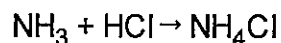


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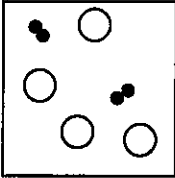
- 1) As an electron in an atom moves from the ground state to the excited state, the electron
  - A) gains energy as it moves to a lower energy level
  - B) loses energy as it moves to a lower energy level
  - C) gains energy as it moves to a higher energy level
  - D) loses energy as it moves to a higher energy level
- 2) Which subatomic particle will be attracted by a positively charged object?
  - A) proton
  - B) positron
  - C) neutron
  - D) electron
- 3) Which conclusion is based on the "gold foil experiment" and the resulting model of the atom?
  - A) An atom is mainly empty space, and the nucleus has a positive charge.
  - B) An atom has hardly any empty space, and the nucleus has a positive charge.
  - C) An atom has hardly any empty space, and the nucleus has a negative charge.
  - D) An atom is mainly empty space, and the nucleus has a negative charge.
- 4) Which two particles have approximately the same mass?
  - A) neutron and electron
  - B) proton and electron
  - C) neutron and positron
  - D) proton and neutron
- 5) Which element has chemical properties that are *most* similar to the chemical properties of sodium?
  - A) Se
  - B) Cl
  - C) K
  - D) Mg
- 6) Germanium is classified as a
  - A) nonmetal
  - B) metalloid
  - C) metal
  - D) noble gas
- 7) Which statement correctly describes diamond and graphite, which are different forms of solid carbon?
  - A) They differ in their molecular structure and properties.
  - B) They differ in their molecular structure, only.
  - C) They differ in their properties, only.
  - D) They do not differ in their molecular structure or properties.
- 8) What is the chemical formula for copper (II) hydroxide?
  - A)  $\text{CuOH}_2$
  - B)  $\text{CuOH}$
  - C)  $\text{Cu}_2(\text{OH})$
  - D)  $\text{Cu}(\text{OH})_2$
- 9) What is the percent composition by mass of aluminum in  $\text{Al}_2(\text{SO}_4)_3$  (gram-formula mass = 342 grams/mole)?
  - A) 7.89%
  - B) 15.8%
  - C) 20.8%
  - D) 36.0%
- 10) Which statement describes a chemical property that can be used to distinguish between compound A and compound B?
  - A) A dissolves in water, and B does not dissolve in water.
  - B) A is a blue solid, and B is a white solid.
  - C) A has a high melting point, and B has a low melting point.
  - D) A does not burn in air, and B does burn in air.
- 11) Which compound contains *both* ionic and covalent bonds?
  - A)  $\text{PCl}_3$
  - B)  $\text{CaCO}_3$
  - C)  $\text{CH}_2\text{O}$
  - D)  $\text{MgF}_2$

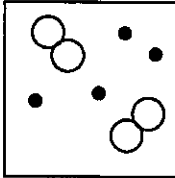
- 12) Which formula represents a nonpolar molecule?  
 A)  $\text{CF}_4$                       B)  $\text{HCl}$                       C)  $\text{NH}_3$                       D)  $\text{H}_2\text{O}$
- 13) When a lithium atom forms an  $\text{Li}^+$  ion, the lithium atom  
 A) loses an electron                      C) gains a proton  
 B) gains an electron                      D) loses a proton
- 14) Which Lewis electron-dot diagram represents a boron atom in the ground state?  
 A)  $:\ddot{\text{B}}\cdot$                       B)  $:\ddot{\text{B}}\cdot$                       C)  $:\ddot{\text{B}}$                       D)  $\cdot\text{B}$
- 15) A sample is prepared by completely dissolving 10.0 grams of  $\text{NaCl}$  in 1.0 liter of  $\text{H}_2\text{O}$ . Which classification *best* describes this sample?  
 A) heterogeneous mixture                      C) heterogeneous compound  
 B) homogeneous mixture                      D) homogeneous compound
- 16) Which form of energy is converted to thermal energy when propane burns in air?  
 A) nuclear                      C) chemical  
 B) electromagnetic                      D) electrical
- 17) Which physical changes are endothermic?  
 A) condensation and deposition                      C) condensation and sublimation  
 B) melting and evaporating                      D) melting and freezing
- 18) Which transfer of energy occurs when ice cubes are placed in water that has a temperature of  $45^\circ\text{C}$ ?  
 A) Chemical energy is transferred from the ice to the water.  
 B) Chemical energy is transferred from the water to the ice.  
 C) Thermal energy is transferred from the ice to the water.  
 D) Thermal energy is transferred from the water to the ice.
- 19) At STP, 4 liters of  $\text{O}_2$  contains the same total number of molecules as  
 A) 1 L of  $\text{NH}_3$                       B) 8 L of He                      C) 2 L of  $\text{Cl}_2$                       D) 4 L of  $\text{CO}_2$
- 20) The compound  $\text{HNO}_3$  can be described as an  
 A) Arrhenius acid and an electrolyte                      C) Arrhenius base and a nonelectrolyte  
 B) Arrhenius acid and a nonelectrolyte                      D) Arrhenius base and an electrolyte
- 21) According to the *Common Acid-Base Indicators* chemistry reference table, what is the color of the indicator methyl orange in a solution that has a pH of 2?  
 A) blue                      B) orange                      C) red                      D) yellow
- 22) Given the reaction:

