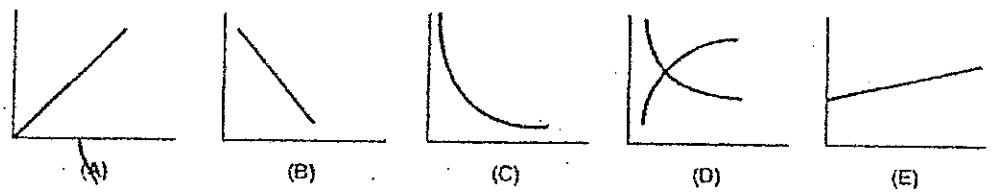
# Practice Test 4

Note: For all questions involving solutions and/or chemical equations, assume that the system is in water unless otherwise stated.

## Part A

Directions: Each set of lettered choices below refers to the numbered statements or formulas immediately following it. Select the one lettered choice that best fits each statement or formula and then fill in the corresponding oval on the answer sheet. A choice may be used once, more than once, or not at all in each set.

Questions 1–3 refer to the following graphs:




1. The graph that best shows the relationship of gas volume to temperature, with pressure held constant
2. The graph that best shows the relationship of gas volume to pressure, with temperature held constant
3. The graph that best shows the relationship of the number of grams of solute that is soluble in 100 grams of $H_2O$ at varying temperatures if the solubility begins at a small quantity and increases at a slow, steady pace as the temperature is increased

Questions 4–7

(A) A molecule
(B) A mixture of compounds
(C) An isotope
(D) An isomer
(E) An acid salt

4. The simplest unit of water that retains its properties
5. A commercial cake mix
6. An atom with the same number of protons as another atom of the same element but a different number of neutrons
7. Classification of $NaHCO_3$

Questions 8–10

(A) 1
(B) 7
(C) 9
(D) 10
(E) 14

8. The atomic number of an atom with an electron dot arrangement similiar to :Ī:
9. The number of atoms represented in the formula $Al(OH)_3$
10. The number that represents the most acid pH

Questions 11–14

(A) Density
(B) Equilibrium constant
(C) Molar mass
(D) Freezing point
(E) Molarity

11. Can be expressed in moles of solute per liter of solution
12. Can be expressed in grams per liter of a gas
13. Will NOT be affected by changes in temperature and pressure
14. At STP, can be used to determine the molecular mass of a pure gas

Questions 15–18

(A) Buffer
(B) Indicator
(C) Arrhenius acid
(D) Arrhenius base
(E) Neutral condition

15. Resists a rapid change of pH
16. Exhibits different colors in acidic and basic solutions
17. At 25°C, the aqueous solution has a pH < 7.
18. At 25°C, the aqueous solution has a pH > 7.

Questions 19–23

(A) $H_2$
(B) $NH_3$
(C) $CO_2$
(D) HCl
(E) $O_2$

19. A gas produced by the reaction of zinc with hydrochloric acid
20. A gas combustion product that is heavier than air
21. A gas produced by the heating of potassium chlorate
22. A gas that is slightly soluble in water and gives a weakly acid solution
23. A gas that is very soluble in water and gives a weakly basic solution

Part B

ON THE ACTUAL CHEMISTRY TEST, THE FOLLOWING TYPE OF QUESTION MUST BE ANSWERED ON A SPECIAL SECTION (LABELED "CHEMISTRY") AT THE LOWER LEFT-HAND CORNER OF PAGE 2 OF YOUR ANSWER SHEET. THESE QUESTIONS WILL BE NUMBERED BEGINNING WITH 101 AND MUST BE ANSWERED ACCORDING TO THE FOLLOWING DIRECTIONS.

Directions: Each question below consists of two statements, I in the left-hand column and II in the right-hand column. For each question, determine whether statement I is true or false and if statement II is true or false and fill in the corresponding T or F ovals on your answer sheet. Fill in oval CE only if statement II is a correct explanation of statement I.

**Sample Answer Grid:**

CHEMISTRY * Fill in oval CE only if II is a correct explanation of I.

| | I | II | CE* |
|---|---|---|---|
| 101. | (T) (F) | (T) (F) | ◯ |

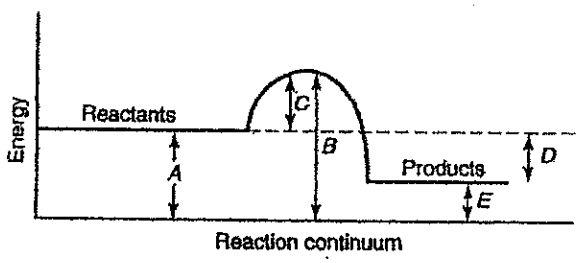
| | | |
|---|---|---|
| 101. | According to the Kinetic Molecular Theory, the particles of a gas are in random motion above absolute zero | BECAUSE the degree of random motion of gas molecules varies inversely with the temperature of the gas. |
| 102. | An electron has wave properties as well as corpuscular properties | BECAUSE the design of a particular experiment determines which properties are verified. |
| 103. | The alkanes are considered a homologous series | BECAUSE homologous series have the same functional group but differ in formula by the addition of a fixed group of atoms. |
| 104. | When an atom of an active metal becomes an ion, the radius of the ion is less than that of the atom | BECAUSE the nucleus of an active metallic ion has less positive charge than the electron "cloud." |
| 105. | When the heat of formation for a compound is negative, $\Delta H$ is negative | BECAUSE a negative heat of formation indicates that a reaction is exothermic with a negative enthalpy. |
| 106. | Water is a polar substance | BECAUSE the sharing of the bonding electrons in water is equal. |
| 107. | A catalyst accelerates a chemical reaction | BECAUSE a catalyst lowers the activation energy of the reaction. |
| 108. | Copper is an oxidizing agent in the reaction with silver nitrate solution | BECAUSE copper loses electrons in a reaction with silver ions. |
| 109. | The rate of diffusion (or effusion) of hydrogen gas compared with that of helium gas is 1 : 4 | BECAUSE the rate of diffusion (or effusion) of gases varies inversely as the square root of the molecular mass |
| 110. | A gas heated from 10°C to 100°C at constant pressure will increase in volume | BECAUSE as Charles's Law states, if the pressure remains constant, the volume varies directly as the absolute temperature varies. |

