*(Key)* *1988*

# CHEMISTRY TEST

*have periodic table out*

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

*1st SAT II*

## 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 1-5

    (A) Buret
    (B) Calorimeter
    (C) Manometer
    (D) Geiger counter
    (E) Voltmeter

1. Equipment needed to determine the half-life of carbon-14   D

2. Equipment needed for measuring the vapor pressure of a liquid   C

3. Equipment needed for measuring the volume of a solution that is delivered   A

4. Equipment needed to determine the heat of reaction   B

5. Equipment needed for measuring the potential of a cell   E

Questions 6-9

    (A) Boiling point
    (B) Rate of reaction
    (C) Molecular mass
    (D) Molarity
    (E) Density

6. Can be expressed as grams per milliliter   E

7. Can be expressed as grams per mole   C

8. Does NOT vary with changes of temperature and pressure   C   *Density of a gas will Δ w/ pressure Δ's*

9. Is a quantity necessary to determine the molecular formula of a compound   C

*empirical formula*
*add up mass ÷ into MM to get ratio*

Questions 10-12

    (A) $Fe^{2+}$
    (B) $Cl$
    (C) $K^+$
    (D) $Cs$
    (E) $Au$

10. Has the electron configuration $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6$   A   $(4s^2)$ *lost*

11. Has a noble gas electron configuration   C

12. Has electrons in $f$ orbitals   E

Questions 13-16

    (A) Ionic substance
    (B) Nonpolar covalent substance
    (C) Polar covalent substance
    (D) Macromolecular substance *(Network Solid)*
    (E) Metallic substance

13. Methyl alcohol, $CH_3OH$   C

14. Carbon tetrachloride, $CCl_4$   B

15. Cesium   E
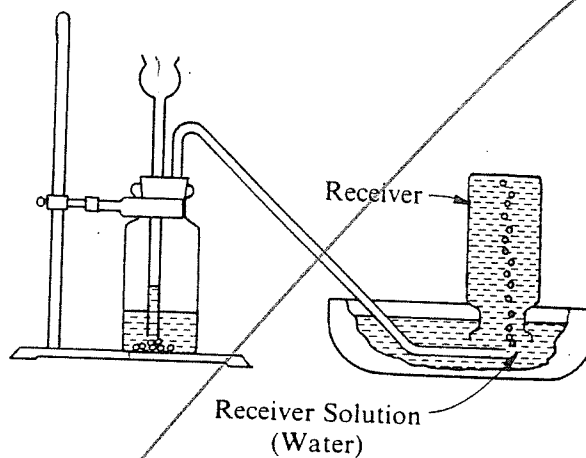
16. Strontium chloride   A

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# CHEMISTRY TEST—*Continued*

Questions 17-19

(A) Arrhenius acid
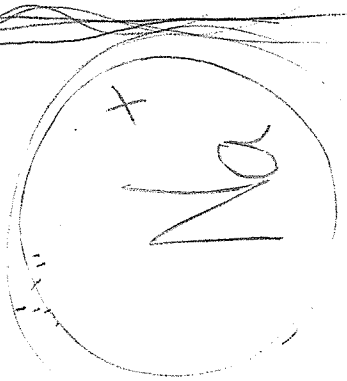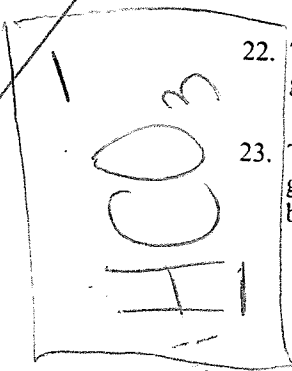(B) Arrhenius base
(C) Buffer
(D) Indicator
(E) Salt
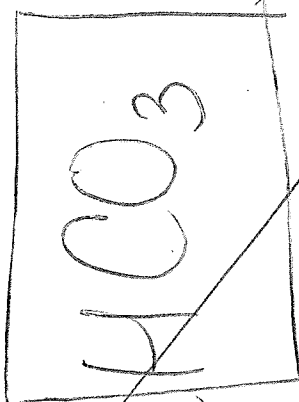
17. At 25° C, produces an aqueous solution with pH > 7

18. At 25°C, produces an aqueous solution with $[H^+] > 1.0 \times 10^{-7}$ moles per liter

19. Has different colors in its acidic and basic forms

Questions 20-23 refer to the following experimental setup that was used to generate various gases.

