ATOMIC THEORY

1. The number of protons in the nucleus of an atom determines the:
   a) mass number
   b) atomic number
   c) isotopic mass
   d) atomic weight
   e) atomic mass

2. Isotopes of the same element have a different number of:
   a) protons
   b) ions
   c) electrons
   d) isotopes
   e) neutrons

3. A particle containing 5 protons, 4 electrons, and 6 neutrons weighs as much as:

   a) 10 protons
   b) 11 neutrons
   c) 15 neutrons
   d) 4 electrons
   e) 5 protons

4. Boron has two isotopes in nature 20 % B-10 and 80 % B-11. From this data the average atomic weight of boron is:
   a) 10.2
   b) 10.4
   c) 10.6
   d) 10.8

5. If the mass number of an atom is increased by the addition of neutrons to the nucleus, the result is the formation of:
   a) an ion
   b) an isotope
   c) a positively charged atom
   d) a different element

6. Which of the following is isoelectric with the aluminum ion:
   a) neon
   b) the sulfur ion
   c) silicon
   d) the boron ion
   e) argon

7. Which statement below is incorrect about $^{20}_{10}$ Ne

   a) Ne is the symbol for neon
   b) "20" refers to the number of protons + neutrons
   c) "10" refers to the number of protons
   d) "10" is the number of neutrons
   e) "10" refers to the atomic mass

8. The electron configuration for antimony ends in this block of the periodic table
   a) s-block
   b) p-block
   c) d-block
   d) f-block
   e) T-block

PERIODIC TABLE

1. The correct relationship between the electro-negativities of the following pairs is:
   a) potassium is greater than calcium
   b) lithium is greater than nitrogen
   c) sulphur is less than selenium
   d) fluorine is less than cesium
   e) sulphur is less than oxygen

2. The most metallic element below is:
   a) aluminum
   b) calcium
   c) magnesium
   d) potassium
   e) sodium

3. The halogen with the highest ionization energy is:
   a) At
   b) Br
   c) Cl
   d) F
   e) I

4. An element whose oxide will react with water to form an acidic solution is:
   a) Ca
   b) Mg
   c) Na
   d) Ne
   e) P

5. Which of the following elements is a actinon:
   a) Ta
   b) Cs
   c) Ce
   d) Cm
   e) Pb

6. Which group on the periodic table contains uranium:
   a) alkali elements
   b) halogens
   c) actinons
   d) lanthonons

7. Which of the following is NOT a property of metals:
   a) high luster
   b) grey
   c) malleable
   d) good conductors
   e) low density

8. The halogen with the lowest electronegativity in a neutral atom is:
   a) At
   b) Br
   c) Cl
   d) F

9. Who designed the first Modern Periodic Table:
   a) John Dalton
   b) Dmitri Mendeleev
   c) Ernest Rutherford
   d) Niels Bohr
   e) J.J Thompson

10. The trends in the periodic table:
   a) are always exactly followed by the elements
   b) all increase from left to right
   c) were all discovered by Mendeleev
   d) cannot be used to predict reactivity
   e) were used to predict the existence of other undiscovered elements

11. Within the halogen family, as atomic number of electrons increases then:
   a) metallic character decreases
   b) atomic radius decreases
   c) electronegativity increases
   d) ionization energy decreases
   e) valence increases

12. The first I.E. of As is 235 kcal/mol. What would you expect the first I.E. of Se to be:
   a) unrelated to that of arsenic
   b) larger than that of arsenic
   c) smaller than that of arsenic
   d) equal to that of arsenic

13. Calcium ions contribute to the hardness of water. Another ion most likely to do so is:
   a) magnesium
   b) potassium
   c) sodium
   d) aluminum
   e) hydrogen

14. Of the elements listed below, which has the lowest first ionization energy:
   a) Br
   b) Ca
   c) As
   d) K
   e) Kr

15. An element "X", that reacts vigorously with water according to the following equation is:
   $$2X + 2H_2O \rightarrow 2XOH + H_2$$
   a) Al
   b) Ag
   c) Ca
   d) Mg
   e) K

16. Which of the following pairs of ions/atoms is in order of DECREASING RADIUS:
   a) Li, Li^+
   b) Mg, Na
   c) F, Cl
   d) Ar, Cl^-
   e) Ca^{2+}, Ar

BONDING

1. The water molecule is:
   a) bent and polar
   b) linear and polar
   c) v-shaped and polar
   d) tetrahedral and nonpolar
   e) pyramidal and polar

2. In the H--Cl bond, the two bonding electrons are:
   a) closer to the hydrogen than chlorine atom
   b) closer to the chlorine atom than hydrogen
   c) the same distance between both atoms
   d) donated by one atom

