





一、選擇題 (單選題), 請在電腦卡作答 (每題二分)

- The fact that no two electrons in the same atom can have the same set of four quantum numbers is a statement of:  
(a) the Pauli Exclusion Principle; (b) Einstein's Hypothesis; (c) Bohr's rule; (d) Hund's rule.
- A gasoline with an octane rating of 90 would give the same performance in a standard test engine as a mixture of (a) 90% isooctane and 10% n-heptane; (b) 90% n-heptane and 10% isooctane; (c) 90 parts isooctane and 10 parts isohexane; (d) 90 parts isooctane and 90 parts water; (e) 90 parts isooctane and 90 parts isohexane.
- Which substance is serving as the reducing agent in the following reaction?  
 $\text{Fe}_2\text{S}_3 + 12 \text{HNO}_3 \rightarrow 2 \text{Fe}(\text{NO}_3)_3 + 3 \text{S} + 6 \text{NO}_2 + 6\text{H}_2\text{O}$   
(a)  $\text{NO}_2$ ; (b)  $\text{Fe}(\text{NO}_3)_3$ ; (c)  $\text{HNO}_3$ ; (d)  $\text{Fe}_2\text{S}_3$ .
- "Pure" rainfall (rainfall undisturbed by human influences) has a pH of approximately 5.5. The pH of rain in some heavy polluted industrial area has been measured at about 2.5. The acidity of this acid rain is (a) three times that of normal rain; (b) 10 times that of normal rain; (c) 100 times that of normal rain; (d) 1000 times that of normal rain.
- Select the substance that is thought to be partially responsible for depleting the concentration of ozone in the stratosphere.  
(a)  $\text{CFCl}_3$ ; (b)  $\text{CCl}_4$ ; (c)  $\text{SiF}_4$ ; (d)  $\text{CO}_2$ .
- The solubility of  $\text{Mn}(\text{OH})_2$  is  $2.2 \times 10^{-5}$  mol/L. What is the  $K_{sp}$  of  $\text{Mn}(\text{OH})_2$ ?  
(a)  $1.1 \times 10^{-14}$ ; (b)  $6.8 \times 10^{-14}$ ; (c)  $2.1 \times 10^{-14}$ ; (d)  $4.8 \times 10^{-14}$ ; (e)  $4.3 \times 10^{-14}$ .
- Consider the following reactions.  
 $\text{AgNO}_3(\text{aq}) + \text{Zn}(\text{s}) \rightarrow \text{Ag}(\text{s}) + \text{Zn}(\text{NO}_3)_2$   
 $\text{Zn}(\text{NO}_3)_2(\text{aq}) + \text{Co}(\text{s}) \rightarrow \text{no reaction}$   
 $\text{AgNO}_3(\text{aq}) + \text{Co}(\text{s}) \rightarrow \text{Co}(\text{NO}_3)_2(\text{aq}) + \text{Ag}(\text{s})$   
What is the correct order of increasing activity for these metals?  
(a)  $\text{Ag} < \text{Zn} < \text{Co}$ ; (b)  $\text{Co} < \text{Ag} < \text{Zn}$ ; (c)  $\text{Co} < \text{Zn} < \text{Ag}$ ; (d)  $\text{Ag} < \text{Co} < \text{Zn}$ .
- When coal containing sulfur is burned, the sulfur is converted to (a) gaseous sulfur oxides that goes up the smokestack; (b) liquid sulfur oxides that stay behind as ash; (c) solid sulfur oxides that stay behind as ash; (d) all of the above.
- All of the following compounds are ionic compounds except  
(a)  $\text{K}_2\text{O}$  (b)  $\text{Na}_2\text{SO}_4$ ; (c)  $\text{Li}_3\text{N}$ ; (d)  $\text{ZnCl}_2$ ; (e)  $\text{SiO}_2$ .
- Which one of the following forms of carbon contains only  $sp^3$  hybridized carbon atoms?  
(a) diamond; (b) fullerene; (c) carbon nanotube (d) graphite (e) charcoal.
- Nylon is an example of a polymer formed by which of the following process.  
(a) free radical polymerization; (b) addition polymerization; (c) polymerization catalyzed by metallocene; (d) condensation polymerization; (e) substitution polymerization.
- This element reacts with oxygen to form an oxide with the formula  $\text{XO}_3$ . When added to water at room temperature,  $\text{XO}_3$  forms an acidic solution. Element X is: (a) K; (b) Cl; (c) C; (d) Mg; (e) S.