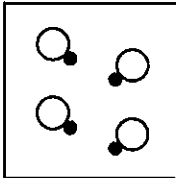


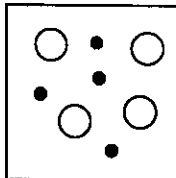
In this reaction, ammonia molecules ( $\text{NH}_3$ ) act as a base because they

- A) accept hydrogen ions ( $\text{H}^+$ )                      C) donate hydrogen ions ( $\text{H}^+$ )  
 B) donate hydroxide ions ( $\text{OH}^-$ )                      D) accept hydroxide ions ( $\text{OH}^-$ )

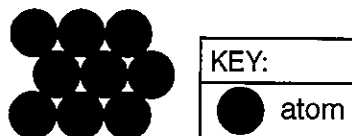
- 23) An unknown element  $X$  can form a compound with the formula  $XBr_3$ . In which group on the Periodic Table would element  $X$  be found?  
 A) 1                                      B) 14                                      C) 2                                      D) 13
- 24) As the elements in Group 17 on the Periodic Table are considered from top to bottom, what happens to the atomic radius and the metallic character of each successive element?  
 A) The atomic radius decreases and the metallic character increases.  
 B) The atomic radius increases and the metallic character decreases.  
 C) The atomic radius and the metallic character both increase.  
 D) The atomic radius and the metallic character both decrease.
- 25) Which pair of compounds has the same empirical formula?  
 A)  $CH_3OH$  and  $C_2H_5OH$                                       C)  $C_2H_6$  and  $C_3H_8$   
 B)  $C_2H_2$  and  $C_6H_6$                                       D)  $CH_3CHO$  and  $CH_3COOH$
- 26) Which equation shows a conservation of mass?  
 A)  $Na + Cl_2 \rightarrow NaCl$                                       C)  $H_2O \rightarrow H_2 + O_2$   
 B)  $PCl_5 \rightarrow PCl_3 + Cl_2$                                       D)  $Al + Br_2 \rightarrow AlBr_3$
- 27) How many electrons are in an  $Fe^{2+}$  ion?  
 A) 56                                      B) 28                                      C) 26                                      D) 24
- 28) A substance that does *not* conduct electricity as a solid but does conduct electricity when melted is most likely classified as  
 A) a molecular compound                                      C) a nonmetal  
 B) an ionic compound                                      D) a metal
- 29) According to the *Vapor Pressure of Four Liquids* chemistry reference table, what is the boiling point of ethanoic acid at 80 kPa?  
 A)  $100^\circ C$                                       B)  $125^\circ C$                                       C)  $111^\circ C$                                       D)  $28^\circ C$
- 30) Which particle diagram represents one pure substance, only?
- A) 

B) 

C) 

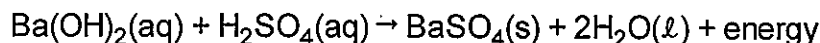
D) 
- 31) A sample of helium gas has a volume of 900. milliliters and a pressure of 2.50 atm at 298 K. What is the new pressure when the temperature is changed to 336 K and the volume is decreased to 450. milliliters?  
 A) 5.64 atm                                      B) 4.43 atm                                      C) 0.177 atm                                      D) 14.1 atm

32) Given the particle diagram:



At 101.3 kPa and 298 K, which element could this diagram represent?