3. Which substance below involves ionic bonding:
   a) ice, $H_2O_{(s)}$
   b) liquid ammonia NH_3
   c) solid silicon dioxide $SiO_{2(s)}$
   d) solid cesium fluoride $CsF_{(s)}$
   e) gaseous potassium $K_{(g)}$

4. Which of the following molecules contains a coordinate covalent bond:
   a) NH_3
   b) N_2
   c) SO_2
   d) H_2S

5. Which bond below shows the greatest ionic character:
   a) H--Cl
   b) Br--Br
   c) Br--Cl
   d) H--Br
   e) Cl--Cl

6. The number of lone electron pairs in NH_3 is:
   a) one
   b) two
   c) three
   d) four
   e) none

7. Which of the following is NOT an electrolyte:
   a) solid salt
   b) hydrochloric acid
   c) aqueous sodium hydroxide
   d) molten calcium chloride

8. When a calcium atom bonds to a chlorine atom
   a) the calcium atom accepts two electrons
   b) a non-polar bond is formed
   c) a coordinate bond is formed
   d) each chlorine will donate one electron
   e) calcium will donate two electrons

9. How many single bond are there in CH_4:
   a) one
   b) two
   c) three
   d) four
   e) none

10. Solid compounds that will conduct electricity when molten or dissolved in water have:
    a) a high degree of ionic bonding
    b) non-polar covalent bonding
    c) symmetrical covalent bonding
    d) macromolecular bonding
    e) polar covalent bonding

11. Nonpolar compounds would be expected to:
    a) conduct electricity in a current
    b) have a high melting point
    c) dissolve readily in polar solvents
    d) have a low solubility in water
    e) dissolve in water to form ions

12. Which reaction below would require the most energy:
    a) breaking the bond of N_2
    b) breaking the bond of O_2
    c) breaking the bond of H_2
    d) they would all be the same

13. Draw a Lewis Dot Diagram for Ca_3N_2 and HCN

14. Draw a structural diagram of BF_3 PH_3 SiH_4 SO_2

NOMENCLATURE--You will be given the table of common ions but you need to remember the rules about how to change the name of the ion or acid if the number of oxygen atoms is different from the main ion or acid.

1. **Name the following:**

CS_2	P_2O_5	OF_2
Na_3PO_4	$BaCl_2$	PbO
Fe_2S_3	PH_3	$Ca(BrO_3)_2$
Na_2O	$KMnO_4$	$BaSO_5$
$NaHCO_3$	$H_3PO_{4(aq)}$	$HBr_{(aq)}$
NH_3	KOH	$HClO_{2(aq)}$
$CuCl_2 \cdot 10H_2O$	LiH	

2. **Give the formula for the following:**

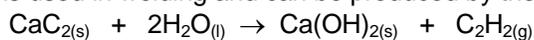|	
carbon monoxide	hydrogen chloride
calcium hydroxide	strontium fluorite
carbon tetrachloride	silicon phosphide
hydrosulphuric acid	iron (II) oxide
manganese (IV) chloride	barium carbonate
sodium silicate	bromiic acid
dinitrogen oxide	hyposulphurous acid
silver nitrate	gold (I) bromide
potassium chromate	aluminum hypophosphite
copper (I) sulfate hexahydrate	calcium acetate

MOLES AND REACTIONS

1. The number of molecules in 4.5 g of Carbon tetrachloride (CCl_4):
   a) 2.7×10^{24}
   b) 4.2×10^{26}
   c) 1.2×10^{21}
   d) 1.7×10^{22}

2. What is the mass of 2.5 mol of sodium atoms
   a) 23 g
   b) 58 g
   c) 9.2 g
   d) 0.11 g
   e) 11 g

3. How many atoms are found in 8.11 g of argon:
   a) 297×10^{24}
   b) 2.71
   c) 1.22×10^{23}
   d) 4.88×10^{24}
   e) none of the above

4. Any sample of Carbon dioxide must have 1 atoms of carbon for every 2 atoms of oxygen. This statement is defined by which Law:
   a) Law of Conservation of Mass
   b) Law of Combining Volumes
   c) Avogadro's Hypothesis
   d) Law of Definite Proportions

5. The mass of nitrogen dioxide NO_2 which has the same number of molecules as 18.0 g of water is:
   a) 6.02 g
   b) 18.0 g
   c) 23.0 g
   d) 46.0 g

6. The mass of carbon in 1.00 mol of sucrose is:
   a) 12.0 g sucrose $C_{12}H_{22}O_{11}$
   b) 72.0 g
   c) 144 g
   d) 156 g
   e) none of the above

