

## AN "ANTHOLOGY" OF GENERAL CHEMISTRY QUESTIONS

This collection of questions may be of assistance to you in preparing for general chemistry examinations. Most of the questions provided are typical of ones used in multiple-choice general chemistry exams. Some of these questions may appear on the exams, modifications of some of these questions may appear on the exams, or questions similar to these may appear on the exams. In any case do not assume that only these questions will be used on exams. Some of the questions in the "Anthology" are designed not as exam questions but as aids to your learning of the material. The questions are grouped together by topic. The answers are provided in a separate section of the chemistry/biochemistry home page ("Anthology" Answers). Because the coverage of material differs from one general chemistry course to another, e.g. a topic covered in Chem 111 may not be covered in Chem 110, you should correlate your choice of topics for review in this "Anthology" with your lecture notes. These questions serve only to supplement not replace your lecture notes and your text.

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## THE SCIENTIFIC METHOD

1. A well-verified explanation of a series of observations is termed

- A. a scientific law B. a hypothesis C. a theory D. a postulate

2. A scientific law is

- A. a statement of fact  
B. a well-verified hypothesis  
C. an explanation that enables a scientist to make predictions about natural phenomena.  
D. a theory that has been well proven.

3. Which statement about a scientific theory is incorrect?

- A. A theory is falsifiable.  
B. A theory is a well-verified hypothesis.  
C. A theory provides an explanation for a scientific law.  
D. A theory can be proven to be correct given that the appropriate series of experiments are performed.

## THE METRIC SYSTEM AND UNITS

4. The S.I. unit of volume is the

- A. liter B. cubic meter( $m^3$ ) C. milliliter D. cubic centimeter( $cm^3$ )

5. In the S.I. system the units for length, mass, and volume are

- A. meter, gram, and liter  
B. meter, kilogram, and liter  
C. meter, gram, and cubic meter  
D. meter, kilogram, and cubic meter

6. Which combination of units is a correct derived unit in the S.I. system?

- A.  $kg \cdot m^2/s^2$  B.  $g \cdot m^2/min^2$  C.  $g \cdot mm^2/s^2$  D.  $kg \cdot m^2/min^2$

7. The prefix used to indicate  $10^{-6}$  is

- A. milli- B. kilo- C. micro- D. mega-

8. The number of mL's in one-half liter is

- A. 5 B. 50 C. 500 D. 5000

9. The prefix used to indicate  $10^6$  is  
A. milli- B. mega- C. micro- D. mini-
10. The quantity 0.150 meter is specified by:  
A. 150 mm B. 150 cm C. 150 km D. 150 nm
11. The quantity  $10 \text{ cm}^3$  is identical to  
A. 10 L B. 10 mL C. 10 dL D. 10 kL
12. An object has a mass of 98.2 g. and occupies 71.7 mL. Its density equals  
A.  $1.37 \text{ g/cm}^3$  B. 7041 g.mL. C.  $1.37 \text{ g/m}^3$  D. 7071 g/mL

#### CONVERSIONS AND CONVERSION FACTORS

13. A temperature of -40 degrees F equals  
A. -40 degrees C B. 233 K C. both A. and B.
14. The temperature in Las Cruces is reported to you as  $41^\circ\text{C}$ . You are more familiar with the Fahrenheit scale. Therefore, you calculate this temperature to be  
A.  $72^\circ\text{F}$  B.  $106^\circ\text{F}$  C.  $89^\circ\text{F}$  D.  $97^\circ\text{F}$
15. An object has a volume of  $0.0010 \text{ m}^3$ . Its volume given in  $\text{cm}^3$  is  
A. 0.10 B. 1000 C. 100 D. 10
16. A distance is determined to be  $1000 \mu\text{m}$ . This distance can also be reported as  
A. 0.0010 m B. 0.100 cm C. 0.010 dm D. A,B, and C
17. Given that  $2.54 \text{ cm} = 1 \text{ in}$  (exact) convert 75 miles to kilometers.  
A. 47 B. 92 C. 121 D. 109
18. A liquid has a density of  $0.89 \text{ g/mL}$ . Calculate the volume of 1.0 kg. of this liquid.  
A. 1.12 L B. 890 mL C. 1.12 mL D. 890 L
19. Given that  $454 \text{ g.} = 1 \text{ lb.}$ , a 50.0 lb. weight can be labeled ----- kg.

- A. 110      B. 31.8      C. 22.7      D. 89.5

20. You need to fill your gas tank in Mexico by purchasing 11.6 gallons of gas. You thus will purchase----- liters of gas. (1 qt.=.9464 L)

- A. 11.0 L      B. 12.3 L      C. 43.9 L      D. 46.4 L

#### SCIENTIFIC(EXPONENTIAL) NOTATION

21. Convert 12345 to scientific notation.

- A. 1,2345      B. 1.2345      C.  $1.2345 \times 10^5$       D.  $1.2345 \times 10^4$

22. Convert 12300 to scientific notation.

- A. 1,2300      B. 1.2300      C.  $1.2300 \times 10^4$       D.  $1.23 \times 10^4$

23. Convert 0.00010 to scientific notation.

- A.  $1 \times 10^{-3}$       B.  $1.0 \times 10^{-3}$       C.  $1 \times 10^{-4}$       D.  $1.0 \times 10^{-4}$

#### SIGNIFICANT FIGURES

24. The number of significant figures in 12000

- A. is 5      B. is 4      C. is 3      D. is 2      E. cannot be specified.

25. The number of significant figures in 0.001

- A. is 4      B. is 3      C. is 2      D. is 1      E. cannot be specified.

26. The number of significant figures in 0.010

- A. is 4      B. is 3      C. is 2      D. is 1      E. cannot be specified.

27. The number of significant figures in 1.01010 is

- A. 6      B. 5      C. 4      D. 3      E. 2

For questions 28 - 32 select the answer to the calculation that contains the correct units and the result to the correct number of significant figures.

28. The result of  $38.7 \text{ cm} \times 9.1 \text{ cm}$  is

- A.  $352 \text{ cm}^2$       B.  $352 \text{ cm}$       C.  $350 \text{ cm}$       D.  $350 \text{ cm}^2$

29. The result of  $30.70 \text{ kg} \times 1.3 \text{ m} \times 1.3 \text{ m} / 60.0 \text{ s} \times 60.0 \text{ s}$  is

- A. 0.01 J      B. 0.014J      C. 0.0144 J      D. 0.01441 J

30. The result of  $0.9979 + 0.91$  is  
A. 1.9079                      B. 1.908                      C. 1.91                      D. 1.9
31. The result of  $1.009544 - 1.0093$  is  
A. 0.0002                      B. 0.00024                      C. 0.000244                      D. 0.0002440
32. The result of  $(3.6 \times 10^4)(1.222 \times 10^{-2})$  is  
A.  $4.3992 \times 10^2$                       B.  $4.399 \times 10^2$                       C.  $4.40 \times 10^2$                       D.  $4.4 \times 10^2$
33. The result of  $(1.0 \times 10^{-6})(5.0 \times 10^{11})/2.0 \times 10^{-8}$  is  
A.  $2.5 \times 10^{-74}$                       B.  $2.5 \times 10^{25}$                       C.  $2.5 \times 10^{13}$                       D.  $2.5 \times 10^{-3}$

### PHYSICAL AND CHEMICAL PROPERTIES

34. From the following statements, select that one or more that specifies a physical property.  
i. Sulfur burns in air. ii. Chlorine is a colored gas. iii. Ether evaporates at room temperature. iv. Iron rusts readily in the tropics. v. Water freezes at  $0^\circ\text{C}$ . vi. Mercury, a liquid, combines with oxygen, a gas, to produce a red solid.  
A. i.,ii.,and vi. B. ii., iii., and vi. C. ii.,iii.,v.,and vi. D. i.,iv.,and vi.
35. From the list given in Question 34, select one or more chemical properties.  
A. i., ii., and iii B. i., iv., and vi. C.i. and iv. D. i. and vi.

### ATOMIC STRUCTURE

36. An atom has an atomic number of 12 and a mass number of 24. This atom consists of  
A. 24 protons, 24 electrons, and 12 neutrons.  
B. 12 protons, 12 electrons, and 24 neutrons.  
C. 12 protons, 12 electrons, and 12 neutrons.
37. A given atom has an atomic number of 35. It is an atom of the element  
A. chlorine      B. bromine      C. boron      D. calcium

38. Two atoms have the same Z but differ in A. These atoms are  
A. allotropes. B. isotopes. C. isomers. D. chelates

#### ELEMENTS AND COMPOUNDS

39. Most elements are  
A. nonmetals B. metalloids. C. metals D. lanthanides

40. From the following list select the elements that are metals:  
i.: Fe, ii. S iii. Si, iv. Na, v. U, vi. Hg  
A. ii.,iii. B. i.,iv., v. C. i.,iv.,v.,vi. D.iii.,iv.,v.

41. Which of the following is a nonmetal?  
A. Mg B. Si C. Lu D. I

42. Which of the following is an actual compound?  
A. S<sub>8</sub> B. P<sub>4</sub> C. CO D. AgCu

#### MOLECULES AND IONIC COMPOUNDS

43. Which of the following groups include only molecular species?  
A. H<sub>2</sub>(g), CO(g), CaCO<sub>3</sub>(s), LiH(s) C. S<sub>8</sub>(s), AlCl<sub>3</sub>(s), BrCl(g), HCl(g)  
B. NH<sub>3</sub>(g), NaH(s), H<sub>2</sub>SO<sub>4</sub>(l), H<sub>2</sub>O(l) D. HF(g), H<sub>2</sub>O<sub>2</sub>(l), SO<sub>2</sub>(g), SF<sub>6</sub>(g)

44. A transfer of electrons occurs when  
A. hydrogen reacts with a nonmetal  
B. two or more nonmetals react with one another  
C. an active metal reacts with a nonmetal  
D. a metalloid reacts with a nonmetal

45. When two nonmetals react , they ----- form molecules.  
A. never B. sometimes C. always

46. The subscripts that generally appear in the formula of a molecule,  
A. tell us the relative number of each kind of atom present.  
B. tell us the exact number of each kind of atom present.  
C. A. or B. depending upon the identity of the molecule.

47. When calcium ions(Ca<sup>2+</sup>) combine with nitride ions (N<sup>3-</sup>)  
the formula of the compound formed is  
A. CaN B. Ca<sub>2</sub>N<sub>3</sub> C. Ca<sub>3</sub>N<sub>2</sub>

## POLYATOMIC IONS

48. Which of the following polyatomic ions is named incorrectly?

- A.  $\text{NO}_3^-$  “nitrate”
- B.  $\text{SO}_4^{2-}$  “sulfate”
- C.  $\text{NH}_4^+$  “ammonium”
- D.  $\text{PO}_4^{3-}$  “phosphite”

49. The sodium cation forms sodium nitrate with the anion of the oxyacid

- A. nitrous acid
- B. hydronitric acid
- C. nitric acid
- D. nitronic acid

50. The correct formula for the perchlorate ion is

- A.  $\text{ClO}^-$
- B.  $\text{ClO}_2^-$
- C.  $\text{ClO}_3^-$
- D.  $\text{ClO}_4^-$

51. The correct formula for the compound formed from aluminum ions and hydroxide ions is

- A.  $\text{AlOH}$
- B.  $\text{AlOH}_2$
- C.  $\text{Al}(\text{OH})_3$
- D.  $\text{AlH}_2$

## NAMING IONIC COMPOUNDS

52. Select from the following the compound that is incorrectly named.

- A.  $\text{Ca}(\text{NO}_3)_2$  “calcium nitrate”
- B.  $\text{Fe}(\text{NO}_3)_3$  “iron nitrate”
- C.  $\text{CoS}$  “cobalt(II) sulfide”
- D.  $\text{AlN}$  “aluminum nitride”

53. The compound having the formula  $\text{NH}_4\text{NO}_2$  is named

- A. ammoniacal nitrite
- B. ammonia hydrogen nitrite
- C. ammonium nitrate
- D. ammonium nitrite

54. The formula of aluminum oxide is

- A.  $\text{AlO}$
- B.  $\text{AlO}_2$
- C.  $\text{Al}_2\text{O}_3$
- D.  $\text{Al}_3\text{O}_2$

55. The formula of copper(I) phosphate is  
A.  $\text{Cu}_3\text{PO}_4$     B.  $\text{Cu}_3(\text{PO}_4)_2$     C.  $\text{Cu}(\text{PO}_4)_3$     D.  $\text{Cu}_2\text{PO}_4$

56. The correct name of  $\text{TiO}_2$  is  
A. titanium oxide    B. titanium dioxide    C. titanium(IV) oxide

#### NAMING MOLECULAR COMPOUNDS

57. The numerical prefix indicating 4 is  
A. tri-    B. tetra-    C. tris-    D. trig-

58. The common name of dihydrogen monoxide is  
A. peroxide    B. ammonia    C. water

59. Which of the following compounds is named incorrectly?

- A.  $\text{PCl}_3$     “phosphorus trichloride”
- B.  $\text{S}_2\text{Cl}_2$     “sulfur chloride”
- C.  $\text{N}_2\text{O}$     “dinitrogen monoxide”
- D.  $\text{P}_4\text{S}_3$     “tetraphosphorus trisulfide”

#### BALANCING CHEMICAL EQUATIONS

60. When the following equation is balanced, the sum of all the balancing coefficients is:  $\text{C}_3\text{H}_8 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$   
A. 13    B. 12    C. 11    D. 10

61. In balancing  $\text{Mg}_3\text{N}_2 + \text{HCl} \rightarrow \text{MgCl}_2 + \text{NH}_3$  the coefficient ---- must appear in front of HCl.  
A. 3    B. 6    C. 9    D. 12

62. When the following equation is balanced, the coefficient in front of the Na is

$\text{Na} + \text{H}_2\text{O} \rightarrow \text{NaOH} + \text{H}_2$   
A. 1    B. 2    C. 3    D. 4

63. When the following equation is balanced, the sum of the balancing coefficients is:  $\text{Al} + \text{Fe}_3\text{O}_4 \rightarrow \text{Fe} + \text{Al}_2\text{O}_3$   
A. 20    B. 22    C. 24    D. 26

## ELECTROLYTES

64. Which general statement about electrolytes is correct?
- A. An electrolyte is a substance that produces ions in aqueous solution.
  - B. An electrolyte is a substance that in water produces a solution which conducts electricity.
  - C. An electrolyte may be an ionic or molecular substance.
  - D. All of the above.