Receiver

Receiver Solution
(Water)

(A) HCl
(B) NH₃
(C) N₂
(D) H₂
(E) CO₂

20. The evolved gas is not very soluble in the water and the water remains neutral. When ignited in air, the gas burns with a blue flame.

21. The evolved gas dissolves readily in the water to give a strongly acidic solution.

22. The evolved gas is very soluble in the water and gives a basic solution.

23. The evolved gas is slightly soluble in the water and gives a weakly acidic solution. The gas does not burn in air.

**GO ON TO THE NEXT PAGE**

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Questions 17-19

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

17. At 25° C, produces an aqueous solution with pH > 7 *B*

18. At 25°C, produces an aqueous solution with $[H^+] > 1.0 \times 10^{-7}$ moles per liter *A*

19. Has different colors in its acidic and basic forms *D*

Questions 20-23 refer to the following experimental setup that was used to generate various gases.



Receiver

Receiver Solution
(Water)
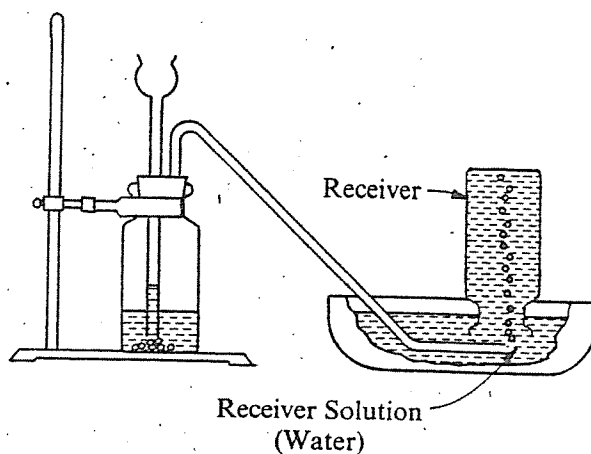
(A) HCl *Acid*
(B) $NH_3$ *Base*
(C) $N_2$ *Non reactive*
(D) $H_2$ *Neutral / reactive*
(E) $CO_2$ *Acid*

*D* 20. The evolved gas is not very soluble in the water and the water remains neutral. When ignited in air, the gas burns with a blue flame.

*A* 21. The evolved gas dissolves readily in the water to give a strongly acidic solution.

*B* 22. The evolved gas is very soluble in the water and gives a basic solution.

*E* 23. The evolved gas is slightly soluble in the water and gives a weakly acidic solution. The gas does not burn in air.

$$CO_2 + H_2O \rightarrow H_2CO_3$$

*phantom*
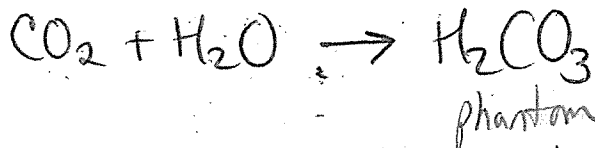
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## Part B

Directions: Each question below consists of an <u>assertion</u> (statement) in the left-hand column and a <u>reason</u> in the right-hand column. On the appropriate line of the answer sheet fill in oval

A   if both assertion and reason are true statements and the reason is a <u>correct explanation</u> of the assertion;

B   if both assertion and reason are true statements, but the reason is <u>NOT a correct explanation</u> of the assertion;

C   if the assertion is true, but the reason is a false statement;

D   if the assertion is false, but the reason is a true statement;
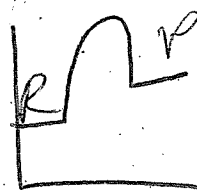
E   if both assertion and reason are false statements.

| Directions Summarized | | |
|---|---|---|
| A-True | True | Reason is a correct explanation |
| B-True | True | Reason is NOT a correct explanation |
| C-True | False | |
| D-False | True | |
| E-False | False | |

<u>Assertion</u>                                             <u>Reason</u>

24. Oxygen is an element          BECAUSE          oxygen exists in the form of diatomic molecules at room temperature and atmospheric pressure.

25. A saturated solution may be quite dilute          BECAUSE          some substances have a very low solubility.

26. $^{14}C$ is an isotope of $^{14}N$          BECAUSE          $^{14}C$ and $^{14}N$ have the same mass number.