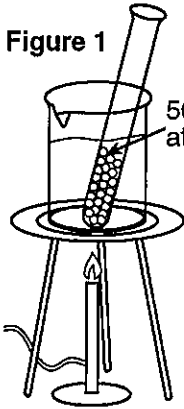
- A) Kr                      B) Xe                      C) Rn                      D) Ag
- 33) Which of these changes produces the *greatest* increase in entropy?
- A)  $\text{CO}_2(\text{g}) \rightarrow \text{CO}_2(\text{s})$                       C)  $\text{CaCO}_3(\text{s}) \rightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$   
 B)  $\text{H}_2\text{O}(\text{g}) \rightarrow \text{H}_2\text{O}(\ell)$                       D)  $2\text{Mg}(\text{s}) + \text{O}_2(\text{g}) \rightarrow 2\text{MgO}(\text{s})$
- 34) Given the reaction:

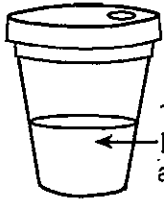


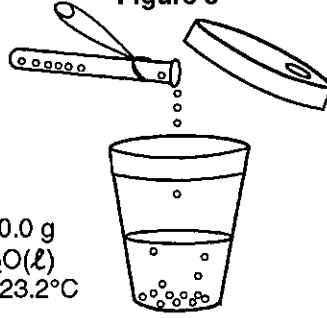
As the barium hydroxide solution is added to the solution of sulfuric acid, the electrical conductivity of the acid solution decreases because the

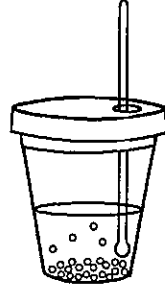
- A) concentration of ions increases  
 B) concentration of ions decreases  
 C) temperature of the reaction mixture decreases  
 D) volume of the reaction mixture increases
- 35) Which chemical equation represents the reaction of an Arrhenius acid and an Arrhenius base?
- A)  $\text{HC}_2\text{H}_3\text{O}_2(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{NaC}_2\text{H}_3\text{O}_2(\text{aq}) + \text{H}_2\text{O}(\ell)$   
 B)  $\text{Zn}(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{ZnCl}_2(\text{aq}) + \text{H}_2(\text{g})$   
 C)  $\text{BaCl}_2(\text{aq}) + \text{Na}_2\text{SO}_4(\text{aq}) \rightarrow \text{BaSO}_4(\text{s}) + 2\text{NaCl}(\text{aq})$   
 D)  $\text{C}_3\text{H}_8(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 3\text{CO}_2(\text{g}) + 4\text{H}_2\text{O}(\ell)$
- 36) Based on the *Solubility Guidelines* chemistry reference table, which of these saturated solutions has the *lowest* concentration of dissolved ions?
- A)  $\text{MgCl}_2(\text{aq})$                       B)  $\text{NaCl}(\text{aq})$                       C)  $\text{AgCl}(\text{aq})$                       D)  $\text{NiCl}_2(\text{aq})$

37)

**Figure 1**  
  
 50.0 g Cu(s)  
 at 100.0°C

**Figure 2**  
  
 100.0 g  
 H<sub>2</sub>O(l)  
 at 23.2°C  
 Calorimeter

**Figure 3**  
  
 Calorimeter

**Figure 4**  
  
 Calorimeter

In a laboratory investigation, a 50.0-gram sample of copper is at 100.0°C in a boiling water bath.

A Styrofoam cup with a lid is used as calorimeter. The cup contains 100.0 grams of distilled water at 23.2°C.

The hot copper is poured into the cup of water, and the cup is quickly covered with a lid.

A thermometer is inserted through the lid. The copper and water are gently stirred in the cup. The temperature is checked periodically. The highest average temperature noted is 26.3°C.

In terms of energy flow, explain why the temperature of the water in the calorimeter used in the investigation shown increases.

- 38) In the modern wave-mechanical model of the atom, the orbitals are regions of the most probable location of
- A) electrons                      B) protons                      C) neutrons                      D) positrons
- 39) Compared to a proton, an electron has
- A) the same quantity of charge and the same sign  
 B) a greater quantity of charge and the same sign  
 C) a greater quantity of charge and the opposite sign  
 D) the same quantity of charge and the opposite sign
- 40) Which two notations represent atoms that are isotopes of the same element?
- A)  $^{121}_{50}\text{Sn}$  and  $^{119}_{50}\text{Sn}$                       C)  $^{19}_8\text{O}$  and  $^{19}_9\text{F}$   
 B)  $^{121}_{50}\text{Sn}$  and  $^{121}_{50}\text{Sn}$                       D)  $^{39}_{17}\text{Cl}$  and  $^{39}_{19}\text{K}$
- 41) The elements in Period 5 on the Periodic Table are arranged from left to right in order of
- A) decreasing atomic mass                      C) increasing atomic number  
 B) increasing atomic mass                      D) decreasing atomic number
- 42) Which list of elements contains a metal, a metalloid, and a nonmetal?
- A) Cd, Sb, I                      B) F, Cl, Br                      C) Zn, Ga, Ge                      D) Si, Ge, Sn
- 43) An example of a physical property of an element is the element's ability to
- A) form a compound with chlorine                      C) react with an acid  
 B) react with oxygen                      D) form an aqueous solution