| | | |
|---|---|---|
| 111. The Gibbs free-energy equation can be used to predict the solubility of a solute | BECAUSE | the solubility of most salts increases as temperature increases. |
| 112. The complete electrolysis of 45 grams of water will yield 40 grams of $H_2$ and 5 grams of $O_2$ | BECAUSE | water is composed of hydrogen and oxygen in a ratio of 8 : 1 by mass. |
| 113. 320 calories of heat will melt 4 grams of ice at 0°C | BECAUSE | the heat of fusion of water is 80 calories per gram. |
| 114. When 2 liters of oxygen gas react with 2 liters of hydrogen completely, the limiting factor is the volume of the oxygen | BECAUSE | the coefficients in balanced equations of gaseous reactions give the volume relationships of the envolved gases. |
| 115. Water is a good solvent | BECAUSE | water shows hydrogen bonding between oxygen atoms. |
| 116. Ammonia gas, $NH_3$, has a smaller density than argon gas, Ar, at STP | BECAUSE | the density of a gas at STP is found by dividing the molar mass by 22.4 liters. |

## Part C

Directions: Each of the questions or incomplete statements below is followed by five suggested answers or completions. Select the one that is best in each case and then fill in the corresponding oval on the answer sheet.

40. In this graphic representation of a chemical reaction, which arrow depicts the activation energy?
    (A) *A*
    (B) *B*
    (C) *C*
    (D) *D*
    (E) *E*




41. How many liters (STP) of $O_2$ can be produced by completely decomposing 2 moles of $KClO_3$?
    (A) 11.2
    (B) 22.4
    (C) 33.6
    (D) 44.8
    (E) 67.2

42. Which of the following is the correct structural representation of sodium?

(A) $^{11\ p}_{11\ n}$ Nucleus and orbital notation: $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 4p^5$

(B) $^{11\ p}_{12\ n}$ Nucleus and orbital notation: $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^1, 4p^2$

(C) $^{23\ p}_{23\ n}$ Nucleus and orbital notation: $1s^2, 2s^2, 2p^6, 3s^1$

(D) $^{23\ p}_{23\ n}$ Nucleus and orbital notation: $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^3, 4s^2$

(E) $^{11\ p}_{12\ n}$ Nucleus and orbital notation: $1s^2, 2s^2, 2p^6, 3s^1$

43. Which of the following statements is true?

(A) A catalyst cannot lower the activation energy.
(B) A catalyst can lower the activation energy.
(C) A catalyst affects only the activation energy of the forward reaction.
(D) A catalyst affects only the activation energy of the reverse reaction.
(E) A catalyst is permanently changed after the activiation energy is reached.

44. If the molecular mass of $NH_3$ is 17, what is the density of this compound at STP?

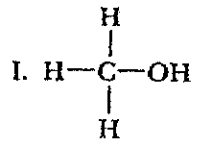
(A) 0.25 g/L
(B) 0.76 g/L
(C) 1.52 g/L
(D) 3.04 g/L
(E) 9.11 g/L

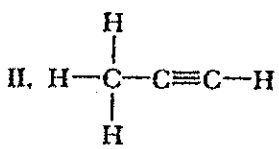
45. Which bond(s) is (are) ionic?

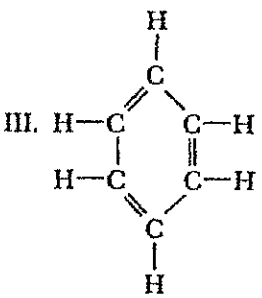
I. H—Cl(g)
II. S—Cl(g)
III. Cs—F(s)

(A) I only
(B) III only
(C) I and II only
(D) II and III only
(E) I, II, and III

46. Aromatic hydrocarbons are represented by which of the following?

I. 

II. 

III. 

(A) I only
(B) III only
(C) I and II only
(D) II and III only
(E) I, II, and III

47. According to placement in the periodic table, which statement(s) regarding the first ionization energies of certain elements should be true?
    I. Li has a higher value than Na.
    II. K has a higher value than Cs.
    III. Na has a higher value than Al.
    (A) I only
    (B) III only
    (C) I and II only
    (D) II and III only
    (E) I, II, and III

48. Correctly expressed half-reactions include which of the following?
    I. $CrO_4^{2-} + 8H^+ + 6e^- \rightarrow Cr^{3+} + 4H_2O$
    II. $I^- + 6OH^- \rightarrow IO_3^- + 3H_2O + 6e^-$
    III. $MnO_4^- + 2H_2O + 3e^- \rightarrow MnO_2 + 4OH^-$
    (A) I only
    (B) III only
    (C) I and II only
    (D) II and III only
    (E) I, II, and III

Questions 49–51. What is the apparent oxidation number of the underlined element in the compound