65. Which of the following is a weak electrolyte ?
- A. HCl
  - B. HCN
  - C. NaOH
  - D. HNO<sub>3</sub>

66. Which of the following is a strong electrolyte ?
- A. CH<sub>3</sub>NH<sub>2</sub>
  - B. HC<sub>2</sub>H<sub>3</sub>O<sub>2</sub>
  - C. HClO
  - D. HClO<sub>4</sub>

67. Which of the following is a nonelectrolyte ?
- A. H<sub>2</sub>O
  - B. NaCl
  - C. table sugar
  - D. Ca(OH)<sub>2</sub>

68. When NH<sub>3</sub> dissolves in H<sub>2</sub>O, the resulting solution contains a limited number of ammonium and hydroxide ions but mostly ammonia molecules. This observation enables us to classify ammonia as a

- A. strong electrolyte
- B. weak electrolyte
- C. nonelectrolyte

## ACIDS AND BASES

69. According to the Bronsted-Lowry definition, an acid
- A. is an electron-pair donor
  - B. is an electron-pair acceptor
  - C. is a proton donor
  - D. is a proton acceptor

70. Which one of the following species is not a strong acid ?
- A. HF
  - B. HCl
  - C. H<sub>2</sub>SO<sub>4</sub>
  - D. HNO<sub>3</sub>

71. HClO<sub>4</sub> is classified as a strong acid because
- A. it is highly corrosive

- B. it reacts vigorously with H<sub>2</sub>O
- C. it ionizes essentially completely in aqueous solution.
- D. it reacts only with strong bases

72. Identify which of the following is a neutralization reaction.

- A.  $\text{Cu}^{2+}(\text{aq}) + \text{Zn}(\text{s}) \rightarrow \text{Cu}(\text{s}) + \text{Zn}^{2+}(\text{aq})$
- B.  $\text{HCl}(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{NaCl}(\text{aq}) + \text{H}_2\text{O}(\text{l})$
- C.  $\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$
- D.  $\text{CaCO}_3(\text{s}) \rightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$

73. Which one of the following is a strong base ?

- A. NH<sub>3</sub>
- B. CH<sub>3</sub>NH<sub>2</sub>
- C. NH<sub>2</sub>OH
- D. KOH

#### WATER INSOLUBLE COMPOUNDS

74. Which one of the following statements about solubility is NOT true?

- A. All compounds containing Na<sup>+</sup>, NH<sub>4</sub><sup>+</sup>, K<sup>+</sup>, or Rb<sup>+</sup> are water soluble.
- B. All acetates and nitrates are water soluble.
- C. With a few exceptions, all sulfides, carbonates, and phosphates are insoluble in water.
- D. All chlorides, bromides, and iodides are water soluble.

75. Which one of the following is water soluble?

- A. Pb(C<sub>2</sub>H<sub>3</sub>O<sub>2</sub>)<sub>2</sub>
- B. PbS
- C. PbSO<sub>4</sub>
- D. PbCO<sub>3</sub>

76. To form a water-insoluble substance, a solution containing Ca<sup>2+</sup> ions should be mixed with a solution containing ----- ions.

- A. Cl<sup>-</sup>
- B. SO<sub>4</sub><sup>2-</sup>
- C. NO<sub>3</sub><sup>-</sup>
- D. ClO<sub>4</sub><sup>-</sup>

#### IONIC EQUATIONS



83. A reaction occurs in aqueous solution when a cation and an anion combine to form

- A. a precipitate
- B. a weak electrolyte
- C. a gas
- D. any one of the above

84. Redox reactions occur in aqueous solution when

- A. a transfer of protons takes place.
- B. a transfer of electron pairs occurs.
- C. a transfer of one or more electrons occurs.

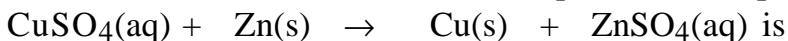
85. When  $\text{BaCl}_2(\text{aq})$  is mixed with  $\text{Na}_2\text{SO}_4(\text{aq})$ ,

- A. no reaction occurs.
- B.  $\text{BaSO}_4$  precipitates
- C.  $\text{NaCl}$  precipitates
- D.  $\text{BaSO}_4$  and  $\text{NaCl}$  precipitate

86. When solid  $\text{CaCO}_3$  is added to  $\text{HCl}(\text{aq})$ ,

- A. nothing happens.
- B.  $\text{CO}_2$  gas and liquid  $\text{H}_2\text{O}$  form.
- C.  $\text{CaCl}_2$  precipitates.

87. The net ionic equation corresponding to



- A.  $\text{Cu}^{2+}(\text{aq}) + \text{Zn}(\text{s}) \rightarrow \text{Cu}(\text{s}) + \text{Zn}^{2+}(\text{aq})$
- B.  $\text{Cu}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{Zn}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq})$
- C.  $\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Cu}(\text{s})$

#### OTHER REACTIONS

88. The reaction  $\text{Cu}(\text{s}) + \text{S}(\text{s}) \rightarrow \text{CuS}(\text{s})$  is an example of

- A. a combustion reaction
- B. a decomposition reaction
- C. a combination reaction
- D. a redox reaction
- E. B and D
- F. C and D

89. When a hydrocarbon burns in excess oxygen, the product(s) is(are)

- A.  $\text{CO}_2$
- B.  $\text{H}_2\text{O}$
- C. heat
- D. A and B
- E. A, B, and C

#### THE MOLE CONCEPT

90. The mole, the chemistry counting unit, consists of  
A. 12 units B. 6.022 units C.  $6.022 \times 10^{-23}$  units D.  $6.022 \times 10^{23}$  units

91. The mole is defined in terms of the number of atoms of C-12 in exactly ----- grams of C-12.  
A. 1.0 B. 12.0 C. 100.0 D. 1000.0

#### ATOMIC WEIGHTS

92. The atomic masses provided on the Periodic Table  
A. are relative masses  
B. are based upon the C-12 mass as the reference mass  
C. are given in atomic mass units (amu)  
D. are based upon the proportion of each isotope present in the naturally occurring mixture.  
E. all of the above

93. A certain element has 2 isotopes, one having a mass of 84.9118 amu and a fractional abundance of 0.7215 and the other having a mass of 86.9092 and a fractional abundance of 0.2785. The atomic weight of this element is  
A. 85.9105 amu B. 85.4681 amu C. 86.0025 amu D. 85.7253 amu

94. The average atomic mass of B is 10.811 amu. It consists of two isotopes B-10 (10.013 amu) and B-11 (11.009 amu). Calculate the fractional abundance of B-10.  
A. 0.199 B. 0.801 C. 0.204 D. 0.796

95. The compound ammonia consists of 3 H atoms and 1 N atom per molecule, i.e.  $\text{NH}_3$ . A sample of ammonia contains 7.933 g of N and 1.712 g of H. What is the atomic mass of N relative to that of H?  
A. 13.90 B. 14.01 C. 4.634 D. 13.96

#### MOLECULAR AND FORMULA WEIGHTS

96. The molecular weight of  $\text{CO}_2$  is  
A. 44.01 amu B. 28.01 amu C. 44.01 g D. 28.01 g

97. The molar mass of  $\text{CO}_2$  is  
A. 44.01 amu B. 28.01 amu C. 44.01 g D. 28.01 g

98. The molecular weight of  $C_2H_6O$  is  
A. 30.08 amu    B. 46.08 amu    C. 30.08 g    D. 46.08 g
99. The molar mass of  $C_2H_6O$  is  
A. 30.08 amu    B. 46.08 amu    C. 30.08 g    D. 46.08 g
100. The molecular weight of  $N_2$  is  
A. 28.014 amu    B. 28.014 g    C. 14.007 g    D. 14.007 amu
101. The molecular weight of  $S_8$  is  
A. 32.066 amu    B. 256.53 amu    C. 32.066 g    D. 256.53 g
102. Which of the following statements is incorrect?  
A. The formula weight of S is 32.066 amu  
B. The molar mass of S is 32.066 g  
C. The formula weight of  $O_2$  is 32.0 g  
D. The molar mass of O is 32.0 g
103. The formula weight of  $NaNO_3$  is  
A. 85.0 amu    B. 85.0 g    C. 69.0 amu    D. 69.0 g
104. The formula weight of  $Na_2B_4O_7$  is  
A. 185.2 amu    B. 201.24 amu    C. 174.44 amu    D. 197.81 amu

#### MASS PERCENT

105. The mass percent of oxygen in  $Na_2B_4O_7$  is  
A. 22.86%    B. 55.65%    C. 61.52%    D. 69.95%
106. A sample of  $Na_2B_4O_7$  contains 0.3478 g. of Na. What is the mass of this sample?  
A. 1.521 g    B. 1.784 g    C. 2.011 g    D. 1.967 g
107. The percent composition of  $CH_2O$  is -----%C, -----%H, and -----%O.  
A. 37.2, 6.73, 56.1    B. 42.3, 6.51, 51.2  
C. 39.8, 6.34, 53.9    D. 40.0, 6.73, 53.3

## EMPIRICAL FORMULAS/THEIR CALCULATION

108. A compound contains only N and O. A sample of this compound contains 0.2801 g of N and 0.1600 g of O. What is the empirical formula of this compound?

- A.  $\text{NO}_2$       B.  $\text{NO}$       C.  $\text{N}_2\text{O}$       D.  $\text{N}_2\text{O}_3$

109. A compound has the percent composition 80.0% C and 20.0% H. Its empirical formula is

- A.  $\text{CH}$       B.  $\text{CH}_3$       C.  $\text{CH}_2$       D.  $\text{CH}_4$

110. Calculate the empirical formula of a compound with the composition 17.5% Na, 39.7% Cr, and 42.8% O.

- A.  $\text{NaCrO}_4$       B.  $\text{Na}_2\text{CrO}_4$       C.  $\text{Na}_2\text{Cr}_2\text{O}_7$       D.  $\text{NaCrO}_3$

111. Calculate the empirical formula of a compound having the following % composition: C, 68.8%; H, 5.0%; O, 26.2%.

- A.  $\text{C}_7\text{H}_6\text{O}_2$       B.  $\text{C}_4\text{H}_3\text{O}$       C.  $\text{C}_3\text{H}_3\text{O}$       D.  $\text{C}_4\text{H}_3\text{O}_2$

## MOLECULAR FORMULAS/THEIR CALCULATION

112. A compound is analyzed and found to have the empirical formula  $\text{CH}_2$ . Its molar mass is found to be 84 g/mole. Its molecular formula is

- A.  $\text{C}_2\text{H}_4$       B.  $\text{C}_4\text{H}_8$       C.  $\text{C}_6\text{H}_{12}$       D.  $\text{C}_8\text{H}_{16}$

113. A sample of a carbon-hydrogen-oxygen compound contains 1.69 mg of C, 0.285 mg of H, and 2.27 mg of O. Its molecular weight is 60.0 amu. Its molecular formula is

- A.  $\text{CH}_2\text{O}$       B.  $\text{C}_2\text{H}_4\text{O}_2$       C.  $\text{C}_3\text{H}_8\text{O}$

## ELEMENTAL ANALYSIS

114. Combustion analysis is used to obtain the % composition of a C-H-O compound. The carbon content of the sample is obtained from the mass of  $\text{CO}_2$  formed, the hydrogen content from the mass of  $\text{H}_2\text{O}$  formed. The oxygen content of the sample is determined

- A. from the mass of  $\text{CO}_2$  formed.
- B. from the mass of  $\text{H}_2\text{O}$  formed.
- C. from the mass of  $\text{CO}_2$  and of  $\text{H}_2\text{O}$ .
- D. from the difference between the mass of the sample and the masses of C and H.

115. The substance "glycol" consists of C, H, and O. The combustion of 6.38 mg of glycol in excess  $\text{O}_2$  produced 9.06 mg of  $\text{CO}_2$  and 5.58 mg of  $\text{H}_2\text{O}$ . Determine the empirical formula of this substance.

- A.  $\text{CH}_2\text{O}$
- B.  $\text{CH}_3\text{O}$
- C.  $\text{C}_2\text{H}_5\text{O}$
- D.  $\text{C}_2\text{H}_5\text{O}_2$

## THE MOLE CONCEPT/CHEMICAL EQUATIONS

116. Diethyl ether has the formula  $(\text{C}_2\text{H}_5)_2\text{O}$ . Calculate the molar mass of this ether.

- A. 74.1 g/mol
- B. 45.1 g/mol
- C. 69.7 g/mol
- D. 53.4 g/mol

117. Calculate the mass in grams of one molecule of this ether.

- A. 1.23
- B.  $1.23 \times 10^{-22}$
- C.  $1.23 \times 10^{-23}$
- D.  $1.23 \times 10^{22}$

118. For a given reaction, 0.250 mole of this ether is needed. How many grams of the ether should be weighed out?

- A. 3.08
- B. 11.6
- C. 18.5
- D. 11.3

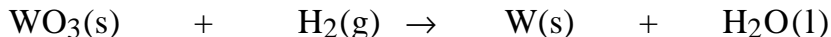
119. This ether is a liquid having a density of 0.714 g per mL. What volume in mL of the liquid is needed to provide 0.750 mole ?