7. In the reaction $2H_2 + O_2 \rightarrow 2H_2O$, the number of moles of water produced when 3 moles of hydrogen react is:
   a) 3
   b) 1
   c) 2
   d) 4
   e) 5

8. In the reaction $N_2 + 2O_2 \rightarrow 2NO_2$, the mass of nitrogen dioxide gas produced when 14 g of nitrogen gas reacts is:
   a) 12 g
   b) 23 g
   c) 46 g
   d) 69 g
   e) 92 g

9. What is the molar mass of tin (II) fluoride:
   a) 59.0 g
   b) 68.0 g
   c) 157 g
   d) 138 g
   e) 196 g

10. The combustion of 3.99 g of butane C_4H_{10} will produce what mass of water:
   a) 0.07 g
   b) 0.34 g
   c) 6.18 g
   d) 8.33 g

11. The molecular formula of a compound whose simplest formula is CH_2O and whose molecualr mass is 60.0 u is:
   a) $C_2H_4O_2$
   b) CH_2O
   c) C_2H_4O
   d) C_3H_2O
   e) $C_3H_6O_3$

12. The percentage by mass of nitrogen in N_2O is:
   a) 44 %
   b) 31.8 %
   c) 63.6 %
   d) 36.4 %
   e) 33.3 %

13   C_3H_4 has what possible molecular formula:
      a) CH_2
      b) C_2H_4
      c) C_6H_7
      d) C_9H_{12}
      e) none of the above

14. What is the empirical formula that corresponds to the following percentages: 25.9 % Fe and 74.1 % Br
      a) Fe_2Br_3
      b) $FeBr_2$
      c) FeBr
      d) $FeBr_3$

15.   Predict the products with correct symbols of state, and state what type of chemical reaction has occurred: Leave the equations unbalanced.
      a) $LiOH_{(aq)}$ + $H_2SO_{4(aq)} \rightarrow$
      b) $FeCl_{3(aq)}$ + $NaOH_{(aq)} \rightarrow$
      c) $Cl_{2(g)}$ + $ZnI_{2(aq)} \rightarrow$
      d) $CaO_{(s)}$ + $H_2O_{(l)} \rightarrow$
      e) $MgCO_{3(s)} \rightarrow$
      f) $Sn_{(s)}$ + $AgNO_{3(aq)} \rightarrow$
        (II)

16.   Write a full ionic equation and a net ionic equation for the following reactions:
      a) $Ni_{(s)}$ (III) + $Cu(NO_3)_{2(aq)} \rightarrow$
      b) $AgNO_{3(aq)}$ + $K_2S_{(aq)} \rightarrow$
      c) $NaOH_{(aq)}$ + $H_2SO_{4(aq)} \rightarrow$

17.   Synthetic vitamin C is ascorbic acid. An anlysis of this vitamin gives C 40.91%   H 4.55% and O 54.55%.
      a) Calculate the empirical formula of this compound.
          If 3.55 g of this compound is vaporized, it will occupy the same volume of 0.560 g of nitrogen gas under
          similar conditions.
      b) Calculate the molecular formula of ascorbic acid

18.   Acetylene C_2H_2 is used in welding and can be produced by the reaction of calcium carbide with water.
                    $CaC_{2(s)}$ + $2H_2O_{(l)}$ → $Ca(OH)_{2(s)}$ + $C_2H_{2(g)}$
      a) What is the theoretical yield of acetylene if 2.4 g of calcium carbide is reacted with water
      b) If 0.77g of acetylene is actually produced, calculate the percent yield

19.   Sodium hydroxide can be prepared by the following reaction
                    $Na_2O_{(s)}$ + $2H_2O_{(l)}$ → $2NaOH_{(aq)}$ + $H_{2(g)}$
      a) If 36.0 g of Na_2O reacts with 25.0 g of H_2O, calculate the limiting reagent
      b) Calculate the percent yield if only 40.2 g of NaOH is actually recovered
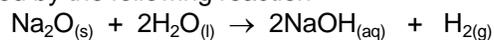
SOLUTIONS & ACIDS AND BASES

1.   How many grams of sugar $C_{12}H_{22}O_{11}$ are contained in a 50 mL, 0.4 mol/L solution?

2.   What volume of 3.0 M NaOH would be required to make 250 mL of 0.15 M NaOH?

3.   What concentration of carbonate ions are found in a 2.45 L solution made from 4.55 g of aluminum carbonate?

4.   400.0 mL of a 0.800 M hydrochloric acid solution is poured over excess zinc metal. Calculate the mass of zinc chloride produced and b) the volume of hydrogen gas produced at I00.0 kPa and 27 °C (also requires knowledge of gas unit!)