49. $Na\underline{N}O_3$?
    (A) +1
    (B) +2
    (C) +3
    (D) +4
    (E) +5

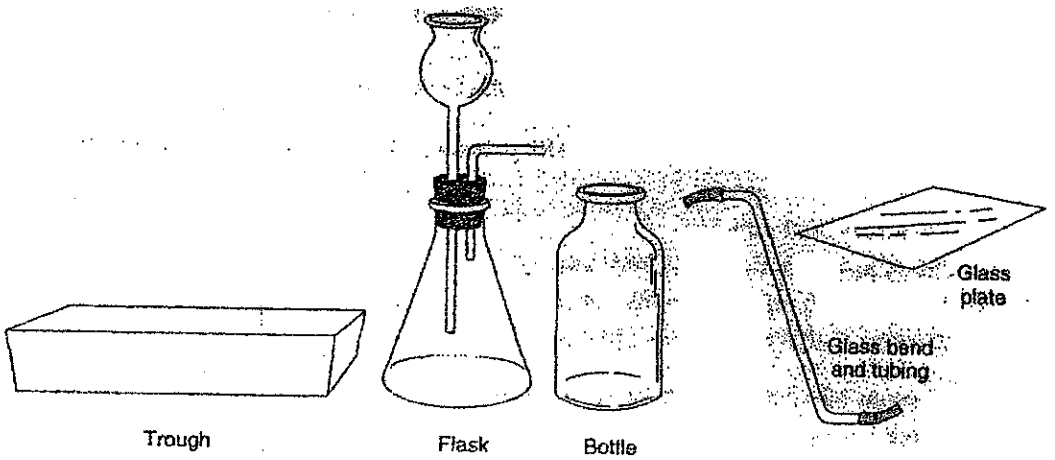
50. $\underline{Ca}SO_4$?
    (A) +1
    (B) −1
    (C) +2
    (D) −2
    (E) +3

51. $\underline{N}H_3$?
    (A) +2
    (B) −2
    (C) +3
    (D) −3
    (E) +5

52. An atom with an orbital notation of $1s^2$, $2s^2$, $2p^6$, $3s^2$, $3p^4$ will probably exhibit which oxidation state?
    (A) +2
    (B) −2
    (C) +3
    (D) −3
    (E) +5

53. In the Lewis dot structure $\dot{X}:$, what is the predictable oxidation number?
    (A) +1
    (B) −1
    (C) +2
    (D) −2
    (E) +3

Questions 54–57 refer to the following apparatus assembled by a student:

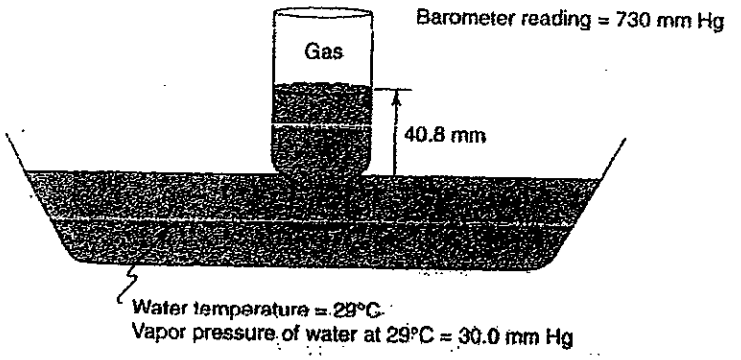



54. The apparatus assembled is used to prepare a gas by a reaction that takes place when a solid
    (A) is heated
    (B) is exposed
    (C) reacts with a liquid
    (D) is heated in a vacuum
    (E) is decomposed by a catalyst

55. This apparatus suggests that the student plans to collect a gas that
    (A) supports combustion
    (B) is heavier than air
    (C) is not flammable
    (D) is insoluble in water
    (E) reacts with water

56. If the student planned to prepare hydrogen, what would also be needed?
    (A) mercuric oxide
    (B) acid plus zinc
    (C) potassium chlorate
    (D) carbon disulfide
    (E) benzene

57. If you collected hydrogen gas by the displacement of water and under the conditions shown:




which of the following would give you the pressure of the hydrogen in the bottle?

(A) 730 mm – 40.8 mm
(B) 730 mm – 30.0 mm
(C) 730 mm – 30 mm/13.6 + 40.8 mm
(D) 730 mm – 30 mm/13.6 – 40.8 mm
(E) 730 mm – 40.8 mm/13.6 – 30.0 mm

58. What occurs when a reaction is at equilibrium and more reactant is added to the container?

(A) The equilibrium remains unchanged.
(B) The forward reaction rate increases.
(C) The reverse reaction rate increases.
(D) The forward reaction rate decreases.
(E) The reverse reaction rate decreases.

59. How much heat energy is released when 8 grams of hydrogen are burned? The thermal equation is: $2H_2 + O_2 \rightarrow 2H_2O + 136.64$ kcal.

(A) 68.32 kcal
(B) 102.48 kcal
(C) 136.64 kcal
(D) 273.28 kcal
(E) 546.56 kcal

60. Would a spontaneous reaction occur between zinc *ions* and gold *atoms*?

$Zn^{2+} + 2e^- \rightleftharpoons Zn^0 \quad E^0 = -0.76$ volt
$Au^{3+} + 3e^- \rightleftharpoons Au^0 \quad E^0 = +1.42$ volts

(A) yes—Reaction potential 2.18 V
(B) no—Reaction potential –2.18 V
(C) yes—Reaction potential 0.66 V
(D) no—Reaction potential –0.66 V
(E) yes—Reaction potential 0.56 V

61. Four moles of electrons ($4 \times 6.02 \times 10^{23}$ electrons) would electroplate how many grams of silver from a silver nitrate solution?