- A. 39.7
- B. 77.8
- C. 81.6
- D. 62.4

120. A sample of this ether weighs 50.0 g. How many moles of the ether are present ?

- A. 0.921
- B. 0.611
- C. 0.675
- D. 0.877

THE NEXT THREE QUESTIONS RELATE TO THE FOLLOWING EQUATION WHICH IS NOT BALANCED



121. How many moles of  $\text{H}_2\text{O}$  can be produced from 1.00 mole of  $\text{WO}_3$  ?

- A. 1.00    B. 2.00    C. 3.00    D. 4.00

122. How many moles of  $\text{H}_2$  are required to react completely with 1 mole of  $\text{WO}_3$  ?

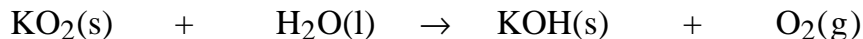
- A. 1    B. 2    C. 3    D. 4

123. If 1 mole of  $\text{H}_2$  is consumed in the reaction, how many moles of  $\text{W}(\text{s})$  are produced ?

- A. 1.00    B. 0.667    C. 0.333    D. 1.33

STOICHIOMETRY(CHEMICAL ARITHMETIC)

THE NEXT EIGHT QUESTIONS RELATE TO THE FOLLOWING EQUATION WHICH IS NOT BALANCED.



124. How many moles of  $\text{KO}_2$  are needed to react with 4 moles of  $\text{H}_2\text{O}$  ?

- A. 2    B. 4    C. 6    D. 8

125. How many moles of  $\text{O}_2$  are produced when 0.500 moles of  $\text{KOH}$  are produced ?

- A. 0.375    B. 0.500    C. 0.750    D. 1.00

126. How many moles of  $\text{H}_2\text{O}$  must react to form 0.100 mole of  $\text{O}_2$  ?

- A. 0.100    B. 0.667    C. 0.0100    D. 0.0667

127. How many grams of  $\text{KO}_2$  must be provided to react completely with 180.0 g of  $\text{H}_2\text{O}$  ?

- A. 1422    B. 710.9    C. 2844    D. 2133

128.  $\text{KO}_2$  in the amount of 0.500 kg. is allowed to react with excess  $\text{H}_2\text{O}$ . How many kg. of  $\text{KOH}$  are produced ?

- A. 0.500      B. 0.789      C. 0.635      D. 0.395

129. In this reaction 10.0 g of  $\text{KO}_2$  and 10.0 g of  $\text{H}_2\text{O}$  are used. What mass in grams of  $\text{KOH}$  can be produced ?

- A. 7.91      B. 20.0      C. 6.22      D. 11.1

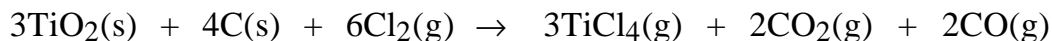
130. For the reaction as described in Ques. 129, one reactant was present in excess. How much of this reactant was left over ?

- A. 1.27 g      B. 8.72 g      C. 5.63 g      D. 4.59 g

131. When 25.0 g of  $\text{KO}_2$  was allowed to react with excess  $\text{H}_2\text{O}$ , 15.7 g of  $\text{KOH}$  was actually obtained. Calculate the percent yield.

- A. 100%      B. 79.7%      C. 15.7%      D. insufficient information

THE NEXT THREE QUESTIONS RELATE TO THE BALANCED EQUATION



132.  $\text{TiO}_2$  in the amount of 10.0 g is allowed to react with excess C and  $\text{Cl}_2$ . The total mass of the products is

- A. 23.7 g      B. 27.4 g      C. 29.7 g      D. cannot be determined

133. How much  $\text{Cl}_2$  must be provided to react with 10.0 g of  $\text{TiO}_2$  in the presence of excess C ?

- A. 17.7 g      B. 8.86 g.      C. 15.1 g.      D. 18.6 g

134. How much of the excess C must react under conditions described in Question 133 ?

- A. 4.11g.      B. 2.00 g.      C. 13.3 g      D. 7.17 g

**STOICHIOMETRY - SOLUTIONS**

135. A solution is prepared by dissolving 10.0 g of  $\text{NaOH}$  in sufficient  $\text{H}_2\text{O}$  to produce 250 mL of solution. Calculate the molarity of this solution.

- A. 0.250 M      B. 0.500 M      C. 0.750 M      D. 1.00 M

136. A solution is prepared by dissolving 25.0 g. of  $\text{ZnSO}_4$  in 100.0 g. of  $\text{H}_2\text{O}$ . This solution has a density of 1.124 g./mL. Calculate the molarity of this solution.

A. 1.24 M      B. 1.39 M      C. 1.08 M      D. 1.67 M

137. A solution in the amount of 2.00 L is prepared by diluting 28.0 mL of 18.0 M  $\text{H}_2\text{SO}_4$  with distilled  $\text{H}_2\text{O}$ . Calculate the molarity of this solution.

A. 0.252 M      B. 0.504 M      C. 0.126 M      D. 0.630 M

138. For a certain reaction 0.050 mole of HCl is needed. What volume of 0.888 M  $\text{HCl(aq)}$  is needed ?

A. 34.2 mL      B. 17.9 mL      C. 42.2 mL      D. 56.3 mL.

139. What volume of 0.111 M  $\text{AlCl}_3\text{(aq)}$  is needed to provide 0.010 mole of  $\text{Cl}^-$  ?

A. 30.0 mL.      B. 60.0 mL      C. 90.1 mL      D. 120. mL

140. For the reaction  $\text{HCl(aq)} + \text{NaOH(aq)} \rightarrow \text{NaCl(aq)} + \text{H}_2\text{O(l)}$ , how many mL of 0.0100 M NaOH are necessary to neutralize the HCl present in 10.0 mL of 0.0900 M HCl ?

A. 90.0 mL      B. 9.00 mL      C. 0.90 mL      D. 900 mL

141. In an acid - base titration in which NaOH neutralized  $\text{H}_2\text{SO}_4$ :  $2\text{NaOH(aq)} + \text{H}_2\text{SO}_4\text{(aq)} \rightarrow 2\text{H}_2\text{O(l)} + \text{Na}_2\text{SO}_4\text{(aq)}$ , 30.0 mL of the acid of unknown concentration required 37.2 mL. of 0.1011 M NaOH for neutralization. Calculate the molarity of this sample of  $\text{H}_2\text{SO}_4\text{(aq)}$ .

A. 0.125 M      B. 0.0627 M      C. 0.0313 M      D. 0.157 M

## ENERGY - FORMS AND UNITS

142. Which of the following statements about energy is correct ?

- A. Energy is neither created nor destroyed.
- B. Energy is either kinetic or potential.
- C. Energy readily changes from one form to another.
- D. All of the above.

143. When you start your car,

- A. electrical energy is converted to mechanical energy.
- B. chemical energy is converted to electrical energy.
- C. electrical energy is transferred as heat.
- D. chemical energy is transferred as heat.

144. The first law of thermodynamics states
- A. the energy of the universe is constantly increasing.
  - B. the energy of the universe is a constant.
  - C. the energy of the universe is constantly dissipating

145. The S.I. unit of energy is
- A. the calorie
  - B. the erg
  - C. the Joule
  - D. the dyne

146. The Joule equals one
- A.  $\text{g.m}^2/\text{s}^2$
  - B.  $\text{g.cm}^2/\text{s}^2$
  - C.  $\text{kg.m/s}$
  - D.  $\text{kg.m}^2/\text{s}^2$

147. Convert 5.1 cal to J.
- A. 1.22 kJ
  - B. 1.22 J
  - C. 21.3 kJ
  - D. 21.3 J

148. An object has a mass of 150 g. It is moving at a speed of 9.95 m/s. Calculate its kinetic energy in J.
- A. 7430 J
  - B. 7.43 J
  - C. 14.9 J
  - D. 14900 J

## ENTHALPY

149. Energy can be transferred as either heat or work. Enthalpy is the energy
- A. transferred as heat in a change occurring at constant volume.
  - B. transferred as work in a change occurring at constant volume.
  - C. transferred as heat in a change occurring at constant pressure.
  - D. transferred as work in a change occurring at constant pressure.

150. The symbol for enthalpy is
- A. E
  - B. U
  - C. S
  - D. H
  - E. G

151. In an exothermic process the system
- A. absorbs energy and  $\Delta H$  is positive
  - B. absorbs energy and  $\Delta H$  is negative
  - C. releases energy and  $\Delta H$  is positive
  - D. releases energy and  $\Delta H$  is negative.

152. Enthalpy, temperature, pressure are all state functions, but heat and work are not because

- A. heat and work cannot be accurately measured.
- B. heat and work are path dependent.
- C. heat and work are temperature dependent.
- D. heat and work are not measurable quantities.

153. Enthalpy equals

- A.  $w_p$     B.  $q_p$     C.  $w_v$     D.  $q_v$

## CALORIMETRY

154. The quantity associated with the change in temperature of one gram of a substance is termed

- A. heat capacity    B. molar heat capacity    C. specific heat

155. The quantity associated with the change in temperature of an object is termed

- A. heat capacity    B. molar heat capacity    C. specific heat.

156. A certain calorimeter has a heat capacity of 192J/K. For the temperature of the calorimeter to increase from 298 to 327K, the calorimeter must absorb ----- J.

- A. 192    B. 5600    C. 5200    D. 6100

157. Calculate  $q$  when a 10.0 g sample of Fe (specific heat = 0.449J/gK) is cooled from 50 degrees C to 27 degrees C.

- A. 103J    B. -103J    C. 10.3J    D. -10.3J

158. The specific heat of water is 4.184 J/gK. Calculate the final temperature of the mixture when 50.0 g of water at 358K is added to 100.0 g of water at 298K.

- A. 318K    B. 328K    C. 308K    D. 338K

159. The specific heat of Fe is 0.449 J/gK. Calculate the final temperature of the water and the Fe when 10.0 g of Fe at 120 degrees C is dropped into 100.0 g of water at 25 degrees C.

- A. 48 degrees C    B. 37 degrees C    C. 26 degrees C    D. 31 degrees C

160. A calorimeter has a heat capacity of 255J/K. In an experiment the temperature of the calorimeter went from 298K to 301K. Calculate  $q$  for the calorimeter.

- A. 255J    B. 765J    C. 510J    D. 625J

161. A 1.05 g sample of benzoic acid ( $C_7H_6O_2$ ) was burned in a calorimeter having a heat capacity of  $1.80\text{kJ}/^\circ\text{C}$ . The temperature of the calorimeter rose  $15.4^\circ\text{C}$ . Calculate  $\Delta H$  per mole of benzoic acid for this reaction.

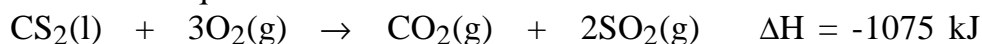
- A.  $3220\text{ kJ}$       B.  $-3220\text{ kJ}$       C.  $26.4\text{ kJ}$       D.  $-26.4\text{ kJ}$

162. A certain hydrocarbon (molar mass =  $78.0\text{ g/mol}$ ) has a molar heat of combustion of  $-4100\text{ kJ/mol}$ . A  $1.00\text{ g}$  sample of this hydrocarbon is burned in a calorimeter having a heat capacity of  $3.00\text{ kJ}/^\circ\text{C}$ . Calculate  $\Delta T$  for the calorimeter.

- A.  $-17.5^\circ\text{C}$       B.  $-36.6^\circ\text{C}$       C.  $36.6^\circ\text{C}$       D.  $17.5^\circ\text{C}$

### THERMOCHEMICAL EQUATIONS

163. Which statement is correct about the following thermochemical equation:



- A. This reaction is endothermic.  
B. To consume completely 1 mole of  $CS_2$   $1075\text{ kJ}$  of thermal energy must be absorbed in the reaction.  
C. Thermal energy in the amount of  $1075\text{ kJ}$  is released per mole of  $SO_2$  produced.  
D. When 1 mole of  $CO_2$  is formed,  $1075\text{ kJ}$  of thermal energy is released.

164. For which of the following chemical changes does the heat of reaction correspond to a heat of formation?

- A.  $N(g) + 3H(g) \rightarrow NH_3(g)$   
B.  $H_2NNH_2(g) + H_2(g) \rightarrow 2NH_3(g)$   
C.  $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$   
D.  $1/2N_2(g) + 3/2H_2(g) \rightarrow NH_3(g)$

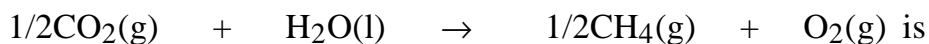
165. Consider the thermochemical equation:



What is  $\Delta H$  for the reaction of  $5.05\text{ g}$  of  $CH_4(g)$  ?