27. A catalyst accelerates a chemical reaction          BECAUSE          a catalyst decreases the activation energy for a chemical reaction.

28. An endothermic reaction has a positive $\triangle H$ value          BECAUSE          in an endothermic reaction, the total enthalpy (heat content) of the products is greater than that of the reactants.

29. Molten potassium chloride is a good electrical conductor          BECAUSE          the melting process frees the ions in potassium chloride from their fixed positions in the crystal lattice.

30. Hydrogen chloride is a polar substance          BECAUSE          hydrogen and chlorine have the same electro-negativity.

31. Ice is less dense than liquid water          BECAUSE          water molecules are nonpolar.

GO ON TO THE NEXT PAGE

| | Directions Summarized | | |
|---|---|---|---|
| A-True | True | Reason is a correct explanation | |
| B-True | True | Reason is NOT a correct explanation | |
| C-True | False | | |
| D-False | True | | |
| E-False | False | | |

Assertion                                                                       Reason

A    32. A 0.1-molar solution of acetic acid    BECAUSE    at the same concentration, the number of acetic
         is a poorer electrical conductor than              acid molecules that ionize in water is less than
         a 0.1-molar solution of hydrochloric               the number of hydrogen chloride molecules that
         acid                                               ionize in water.

D    33. Covalent bonds are broken when    BECAUSE    in molecules with covalent bonds, electrons are
         sugars are dissolved in water                 shared by two or more atoms.

B    34. Sodium chloride is used effectively    BECAUSE    sodium chloride melts at a high temperature.
         to melt snow and ice

D    35. The $O^{2-}$ ion and the neon atom    BECAUSE    the $O^{2-}$ ion and the neon atom have the same
         have similar chemical properties              number of electrons.

B    36. At low temperatures and high    BECAUSE    gases expand to fill the container in which they
         pressures gases tend to condense          are placed.

A    37. The compound sodium hydrogen    BECAUSE    the hydrogen carbonate ion can either accept
         carbonate, $NaHCO_3$, can act             or donate a proton.
         as either a Brönsted base or a
         Brönsted acid

E    38. Fluorine is a weaker oxidizing    BECAUSE    fluorine atoms are larger than chlorine atoms.
         agent than chlorine
         + likes to be reduced

D    39. A solution with pH = 5 has    BECAUSE    pH is defined as $-\log [H^+]$.
         a higher concentration of
         hydronium ions than one
         with pH = 3

# CHEMISTRY TEST—*Continued*

## 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.

*B*   40. What volume of a 0.500-molar solution of hydrochloric acid is required to neutralize 60.0 milliliters of a 1.50-molar potassium hydroxide solution?

(A) 360. ml
(B) 180. ml
(C) 120. ml
(D) 60.0 ml
(E) 20.0 ml

$(.5)(x) = (1.50)(60)$

$(x) = \dfrac{(1.5)(60)}{.5}$ ← (double numerator)

$(3)(60) = 180$

*A*   41. ... $Al_2(C_2O_4)_3(s) \xrightarrow{\Delta}$ ... $Al_2O_3(s) + $ _3_ $CO(g) + $ _3_ . $CO_2(g)$

According to the equation for the reaction represented above, what is the mole ratio of $CO$ to $CO_2$ that is produced by the decomposition of aluminum oxalate?

(A) 1 mole $CO$ : 1 mole $CO_2$
(B) 1 mole $CO$ : 2 moles $CO_2$
(C) 1 mole $CO$ : 3 moles $CO_2$
(D) 2 moles $CO$ : 1 mole $CO_2$
(E) 3 moles $CO$ : 1 mole $CO_2$

$3 : 3 = 1 : 1$

*B*   42. _3_ . $LiAlH_4(s) + $ _4_ $BCl_3(\ell) \rightarrow$ _2_ $B_2H_6(g) + $ _3_ . $LiCl(s) + $ _3_ $AlCl_3(s)$

When the equation for the reaction represented above is balanced and all coefficients are reduced to lowest whole-number terms, the coefficient of $B_2H_6$ is

(A) 1
(B) 2
(C) 3
(D) 4
(E) 5

First   3 LiAlH₄ &   2 B₂H₆

2nd   3 LiCl

3rd   3 AlCl₃

4th   4 BCl₃

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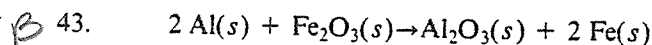
**43.** $$2 Al(s) + Fe_2O_3(s) \rightarrow Al_2O_3(s) + 2 Fe(s)$$

According to the equation for the reaction represented above, which of the following statements is true?