(A) 108
(B) 216
(C) 324
(D) 432
(E) 540

62. A 5 M solution of HCl has how many moles of $H^+$ ion in 1 liter?
(A) 0.5
(B) 1.0
(C) 2.0
(D) 2.5
(E) 5.0

63. What is the $K_{sp}$ for silver acetate if a saturated solution contains $2 \times 10^{-3}$ moles of silver ion/liter of solution?
(A) $2 \times 10^{-5}$
(B) $2 \times 10^{-6}$
(C) $4 \times 10^{-5}$
(D) $4 \times 10^{-6}$
(E) $4 \times 10^{6}$

64. The following data were obtained for $H_2O$ and $H_2S$:

| | *Formula Mass* | *Freezing Point (°C)* | *Boiling Point (°C)* |
|---|---|---|---|
| $H_2O$ | 18 | 0 | 100 |
| $H_2S$ | 34 | −83 | −60 |

What is the best explanation for the variation of physical properties between these two compounds?
(A) The $H_2S$ has stronger bonds between molecules.
(B) The $H_2O$ has a great deal of hydrogen bonding.
(C) The bond angles differ by about 15°
(D) The formula mass is of prime importance.
(E) The oxygen atom has a smaller radius and thus cannot bump into other molecules as often as the sulfur.

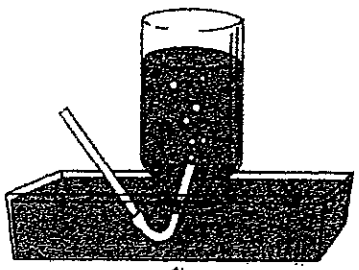
65. What is the pH of a solution that has 0.00001 mole of $H_3O^+$/liter of solution?
(A) 2
(B) 3
(C) 4
(D) 5
(E) 9

66. How many grams of sulfur are present in 1 mole of $H_2SO_4$?
(A) 2
(B) 32
(C) 49
(D) 64
(E) 98

67. What is the approximate mass, in grams, of 1 liter of nitrous oxide, $N_2O$, at STP?
(A) 1
(B) 2
(C) 11.2
(D) 22
(E) 44

68. If the simplest formula of a substance is $CH_2$ and its molecular mass is 56, what is its true formula?
    (A) $CH_2$
    (B) $C_2H_4$
    (C) $C_3H_4$
    (D) $C_4H_8$
    (E) $C_5H_{10}$

Questions 69 and 70 refer to the following diagrams of two methods of collecting gases:


1


2

69. Method 1 is best suited to collect
    (A) a gas heavier than air
    (B) a gas lighter than air
    (C) a gas that is insoluble in water
    (D) a gas that is soluble in water
    (E) a gas that has a distinct color

70. Which of these gases, because of its density and solubility, should be collected by Method 2?
    (A) $NH_3$
    (B) $H_2$
    (C) HCl
    (D) $CO_2$
    (E) He

71. What is the molar mass of $CaCO_3$?
    (A) 68 g/mol
    (B) 75 g/mol
    (C) 82 g/mol
    (D) 100 g/mol
    (E) 116 g/mol

72. What volume, in liters, will be occupied at STP by 4 grams of $H_2$?
    (A) 11.2
    (B) 22.4
    (C) 33.6
    (D) 44.8
    (E) 56.0

73. How many moles of KOH are needed to neutralize 196 grams of sulfuric acid? ($H_2SO_4$ = 98 amu)
    (A) 1.0
    (B) 1.5
    (C) 2.0
    (D) 4.0
    (E) 6.0

74. What volume, in liters, of $NH_3(g)$ is produced when 22.4 liters of $N_2(g)$ are made to combine completely with a sufficient quantity of $H_2(g)$ under appropriate conditions?
(A) 11.2
(B) 22.4
(C) 44.8
(D) 67.0
(E) 78.2

75. What volume, in liters, of $SO_2$ will result from the complete burning of 64 grams of sulfur?
(A) 2
(B) 11.2
(C) 44.8
(D) 126
(E) 158

76. The amount of energy required to melt 5 grams of ice at 0°C would also heat 1 gram of water at 4°C to what condition? (Heat of fusion = 80 cal/g; heat of vaporization = 540 cal/g)
(A) water at 90°C
(B) water at 100°C
(C) steam at 100°C
(D) Part of the water would be vaporized to steam.
(E) All of the water would be vaporized to steam.

77. How many moles of electrons are needed to electroplate a deposit of 0.5 mole of silver from a silver nitrate solution?
(A) 0.5
(B) 1
(C) 27
(D) 54
(E) 108

78. All of the following statements about carbon dioxide are true EXCEPT:
(A) It can be prepared by the action of acid on $CaCO_3$.
(B) It is used in fire extinguishers.
(C) It dissolves in water at room temperature.
(D) It sublimes rather than melts at 20°C and 1 atm pressure.
(E) It is a product of photosynthesis in plants.

79. Three moles of $H_2$ and 3 moles of $I_2$ are introduced into a liter box at a temperature of 490°C. What will the $K_{eq}$ expression be for this reaction? ($K_{eq} = 45.9$)

(A) $K_{eq} = \dfrac{[H_2][I_2]}{[HI]}$

(B) $K_{eq} = \dfrac{[HI]}{[H_2][I_2]}$

(C) $K_{eq} = \dfrac{2x}{(x)(x)}$

(D) $K_{eq} = \dfrac{(2x)^2}{(3-x)^2}$

(E) $K_{eq} = \dfrac{(3-x)^2}{(2x)^2}$

80. If the following reaction has achieved equilibrium in a closed system:
$N_2O_4(g) \rightleftharpoons 2\ NO_2(g)$
which of the following is (are) increased by decreasing the size of the container?
I. The value of $K_{eq}$
II. The concentration of $N_2O_4(g)$
III. The rate of the reverse reaction
(A) I only
(B) III only
(C) I and II only
(D) II and III only
(E) I, II, and III

81. Which of the following correctly completes this nuclear reaction: ${}^{14}_{7}N + {}^{4}_{2}He \rightarrow \cdots + {}^{1}_{1}H$?
(A) ${}^{17}_{8}O$
(B) ${}^{16}_{9}O$
(C) ${}^{17}_{8}N$
(D) ${}^{17}_{7}N$
(E) ${}^{16}_{8}O$