- A.  $253\text{kJ}$       B.  $-253\text{kJ}$       C.  $-801\text{kJ}$       D.  $801\text{kJ}$

166.  $\Delta H$  for the reaction:



- A.  $-801\text{kJ}$       B.  $801\text{kJ}$       C.  $401\text{kJ}$       D.  $-401\text{kJ}$

FOR THE NEXT TWO QUESTIONS YOU WILL NEED TO USE THE STANDARD HEATS OF FORMATION GIVEN IN THE THERMODYNAMICS TABLE OF YOUR TEXT

167. What is the heat of reaction for  $\text{P}_4(\text{s}) + 5\text{O}_2(\text{g}) \rightarrow \text{P}_4\text{O}_{10}(\text{s})$  ?  
A. 2940J      B. -2940J      C. 2940kJ      D. -2940kJ

168. Calculate the heat of reaction for:  
$$\text{P}_4\text{O}_{10}(\text{s}) + 6\text{H}_2\text{O}(\text{l}) \rightarrow 4\text{H}_3\text{PO}_4(\text{aq})$$
  
A. -113.2kJ      B. -498kJ      C. 113.2kJ      D. 498kJ

169. In the reaction described by  $2\text{NO}(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{NO}_2(\text{g})$ , thermal energy in the amount of 114 kJ is released. Calculate  $\Delta\text{H}$  per gram of NO.  
A. -1.9kJ      B. 1.9kJ      C. -3.8kJ      D. 3.8kJ

170. Based upon the following thermochemical equation, calculate the grams of  $\text{C}_3\text{H}_8(\text{g})$  that must be burnt to provide 255kJ of thermal energy:

$$\text{C}_3\text{H}_8(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 3\text{CO}_2(\text{g}) + 4\text{H}_2\text{O}(\text{g}) \quad \Delta\text{H} = -2044\text{kJ}$$
  
A. 4.95 g      B. 5.50 g      C. 3.78 g      D. 9.11 g

AGAIN USE TABULATED STANDARD HEATS OF FORMATION TO DO THE NEXT TWO QUESTIONS.

171. Which of the following liquids has the greatest molar heat of vaporization ?  
A.  $\text{CCl}_4$       B.  $\text{CH}_3\text{OH}$       C.  $\text{CS}_2$       D. HCN

172. Using the information provided in this thermochemical equation and tabulated standard heats of formation, calculate the standard heat of formation of  $\text{C}_4\text{H}_{10}(\text{g})$ .

$$\text{C}_4\text{H}_{10}(\text{g}) + 13/2 \text{O}_2(\text{g}) \rightarrow 4\text{CO}_2(\text{g}) + 5\text{H}_2\text{O}(\text{l}) \quad \Delta\text{H} = -2855 \text{ kJ}$$
  
A. 148 kJ      B. -148 kJ      C. -60.0 kJ      D. 60.0 kJ

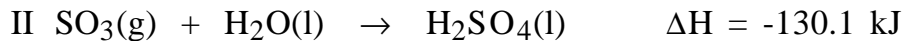
HESS LAW

173. Using I  $\text{H}_2\text{O}_2(\text{l}) \rightarrow \text{H}_2\text{O}(\text{l}) + 1/2\text{O}_2(\text{g}) \quad \Delta\text{H} = -98.0\text{kJ}$  and  
II  $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{l}) \quad \Delta\text{H} = -571.6\text{kJ}$

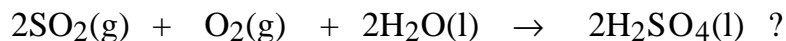
determine  $\Delta H$  for  $\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow \text{H}_2\text{O}_2(\text{l})$

- A. -187.8 kJ      B. 187.8 kJ      C. -473.6 kJ      D. 473.6 kJ

174. Given the following data:

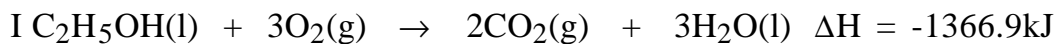
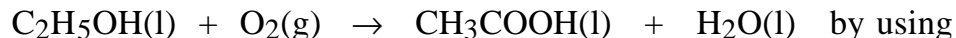


what is the heat of reaction for



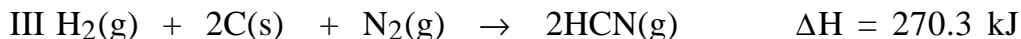
- A. -456.9 kJ      B. 456.9 kJ      C. 326.7 kJ      D. -326.7 kJ

175. Determine the heat of reaction for

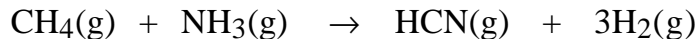


- A. -2237 kJ      B. 2237 kJ      C. -497 kJ      D. 497 kJ

176. Given the following data:



determine the heat of reaction for:



- A. -256 kJ      B. 256 kJ      C. 302 kJ      D. -302 kJ

#### “LIGHT”, ELECTROMAGNETIC RADIATION

177. The spectrum of light does not include

- A. X-rays      B. gamma rays      C. sound waves      D. microwaves

178. Which of the following wavelengths corresponds to the most energetic light ?

- A. 750 nm      B. 12.5 nm      C. 7000 nm      D. 27 nm

179. Which of the following equations specifies the energy of light ?

- A.  $E = \lambda v$       B.  $E = hv$       C.  $E = 1/2mv^2$       D.  $E = mc^2$

180. Calculate the wavelength of light having a frequency of  $5.00 \times 10^{14} \text{ Hz}$ .

A. 600 nm    B. 150 nm    C. 60000 nm    D. 15000 nm

181. Calculate the frequency of light having a wavelength equal to 626 nm.

A.  $1.88 \times 10^4$  Hz    B.  $4.79 \times 10^{16}$  Hz    C.  $4.79 \times 10^{14}$  Hz    D.  $1.88 \times 10^7$  Hz

182. The quantum of light energy is the

A. neuron    B. exciton    C. photon    D. phonon

183. A photon has a frequency of  $4.20 \times 10^{13}$  Hz. Calculate its energy in J.

A.  $1.58 \times 10^{-21}$  J    B.  $2.78 \times 10^{-20}$  J    C.  $6.34 \times 10^{-20}$  J    D.  $3.60 \times 10^{-9}$  J

184. A photon has a wavelength of 155 nm. Calculate its energy in J.

A.  $7.80 \times 10^{-17}$  J    B.  $3.51 \times 10^{-14}$  J    C.  $1.28 \times 10^{-18}$  J    D.  $4.27 \times 10^{-11}$  J

185. What observations or series of experiments directly led to Einstein's quantization of the energy of light ?

- A. the line spectra of atoms
- B. the photoelectric effect
- C. black-body radiation
- D. the scattering of alpha particles.

#### QUANTUM MECHANICS - GENERAL

186. Which of the following statements is FALSE?

- A. Energy flows between objects in discrete indivisible amounts rather than continuously.
- B. The energy of the atom is restricted to specific amounts.
- C. Once the energy of the electron is known so is its exact position.
- D. Light can exhibit either particle or wave behavior depending upon the system with which it is interacting.

187. The concept that the energy of the atom is quantized was based upon a consideration of

- A. black-body radiation
- B. the line spectra exhibited by atoms
- C. the stability of the Rutherford (nuclear) atom
- D. A, B, and C

E. B and C

188. The uncertainty principle is due to the scientist

A. Bohr    B. Pauli    C. Schroedinger    D. Heisenberg    E. Planck

189. Calculate the deBroglie wavelength of a neutron (mass =  $1.67 \times 10^{-27}$  kg) traveling at a speed of  $1.00 \times 10^5$  m/s.

A.  $3.97 \times 10^{-12}$ m    B.  $2.52 \times 10^{11}$ m    C.  $4.29 \times 10^{-21}$ m    D.  $5.11 \times 10^{10}$ m

### QUANTUM NUMBERS OF THE HYDROGEN ATOM

190. The principle quantum number of the atom is symbolized

A.  $m_s$     B.  $m_l$     C.  $n$     D.  $l$

191. The allowed values of  $n$  are

A. 0,1, 2, or 3

B. 1, 2, 3,....., $\infty$

C. 0, 1, 2,....., $\infty$

D. 1, 2, or 3

192. The allowed value(s) of  $l$  is(are)

A.  $n+1$

B.  $n-1$

C. 0, 1, 2, .....,  $n-1$

D. 0, 1, 2,.....,  $n+1$

193. The maximum allowed value of  $m_l$  is

A. 0    B. 3    C. 2    D.  $+l$

194. The quantum number that has only two allowed values is

A.  $n$     B.  $l$     C.  $m_l$     D.  $m_s$

195. The energy of the hydrogen atom is determined solely by the orbital's value of

A.  $n$     B.  $l$     C.  $m_l$     D.  $m_s$

196. The shape of the orbital depends upon the quantum number

A.  $n$     B.  $l$     C.  $m_l$     D.  $m_s$

197. The average distance of the electron from the nucleus of the hydrogen atom depends upon

A.  $n$  B.  $l$  C.  $m_l$  D.  $m_s$

198. The orientation of the orbital in space depends upon

A.  $n$  B.  $l$  C.  $m_l$  D.  $m_s$

199. When  $l$  equals 2 the orbital is referred to as

A. an s orbital B. a p orbital C. a d orbital D. an f orbital

200. Which one of the following sets of the four quantum numbers is not allowed ?

	$n$	$l$	$m_l$	$m_s$
A.	2	1	-1	1/2
B.	1	1	-1	1/2
C.	2	0	0	-1/2
D.	3	2	1	-1/2

201. A "shell" consists of all orbitals having

A. the same value of  $n$ .

B. the same value of  $n$  and  $l$ .

C. the same value of  $n$ ,  $l$ , and  $m_l$ .

D. the same value of all four quantum numbers.

202. The subshell consisting of 5 orbitals of equal energy is

A. the s subshell

B. the p subshell

C. the d subshell

D. the f subshell

203. The number of orbitals in the  $n = 4$  shell is

A. 4 B. 9 C. 16 D. 26

204. An electron releases energy in a transition from the  $n = 4$  shell to the  $n = 2$  shell of the hydrogen atom. How much energy is released ?

A.  $4.09 \times 10^{-19}$  J B.  $3.49 \times 10^{-17}$  J C.  $7.77 \times 10^{-15}$  J D.  $6.63 \times 10^{-34}$  J

205. Calculate the wavelength of the photon released in the process of Question 204.

A. 2600 nm B. 484 nm C. 17662 nm D. 7997 nm

MANY-ELECTRON ATOMS

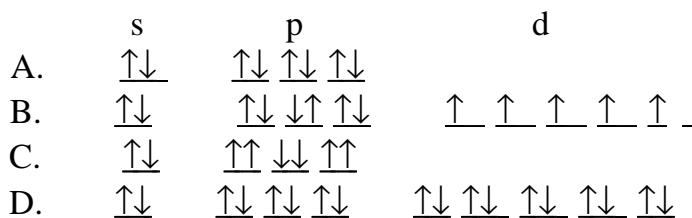
206. The Pauli exclusion principle states that in the many-electron atom
- A. the exact position of any one of the electrons cannot be given.
  - B. no two electrons can have the same value of the spin quantum number.
  - C. each electron must have its own unique set of the 4 quantum numbers.
  - D. all of the above.

207. The maximum number of electrons that can be accommodated in the 4d subshell is
- A. 4
  - B. 6
  - C. 8
  - D. 10

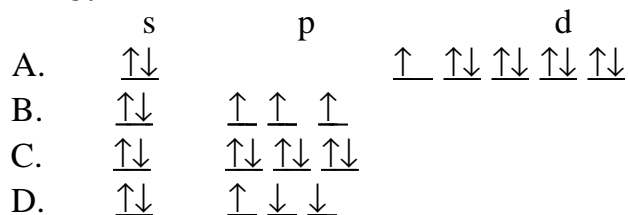
208. The maximum number of electrons that can be accommodated in the  $n = 3$  shell is
- A. 18
  - B. 16
  - C. 14
  - D. 12

### ORBITAL DIAGRAMS

209. Which of the following abbreviated orbital diagrams is invalid ?



210. Which of the following orbital diagrams DOES NOT represent the outermost electrons of an atom in its ground (lowest energy) state?



### ELECTRON CONFIGURATIONS

211. Which of the following electron configurations is VALID ?

- A.  $1s^2 2s^2 2p^7 3s^1$
- B.  $1s^2 2s^2 2p^6 2d^2$

- C.  $1s^2 2s^2 2p^6 3s^1 3p^6$   
D.  $1s^1 2s^1 2p^8$

212. Which of the following electron configurations represents the ground state of O ?

- A.  $1s^2 2p^6$  B.  $1s^2 2s^2 2p^2 3s^2$  C.  $1s^2 2s^2 2p^2 2d^2$  D.  $1s^2 2s^2 2p^4$

213. Which of the following represents the ground state of potassium ?

- A.  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^1$   
B.  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$   
C.  $1s^2 2s^2 2p^6 2d^{10} 3s^1$   
D.  $1s^2 2s^2 2p^4 3s^2 3p^4 3d^5$

214. Which of the following represents the ground state of vanadium ?

- A.  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3 4s^2$   
B.  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$   
C.  $1s^2 2s^2 2p^4 3s^2 3p^4 3d^9$   
D.  $1s^2 2s^2 2p^4 3s^2 3p^4 3d^7 4s^2$

215. Which of the following represents the ground state of gallium ?

- A.  $[\text{Ar}]4s^2 4p^1$   
B.  $[\text{Ar}]3d^{10} 4s^2 4p^1$   
C.  $[\text{Ar}]4s^2 4p^6 4d^5$   
D.  $[\text{Ar}]4f^{13}$

216. Which of the following represents the ground state of Sm (samarium) ?

- A.  $[\text{Xe}]4f^6 6s^2$  B.  $[\text{Xe}]5d^6 6s^2$  C.  $[\text{Xe}]4f^3 5d^3 6s^2$  D.  $[\text{Xe}]4f^3 5d^5$

217. Which of the following represents the ground state of silver ?

- A.  $[\text{Kr}]4d^{10} 4f^1$  B.  $[\text{Kr}]4d^9 4f^2$  C.  $[\text{Kr}]4d^9 5s^2$  D.  $[\text{Kr}]4d^{10} 5s^1$

218. Which of the following represents the ground state of the manganese(II) ion ?

- A.  $[\text{Ar}]3d^5$  B.  $[\text{Ar}]3d^3 4s^2$  C.  $[\text{Ar}]3d^4 4s^1$  D.  $[\text{Ar}]3d^5 4s^1$

219. Which of the following represents the ground state of the oxide ion ?

- A. [Ne]      B.  $1s^22s^22p^4$       C.  $2s^22p^6$       D. [Ar]

220. From inspection of their of their orbital diagrams determine which of the following species is paramagnetic.

- A. Mg      B.  $N^{3-}$       C. Mn      D.  $Na^+$

221. The valence electron configuration of an atom is  $ns^2$ . This atom is

- A. an alkali metal    B. a halogen    C. a rare earth    D. an alkaline earth metal.