5.   In an acid-base titration 32.75 mL of sodium hydroxide were neutralized completely by 18.45 mL of 0.12 mol/L nitric acid. Calculate the concentration of the sodium hydroxide solution.

6.   Calcium chloride reacts with sodium carbonate as follows

$CaCl_{2(aq)}$ + $Na_2CO_{3(aq)}$ → $CaCO_{3(s)}$ + $2NaCl_{(aq)}$

If excess calcium chloride was added to 43 mL of a sodium carbonate solution and 4.11 g of calcium carbonate was produced. determine the concentration of the sodium carbonate   solution.

7.   Calculate the sodium ion concentration in a solution made by dissolving 6.55 g of sodium sulphate in 560.0 mL of water.

8.   Calculate the pH of a acid solution with a hydronium concentration of 3.0×10^{-3} mol/L.

9.   Draw a diagram showing how a salt like potassium bromide dissolves in water.

10.   Calculate the %V/V of a bottle of alcohol, if there is 24 mL of alcohol and 475 mL bottle.

11.   Determine the mass of fluoride ions in a 750 mL sample of drinking water that contains 15 ppm.

12.   Explain why a substance such as gasoline will not dissolve in water.

13. Which of the following statements is FALSE regarding ionic compounds:
   a) those with weaker ionic bonds will be soluble in water
   b) all ionic compounds are electrolytes
   c) they are brittle
   d) they have high melting points
   e) none of the above

14. What type of intermolecular forces will be found between polar molecules of $SF_{2(g)}$:
   a) London dispersion forces only
   b) London dispersion and dipole-dipole
   c) hydrogen bonding
   d) hydrogen bonding and dipole-dipole

15. Which of the following statements is TRUE:
   a) the solubility of ionic compounds increases with decreasing temperature
   b) the solubility of gases decreases with decreasing temperature
   c) H_2O and CH_3OH are immiscible
   d) most ionic phosphates are insoluble

16. Which of the following would produce hydroxide ions in solution:
   a) H_3O^+
   b) H_2S
   c) O_2
   d) HCl
   e) NH_3

17. Which of the following does not apply to the reaction $HCl_{(aq)} \rightarrow H^+_{(aq)} + Cl^-_{(aq)}$:
   a) ionization
   b) strong acid
   c) Arrhenius Theory
   d) dissociation
   e) electrolyte

18. What is the hydronium ion concentration if an acid solution has a pH of 8.80:
   a) zero since this solution is a base
   b) 8.8×10^{-7} mol/L
   c) 1.6×10^{-9} mol/L
   d) 1.6×10^{-8} mol/L
   e) 3.5×10^{-4} mol/L

GASES

1. What will be the new volume of a fixed mass of gas at 4.40×10^2 L, when the pressure is increased from 50.0 kPa to 200.0 kPa at constant temperature? What Law allowed you to calculate this?

2. If a balloon has a volume of 10.5 L at a pressure of 100 kPa, what will its new volume be at a pressure of 14.7 kPa?

3. What must happen to the Kelvin temperature of a fixed mass of gas whose volume has increased from 10 mL to 50 mL at constant pressure?

4. The temperature of a fixed volume of gas changes from 200 K to 500K. What has happened to the pressure of the gas?

5. If a given mass of a gas occupies a volume of 8.50 L at a pressure of 95.0 kPa and 35°C, what will it occupy at a pressure of 75.0 kPa and a temperature of 150°C?

6. A certain mass of a gas occupies a volume of 7.50 L at a pressure of 101.0 kPa and a temperature of 27°C. What will be its Celsius temperature when its volume is 7.15 L and its pressure is 85.0 kPa?

7. What volume is occupied by 0.027 mol of oxygen at 27°C and 107 kPa?

8. If 2.0 g of liquid benzene can be converted into a vapour which occupies 903 mL and 150°C and 99.7 kPa, what is its approximate molar mass?

9. Calculate the density of CH_4 gas at 100.0 kPa and 24°C.

10. $2NH_3 + CO_2 \rightarrow CO(NH_2)_2 + H_2O$

    a) What volume of ammonia gas (NH_3) measured at 37°C and 105 kPa is required
       to produce 600.0 g of urea ($CO(NH_2)_2$) by reaction with CO_2?
    b) What volume of CO_2 at the same temperature and pressure is required?

