sub>4</sub>(*s*) + 4H<sub>2</sub>(*g*), ΔH° = -150 kJ
23. Which of the following conditions will fit the results of ΔS > 0 and ΔH < 0?  
 (A) The temperature of a solid is lowered by 25 °C.  
 (B) A diatomic molecule dissociates into atoms.  
 (C) A piece of charcoal is combusted to form CO<sub>2</sub>(*g*) and H<sub>2</sub>O(*g*).  
 (D) A solid sublimates.  
 (E) Polymerization of ethylene to polyethylene.
24. Given the following reduction potentials for a typical NiCd voltaic cell, find the standard emf of the cell.  

$$\text{Cd}(\text{OH})_2(s) + 2e^- \rightarrow \text{Cd}(s) + 2\text{OH}^-(aq) \quad E_{\text{red}}^\circ = -0.76 \text{ V}$$

$$\text{NiO}(\text{OH})(s) + \text{H}_2\text{O}(l) + e^- \rightarrow \text{Ni}(\text{OH})_2(s) + \text{OH}^-(aq) \quad E_{\text{red}}^\circ = +0.49 \text{ V}$$
 (A) 1.50 V (B) -1.50 V (C) 1.25 V (D) -1.25 V (E) -0.27 V
25. The following is a list of common particles in radioactive decay and nuclear transformations. Which is an electromagnetic radiation?  
 (A) α particle (B) β particle (C) γ particle (D) Positron (E) Proton
26. From the VSEPR model, the best one to describe the molecular geometries of BrF<sub>3</sub> is  
 (A) linear (B) a bent T (C) trigonal planar (D) trigonal bipyramidal (E) octahedral.
27. How many unpaired electrons does the tetrahedral [CoCl<sub>4</sub><sup>2-</sup>] ion have?  
 (A) 3 (B) 4 (C) 5 (D) 6 (E) 7

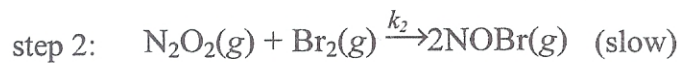
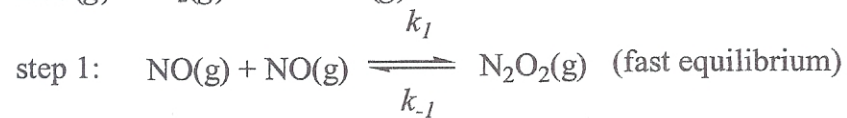
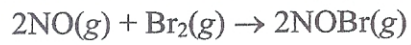
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28. From the following five sets of d electron configurations, pick up a set that both have the possibility of a distinction between high-spin and low-spin arrangements in octahedral complexes.  
 (A)  $d^1, d^3$  (B)  $d^2, d^5$  (C)  $d^5, d^7$  (D)  $d^6, d^8$  (E)  $d^8, d^{10}$
29. How many chiral carbon atoms are there in the open chain form of glucose?  
 (glucose:  $\text{HOCH}_2[\text{CH}(\text{OH})]_4\text{CHO}$ )  
 (A) 2 (B) 3 (C) 4 (D) 5 (E) 6
30. How many different tripeptides can be made from the two amino acids, serine and phenylalanine? (Both amino acids should present in the tripeptides.)  
 (A) 2 (B) 4 (C) 6 (D) 8 (E) 10
31. For a strand of a DNA molecule has the sequence of bases ACC, what must be the sequence on the complementary strand and the total number of H bonds?  
 (A) TGG, 8 H bonds (B) TGG, 7 H bonds (C) CAA, 8 H bonds (D) CAA, 7 H bonds (E) GTT, 7 H bonds
32. In Taiwan, liquid butane,  $\text{C}_4\text{H}_{10}$ , is commonly stored in a cylindrical can and used as a fuel. Suppose 3.00 L of butane gas at  $27^\circ\text{C}$  and 735 Torr is removed from the cylinder. How much heat must be added to vaporize this much butane if the heat of vaporization is 21.3 kJ/mol?  
 (A) 1.16 J (B) 24.8 J (C) 2.51 kJ (D) 27.9 kJ (E) 294 kJ
33. The wavelengths of visible region are within  
 (A)  $10^{-7} \sim 10^{-6}$  m  
 (B)  $10^{-6} \sim 10^{-5}$  m  
 (C)  $10^{-5} \sim 10^{-4}$  m  
 (D)  $10^{-4} \sim 10^{-3}$  m  
 (E)  $10^{-3} \sim 10^{-2}$  m
34. For a 2p electron in beryllium, what is total number of all possible values of the four quantum numbers (i.e., how many sets of  $[n, l, m_l, m_s]$ )?  
 (A) 4 (B) 6 (C) 8 (D) 9 (E) 12
35. Given the Rydberg constant and Planck's constant,  $R_H = 2.18 \times 10^{-18}$  J and  $h = 6.63 \times 10^{-34}$  J·sec. From the following, select the range of the wavelength of light that corresponds to the transition of the electron from the  $n = 4$  to  $n = 2$  state of the hydrogen atom.  
 (A)  $2.5 \times 10^{-9} \sim 7.5 \times 10^{-9}$  m  
 (B)  $7.5 \times 10^{-9} \sim 2.5 \times 10^{-8}$  m  
 (C)  $2.5 \times 10^{-8} \sim 7.5 \times 10^{-8}$  m  
 (D)  $7.5 \times 10^{-8} \sim 2.5 \times 10^{-7}$  m  
 (E)  $2.5 \times 10^{-7} \sim 7.5 \times 10^{-7}$  m
36. Balance the reaction of gasoline combustion:  
 $\text{C}_8\text{H}_{18}(l) + a\text{O}_2(g) \rightarrow b\text{CO}_2(g) + c\text{H}_2\text{O}(l)$   
 $c =$  (A) 3 (B) 6 (C) 9 (D) 12 (E) 18
37. Balance the titration of hydrogen peroxide with permanganate ion:  
 $\text{MnO}_4^-(aq) + a\text{H}_2\text{O}_2(aq) + b\text{H}^+(aq) \rightarrow c\text{Mn}^{2+}(aq) + d\text{O}_2(g) + e\text{H}_2\text{O}(l)$   
 $b =$  (A) 1 (B) 2 (C) 3 (D) 4 (E) 5
38. Balance the redox reaction of oxalate with permanganate ion:  
 $\text{MnO}_4^-(aq) + a\text{C}_2\text{O}_4^{2-}(aq) + b\text{H}^+(aq) \rightarrow c\text{Mn}^{2+}(aq) + d\text{CO}_2(g) + e\text{H}_2\text{O}(l)$   
 $b =$  (A) 8 (B) 10 (C) 12 (D) 14 (E) 16
39. Sodium oxalate ( $\text{Na}_2\text{C}_2\text{O}_4$ , fw 134.0) is a substance used to standardize  $\text{KMnO}_4(aq)$ (fw 158.0). If a 25.00-mL sample of a  $\text{KMnO}_4(aq)$  is required to titrate 0.2680 g sodium oxalate in acidic solution, what is the molarity of the  $\text{KMnO}_4$  solution?  
 (A) 0.016 M (B) 0.0160 M (C) 0.01600 M (D) 0.0320 M (E) 0.03200 M

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40. What is the rate constant,  $k$ , for the following reactions.



(A)  $k_2$  (B)  $k_2/k_{-1}$  (C)  $k_2(k_{-1}/k_1)$  (D)  $k_2(k_1 - k_{-1})$  (E)  $k_2(k_1/k_{-1})$