222. With one exception, a noble gas has the outermost electron configuration

- A.  $ns^2np^4$       B.  $ns^2np^6$       C.  $(n-1)d^{10}ns^2np^6$       D.  $(n+1)s^2np^6$

#### ATOMIC AND IONIC RADII

223. The radius of an atom depends upon

- A.  $n$ , the principle quantum number, and  $Z$ , the atomic number  
B.  $l$ , the angular momentum quantum number, and  $n$   
C.  $n$  and  $A$ , the mass number  
D.  $l$  and  $Z$

224. Which of the following Mg, Ca, Ba, or Sr has the largest atomic radius ?

- A. Mg    B. Ca    C. Ba    D. Sr

225. Which of the following has the smallest atomic radius ?

- A. Be    B. N    C. B    D. O

226. Which of the following arrangements shows the atoms increasing from smallest to largest ?

- A.  $Cs < Rb < Mg < Si < C$   
B.  $Rb < Cs < Si < Mg < C$   
C.  $C < Si < Mg < Rb < Cs$   
D.  $C < Mg < Rb < Si < Cs$

227. Which of the following is the largest species ?

- A.  $F^-$     B.  $Cl^-$     C.  $O^{2-}$     D.  $S^{2-}$     E.  $N^{3-}$     F.  $P^{3-}$

228. Which of the following is the smallest ?  
A.  $O^{2+}$  B.  $O^+$  C. O D.  $O^-$  E.  $O^{2-}$

#### IONIZATION ENERGIES/ELECTRON AFFINITY

229. The first ionization energy of an atom (symbol M) is described by the equation

- A.  $M(s) + \text{energy} \rightarrow M^+(g) + e^-$   
B.  $M(s) \rightarrow M^+(g) + e^- + \text{energy}$   
C.  $M(g) + \text{energy} \rightarrow M^+(g) + e^-$   
D.  $M(g) \rightarrow M^+(g) + e^- + \text{energy}$

230. The general trend in the increase in first ionization energies of the representative (main-group) elements

- A. is identical to the trend in the increase in their atomic radii.  
B. is the reverse of the trend in the increase in their atomic radii.  
C. has no correlation at all to the trend in the increase in their atomic radii.

231. Which of the following atoms has the greatest first ionization energy ?

- A. I B. Br C. Cl D. F

232. Which of the following has the lowest first ionization energy ?

- A. Na B. Mg C. P D. Ar

233. Which of the following arrangements from lowest to highest in first ionization energies is correct ?

- A. He<Li<Be<N<Ne  
B. Li<Be<N<Ne<He  
C. Be<Li<N<He<Ne  
D. He<Ne<N<Be<Li

234. Which of the following atoms has a third ionization energy several times greater than its second ionization energy ?

- A. N B. C C. B D. Be

THE FOLLOWING QUESTIONS DEAL WITH ELECTRON AFFINITY. TWO CONVENTIONS EXIST IN DEFINING THIS QUANTITY. THUS, BECAUSE OF THE DIFFERENCE IN CONVENTIONS, A QUESTION MAY HAVE ALTERNATIVELY CORRECT ANSWERS. CHECK YOUR LECTURE NOTES

AND TEXT CAREFULLY TO DETERMINE THE CONVENTION BEING USED IN YOUR GENERAL CHEMISTRY COURSE.

235. The energy change in which of the following processes constitutes the electron affinity of the species symbolized M ?

- A.  $M(g) + e^- \rightarrow M^-(g)$
- B.  $M^-(g) \rightarrow M(g) + e^-$
- C.  $M(s) + e^- \rightarrow M^-(g)$
- D.  $M^-(s) \rightarrow M(g) + e^-$

236. Which generalization about electron affinity is correct ?

- A. The formation of a stable gaseous anion ( $M^-(g)$ ) is accompanied by the release of energy.
- B. Nonmetallic atoms have electron affinities of greatest magnitude.
- C. The energy change in the gain of an electron by an atom may be a positive or negative quantity depending upon the identity of the atom.
- D. all of the above.

237. A family or group of elements that do not form stable negative ions is

- A. the alkali metals
- B. the alkaline earth metals
- C. the noble gases
- D. A and B
- E. B and C.

238. Which of the following atoms has the electron affinity of greatest magnitude ?

- A. Cs
- B. C
- C. Se
- D. Cl

## IONIC BONDING

239. Ionic bonds result from

- A. the transfer of protons from one nonmetal to another
- B. the transfer of electrons from one nonmetal to another
- C. the transfer of electrons from a metal to a nonmetal
- D. the transfer of protons from a nonmetal to a metal

240. All the following except----- are examples of ionic compounds.

- A. NaCl
- B. NaHSO<sub>4</sub>
- C. Na<sub>2</sub>SO<sub>4</sub>
- D. H<sub>2</sub>SO<sub>4</sub>

241. Ionic compounds

- A. have high melting points.
- B. are always solids at normal conditions.
- C. conduct electricity only when melted or dissolved in water.
- D. all of the above.

242. Which of the following equations describes the lattice energy of a substance ?

- A.  $M(s) + \text{energy} \rightarrow M^+(g) + e^-$
- B.  $MX(s) + \text{energy} \rightarrow M^+(g) + X^-(g)$
- C.  $X^-(g) + \text{energy} \rightarrow X(g) + e^-$
- D.  $M^+(g) + X^-(g) \rightarrow MX(g) + \text{energy}$

243. When a representative (main-group) element forms an ion, it attains the ----- electronic configuration

- A. alkali metal
- B. noble gas
- C. pseudo-noble gas
- D. either B or C

244. Cations formed by representative elements have

- A. a positive charge equal to the group number.
- B. a charge equal to the group number - 8.
- C. one of several different positive charges.
- D. a negative charge equal to the group number.

#### LEWIS DOT STRUCTURES

245. The correct Lewis dot structure of the carbon atom is:

- A.  $\text{:C:}$
- B.  $\cdot\overset{\cdot}{\underset{\cdot}{\text{C}}}\cdot$
- C.  $\overset{\cdot\cdot}{\underset{\cdot\cdot}{\text{C}}}$
- D.  $\text{:}\overset{\cdot}{\text{C}}\cdot$

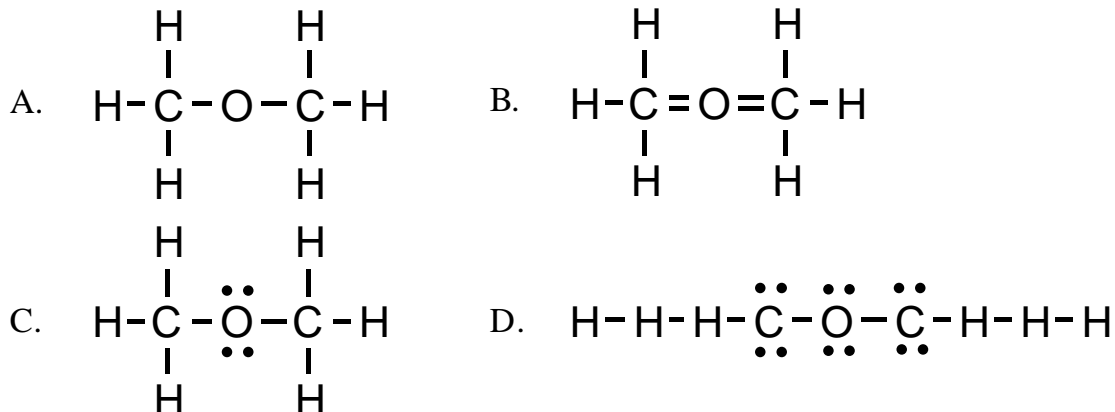
246. The correct Lewis dot structure for  $N^{3-}$  is:

- A.  $\cdot\overset{\cdot}{\underset{\cdot}{\text{N}}}\cdot^{3-}$
- B.  $\cdot\overset{\cdot}{\underset{\cdot\cdot}{\text{N}}}\cdot^{3-}$
- C.  $\overset{\cdot\cdot}{\underset{\cdot\cdot}{\text{N}}}\overset{\cdot\cdot}{\cdot}^{3-}$
- D. Ne

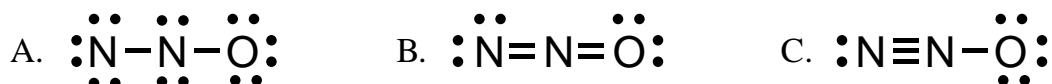
#### LEWIS STRUCTURAL FORMULAS

247. The formula of  $AlF_3$  in terms of Lewis dot structures is:



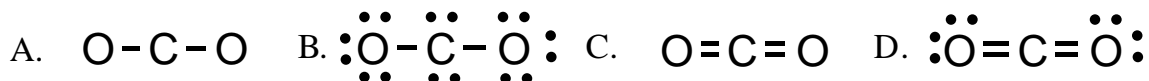


253. A correct Lewis formula for NNO is:

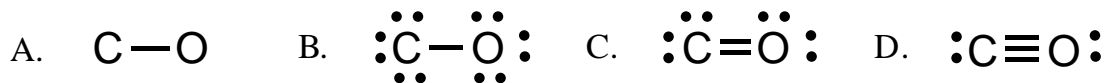


D. A and B      E. A and C      F. B and C

254. The correct Lewis formula for CO<sub>2</sub> is:



255. Which of the following is a valid Lewis structure for CO?



256. Which of the following cannot exhibit resonance?

A. SO<sub>2</sub>      B. O<sub>3</sub>      C. CH<sub>2</sub>O      D. NO<sub>2</sub><sup>-</sup>

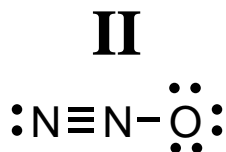
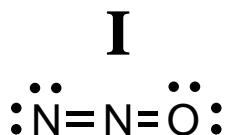
257. Which of the following is a valid Lewis structure for HN<sub>3</sub>?

258. A student offers the following Lewis structure for HCN: H=C=N.

What errors do you observe in the proposed structure ?

- A. a miscount in the number of valence electrons
- B. a doubly bonded hydrogen
- C. nitrogen without an octet
- D. all of the above

259. At least two valid Lewis structures can be drawn for N<sub>2</sub>O.

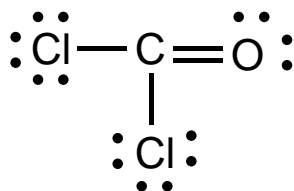


The true molecular structure is best represented by:

- A. Structure I
- B. Structure II
- C. A combination of structures I and II

#### FORMAL CHARGES

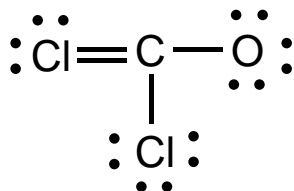
260. For  $\text{COCl}_2$  the following Lewis structure can be drawn:



The formal charges on the C, the O and both of the Cl atoms are:

- A. +1, -1, 0 B. 0, 0, 0 C. +2, -2, 0 D. +2, 0, 1

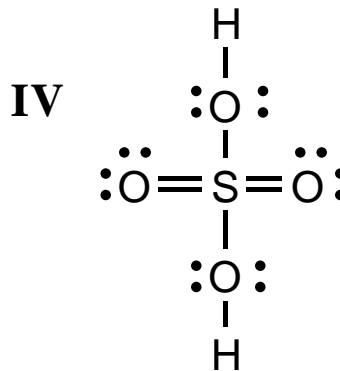
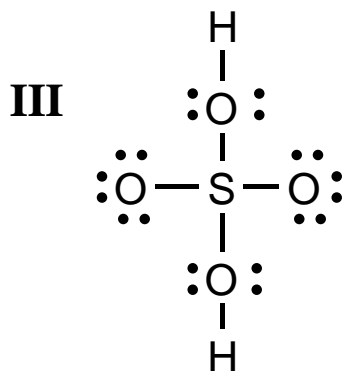
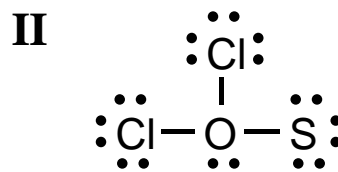
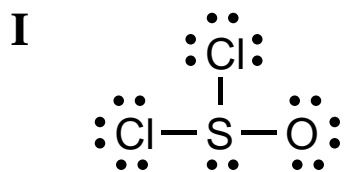
261. For  $\text{COCl}_2$  the following Lewis structure can be drawn:



The formal charges on the C, the O, the single bond Cl, and the double bond Cl are:

- A. 0, 0, 0, 0 B. 0, -2, 0, +2 C. 0, -1, 0, +1 D. 0, +1, 0, -

262. Consider the following four Lewis structures:



On the basis of the formal charges calculated for each structure, select the correct statement concerning these structures.