82. How many grams of NaCl will be needed to make 100 milliliters of 2 M solution?
(A) 5.85
(B) 11.7
(C) 29.2
(D) 58.5
(E) 117

83. How many grams of $H_2SO_4$ are in 1,000 grams of a 10% solution? (1 mol of $H_2SO_4 = 98$ g)
(A) 1.0
(B) 9.8
(C) 10
(D) 98
(E) 100

84. If 1 mole of ethyl alcohol in 1,000 grams of water depresses the freezing point by 1.86° Celsius, what will be the freezing point of a solution of 1 mole of ethyl alcohol in 500 grams of water?
(A) −0.93°C
(B) −1.86°C
(C) −2.79°C
(D) −3.72°C
(E) −5.58°C

85. Which nuclear reaction shows the release of a beta particle?
(A) ${}^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{93}_{36}Kr + {}^{140}_{58}Ba + 3\ {}^{1}_{0}n$
(B) ${}^{210}_{84}Po \rightarrow {}^{206}_{82}Pb + {}^{4}_{2}He$
(C) ${}^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}\beta$
(D) ${}^{106}_{47}Ag + {}^{0}_{-1}e \rightarrow {}^{106}_{46}Pd$
(E) ${}^{58}_{19}K \rightarrow {}^{58}_{18}Ar + {}^{0}_{+1}\beta$

**STOP**

IF YOU FINISH BEFORE ONE HOUR IS UP, YOU MAY GO BACK TO CHECK YOUR WORK OR COMPLETE UNANSWERED QUESTIONS.

# Answers and Explanations for Test 4

1. (A) The volume of a gas increases as temperature increases provided that pressure remains constant. This is a direct proportion. Heating a balloon is a good example.
2. (B) The volume of a gas decreases as the pressure is increased provided that the temperature is held constant. This is shown by the inversely proportional curve in (B). Pressure increase on a closed cylinder is a good example.
3. (E) The graph shows that there is a starting quantity in solution, and a slight positive slope to the right indicates a directly proportional change in solubility as temperature rises.
4. (A) This is the definition of any molecule.
5. (B) A commercial cake mix is a mixture of ingredients.
6. (C) This is the definition of an isotope.
7. (E) An acid salt contains one or more H atoms in the salt formula separating a positive ion and the hydrogen-bearing negative ion. For example, $Na_2SO_4$ is a *normal* salt and $NaHSO_4$ is an *acid* salt because of the presence of H in the hydrogen sulfate ion.
8. (C) An atom with atomic number 9 would have a 2,7 electron configuration, which matches the outer energy level of iodine.
9. (B) Three $(OH)^-$ each have 2 atoms = 6 atoms plus one Al = 7.
10. (A) pH from 1 to 6 is acid, 7 neutral, 8 to 14 basic. Most acid is 1.
11. (E) Molarity is defined as moles of solute/liter of solution.
12. (A) Gas densities can be expressed in grams/liter.
13. (C) Molar mass is not affected by pressure and temperature.
14. (A) If the density of a gas is known, the mass of 1 L can be multiplied by 22.4 to find the molecular mass because 1 mol occupies 22.4 L at STP.
15. (A) Buffers resist changes in pH.
16. (B) Color change is the function of indicators.
17. (C) On the pH scale, from 1 to 6 is acid and 7 is neutral.
18. (D) On the pH scale, from 8 to 14 is basic.
19. (A) $Zn + 2HCl \rightarrow ZnCl_2 + H_2(g)$ is the reaction that occurs.
20. (C) Only $CO_2$, with a molecular mass of 44, is heavier than air, for which the molecular mass is 29.
21. (E) $2KClO_3 \rightarrow 2KCl + 3O_2(g)$ is the reaction that occurs.
22. (C) $CO_2$ is slightly soluble in water, forming carbonic acid, $H_2CO_3$, which is a weak acid.
23. (B) $NH_3$ is very soluble in water, and forms a solution of the weak ammonium hydroxide base.

101. (T, F) The assertion is true, but the degree of motion of gas molecules is directly related to the temperature.
102. (T, T, CE) Assertion and reason are true; an electron can be treated as either an electromagnetic wave or a bundle of negative charge.
103. (T, T) A homologous series increases each member by a constant number of carbons and hydrogens. Examples are the alkane, alkene, and alkyne series, which each increase the chain by a $CH_2$ group. The reason is true but does not explain the assertion.
104. (T, F) The nuclear charge of an active metallic ion is greater than that of the electron cloud. The reason is false.
105. (T, T, CE) A negative heat of formation indicates that the reaction is exothermic and the enthalpy is negative.
106. (T, F) Water is a polar molecule because there is unequal, not equal, sharing of bonding electrons.
107. (T, T, CE). This is a function of a catalyst—to either speed up or slow down a reaction without permanent change to itself. Assertion and reason are true.

108. (F, T) The Cu is losing electrons and thus being oxidized; the assertion is false. It is furnishing electrons and thus is a reducing agent; the reason is true.

109. (F, T) $H_2 = 2$, He = 4 (molecular mass); then inversely $\sqrt{4} : \sqrt{2} = 2 : \sqrt{2}$ is the rate of diffusion of hydrogen to helium. The assertion is false; the reason, true.

110. (T, T, CE) Since the gas is being heated at constant pressure, it expands. The temperatures are converted to kelvins (K) by adding 273° to the Celsius readings. The fraction must be $\frac{373}{273}$ and this will increase the volume.

111. (F, T) Gibbs free energy is useful in indicating the conditions under which a chemical reaction will occur. It is not related to solubility. It is true that, generally speaking, solubility of a solute increases with an increase in the temperature of the solvent.

112. (F, F) Water is $\frac{1}{9}$ hydrogen and $\frac{8}{9}$ oxygen by weight. Both assertion and reason are false.