(A) If 2 moles of aluminum are used, 1 mole of iron is produced.
(B) If 1 mole of aluminum is used, 0.5 mole of $Fe_2O_3$ is consumed.
(C) If 1 mole is aluminum is used, 1 mole of $Al_2O_3$ is produced.
(D) If 0.5 mole of aluminum is used, 1 mole of $Al_2O_3$ is produced.
(E) If 0.5 mole of aluminum is used, 0.5 mole of $Fe_2O_3$ is consumed.

**44.** Which of the following combinations of particles represents an ion of net charge $-1$ and of mass number 80 ?

(A) 44 neutrons, 35 protons, 36 electrons
(B) 44 neutrons, 36 protons, 35 electrons
(C) 44 neutrons, 36 protons, 36 electrons
(D) 45 neutrons, 35 protons, 35 electrons
(E) 45 neutrons, 35 protons, 36 electrons

**45.** The colored complexes of the transition elements have color because they

(A) have very high formation constants
(B) absorb light of some visible wavelengths
(C) absorb light of some ultraviolet wavelengths
(D) have unpaired electrons
(E) are soluble in water

**46.** $$C_2H_4(g) + 3 O_2(g) \rightarrow 2 CO_2(g) + 2 H_2O(\ell)$$
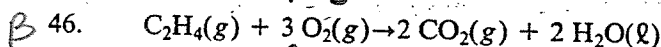
When 100 grams of $O_2$ are allowed to react completely with 1.0 mole of $C_2H_4$ according to the equation above, which of the following results?

(A) Some $C_2H_4$ remains unreacted.
(B) Some $O_2$ remains unreacted.
(C) Only $CO_2$ and $H_2O$ are present when the reaction has run to completion.
(D) Less than 2 moles of $CO_2$ is formed.
(E) The partial pressure of $O_2$ falls to zero.
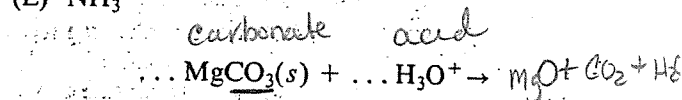
**47.** $$\ldots Ag^+ + \ldots S^{2-} \rightarrow$$

When the equation for the reaction represented above is completed and balanced by the use of lowest whole-number coefficients, the coefficient for $Ag^+$ is

(A) 1
(B) 2
(C) 3
(D) 4
(E) 6

**48.** The oxidation state of nitrogen is most positive in which of the following compounds?

(A) $NO_3^-$
(B) $NO_2^-$
(C) $N_2O$
(D) $N_2$
(E) $NH_3$

**49.** $$\ldots MgCO_3(s) + \ldots H_3O^+ \rightarrow$$

Products of the reaction represented above include which of the following?

  I. $Mg(s)$
 II. $H_2O(\ell)$
III. $CO_2(g)$

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

**50.** Of the following, the field of organic chemistry is LEAST concerned with the study of

(A) petroleum products
(B) alloys
(C) polymers
(D) carbohydrates
(E) alcohols

**GO ON TO THE NEXT PAGE**

51. According to quantum mechanics, correct statements concerning the electron in the hydrogen atom include which of the following?

    I. It moves in a definite orbit around the nucleus.
    II. It is associated with definite energy levels.
    III. It occupies a fixed position in space with reference to the nucleus.

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

52. The conversion of $Cr_2O_7^{2-}$ to $Cr^{3+}$ during a chemical reaction is an example of

    (A) hydrolysis     (B) displacement
    (C) neutralization     (D) reduction
    (E) oxidation

53. Oxidation-reduction processes include all of the following EXCEPT the

    (A) burning of wood
    (B) rusting of iron
    (C) generation of power by a storage battery
    (D) combustion of gasoline in an automobile engine
    (E) conduction of an electric current in a copper wire

54. Characteristic features of naturally radioactive elements include which of the following?

    I. The emission of $\alpha$ or $\beta$ particles or $\gamma$ rays
    II. A characteristic half-life
    III. Spontaneous decay

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

55. What mass of lead nitrate, $Pb(NO_3)_2$, (formula weight = 331) is needed to make 100 milliliters of a 1.00-molar solution?