- A. Structure II is preferable to structure I and structure IV is preferable to structure III.
- B. Structure II is preferable to structure I and structure III is preferable to structure IV.
- C. Structure I is preferable to structure II and structure III is preferable to structure IV.
- D. Structure I is preferable to structure II and structure IV is preferable to structure III.

#### EXCEPTIONS TO THE OCTET RULE

263. Exceptions to the octet rule occur because

- A. A bonding atom may not provide sufficient valence electrons.
- B. The total number of valence electrons is odd.
- C. The d orbitals of a bonded atom are very close in energy to its valence electrons.
- D. all of the above.

264. Which of the following molecules violates the octet rule ?

- A.  $\text{N}_2\text{O}$     B.  $\text{NO}$     C.  $\text{N}_2\text{O}_3$     D.  $\text{N}_2\text{H}_4$

265. Which of the following molecules is “electron deficient” ?  
A. CH<sub>4</sub>      B. BH<sub>3</sub>      C. NH<sub>3</sub>      D. H<sub>2</sub>O

266. Which of the following molecules violates the octet rule ?  
A. CH<sub>4</sub>      B. CCl<sub>4</sub>      C. SF<sub>4</sub>      D. XeF<sub>4</sub>      E. C and D

### COVALENT BONDS

267. Covalent bonds form when  
A. metals react with nonmetals.  
B. metals react with one another.  
C. nonmetals including hydrogen react with one another.

268. Which statement about covalent bonding is correct ?  
A. The bond involves the sharing of one or more electron pairs.  
B. In the formation of the bond each of the bonded atoms can contribute a single electron.  
C. In the formation of the bond one of the bonded atoms can contribute both electrons.  
D. The electron pair or pairs can be shared equally by the bonded atoms.  
E. The electron pair or pairs can be shared unequally by the bonded atoms.  
F. All of the above.

269. In the formation of a covalent bond  
A. energy is absorbed.  
B. energy is released.  
C. energy is either absorbed or released depending upon the identity of the bonding atoms.

270. In the formation of the ammonium ion the ammonia molecule donates a pair of electrons to a hydrogen ion to form a covalent bond. The bond is best described as  
A. a dative bond  
B. a polar bond  
C. a coordinate covalent bond.  
D. a nonpolar bond.

### ELECTRONEGATIVITY

271. The quantity termed “electronegativity” is a quantity

- A. artificially constructed.
- B. very easy to measure experimentally.
- C. very difficult to measure experimentally.
- D. difficult or easy to measure experimentally.

Use the following data to answer the next three questions.

Atom	Electronegativity
H	2.1
Cs	0.7
O	3.5
N	3.0
P	2.1
F	4.0
Cl	3.0

272. Predict which of the following bonds is the most polar.
- A. H-O      B. H-P      C. H-Cl      D. H-F

273. Predict which of the following is ionic rather than covalent in nature.

- A. P-N      B. H-Cs      C. F-Cl      D. N-F

274. Which of the following bonds is (are) nonpolar ?
- A. F-O      B. O-O      C. P-H      D. A and B      E. B and C

#### BOND LENGTH, STRENGTH, ORDER

275. Bond order refers to

- A. the arrangement of the bonds within a molecule in order of their polarity.
- B. the arrangement of the bonds within a molecule in order of their length.
- C. the arrangement of the bonds within a molecule in order of their strength.
- D. the number of electron pairs shared by the bonded atoms.

276. In a series of compounds two nitrogen atoms are bonded to one another. In Compound A the N to N bond order is 3, in Compound B it is 2, and in Compound C, it is 1.

- A. The strongest N to N bond is in Compound C.
- B. The longest N to N bond is in Compound C.
- C. The weakest N to N bond is in Compound A.
- D. The N to N bond in Compound B is easier to break than the one in Compound C and harder to break than the one in Compound A.

#### BOND ENERGY

277. For which of the following equations does  $\Delta H$  represent a bond energy ?

- A.  $C(s) \rightarrow C(g)$
- B.  $NaCl(s) \rightarrow Na^+(g) + Cl^-(g)$
- C.  $HCN(g) \rightarrow H(g) + CN(g)$
- D.  $Br_2(l) \rightarrow 2Br(g)$

278. From the following thermochemical equation determine the average C-H bond energy:



- A. 1662 kJ
- B. 416 kJ
- C. -1662 kJ
- D. -416 kJ

The following data may be of use in answering the next two questions.

BOND	BOND ENERGY (kJ/mol)
H - H	432
Cl - Cl	240
H - Cl	428
C - Cl	327
C - C	346
C = C	602

279. Estimate  $\Delta H$  for  $CH_4(g) + Cl_2(g) \rightarrow CH_3Cl(g) + HCl(g)$
- A. -99 kJ
  - B. +99 kJ
  - C. -1411 kJ
  - D. +1411 kJ

280. Estimate  $\Delta H$  for  $H_2C=CH_2(g) + H_2(g) \rightarrow H_3C-CH_3(g)$
- A. -191 kJ
  - B. +202 kJ
  - C. +272 kJ
  - D. -144 kJ

#### MOLECULAR GEOMETRY

281. The geometry of a molecule, i.e. its general shape, is determined by

- A. the polarity of its bonds.
- B. the relative positions of the atomic nuclei.
- C. the relative electronegativity of its atoms.
- D. the arrangement of the electron pairs about each atom.

282. The geometric arrangement that minimizes electron-pair repulsions among three electron pairs is

- A. linear
- B. trigonal planar
- C. tetrahedral
- D. pyramidal

283. The geometric arrangement that minimizes electron-pair repulsions among four electron pairs is

- A. trigonal planar
- B. trigonal bipyramidal
- C. tetrahedral
- D. octahedral

284. The geometric arrangement that minimizes electron-pair repulsions among five electron pairs is

- A. trigonal planar
- B. trigonal bipyramidal
- C. tetrahedral
- D. octahedral

285. The geometric arrangement that minimizes electron-pair repulsions among six electron pairs is

- A. trigonal planar
- B. trigonal bipyramidal
- C. tetrahedral
- D. octahedral

286. According to valence-shell electron-pair repulsion theory, electron-electron repulsions are greatest between

- A. lone pairs
- B. bonding pairs
- C. lone pairs and bonding pairs.

287. According to VSEPR, in a group of five electron pairs if any of the five are lone pairs, they are placed

- A. above the trigonal plane.
- B. below the trigonal plane.
- C. above and below the trigonal plane.
- D. in the trigonal plane.

288. According to VSEPR theory, the  $\text{BF}_3$  molecule has

- A. trigonal pyramidal geometry
- B. tetrahedral geometry
- C. trigonal planar geometry
- D. bent geometry

289. According to VSEPR,  $\text{CH}_4$  is

- A. pyramidal molecule
- B. tetrahedral molecule

- C. octahedral molecule
- D. square planar molecule

290. According to VSEPR,  $\text{NH}_3$  is

- A. pyramidal in shape
- B. tetrahedral in shape
- C. octahedral in shape
- D. trigonal planar in shape.

291. According to VSEPR,  $\text{PCl}_5$  possesses geometry best described as

- A. tetrahedral bipyramid
- B. trigonal bipyramid
- C. a square pyramid
- D. square planar

292. According to VSEPR, the geometry of  $\text{I}_3^-$  is

- A. linear
- B. bent
- C. trigonal
- D. pyramidal

293. According to VSEPR, the shape of  $\text{SF}_6$  is

- A. trigonal bipyramid
- B. octahedral
- C. tetradedral
- D. square planar

294. According to VSEPR, the shape of  $\text{CH}_3\text{Cl}$  is

- A. distorted octahedral
- B. octahedral
- C. tetrahedral
- D. distorted tetrahedral

295. According to VSEPR,  $\text{XeF}_4$  possesses

- A. tetrahedral geometry
- B. square planar geometry
- C. square pyramidal geometry
- D. distorted octahedral geometry

296. According to VSEPR,  $\text{SF}_4$  exhibits

- A. tetrahedral geometry
- B. seesaw geometry
- C. square planar geometry
- D. square pyramidal geometry

297. According to VSEPR,  $\text{IF}_5$  is shaped like

- A. a trigonal bipyramid
- B. an octahedron

- C. a square pyramid
- D. the letter "T"

298. According to VSEPR,  $\text{ClF}_3$  possesses a ----- shape.  
A. trigonal planar B. trigonal pyramidal C. "T" D. tetrahedral

299. According to VSEPR,  $\text{CO}_2$  is a ----- molecule.  
A. linear B. bent C. trigonal D. tetrahedral

300. According to VSEPR,  $\text{H}_2\text{CO}$  possesses  
A. bent geometry  
B. trigonal planar geometry  
C. distorted trigonal planar geometry  
D. distorted tetrahedral geometry

301. According to VSEPR,  $\text{H}_2\text{CO}$  possesses  
A. bent geometry  
B. trigonal planar geometry  
C. distorted trigonal planar geometry  
D. distorted tetrahedral geometry

## POLAR MOLECULES

302. Which of the following statements is incorrect ?  
A. An electric dipole consists of two partial electrical charges equal in magnitude but opposite in sign and separated by a distance.  
B. Whether a molecule is polar or not can be determined experimentally.  
C. A polar molecule must contain polar bonds.  
D. A polar molecule cannot possess a completely symmetric geometry.  
E. None of the above.

303. Which of the following geometries is not symmetric ?  
A. trigonal planar B. tetrahedral C. octahedral D. trigonal pyramid

304. Which of the following molecules is polar ?  
A.  $\text{BeCl}_2$  B.  $\text{CO}_2$  C.  $\text{SO}_2$  D.  $\text{I}_3^-$

305. Which of the following molecules is polar ?  
A.  $\text{SiH}_4$  B.  $\text{TeCl}_4$  C.  $\text{XeF}_4$  D.  $\text{AlF}_4^-$

## HYBRID ATOMIC ORBITALS ON CARBON

306. Hybrid atomic orbitals were “invented” because

- A. the hydrogen-like atomic orbitals were too few in number.
- B. the hydrogen-like atomic orbitals could not produce the correct molecular geometry.
- C. the energies of the hydrogen-like atomic orbitals did not match the energies of the molecules.

307. Which statement about the formation of hybrid atomic orbitals is incorrect ?

- A. Only orbitals close in energy combine with one another.
- B. The number of hybrid orbitals formed always equals the number of hydrogen-like atomic orbitals used.
- C. The hybrid orbitals formed have well-defined directional characteristics.
- D. None of the above.

308. The hybrid orbitals necessary to tetrahedral geometry about the carbon atom are termed

- A. sp hybrids
- B. sp<sup>2</sup> hybrids
- C. sp<sup>3</sup> hybrids
- D. sp<sup>4</sup> hybrids

309. The hybrid orbitals on a doubly bonded carbon are

- A. sp hybrids
- B. sp<sup>2</sup> hybrids
- C. sp<sup>3</sup> hybrids
- D. sp<sup>4</sup> hybrids.

310. Which set of hybrid orbitals meets the following description: two in number, at an angle of 180° from one another, used in the formation of a multiple bond between carbons.

- A. sp<sup>4</sup>
- B. sp<sup>3</sup>
- C. sp<sup>2</sup>
- D. sp

311. A carbon atom forms a triple bond by the use of

- A. two sp hybridized atomic orbitals.
- B. two sp hybridized atomic orbitals and one 2p hydrogen-like atomic orbital.
- C. one sp hybridized atomic orbital and two 2p hydrogen-like atomic orbitals.
- D. three sp<sup>2</sup> hybridized atomic orbitals.

312. When the geometry about a carbon atom is trigonal planar, its four bonds consist of

- A. two sigma( $\sigma$ ) and two pi( $\pi$ ) bonds.
- B. four sigma bonds.
- C. three sigma and one pi bond.
- D. four pi bonds.

## THE GASEOUS STATE

313. A gas is

- A. a fluid
- B. highly compressible
- C. highly disordered
- D. all of these

314. Which of the following statements is correct ?

- A. The volume of any gas is the volume of its container.
- B. A gas exerts pressure due to collisions of the gaseous molecules against a surface.
- C. Under ordinary conditions, all true gases behave the same.
- D. All of the above.

315. Which of the following is not a unit of pressure ?

- A. atmosphere
- B. millimeters of Hg
- C. Torr
- D. manometers of Hg
- E. psi

316. The device commonly used to measure atmospheric pressure is

- A. a manometer
- B. a sphygmomanometer
- C. a torricelli
- D. a barometer

317. Convert 151 mmHg to Torr.

- A. 0.199 Torr
- B. 15.1 Torr
- C. 151 Torr
- D. 199 Torr

318. A gas exerts a pressure of 1.78 atm. This pressure in mmHg is

- A. 1350
- B. 1070
- C. 0.556
- D. 1.78

319. Mercury is commonly used in barometers because of its high density ( $13.596 \text{ g/cm}^3$ ). An alcohol having a density of  $0.899 \text{ g/cm}^3$  is substituted for mercury. Calculate the height of an alcohol column exerting the same pressure as a mercury column 15.6 mm high.

- A. 236 mm
- B. 189 mm
- C. 212 mm
- D. 273 mm

## EMPIRICAL GAS LAWS

320. The following proportionalities relate to the behavior of gases under ordinary conditions. Which proportionality is incorrect ?

- A.  $P \sim T$ ,  $V$  and  $n$  constant
- B.  $P \sim V$ ,  $T$  and  $n$  constant
- C.  $V \sim T$ ,  $P$  and  $n$  constant
- D.  $V \sim n$ ,  $P$  and  $T$  constant

321. A sample of a gas exerts a pressure of 300 Torr and occupies 406 mL. Calculate the volume of this gas at the same temperature but at a pressure of 600 Torr.