113. (T, T, CE) Four grams of ice would require $4 \times 80$ cal/g or 320 cal to melt the ice.

114. (F, T) The reaction is: $2H_2 + O_2 \rightarrow 2H_2O$. The coefficients of this gaseous reaction show that 2 liters of hydrogen react with 1 liter of oxygen. This would leave 1 liter of unreacted oxygen. The limiting factor is the hydrogen.

115. (T, F) The reason why water is a good solvent is false.

116. (T, T, CE) The density of a gas at STP is found by dividing the molecular mass by 22.4 L. $NH_3$ has a gram-molecular mass of N = 14 + 3H = 3 or a total of 17 g. The gram-molecular mass of Ar is 40 g. The density of each can be found by dividing by 22.4 L, but obviously the density of the ammonia will be smaller.

40. (C) The energy necessary to get the reaction started, which is the activation energy, is shown at *C*.

41. (E) $2KClO_3 \rightarrow 2KCl + 3O_2(g)$ shows that 2 mol of $KClO_3$ yield 3 mol of $O_2$.

$$2 \text{ mol} \times \frac{22.4 \text{ L}}{1 \text{ mol}} = 67.2 \text{ L}$$

42. (E) The atomic number gives the number of protons in the nucleus and the total number of electrons. The atomic mass indicates the total number of protons and neutrons in the nucleus—for Na, 23 (11 protons + 12 neutrons).

43. (B) A catalyst can speed up a reaction by lowering the activation energy needed to start the reaction and then keep it going.

44. (B) $\text{Density} = \frac{\text{Mass}}{\text{Volume}}$. For gases this is expressed as grams per liter. Since 1 gram-molecular mass of a gas occupies 22.4 L, 17 g/22.4 L = 0.76 g/L.

45. (B) Choice III is made up of elements from extreme sides of the periodic table and will therefore form ionic bonds.

46. (B) Only III is a ring hydrocarbon of the aromatic series.

47. (C) Since Li is higher in Group 1 than Na, and K is higher than Cs, they have smaller radii and hence higher ionization energies. Al is to the right of Na and therefore has a higher ionization energy.

48. (D) Only II and III are correctly balanced. To be correct, I should have only $3e^-$.

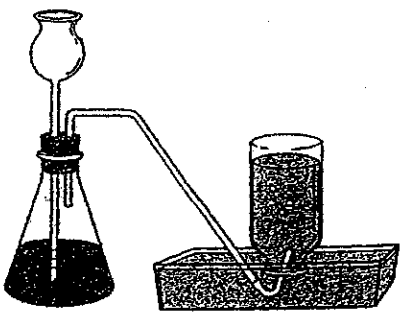
49. (E)
50. (C)
51. (C)

These answers are based on the fact that the total of the assigned oxidation numbers times their occurrence for all the atoms in a compound is zero.

52. (B) This orbital notation shows 6 electrons in the third energy level. The atom would like to gain $2e^-$ to fill the 3*p* and thereby gain a −2 charge.

53. (C) With this structure, the atom would tend to lose these electrons and get a +2 charge.

54. (C) Assembled, the apparatus would look like this:



and could be used to prepare a gas by reacting a solid with a liquid.

55. (D) The setup depends on the property of insolubility of the gas collected over water.

56. (B) An acid plus zero would also be needed to prepare hydrogen.

57. (E) The pressure in the bottle would be less than atmospheric pressure by the Hg equivalent height of the 30 mm of water above the level in the collecting pan. This is calculated as 40.8 mm water/(13.6 mm water/1 mm Hg) and must be subtracted from atmospheric pressure. The other adjustment is to subtract the vapor pressure of water that is in the hydrogen gas since it was collected over water. This pressure is given as 30.0 mm Hg. Subtracting each of these from 730 mm Hg, the given atmospheric pressure, you have 730 mm − 40.8 mm/13.6 − 30.0 mm.

58. (B) The equilibrium shifts in the direction that tends to relieve the stress and thus regain equilibrium.

59. (D) The thermal reaction shows 2 mol of hydrogen reacting, or 4 g. Therefore 8 g would release twice the amount of energy; 2 × 136.64 kcal = 273.28 kcal.

60. (B) The reaction potential calculation would be:

$$\begin{array}{ll} Zn^{2+} + 2e^- \rightarrow Zn^0 & E^0 = -0.76\ V \\ Au^0 \rightarrow Au^{3+} + 3e^- & E^0 = -1.42\ V \\ \hline Zn^{2+} + Au^0 \rightarrow Zn^0 + Au^{3+} & E^0 = -2.18\ V \end{array}$$

61. (D) Since $Ag^+ + 1e^- \rightarrow Ag^0$, 1 mol of electrons yields 1 mol of silver; 1 mol silver = $6.02 \times 10^{23}$ atoms $4 \times 108$ g/mol = 432 g

62. (E) $5\ M = \frac{5\ mol}{L}$, and since HCl ionizes completely there would be 5 mol of $H^+$ and 5 mol of $Cl^-$ ions.

63. (D) $K_{sp} = [Ag^+][C_2H_3O_2^-]$
$= [2 \times 10^{-3}][2 \times 10^{-3}]$
(Since
$AgC_2H_3O_2 \rightleftharpoons Ag^+ + C_2H_3O_2^-$
the silver ion and acetate ion concentrations are equal.)
$K_{sp} = 4 \times 10^{-6}$

64. (B) It is the explanation for the observed high boiling point and high freezing point of water compared with hydrogen sulfide.

65. (D) $pH = -\log [H^+]$
$= -\log [10^{-5}] = -[-5] = 5$

66. (B) 1 mol $H_2SO_4$ contains 1 molar mass of sulfur, that is, 32 g.

67. (B) $N_2O = 44$ g/mol
$(2 \times 14 + 16 = 44)$
1 mol of a gas occupies 22.4 L, so 44 g/22.4 L = 1.99 g/L.