    (A) 438 grams
    (B) 331 grams
    (C) 269 grams
    (D) 53.8 grams
    (E) 33.1 grams

56. $H_2(g) + I_2(g) + 51.9 \text{ kilojoules} \rightarrow 2 HI(g)$

    Which of the following can be expected to increase the rate of the reaction given by the equation above?
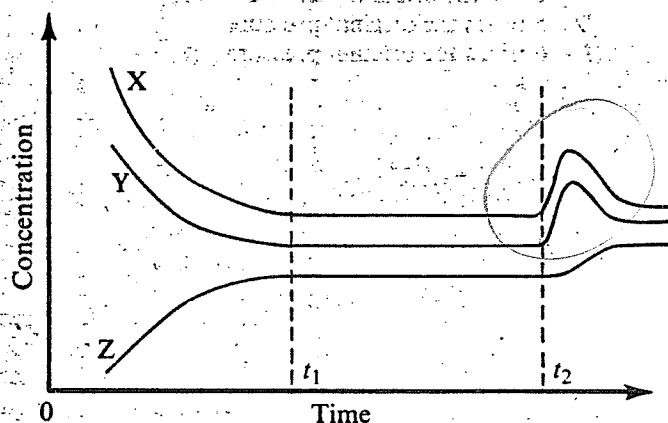
    I. Adding some helium gas
    II. Adding a catalyst
    III. Increasing the temperature

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

57. An example of a network solid is

    (A) limestone, $CaCO_3$
    (B) table salt, NaCl
    (C) diamond, C
    (D) dry ice, $CO_2$
    (E) iodine, $I_2$



58. $X(g) + Y(g) \rightleftharpoons Z(g)$

    The diagram above shows that the reaction between X and Y to form Z had come to equilibrium at time $t_1$. The equilibrium shifts that occurred after time $t_2$ were most likely caused by which of the following?

    (A) Adding more X and Y to the equilibrium mixture
    (B) Adding only more X to the equilibrium mixture
    (C) Adding only more Y to the equilibrium mixture
    (D) Increasing the temperature
    (E) Increasing the pressure

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Questions 59-60 refer to the following situation.

A 5-mole sample of oxygen gas is added to a vessel that contains 1 mole of hydrogen gas and that is maintained at a constant temperature. No chemical reaction occurs. The volume of the vessel remains unchanged.

B 59. The ratio of the pressure exerted by the oxygen gas to the pressure exerted by the hydrogen gas is

(A) 6 : 1
(B) 5 : 1
(C) 4 : 1
(D) 1 : 1
(E) 1 : 5

B 60. After the gases are uniformly mixed, the partial pressure exerted on the walls of the vessel by the hydrogen gas is

(A) $\frac{1}{5}$ the original pressure
(B) the same as before the addition of the oxygen
(C) twice the original pressure
(D) 5 times the original pressure
(E) 6 times the original pressure

D 61. For a particular compound, which of the following pairs can represent the empirical and the molecular formula, respectively?

(A) $CH_3$ and $C_3H_6$
(B) $CH_2$ and $C_2H_2$
(C) $CH_2$ and $C_3H_9$
(D) $CH$ and $C_6H_6$
(E) $CH$ and $CH_4$

*you have to be able to multiply both by the same value.*

62.

$$H_2O(\ell) \rightarrow H_2O(g)$$
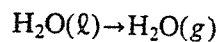
E

Correct statements concerning the process above occurring at 100°C include which of the following?

I. The vaporization process is endothermic. ✓
II. The randomness of the system increases during vaporization. ✓
III. The average potential energy of the vapor molecules is greater than that of the liquid molecules. ✓

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

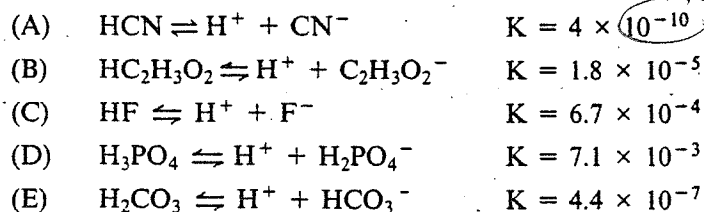A 63. Which of the following statements about the halogens is true?