- A. 812 mL
- B. 203 mL
- C. 406 mL
- D. 609 mL

322. A gas sample at 25°C occupies 105 mL at a pressure of 698 Torr. What volume will it occupy at this temperature and a pressure of 1.91 atm ?

- A. 50.5 mL
- B. 3.84 L
- C. 59.9 mL
- D. 0.0771 L

323. What external pressure must be supplied to compress 2.76 L of a gas at 298K and 0.878 atm to 2.00 L at 298K ?

- A. 484 mmHg
- B. 921 mmHg
- C. 760 mmHg
- D. 878 mmHg

324. A sample of a gas is heated from 25°C to 98°C. The pressure is held constant during the heating process. If the original volume of the gas was 222 mL, what is its volume after heating ?

- A. 870 mL
- B. 566 mL
- C. 276 mL
- D. 444 mL

325. A sample of a gas occupies a rigid 1.00-L container and exerts a pressure of 1.00 atm. at 30°C. What pressure will it exert after the system is cooled to 20°C ?

- A. 507 Torr
- B. 1140 Torr
- C. 786 Torr
- D. 735 Torr

326. The air within a “hot air” balloon is at 18°C. The atmospheric pressure is 688 mmHg. By what percentage does the volume of this hot air balloon increase when the air within it is heated to 75°C ?

- A. 100%
- B. 417%
- C. 120%
- D. 252%

327. Consider a sample of a gas at 100°C, occupying 486 mL at 1.11 atm. What volume will it occupy at 1.55 atm and 200°C ?

- A. 274 mL
- B. 441 mL
- C. 696 mL
- D. 861 mL

328. A sample of a gas occupying 225 mL at 33°C and 721 Torr is heated until its volume is 555 mL and its pressure is 701 Torr. Calculate its temperature after heating.

- A. 84°C      B. 503°C      C. 79°C      D. 461°C

329. Consider the reaction  $\text{H}_2(\text{g}) + \text{Cl}_2(\text{g}) \rightarrow 2\text{HCl}(\text{g})$ .

According to the results of Gay-Lussac's experiments,

- A. 10.0 g of  $\text{H}_2$  reacts with 10.0 g of  $\text{Cl}_2$  at 298K and 1 atm  
B. 10 molecules of  $\text{H}_2$  react with 10 molecules of  $\text{Cl}_2$  at 298K and 1 atm  
C. 10 moles of  $\text{H}_2$  react with 10 moles of  $\text{Cl}_2$  at 298K and 1 atm  
D. 10 L of  $\text{H}_2$  react with 10 L of  $\text{Cl}_2$  at 298K and 1 atm

330. The concept that equal volumes of gases at the same temperature and pressure contain equal number of molecules is that

- A. of Dalton      B. of Avogadro      C. of Boyle      D. of Gay-Lussac

331. Standard conditions for a gas are

- A. 298K and 706 Torr  
B. 273K and 760 Torr  
C. 273K and 706 Torr  
D. 298K and 760 Torr

332. At STP one mole of any gas occupies

- A. 20.4 L      B. 22.4 L      C. 2.04 L      D. 2.24 L

333. A 0.0558-mol sample of a gas is at standard temperature and pressure. What volume does it occupy ?

- A. 1.25 L      B. 2.24 L      C. 1.81 L      D. 2.08 L

#### THE IDEAL GAS LAW

334. The gas constant R that appears in the ideal gas law has the value 0.08206 L atm/mol K. Given that 1 L-atm.= 101.3 J, calculate its numerical value in the units LTorr/mol K and in J/mol K.

- A. 62.4 LTorr/mol K and 8.313 J/mol K  
B. 62.4 LTorr/mol K and 8.031 J/mol K  
C. 61.6 LTorr/mol K and 8.313 J/mol K  
D. 61.6 LTorr/mol K and 8.031 J/mol K

335. A sample of a gas occupies 129 mL at 28°C. and exerts a pressure of 682 mmHg. How many moles of gas are present?

- A.  $5.04 \times 10^{-2}$    B.  $4.68 \times 10^{-3}$    C. 3.56   D.  $6.31 \times 10^{-3}$

336. A sample of  $N_2(g)$  was generated in the lab. At 25°C and 692 Torr its volume was 97.3 mL. How many grams of  $N_2$  were produced ?

- A.  $3.62 \times 10^{-3}$    B.  $1.01 \times 10^{-1}$    C.  $1.59 \times 10^{-3}$    D.  $3.99 \times 10^{-1}$

337. Oxygen gas is prepared in the laboratory via  $2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$ .  $KClO_3$  in the amount of 10.0 g completely decomposed in this manner. What volume of  $O_2(g)$  at 31°C and 0.897 atm was produced ?

- A. 3.40 L   B. 2.26 L   C. 0.346 L   D. 1.55 L

338. For a given reaction 300.0 g of  $N_2(g)$  is required. What volume of  $N_2(g)$  at 25°C and 1 atm must be pumped into a reactor to provide the needed  $N_2(g)$  ?

- A. 22.0 L   B. 49.7 L   C. 262 L   D. 193 L

339. For a given reaction 300.0 g of  $N_2(g)$  is required. What volume of  $N_2(g)$  at 25°C and 1 atm must be pumped into a reactor to provide the needed  $N_2(g)$  ?

- A. 22.0 L   B. 49.7 L   C. 262 L   D. 193 L

340. A given number of moles of any gas, regardless of its identity, occupies a given volume at a specific combination of temperature and pressure. Calculate the number of moles of a gas present in 1 L at 25°C and 709 mmHg.

- A. 0.455   B. 0.0381   C. 0.0345   D. 0.596

341. Calculate the density of  $Cl_2(g)$  at 25°C and 709 Torr.

- A. 2.70g/L   B. 32.3g/L   C. 2.45g/L   D. 1.95g/L

342. Calculate the density of  $Cl_2(g)$  at 37°C. and 0.592 atm.

- A. 2.63g/L   B. 1.65g/L   C. 2.70g/L   D. 1.92g/L

343. Calculate the density of  $O_3(g)$  at 25°C and 709 Torr.

- A. 2.70g/L   B. 1.94g/L   C. 1.83g/L   D. 2.49g/L

344. Two gases at the same temperature and pressure can differ in their density because
- A. the sample of one gas can contain a greater number of molecules than does the sample of the other gas.
  - B. the strength of the attractive forces between molecules are different in the two gases.
  - C. the molecules of the two gases differ in their molecular volumes.
  - D. the two gases differ in their molecular weight.

## GAS MIXTURES

345. In any mixture of nonreacting gases,
- A. the volume of each gas is the volume of the container.
  - B. each gas is exerting its own pressure.
  - C. the total pressure is the sum of each gas' s individual pressure.
  - D. the pressure each gas is exerting depends directly on the number of its molecules present in the mixture.
  - E. all of the above.

The next three questions relate to a mixture of noble gases consisting of 0.150 mole of He, 0.450 mole of Ne, and 0.300 mole of Ar.

346. The mole fraction of Ar in this mixture is
- A. 0.300      B. 0.333      C. 0.667      D. 0.500
347. The partial pressure of the Ne in the mixture is 275 Torr. The total pressure of the mixture is
- A. 550 Torr    B. 275 Torr    C. 611 Torr    D. 900 Torr
348. The partial pressure of the He is
- A. 183 Torr    B. 275 Torr    C. 91.7 Torr    D. 157 Torr
349. The  $O_2(g)$  generated by the decomposition of  $KClO_3$  was collected by the displacement of water at  $31^\circ C$  (vapor pressure of  $H_2O = 32.0$  mmHg). The "wet gas" had a volume of 75.8 mL . The barometric pressure during the collection process was 683mmHg. What pressure did the  $O_2(g)$  exert ?
- A. 715 mmHg    B. 683 mmHg    C. 651 mmHg    D. 667 mmHg
350. How many grams of  $O_2(g)$  were generated in the process described in the previous question ?

A.  $2.60 \times 10^{-3}$     B.  $8.33 \times 10^{-2}$     C.  $2.55 \times 10^{-2}$     D.  $6.77 \times 10^{-3}$

### KINETIC MOLECULAR THEORY OF GASES

351. The kinetic molecular theory of gases was developed to explain the behavior of  
A. real gases    B. noble gases    C. ideal gases    D. inert gases

352. Which of the following statements is not a postulate of the kinetic molecular theory of gases.  
A. The volume of the molecules making up the gas is negligible compared to the distances between the molecules.  
B. The gaseous molecules move constantly and randomly in straight lines throughout the volume of the container.  
C. The attractive forces between molecules are essentially negligible.  
D. The average kinetic energy of the molecules is directly proportional to the pressure they exert.

353. The gaseous state is the simplest state of matter to study because the identity of the gas is irrelevant under ordinary conditions. This irrelevance is based upon  
A. the fact that the gaseous molecules are electrically neutral.  
B. the fact that molecular volume is immaterial under ordinary conditions.  
C. the fact that the gaseous molecules neither attract nor repel one another under ordinary conditions.  
D. A, B, and C  
E. B and C

### COMPARISON OF GASES, LIQUIDS, AND SOLIDS

354. The least compressible state of matter is the ---- state.  
A. liquid    B. solid    C. gaseous    D. irrepressible

355. This substance is a fluid of relatively high density. It conforms to the shape but not the volume of its container. It is a  
A. gas    B. solid    C. liquid    D. plasma

356. Unlike gases, liquids and solids vary widely in their properties under ordinary conditions because

- A. they differ widely in the size of the particles making up the substance.
- B. they differ widely in the nature of attractive forces between particles.
- C. they differ widely in the strength of the attractive forces between particles.
- D. all of the above.

## PHASE TRANSITIONS

357. Each of the following equations describes a phase transition accompanied by the term used to specify the transition. In the list, one mismatch is included. Select the mismatch.

- A. solid → gas, sublimation
- B. liquid → solid, fusion
- C. liquid → gas, vaporization
- D. gas → liquid, condensation

358. Consider the change liquid → solid. In this change,

- A. thermal energy is released as heat to the surroundings.
- B. the temperature of the system slowly drops.
- C. an endothermic process occurs.
- D. all of the above.

359. During a phase transition the system is in a state of dynamic equilibrium. Such an equilibrium is characterized by

- A. change occurring in both the forward and reverse direction.
- B. a very slow change in the temperature of the system.
- C. change occurring in opposite directions at the same rate.
- D. the temperature of the system remaining constant.
- E. A and B.
- F. C and D.

360. Above the liquid phase in a sealed container exists a gaseous phase exerting a constant pressure. This pressure is termed

- A. the ambient pressure
- B. the endoatmospheric pressure
- C. the equilibrium vapor pressure

D. the amphoteric pressure.

361. The vapor pressure of a liquid or of a solid can be changed by changing

- A. the external pressure, i.e. the atmospheric pressure.
- B. the surface area of the liquid
- C. the temperature of the liquid
- D. the humidity, i.e. the moisture content of the atmosphere

362. For the process  $\text{H}_2\text{O}(\text{s}) \leftrightarrow \text{H}_2\text{O}(\text{l})$   $\Delta H = 6.01\text{kJ}$

This equation tells us that

- A. the process is endothermic.
- B. to melt one mole of ice 6.01 kJ must be provided.
- C. the process is an equilibrium process.
- D. all of the above.

363. Using the data supplied in the previous question calculate the change in enthalpy when 50.0 g of  $\text{H}_2\text{O}(\text{l})$  freezes.

- A. 6.01 kJ
- B. -6.01 kJ
- C. 16.7 kJ
- D. -16.7 kJ

364. A sample of liquid water in the amount of 100.0 g absorbs 226 kJ in boiling. Calculate the molar heat of vaporization of water.

- A. 2260 J/mol
- B. 40.7 kJ/mol
- C. 4070 J/mol
- D. 2.26 kJ/mol

## PHASE DIAGRAMS

365. A phase diagram for a given substance shows graphically

- A. the physical state of the substance at a given temperature-pressure combination.
- B. those temperature-pressure combinations which specify the phase equilibria of the substance.
- C. the temperature above which only the gaseous state exists.
- D. all of the above.

366. At one specific temperature and pressure combination, the gas, liquid, and solid states of a given substance are in equilibrium. This T-P combination is

- A. the critical point
- B. the equilibrium point.
- C. the triple point.
- D. the co-existence point.

367. In a phase diagram, a line segment separates the liquid from the solid state. A point along this line designates a pressure of 6 atm and a temperature of  $-56^{\circ}\text{C}$ . These data tell us that

- A. the substance is a pure solid at this T and P.
- B. the substance is a pure liquid at this T and P.
- C. at 6 atm the substance melts at  $-56^{\circ}\text{C}$
- D. at 6 atm the substance freezes at  $-56^{\circ}\text{C}$
- E. C and D.

368. The triple point of water is  $0.01^{\circ}\text{C}$  and 4.58 Torr. This information tells us that at a pressure less than 4.58 Torr,

- A. ice cannot exist
- B. steam cannot exist
- C. liquid water cannot exist

#### PROPERTIES OF THE LIQUID STATE

369. A liquid's resistance to flow is termed its

- A. surface tension
- B. viscosity
- C. cohesion
- D. capillarity

370. The viscosity of a liquid is ----- and its vapor pressure is ----- by an increase in the temperature.

- A. increased, increased
- B. decreased, decreased
- C. increased, decreased
- D. decreased, increased

371. Although a needle can be made to float upon water, the addition of soap causes the needle to sink. This effect occurs because

- A. the soap lowers the viscosity of the water.
- B. the soap lowers the vapor pressure of the water.
- C. the soap lowers the surface tension of the water.
- D. the soap lowers the meniscus of the water.