- 44) Which element is malleable and conducts electricity?  
A) phosphorus                      B) iron                                      C) iodine                                      D) sulfur
- 45) What is the formula of titanium (II) oxide?  
A)  $\text{TiO}_2$                                       B)  $\text{TiO}$                                       C)  $\text{Ti}_2\text{O}$                                       D)  $\text{Ti}_2\text{O}_3$
- 46) Which substance can be decomposed by a chemical change?  
A) ammonia                                      B) copper                                      C) calcium                                      D) potassium
- 47) As a chlorine atom becomes a negative ion, the atom  
A) gains an electron and its radius decreases  
B) loses an electron and its radius increases  
C) loses an electron and its radius decreases  
D) gains an electron and its radius increases
- 48) Based on the *Properties of Selected Elements* chemistry reference table, the atoms of which of these elements have the *strongest* attraction for electrons in a chemical bond?  
A) Na                                      B) P                                      C) N                                      D) Pt
- 49) Which terms are used to identify pure substances?  
A) a solution and a mixture                                      C) an element and a mixture  
B) a solution and a compound                                      D) an element and a compound
- 50) The solubility of  $\text{KClO}_3(\text{s})$  in water increases as the  
A) temperature of the solution increases                                      C) pressure on the solution increases  
B) temperature of the solution decreases                                      D) pressure on the solution decreases
- 51) Compared to a 0.1 M aqueous solution of NaCl, a 0.8 M aqueous solution of NaCl has a  
A) lower boiling point and a higher freezing point  
B) lower boiling point and a lower freezing point  
C) higher boiling point and a lower freezing point  
D) higher boiling point and a higher freezing point
- 52) The kinetic molecular theory assumes that the particles of an ideal gas  
A) are arranged in a regular geometric pattern  
B) are in random, constant, straight-line motion  
C) have strong attractive forces between them  
D) have collisions that result in the system losing energy
- 53) Which statement must be true about a chemical system at equilibrium?  
A) The rate of the forward reaction is equal to the rate of the reverse reaction.  
B) The forward and reverse reactions stop.  
C) The concentration of reactants and products are equal.  
D) The number of moles of reactants is equal to the number of moles of product.
- 54) Adding a catalyst to a chemical reaction results in  
A) an increase in activation energy and a decrease in the reaction rate  
B) a decrease in activation energy and a decrease in the reaction rate  
C) a decrease in activation energy and an increase in the reaction rate  
D) an increase in activation energy and an increase in the reaction rate

- 55) An electron in an atom moves from the ground state to an excited state when the energy of the electron  
 A) decreases                              B) increases                              C) remains the same
- 56) Which symbol represents a particle that has the same total number of electrons as  $S^{2-}$ ?  
 A)  $Se^{2-}$                               B) Ar                              C) Si                              D)  $O^{2-}$
- 57) The data table below shows elements Xx, Yy, and Zz from the same group on the Periodic Table.

Element	Atomic Mass (atomic mass unit)	Atomic Radius (pm)
Xx	69.7	141
Yy	114.8	?
Zz	204.4	171

- What is the most likely atomic radius of element Yy?  
 A) 103 pm                              B) 185 pm                              C) 127 pm                              D) 166 pm
- 58) The molecular formula of glucose is  $C_6H_{12}O_6$ . What is the empirical formula of glucose?  
 A)  $CH_2O$                               B)  $C_6H_{12}O_6$                               C)  $C_{12}H_{24}O_{12}$                               D) CHO
- 59) Which molecule contains a nonpolar covalent bond?  
 A)  $C \equiv O$                               B) Br—Br                              C)  $O=C=O$                               D)  $\begin{array}{c} Cl \\ | \\ Cl-C-Cl \\ | \\ Cl \end{array}$
- 60) Given the balanced equation:  

$$KNO_3(s) + 34.89 \text{ kJ} \xrightarrow{H_2O} K^+(aq) + NO_3^-(aq)$$
 Which statement *best* describes this process?  
 A) It is endothermic and entropy decreases.  
 B) It is exothermic and entropy increases.  
 C) It is endothermic and entropy increases.  
 D) It is exothermic and entropy decreases.
- 61) At STP, fluorine is a gas and iodine is a solid. This observation can be explained by the fact that fluorine has  
 A) lower average kinetic energy than iodine  
 B) weaker intermolecular forces of attraction than iodine  
 C) higher average kinetic energy than iodine  
 D) stronger intermolecular forces of attraction than iodine
- 62) Sulfuric acid,  $H_2SO_4(aq)$ , can be used to neutralize barium hydroxide,  $Ba(OH)_2(aq)$ . What is the formula for the salt produced by this neutralization?  
 A) BaS                              B)  $BaSO_2$                               C)  $BaSO_4$                               D)  $BaSO_3$