13. Optical brighteners of the laundry detergents work by (a) absorbing visible light and emitting invisible UV light (b) absorbing invisible UV light and emitting visible light (c) spontaneously emitting visible light when they attach to clothing fibers (d) spontaneously emitting invisible UV light when they attach to clothing fibers.
14. Using the molecular orbital theory, determine the bond order of the  $C_2$  molecule.  
(a) 0; (b) 1; (c) 1.5; (d) 2; (e) 3.
15. A compound containing only carbon, hydrogen and oxygen is analyzed and found to be 70.6% carbon, 5.9% hydrogen, and 23.5% oxygen. The molecular weight of the compound is 136. What is the molecule formula?  
(a)  $C_8H_8O_2$ ; (b)  $C_8H_4O$ ; (c)  $C_4H_4O$ ; (d)  $C_9H_{12}O$ .
16. Which one of the following describes how *greenhouse* gases lead to possible global warming? (a) These gases allow heat energy to pass through the atmosphere but absorb visible light energy from the sun; (b) These gases allow visible light energy to pass through the atmosphere but absorb radiated heat energy from the Earth; (c) These gases absorb both visible light energy and radiated heat energy from the Earth; (d) These gases spontaneously produce heat energy by a mechanism that is not well understood.
17. Which of the following sketch represents an orbital that cannot have a principle quantum number of 2?
- (i)  


(ii)  


(iii)  


(iv)  

- (a) only orbital (i); (b) both orbitals (i) and (ii); (c) both orbitals (iii) and (iv); (d) only orbital (iv); (e) only orbital (ii).
18. The following five compounds have similar molecular weights, but a wide range of boiling points. Indicate the compound that possesses the highest boiling point among the series: (a) dimethyl ether; (b) formic acid; (c) propane; (d) ethanol; (e) acetaldehyde.
19. Which of the following atoms has the largest number of unpaired electrons in its ground state configuration?  
(a) Ag; (b) Cd; (c) Sn; (d) Mo; (e) Co.
20. When a dilute aqueous solution of  $Li_2SO_4$  is electrolyzed, the products formed at the anode and cathode, respectively, are  
(a) S and Li; (b)  $O_2$  and Li; (c)  $SO_2$  and  $H_2$ ; (d)  $O_2$  and  $H_2$ ; (e)  $SO_2$  and Li.
21. What is the nature of the intermolecular attractive forces that exist among the methanol solvent ( $CH_3OH$ ) and methane solute ( $CH_4$ ) molecule?  
(a) dipole-dipole interaction; (b) hydrogen bonding; (c) London dispersion forces; (d) ion-dipole interaction; (e) ionic electrostatic interaction.