(A) They all form $X^-$ ions. ✓
(B) They have the lowest ionization (potential) energies of the elements in their respective periods. *Highest*
(C) They are all solids. *gases*
(D) They are among the best reducing agents. *oxidized no*
(E) They all react with water to form basic solutions. *Acidic*

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A 64. On the basis of the acid dissociation constants given below, it can be determined that which of the following is the weakest acid?

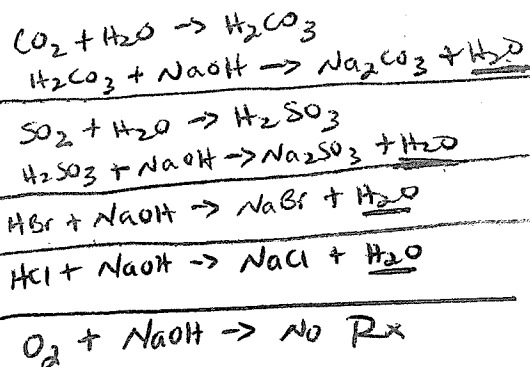(A)    $HCN \rightleftharpoons H^+ + CN^-$         $K = 4 \times 10^{-10}$

(B)    $HC_2H_3O_2 \rightleftharpoons H^+ + C_2H_3O_2^-$    $K = 1.8 \times 10^{-5}$

(C)    $HF \rightleftharpoons H^+ + F^-$         $K = 6.7 \times 10^{-4}$

(D)    $H_3PO_4 \rightleftharpoons H^+ + H_2PO_4^-$    $K = 7.1 \times 10^{-3}$

(E)    $H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$    $K = 4.4 \times 10^{-7}$

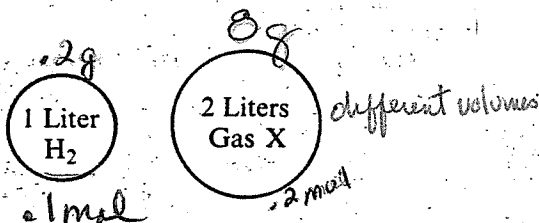E 65. The structure of $CH_4$, the methane molecule, is best described as

(A) linear   (B) trigonal   (C) planar
(D) square   (E) tetrahedral

D 66. A drying agent is not suitable for removing the water vapor from a sample of gas with which the drying agent reacts chemically. Which of the following gases can properly be dried by means of NaOH ?

(A) $CO_2$   (B) $SO_2$   (C) HBr
(D) $O_2$   (E) HCl

C 67. Both of the gas samples represented above are at the same temperature and pressure. The mass of $H_2$ in the one-liter container is 0.20 gram. The mass of X in the two-liter container is 8 grams. The molecular weight of X is

(A) 10   (B) 20   (C) 40   (D) 60   (E) 80

*read*

Questions 68-70 pertain to the reaction represented by the following equation:

$$2 NO(g) + O_2(g) \rightleftharpoons 2 NO_2(g) + 150 \text{ kilojoules}$$
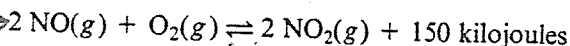
**68.** The equilibrium constant for the reaction is given by the expression

(A) $\dfrac{[2 NO_2]}{[2 NO][O_2]}$

(B) $\dfrac{[NO]^2[O_2]}{[NO_2]^2}$

(C) $\dfrac{[2 NO_2]}{[2 NO] + [O_2]}$

(D) $\dfrac{[NO_2]^2}{[NO]^2[O_2]}$  ✓
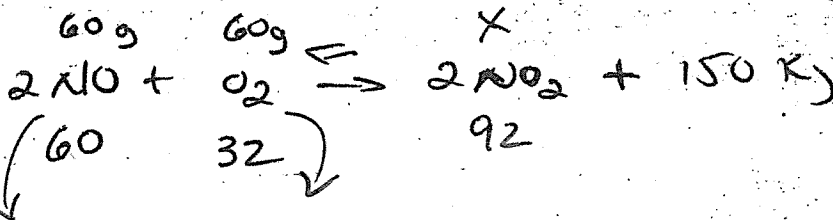
(E) $\dfrac{[2 NO][O_2]}{[2 NO_2]}$