68. (D) $CH_2 = 14$
(12 + 2 = 14 molecular mass)
56 ÷ 14 = 4
Then $4 \times CH_2 = C_4H_8$

69. (C) Only insoluble gases can be collected in this way.

70. (C) HCl is very soluble in water and heavier than air, so it is suited to the No. 2 collection method.

71. (D) Ca = 40
C = 12
3O = 48
100 g/mol

72. (D) Gram-molecular mass of $H_2$ is 2 g. 4 g is 2 mol, and each mole occupies 22.4 L. 2 × 22.4 = 44.8 L.

$x$ mol 196 g

73. (D) $2KOH + H_2SO_4 \rightarrow K_2SO_4 + 2H_2O$
2 mol 98 g
$\frac{x\ mol}{2\ mol} = \frac{196\ g}{98\ g}$
Then $x = 4.0$ mol.

22.4 L $x$ L

74. (C) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$
1 L 2 L
$\frac{22.4\ L}{1\ L} = \frac{x\ L}{2\ L}$
Then $x = 44.8$ L.

64 g $x$ L

75. (C) $S + O_2 \rightarrow SO_2$
32 g 22.4 L
$\frac{64\ g}{32\ g} = \frac{x\ L}{22.4\ L}$ or

$$64\ g \times \frac{1\ mol\ S}{32\ g} \times \frac{1\ mol\ SO_2}{1\ mol\ S} = 2\ mol\ SO_2$$

$$2\ mol\ SO_2 \times \frac{22.4\ L\ SO_2}{1\ mol\ SO_2} = 44.8\ L\ SO_2$$

Then $x = 44.8$ L.

76. (D) 5 g ice to water = 5 × 80 cal = 400 cal. 1 g at 4° can go to 100°C as water and absorb 1 cal/°C. Then 400 cal − (100° − 4°) = 400 − 96 = 304 cal. 304 cal can change $\frac{304\ cal}{540\ cal/g}$ or 0.56 g of

water to steam. There obviously is not enough heat to vaporize all the water.

77. (A) Since $Ag^+$ gains $1e^-$ to become $Ag^0$, 0.5 mol requires 0.5 mol of electrons.

78. (E) $CO_2$ is a reactant in photosynthesis, not a product. The reaction is

$$6CO_2 + 6H_2O \rightarrow \underset{\text{simple sugar}}{C_6H_{12}O_6} + 6O_2(g)$$

or

$$6CO_2 + 5H_2O \rightarrow \underset{\text{cellulose}}{C_6H_{10}O_5} + 6O_2(g)$$

79. (D) $K_{eq} = \dfrac{[HI]^2}{[H_2][I_2]}$

Let $x$ = moles of $H_2$ and also of $I_2$ that combine to form HI.

Then at equilibrium $[H_2] = 3 - x$, $[I_2] = 3 - x$, $[HI] = 2x$.

Then $K_{eq} = \dfrac{(2x)^2}{(3-x)(3-x)}$ or $= \dfrac{(2x)^2}{(3-x)^2}$.

80. (D) In a closed system, decreasing the size of the container will cause the pressure to increase. When pressure is applied to an equilibrium involving gases, the reaction that lowers the pressure by decreasing the number of molecules will increase in rate. In this reaction, the rate of the reverse reaction, in which 2 molecules are decreased to 1, increases, thus reducing pressure while also increasing the concentration of $N_2O_4$. Thus, II and III are true.

81. (A) This is Rutherford's famous artificial transmutation experiment, done in 1919.

82. (B) $2\,M = \dfrac{2\text{ mol}}{1{,}000\text{ mL}}$

2 mol of NaCl = 2 × 58.5 g
= 117.0 g

2 M = 117 g/1,000 mL,

so $\dfrac{117\text{ g}}{1{,}000\text{ mL}} = \dfrac{x\text{ g}}{100\text{ mL}}$,

$x = 11.7$ g

83. (E) Percent is by mass, so 10% is 0.1 × 1,000 g or 100 g.

84. (D) First find the molality. 1 mol in 500 g = 2 mol in 1,000 g. Then 2 × 1.86°C = 3.72°C drop from 0°C or −3.72°C.

85. (C) The nuclear reactions shown release: (A) a neutron, (B) an alpha particle, (C) a beta particle, (D) no particles, (E) a positron.

dents who have taken the SAT II: Chemistry after using this book have reported that they have scored slightly higher on the SAT II test than on the practice tests in this book. They *all* reported that preparing well for the test paid off in a better score!

## DIAGNOSING YOUR NEEDS

After taking Practice Test 4, check your answers against the correct ones. Then fill in the chart below.

In the space under each question number, place a check if you answered that question correctly.

- **EXAMPLE:**

If your answer to question 5 was correct, place a check in the appropriate box.

Next, total the check marks for each section and insert the number in the designated block. Now do the arithmetic indicated, and insert your percent for each area.