國立清華大學命題紙

九十一學年度 化工 系轉學生招生考試

科目 普通化學 科號 064 共 4 頁第 3 頁 \*請在試卷【答案卷】內作答

22. Which of the following is not a characteristic property of the alkali metals? (a) They form 1+ ions. (b) Their oxides dissolve in water to form acidic solutions. (c) The ionic radius is much smaller than the atomic radius. (d) The atomic radius increases with increasing atomic number. (e) They are strong electropositive elements.
23. For the reaction  $\text{CaCO}_3(\text{s}) \rightarrow \text{CaO}(\text{s}) + \text{O}_2(\text{g})$  at 1 atm pressure, the values of  $\Delta H$  and  $\Delta S$  are both positive, and the process is spontaneous at  $900^\circ\text{C}$ . Which of the following statements about this reaction is true? (a)  $\Delta G$  at room temperature is negative. (b) The process is exothermic at  $900^\circ\text{C}$  and endothermic at room temperature. (c) The change in entropy is the driving force for the reaction. (d) The reverse reaction is nonspontaneous at room temperature. (e) The reverse process is endothermic.
24. Which of the following salts when added to pure water will not change the pH of the solution? (a) KI. (b) sodium acetate. (c) BaS. (d)  $\text{LiHSO}_4$ . (e)  $\text{Na}_2\text{O}$ .
25. Transition metals can be distinguished from main-group metals by the fact that (a) transition metals have a greater tendency to form colored compounds than main-group metals. (b) main-group metals only have +1 or +2 oxidation states. (c) main-group metals have higher relative atomic masses than transition metals. (d) transition metals have higher relative atomic masses than main-group metals. (e) only the main-group metals can form complex ions.
26. Which of the following materials is colorless. (a)  $\text{K}_2\text{Cr}_2\text{O}_7$ ; (b)  $\text{Na}_4\text{P}_2\text{O}_7$ ; (c)  $(\text{NEt}_4)_2\text{WS}_4$ ; (d)  $\text{FeSO}_4$ ; (e)  $\text{CuSO}_4 \cdot \text{H}_2\text{O}$ .
27. The equation for the combination of gaseous atoms of nitrogen and hydrogen to give ammonia is  $\text{N}(\text{g}) + 3\text{H}(\text{g}) \rightarrow \text{NH}_3(\text{g})$ . The enthalpy change,  $\Delta H$ , is (a) the heat of formation of ammonia. (b) minus the sum of the bond energies in ammonia. (c) the free energy of formation of ammonia. (d) the entropy of formation of ammonia. (e) the  $\Delta E$  of formation of ammonia.
28. Which of the following description is consistent with the properties of solid BN; (a) A bluish-white, lustrous solid melting at  $327^\circ\text{C}$ ; the solid is soft and malleable; (b) A white solid melting at  $772^\circ\text{C}$ ; the solid is an electrical nonconductor but dissolves in water to give a conducting solution; (c) A yellowish-green solid melting at  $172^\circ\text{C}$ ; (d) A very hard, colorless substance melting at about  $3000^\circ\text{C}$ .
29. The geometry of the carbonated ion,  $\text{CO}_3^{2-}$ , is (a) trigonal planar; (b) tetrahedral; (c) T shaped; (d) octahedral; (e) trigonal pyramidal.
30. The heat of hydration is the energy released when these isolated gaseous ions are placed in water where they become hydrated due to the ion-dipole interaction. Which ion has the largest heat of hydration. (a)  $\text{Na}^+$ ; (b)  $\text{Al}^{3+}$ ; (c)  $\text{F}^-$ ; (d)  $\text{O}^{2-}$ .
31. For the reaction between chloride and nitric oxide,  $\text{Cl}_2(\text{g}) + 2\text{NO}(\text{g}) \rightarrow 2\text{NOCl}(\text{g})$  it is found that doubling the concentration of both reactants increases the rate by a factor of 8. If only the concentration of  $\text{Cl}_2$  is doubled, the rate increases by a factor of 2. The order of this reaction with respect to NO is (a) 0; (b) 1; (c) 2; (d) 3; (e)  $\frac{1}{2}$ .
32. Which of the following species is an ampholyte? (i.e. a substance that can act both as an acid and as a base.) (a)  $\text{CH}_3\text{COO}^-$ ; (b)  $\text{H}_2\text{O}$ ; (c)  $\text{NH}_4^+$ ; (d)  $\text{C}_6\text{H}_5\text{COOH}$ ; (e)  $\text{S}^{2-}$ .

33. A precipitate will be formed when an aqueous solution of hydrochloric acid is added to an aqueous solution of (a) sodium nitrite; (b) barium nitrate; (c) silver nitrate; (d) zinc sulfate; (e) iron(II) carbonate.
34. Which of the following molecules is nonplanar? (a)  $C_6H_6$ ; (b)  $SO_3$ ; (c)  $CF_4$ ; (d)  $XeF_4$ ; (e)  $C_2H_4$ .
35. An element X has the electronic configuration  $1s^2 2s^2 2p^6 3s^2 3p^3$ . The formula of the most probable compound this element will form with calcium, Ca, is (a)  $CaX$ ; (b)  $Ca_2X$ ; (c)  $CaX_2$ ; (d)  $Ca_2X_3$ ; (e)  $Ca_3X_2$ .

二、問答題

36. For each of the following pairs, which substance would you think to be more soluble in water? Why? (a)  $CHCl_3$  or  $CCl_4$ . (b)  $CH_3CH_2OH$  or  $CH_3CH_2CH_3$ . Which ion would you expect to be more strongly hydrated in an aqueous solution? Why? (c)  $Mg^{2+}$  or  $Be^{2+}$ . (d)  $Cl^-$  or  $ClO_4^-$ . (10%)
37. Draw the orbital energy diagram of a diatomic gas molecule  $O_2$ . Construct the bonding interaction of the  $\sigma(2s)$ ,  $\sigma^*(2s)$ ,  $\sigma(2p)$ ,  $\sigma^*(2p)$ ,  $\pi(2p)$  and  $\pi^*(2p)$  molecular orbitals by using the atomic orbitals of oxygen atoms. Which molecule,  $O_2$ ,  $O_2^-$ ,  $O_2^+$  or  $O_2^{2+}$ , has the highest O-O bond strength. Explain concisely. (10%)
38. For which of the following complexes are optical isomers possible? Explain your answers and draw structure of both enantiomers. (a)  $Cr(en)_3^{3+}$ ; (b) cis-1,2-dimethylcyclobutane; (c)  $[Cr(NH_3)_4(en)]^{3+}$ ; (d)  $[Co(en)_2r(NH_3)Cl]^{2+}$ . en =  $H_2NCH_2CH_2NH_2$ . (10%)