**69.** Suppose that 0.80 mole of NO is converted to $NO_2$. The amount of heat evolved would be

(A) 150 kJ
(B) 130 kJ
(C) 80. kJ
(D) 60. kJ
(E) 30. kJ

$$\frac{0.80}{2} = \frac{X}{150 \text{ kJ}}$$

**70.** If 60 grams of NO and 60 grams of $O_2$ are available, what is the maximum amount of $NO_2$ that can be produced? (Molecular weights: NO = 30., $NO_2$ = 46)

(A) 46 grams
(B) 60. grams
(C) 92 grams
(D) 120 grams
(E) 180 grams

60g   60g   X
$2 NO + O_2 \Rightarrow 2 NO_2 + 150 \text{ kJ}$
(60    32)    92

$$\frac{60}{60} = \frac{X}{92 g}$$

$$\boxed{X = 92 g}$$

LR

$$\frac{60}{32} = \frac{X}{92}$$

$$\approx (2)(92) = X$$

$$\approx 18\# = X$$

**71.** Which of the following oxides dissolves in water to form a strongly acidic solution?

E

(A) $Na_2O$   $HoH \Rightarrow NaoH + O_2$
(B) CaO       $CaoH + O_2$
(C) $Al_2O_3$  $\rightarrow Al(OH)_3 + O_2$
(D) ZnO       $\rightarrow Zn(OH)_2 + O_2$
(E) $SO_3$     $\rightarrow$ $\boxed{H_2SO_4}$

**72.** At 23° C, 200 milliliters of an ideal gas exerts a pressure of 750 millimeters of mercury. The volume of the gas at 0° C and 760 millimeters of mercury is found from which of the following expressions?

E

(A) $200 \times \dfrac{760}{750} \times \dfrac{273}{296}$ ml

(B) $200 \times \dfrac{750}{760} \times \dfrac{0}{23}$ ml

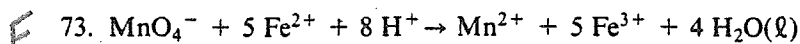(C) $200 \times \dfrac{760}{750} \times \dfrac{23}{0}$ ml

(D) $200 \times \dfrac{760}{750} \times \dfrac{296}{273}$ ml

(E) $200 \times \dfrac{750}{760} \times \dfrac{273}{296}$ ml

**GO ON TO THE NEXT PAGE**

73. $MnO_4^- + 5 Fe^{2+} + 8 H^+ \rightarrow Mn^{2+} + 5 Fe^{3+} + 4 H_2O(\ell)$

In the equation for the reaction represented above, which of the following indicates the reduction that takes place?

(A) $Fe^{2+} + e^- \rightarrow Fe^{3+}$
(B) $Fe^{3+} + e^- \rightarrow Fe^{2+}$
(C) $Fe^{2+} \rightarrow Fe^{3+} + e^-$
(D) $2 H^+ + O^{2-} \rightarrow H_2O(\ell) + 2 e^-$
(E) $MnO_4^- + 8 H^+ + 5 e^- \rightarrow Mn^{2+} + 4 H_2O(\ell)$

| Electron removed | 1st Electron | 2nd Electron | 3rd Electron | 4th Electron | 5th Electron | 6th Electron |
|---|---|---|---|---|---|---|
| Ionization energy (potential), kilojoules per mole | 733 | 1,450 | 7,730 | 10,538 | 13,618 | 18,101 |

74. The ionization energies (potentials) for the removal of different electrons from an atom of an element in the gas phase are shown above. An atom of this element is most likely to form an ion that has a charge of

(A) +1   (B) +2   (C) +3   (D) +4   (E) +5

75. Of the following ground state electron configurations, the one that represents the element of lowest first ionization energy (potential) is

(A) $1s^2 2s^2 2p^5$
(B) $1s^2 2s^2 2p^6$
(C) $1s^2 2s^2 2p^6 3s^1$
(D) $1s^2 2s^2 2p^6 3s^2$
(E) $1s^2 2s^2 2p^6 3s^2 3p^1$

76. A 250-gram sample of a hydrated salt was heated at 110° C until all water was driven off. The remaining solid weighed 160 grams. From these data, the percent of water by weight in the original sample can be correctly calculated as