| SUBJECT AREA | (✓) QUESTIONS ANSWERED CORRECTLY | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **I. Atomic Theory and Structure,** including periodic relationships | 6 | 8 | 102 | 107 | 42 | 47 | 52 | 53 |
| | | | | | | | | |
| ☐ No. of checks ÷ 8 × 100 = _____% | | | | | | | | |
| **II. Nuclear Reactions** | | | | | | | 81 | 85 |
| | | | | | | | | |
| ☐ No. of checks ÷ 2 × 100 = _____% | | | | | | | | |
| **III. Chemical Bonding and Molecular Structure** | 4 | 9 | 106 | 45 | 49 | 50 | 51 | 62 | 64 |
| | | | | | | | | | |
| ☐ No. of checks ÷ 9 × 100 = _____% | | | | | | | | | |
| **IV. States of Matter and Kinetic Molecular Theory of Gases** | 1 | 2 | 14 | 101 | 109 | 110 | 44 |
| | | | | | | | |
| ☐ No. of checks ÷ 7 × 100 = _____% | | | | | | | |
| **V. Solutions,** including concentration units, solubility, and colligative properties | 3 | 11 | 82 | 83 | 84 |
| | | | | | |
| ☐ No. of checks ÷ 5 × 100 = _____% | | | | | |
| **VI. Acids and Bases** | 7 | 10 | 15 | 16 | 17 | 18 |
| | | | | | | |
| ☐ No. of checks ÷ 6 × 100 = _____% | | | | | | |
| **VII. Oxidation-Reduction and Electrochemistry** | 108 | 112 | 48 | 60 | 61 | 77 |
| | | | | | | |
| ☐ No. of checks ÷ 6 × 100 = _____% | | | | | | |

| SUBJECT AREA | (✓) QUESTIONS ANSWERED CORRECTLY | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **VIII. Stoichiometry** | 113 | 114 | 116 | 41 | 66 | 67 | 68 | 71 | 72 | 73 | 74 | 75 |
| | | | | | | | | | | | | |
| ☐ No. of checks ÷ 12 × 100 = _____% | | | | | | | | | | | | |
| **IX. Reaction Rates** | | | | | | | | | | | 107 | 43 |
| | | | | | | | | | | | | |
| ☐ No. of checks ÷ 2 × 100 = _____% | | | | | | | | | | | | |
| **X. Equilibrium** | | | | | | | | 58 | 63 | 65 | 79 | 80 |
| | | | | | | | | | | | | |
| ☐ No. of checks ÷ 5 × 100 = _____% | | | | | | | | | | | | |
| **XI. Thermodynamics:** energy changes in chemical reactions, randomness, and criteria for spontaneity | | | | | | | | 105 | 111 | 40 | 59 | 76 |
| | | | | | | | | | | | | |
| ☐ No. of checks ÷ 5 × 100 = _____% | | | | | | | | | | | | |
| **XII. Descriptive Chemistry:** physical and chemical properties of elements and their familiar compounds; organic chemistry; periodic properties | | | | | | | 5 | 12 | 13 | 19 | 20 | 21 |
| | | | | | | | | | | | | |
| | | | | | | | 22 | 23 | 103 | 115 | 46 | 78 |
| | | | | | | | | | | | | |
| ☐ No. of checks ÷ 12 × 100 = _____% | | | | | | | | | | | | |
| **XIII. Laboratory:** equipment, procedures, observations, safety, calculations, and interpretation of results | | | | | | | 54 | 55 | 56 | 57 | 69 | 70 |
| | | | | | | | | | | | | |
| ☐ No. of checks ÷ 6 × 100 = _____% | | | | | | | | | | | | |

## PLANNING YOUR STUDY

The percentages give you an idea of how you have done on the various major areas of the test. Because of the limited number of questions on some parts, these percentages may not be as reliable as the percentages for parts with larger numbers of questions. However, you should now have at least a rough idea of the areas in which you have done well and those in which you need more study.

## CALCULATING YOUR SCORE

Your score on Practice Test 4 can now be computed manually. The actual test will be scored by machine, but the same method is used to arrive at the raw score. You get one point for each correct answer. For each wrong answer, you lose one-fourth of a point. Questions that you omit or that have more than one answer are not counted. On your answer sheet mark all correct answers with a "C" and all incorrect answers with an "X".

### Determining Your Raw Test Score

Total the number of correct answers you have recorded on your answer sheet. It should be the same as the total of all the numbers you place in the block in the lower left corner of each area of the Subject Area summary in the next section.

A. Enter the total number of correct answers here:_____
Now count the number of wrong answers you recorded on your answer sheet.
B. Enter the total number of wrong answers here:_____
Multiply the number of wrong answers in B by 0.25.
C. Enter that product here:_____
Subtract the result in C from the total number of right answers in A.
D. Enter the result of your subtraction here:_____
E. Round the result in D to the nearest whole number:_____. **This is your raw test score.**

### Conversion of Raw Scores to Scaled Scores

Your raw score is converted by the College Board into a scaled score. The College Board scores range from 200 to 800. This conversion is done to ensure that a score earned on any edition of a particular SAT II: Chemistry test is comparable to the same scaled score earned on any other edition of the same test. Because some editions of the tests may be slightly easier or more difficult than others, scaled scores are adjusted so that they indicate the same level of performance regardless of the edition of the test taken and the ability of the group that takes it. Consequently, a specific raw score on one edition of a particular test will not necessarily translate to the same scaled score on another edition of the same test.

Since the practice tests in this book have no large population of scores with which they can be scaled, scaled scores cannot be determined.

Results from previous SAT II Chemistry tests appear to indicate that the conversion of raw scores to scaled scores GENERALLY follows this pattern:

| *Raw Score* | *Scaled Score* | *Raw Score* | *Scaled Score* |
|---|---|---|---|
| 85–75 | 800–800 | 30–25 | 560–540 |
| 75–70 | 800–780 | 25–20 | 540–520 |
| 70–65 | 780–750 | 20–15 | 520–490 |
| 65–60 | 750–720 | 15–10 | 490–460 |
| 60–55 | 720–700 | 10–5 | 460–430 |
| 55–50 | 700–680 | 5–0 | 430–410 |
| 50–45 | 680–650 | 0 to –5 | 410–380 |
| 45–40 | 650–620 | –5 to –10 | 380–360 |
| 40–35 | 620–590 | –10 to –15 | 360–330 |
| 35–30 | 590–560 | | |

Note that this scale provides only a *general idea* of what a raw score may translate into on a scaled score range of 800–200. Scaling on every test is usually slightly different. Some stu-