#### INTERMOLECULAR FORCES

372. Intermolecular forces

- A. are electrical in nature.
- B. are weaker than chemical bonds.
- C. vary in strength depending upon the distance between molecules.
- D. vary depending upon the nature and identity of the molecules.

- E. account for the formation of the liquid and solid states.
- F. all of the above

373. The intermolecular attractive forces in Substance I are stronger than those in Substance II. Therefore,

- A. I has a lower vapor pressure than does II
- B. I has a lower heat of vaporization than does II
- C. I has a lower melting point than does II
- D. I has a lower boiling point than does II
- E. all of the above

374. Identify the intermolecular force from its description: acts on all molecules, depends upon the occurrence of an instantaneous ("snapshot") dipole which induces dipoles in surrounding molecules.

- A. dipole-dipole interactions
- B. covalent bonding
- C. hydrogen bonding
- D. London (dispersion) forces

375. Only molecules containing a N, O, or F atom experience

- A. dipole-dipole interactions
- B. covalent bonding
- C. hydrogen bonding
- D. London(dispersion) forces

376. This type of intermolecular attraction has been described as an extreme form of dipole-dipole interaction.

- A. covalent bonding
- B. hydrogen bonding
- C. London forces
- D. ionic bonds

377. Which of the following species experiences only London forces ?

- A. HCl
- B. H<sub>2</sub>O
- C. NH<sub>3</sub>
- D. CH<sub>3</sub>CH<sub>3</sub>

378. Which of the following is subject to dipole-dipole interactions?

- A. H<sub>2</sub>
- B. He
- C. CO<sub>2</sub>
- D. H<sub>2</sub>S

379. Consider an ammonia molecule. It experiences

- A. dipole-dipole interactions
- B. London forces

- C. hydrogen bonding
- D. all of the above

380. Which of the following experiences dipole-dipole interactions ? (HINT: review VSEPR)

- A. CH<sub>4</sub>
- B. SiF<sub>4</sub>
- C. TeCl<sub>4</sub>
- D. XeF<sub>4</sub>

381. In general the strongest type of intermolecular force is

- A. dipole-dipole interactions
- B. covalent bonding
- C. hydrogen bonding
- D. London or dispersion forces

382. Consider the two molecules CH<sub>3</sub>-O-CH<sub>3</sub>, an ether, and the alcohol CH<sub>3</sub>CH<sub>2</sub>OH.

- A. The alcohol has a higher vapor pressure than does the ether.
- B. The alcohol has a lower freezing point than does the ether.
- C. The alcohol has a higher boiling point than does the ether.
- D. All of the above

383. Following the usual trend the boiling points of the hydrogen halides should increase systematically from the lowest for HF to the highest for HI. Instead, HF has the highest boiling point. Which of the these explanations for HF's anomalous behavior is the accepted explanation?

- A. The HF molecule is so light in mass it possesses exceptionally high kinetic energy.
- B. The lone pairs on the F atom are drawn so close to the nucleus that the molecule experiences very weak attractive forces.
- C. The presence of the fluorine atom which is very highly polarizable causes the molecule to experience very strong London forces.
- D. The hydrogen atom of one HF molecule is strongly attracted by a lone pair of electrons on the fluorine atom of an adjacent HF molecule.

#### TYPES OF SOLIDS

384. Amorphous solids differ from crystalline solids in that

- A. crystals have a well-defined orderly structure, amorphous solids do not.
- B. crystalline solids have sharp melting points, amorphous solids do not but soften over a temperature range.

C. the particles making up a crystalline solid are restricted to specific sites in the solid, the particles making up an amorphous solid are not so restricted.

D. all of the above

385. A solid in which cations surrounded by freely moving valence electrons form the crystal lattice is a ----- solid.

A. ionic      B. network covalent      C. molecular      D. metallic

386. Diamond consists of an orderly three-dimensional array of carbon atoms forming an extremely hard solid. It is an example of a ----- solid.

A. ionic      B. network covalent      C. atomic      D. molecular      E. metallic

387. Which type of crystalline solid is SO<sub>2</sub> most likely to form ?

A. ionic      B. network covalent      C. atomic      D. molecular      E. metallic

388. Which of the following solids should have the highest melting point ?

A. argon  
B. sulfur dioxide  
C. methane  
D. sodium nitrate  
E. water

389. This solid is not a conductor of electricity but its aqueous solution is. This solid is

A. P<sub>4</sub>      B. SiO<sub>2</sub>      C. NaSCN      D. C<sub>60</sub>

390. The crystalline solid can be constructed by stacking ----- together in three dimensions.

A. crystal lattices      B. unit cells      C. repetitive cells      D. crystal boxes

391. In most -----, the crystal lattices have cubic or hexagonal structure.

A. ionic compounds      B. molecular species      C. metals      D. network covalent species.

392. A network covalent substance having a layered structure is

A. graphite      B. diamond      C. silicon      D. germanium

## SOLUTIONS-GENERAL

393. Which of the following general statements about solutions is correct ?

- A. When a gas dissolves in a liquid, the liquid is always the solvent.
- B. When a solid dissolves in a liquid, the liquid is always the solvent.
- C. When a liquid dissolves in another liquid, the liquid present in the greater amount is the solvent.
- D. All of the above.

394. At 20 degrees Celsius, the solubility of NaCl is 36.0 g per 100 g of water. To 100 g of water at this temperature, 30.0 g of NaCl is added. This solution is best described as

- A. supersaturated
- B. saturated
- C. unsaturated.
- D. dilute

395. To produce NaCl(aq) at 20 degrees Celsius, 40.0 g of NaCl is mixed with 100 g of water. Which of the following statements about this mixture is correct ?

- A. A saturated solution has formed.
- B. At the bottom of the solution sits 4.0 g of solid NaCl.
- C. the solution and the solid constitute a system in a state of dynamic equilibrium.
- D. All of the above.

396. Often as a solubility rule the phrase “like dissolves like” is used. This expression is valid because

- A. substances having about the same molecular mass tend to be mutually soluble.
- B. substances experiencing the same type of attractive forces tend to be mutually soluble.
- C. substances similar in composition tend to be mutually soluble.
- D. substances having similar equilibrium vapor pressures tend to be mutually soluble.

397. Which of the following is considered to be insoluble in water ?

- A. NH<sub>3</sub>(g)
- B. C<sub>2</sub>H<sub>5</sub>OH(l)
- C. CH<sub>4</sub>(g)
- D. CaCl<sub>2</sub>(s)

398. Benzene is a liquid hydrocarbon. Predict which of the following is most likely to be soluble in benzene ?

- A.  $\text{H}_2\text{O}(\text{l})$     B.  $\text{C}_6\text{H}_{14}(\text{l})$     C.  $\text{CH}_3\text{COOH}(\text{l})$     D.  $\text{CH}_3\text{OH}(\text{l})$

399. When an ionic compound dissolves in water, the ----- is released.

- A. lattice energy    B. energy of hydration    C. vaporization energy    D. bond energy

400. The two energy changes that influence the formation of aqueous solutions of ionic compounds are

- A. ionization energy and electron affinity  
B. ionization energy and hydration energy  
C. electron affinity and hydration energy  
D. electron affinity and lattice energy  
E. hydration energy and lattice energy

401. Which of the following cations experiences the greatest energy of hydration ?

- A.  $\text{Li}^+$     B.  $\text{Na}^+$     C.  $\text{K}^+$     D.  $\text{Rb}^+$

402. Which of the following ions experiences the greatest energy of hydration ?

- A.  $\text{Na}^+$     B.  $\text{Mg}^{+2}$     C.  $\text{Al}^{3+}$     D.  $\text{N}^{3-}$

403. Which of the following compounds possesses the greatest lattice energy ?

- A.  $\text{Mg}(\text{OH})_2$     B.  $\text{Ca}(\text{OH})_2$     C.  $\text{Sr}(\text{OH})_2$     D.  $\text{Ba}(\text{OH})_2$

#### EFFECT OF T AND P ON SOLUTIONS

404. A gas is most soluble in a liquid at

- A. low temperature and low pressure  
B. high temperature and high pressure  
C. low temperature and high pressure  
D. high temperature and low pressure

405. High temperatures increase the solubility in water of most

- A. gases    B. ionic compounds    C. hydrocarbons

406. When ammonium nitrate dissolves in water the solution cools because the solution process is

- A. endoentropic    B. exoentropic    C. endothermic    D. exothermic

407. Acetylene gas at room temperature dissolves to the extent of 320 g per liter of liquid acetone at 12 atm pressure. Determine the Henry's law constant for acetylene in acetone at room temperature.

A. 0.0375 L atm/g B. 26.7 g/L atm C. 3840 g atm/L D. 0.260 L/g atm

408. Calculate the solubility of acetylene in acetone at room temperature and a pressure of 5 atm.

A. 187 g/L B. 195 g/L C. 134 g/L D. 173 g/L

#### SOLUTIONS - CONCENTRATION UNITS

409. Which of the following concentration units changes with changes in temperature ?

A. mass percent B. mole fraction C. molarity D. molality E. ppm

410. A solution is prepared by dissolving 0.100 mole of HCl in 75.0 g of water. Calculate the mass percent HCl in this solution.

A. 0.133% B. 4.64% C. 4.87% D. 4.01%

411. Any mixture of gases is a solution. Such a solution is prepared by mixing 10.0 g of He, 10.0 g of Ne, and 10.0 g of Ar. The mole fraction of Ar in this mixture is

A. 0.0769 B. 0.333 C. 0.156 D. 0.00321

412. A solution is prepared by dissolving 10.0 g of HCl in sufficient water to produce 150 mL of solution. Calculate the molarity of this solution.

A. 0.194M B. 1.83M C. 6.67M D. 3.22M

413. A solution is prepared by dissolving 20.0 g of NaOH in 750 g. of water. The molality of this solution is

A. 26.7m B. 0.0267m C. 0.667m D. 0.000667m

414. A 50.0% by mass solution of  $\text{HNO}_3(\text{aq})$  has a density of 1.31g/mL. Calculate the molarity of this solution.

A. 10.4M B. 14.7M C. 11.5M D. 9.77M

415. Calculate the molality of the 50.0% nitric acid solution.

- A. 19.1m      B. 16.7m      C. 15.9m      D. 10.4m

416. Calculate the mole fraction of nitric acid in 50.0% nitric acid solution.

- A. 0.794      B. 0.195      C. 0.500      D. 0.222

417. The antiseptic  $\text{H}_2\text{O}_2(\text{aq})$  is 0.655 molal in the hydrogen peroxide. Calculate the mole fraction of peroxide present.

- A. 0.0118      B. 0.0116      C. 0.119      D. 0.211

### COLLIGATIVE PROPERTIES

418. Colligative properties are the properties of a solution that depend upon

- A. the identity of the solute particles present in the solution.
- B. the size of the solute particles.
- C. the identity of the solvent of the solution.
- D. the size of the solvent particles.
- E. the number of solute particles present.
- F. the number of solvent particles present.

419. Colligative properties include

- A. vapor pressure lowering
- B. boiling point elevation
- C. freezing point depression
- D. osmotic pressure
- E. all of the above

420. A nonvolatile, nonelectrolyte in the amount of 0.0900 mole is dissolved in 100.0 g of water. Given that to  $25^\circ\text{C}$ , the vapor pressure of pure water is 23.8 Torr, calculate the vapor pressure of the solution.

- A. 23.8 Torr      B. 0.379 Torr      C. 23.4 Torr      D. 0.369 Torr

421. Calculate the freezing point in  $^\circ\text{C}$  of a solution containing 0.0100 mole of a nonelectrolyte in 100.0 g of water.

- A. -0.186      B. +0.186      C. 0.010      D. -0.010

422. Calculate the boiling point of the solution of Question 421.

- A. 100.05°C    B. 100.20°C    C. 99.95°C    D. 99.80°C

423. The freezing point of a solution of a nonelectrolyte in benzene (m.p.: 5.455°C; freezing point depression constant: 5.065°C) is 4.200°C. Calculate the molality of this solution.

- A. 0.159m    B. 0.591m    C. 0.248m    D. 0.721m

424. Given that benzene has a normal boiling point of 80.2°C and a boiling point elevation constant of 2.61°C/m, the solution of Question 423 will boil at

- A. 80.8°C.    B. 79.6°C.    C. 80.6°C    D. 79.8°C.

425. Calculate the osmotic pressure of a 0.0010 M solution of a nonelectrolyte at 25°C.

- A. 1.6 mmHg    B. 7.3 mmHg    C. 14 mmHg    D. 19 mmHg

426. Calculate the molarity of a solution having an osmotic pressure of 360 Torr at 25°C.

- A. 1.44 M    B.  $1.94 \times 10^{-2}$  M    C.  $3.04 \times 10^{-4}$  M    D. 0.721 M

## COLLOIDS

427. The scattering of light by colloidal-size particles is termed

- A. Brownian motion    B. the Tyndall effect    C. coagulation    D. homogenation

428. A micelle is an example of

- A. a hydrophobic colloid  
B. an association colloid  
C. a hydrophilic colloid  
D. a hemophilic colloid

429. In general, colloidal particles remain dispersed because of

- A. their size    B. their mass    C. their rapid motion    D. their electric charge

430. An emulsion is a colloid in which

- A. a gas is dispersed in a liquid

- B. a liquid is dispersed in a gas
- C. a liquid is dispersed in a liquid
- D. a solid is dispersed in a liquid.

431. Smoke is an example of a colloid termed

- A. a foam
- B. an aerosol
- C. a gel
- D. sol