(A) $\frac{160}{340} \times 100$   (B) $\frac{90}{340} \times 100$   (C) $\frac{160}{250} \times 100$

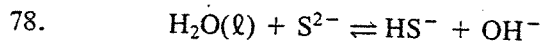(D) $\frac{90}{250} \times 100$   (E) $\frac{90}{160} \times 100$

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79

77. A 0.001-molar solution of which of the following has a hydrogen ion concentration of $1 \times 10^{-3}$ molar?

   (A) $HC_2H_3O_2$
   (B) HCl
   (C) $NaHCO_3$
   (D) NaH
   (E) NaOH

78. $$H_2O(\ell) + S^{2-} \rightleftharpoons HS^- + OH^-$$

   In the equation for the reaction represented above, the species acting as acids (proton donors) are

   (A) $H_2O(\ell)$ and $OH^-$
   (B) $H_2O(\ell)$ and $HS^-$
   (C) $OH^-$ and $HS^-$
   (D) $HS^-$ and $S^{2-}$
   (E) $H_2O(\ell)$ and $S^{2-}$

79. One species of element $X$ has an atomic number of 9 and a mass number of 19; one species of element $Y$ has an atomic number of 10 and a mass number of 19. Which of the following statements about these two species is true?

   (A) They are isotopes.
   (B) They are isomers.
   (C) They are isoelectronic.
   (D) They contain the same number of neutrons in their atoms.
   (E) They contain the same total number of protons plus neutrons in their atoms.

80. Some solid crystalline compounds slowly change to the gaseous state when left at room temperature in an open container. Which of the following is true about this phenomenon?

   (A) It is accompanied by an increase in temperature.
   (B) It is accompanied by an absorption of heat by the solid.
   (C) It is the result of a chemical reaction with air.
   (D) It is best described as fusion.
   (E) It is observed only with ice.
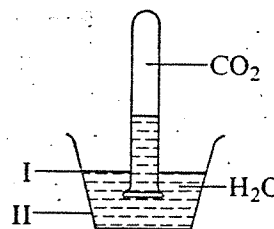
81. A test tube of carbon dioxide gas is inverted over water, as shown above. The gas becomes more soluble in the water if the

   (A) water is heated
   (B) gas is heated
   (C) lip of the tube is moved to level I
   (D) lip of the tube is moved to level II
   (E) amount of gas in the tube is reduced

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82. A molecule of which of the following compounds contains a double bond?

    (A) $C_3H_8$
    (B) $C_2H_6$
    (C) $C_2H_4$
    (D) $C_2H_6O$
    (E) $CH_4$

83. Each of the following systems is at equilibrium in a closed container. A decrease in the total volume of each container increases the number of moles of product(s) for which system?

    (A) $Fe_3O_4(s) + 4H_2(g) \rightleftharpoons 3Fe(s) + 4H_2O(g)$

    (B) $H_2(g) + Cl_2(g) \rightleftharpoons 2HCl(g)$

    (C) $CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$

    (D) $2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$

    (E) $2NH_3(g) \rightleftharpoons N_2(g) + 3H_2(g)$

84. $$Cl_2(g) + 2\,Br^- \text{ (excess)} \rightarrow$$

    When 1 mole of chlorine gas reacts completely with excess KBr solution, as shown above, the products obtained are

    (A) 1 mole of $Cl^-$ ions and 1 mole of Br
    (B) 1 mole of $Cl^-$ ions and 2 moles of Br
    (C) 1 mole of $Cl^-$ ions and 1 mole of $Br_2$
    (D) 2 moles of $Cl^-$ ions and 1 mole of $Br_2$
    (E) 2 moles of $Cl^-$ ions and 2 moles of $Br_2$

85. All of the following statements about ammonia, $NH_3$, are true EXCEPT:

    (A) It has a characteristic odor.
    (B) It is a liquid at room temperature.
    (C) It is readily soluble in water.
    (D) Its aqueous solution has a pH above 7.
    (E) It reacts readily with acids.

# STOP

IF YOU FINISH BEFORE TIME IS CALLED, YOU MAY CHECK YOUR WORK ON THIS TEST ONLY.
DO NOT TURN TO ANY OTHER TEST IN THIS BOOK.