ATOMIC THEORY	PERIODIC TABLE	BONDING	MOLES
1. B	1. E	1. A	1. D
2. E	2. D	2. B	2. B
3. B	3. D	3. D	3. C
4. D	4. E	4. C	4. D
5. B	5. D	5. A	5. D
6. A	6. C	6. A	6. C
7. E	7. E	7. A	7. A
8. B	8. A	8. E	8. C
	9. B	9. D	9. C
	10. E	10. A	10. C
	11. D	11. D	11. A
	12. B	12. A	12. C
	13. A		13. D
	14. D		14. B
	15. E		
	16. A		

Bonding

13. $[Ca]^{2+} [:N:]^{3-} [Ca]^{2+} [:N:]^{3-} [Ca]^{2+}$ $H:C::N:$

14.
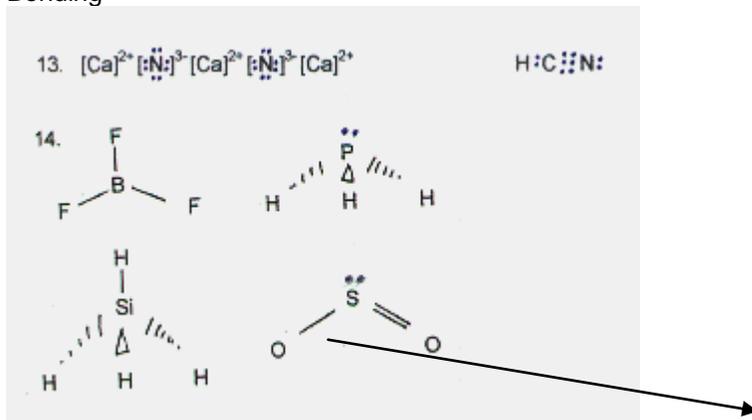
The single bond between the sulfur and the oxygen is a coordinate bond.

MOLES & REACTIONS

15.   a) $LiOH_{(aq)} + H_2SO_{4(aq)} \rightarrow Li_2SO_{4(aq)} + H_2O_{(l)}$ double displacement/neutralization
       b) $FeCl_{3(aq)} + NaOH_{(aq)} \rightarrow Fe(OH)_{3(s)} + NaCl_{(aq)}$ double displacement
       c) $Cl_{2(g)} + ZnI_{2(aq)} \rightarrow ZnCl_{2(aq)} + I_{2(aq)}$ single displacement
       d) $CaO_{(s)} + H_2O_{(l)} \rightarrow Ca(OH)_{2(s)}$ synthesis
       e) $MgCO_{3(s)} \rightarrow MgO_{(s)} + CO_{2(g)}$ decomposition
       f) $Sn_{(s)} + AgNO_{3(aq)} \rightarrow Sn(NO_3)_{2(aq)} + Ag_{(s)}$ single displacement

16.   a) $2Ni_{(s)} + 3Cu(NO_3)_{2(aq)} \rightarrow 2Ni(NO_3)_{3(aq)} + 3Cu_{(s)}$
       $2Ni_{(s)} + 3Cu^{2+}_{(aq)} + 6NO_3^{1-}_{(aq)} \rightarrow 2Ni^{3+}_{(aq)} + 6NO_3^{1-}_{(aq)} + 3Cu_{(s)}$
       $2Ni_{(s)} + 3Cu^{2+}_{(aq)} \rightarrow 2Ni^{3+}_{(aq)} + 3Cu_{(s)}$

       b) $2AgNO_{3(aq)} + K_2S_{(aq)} \rightarrow Ag_2S_{(s)} + 2KNO_{3(aq)}$
       $2Ag^+_{(aq)} + 2NO_3^{1-}_{(aq)} + 2K^+_{(aq)} + S^{2-}_{(aq)} \rightarrow Ag_2S_{(s)} + 2K^+_{(aq)} + 2NO_3^{1-}_{(aq)}$
       $2Ag^+_{(aq)} + S^{2-}(aq) \rightarrow Ag_2S_{(s)}$

       c) Net Ionic Equation: $H^+_{(aq)} + OH^{-1}_{(aq)} \rightarrow H_2O_{(l)}$

17.   a) $C_3H_4O_3$ b) $C_6H_8O_6$
18.   a) 0.96 g   b) 80% (2 sig digs)
19.   a) Na_2O limiting reagent   b) 86.5%

NOMENCLATURE

1. carbon disulfide   diphosphorus pentoxide   oxygen difluoride
    sodium phosophate   barium chloride   lead (II) oxide
    iron (III) sulfide   phosphorous trihydride   calcium bromate
    sodium oxide   potassium permanganate   barium persulfate
    sodium hydrogen carbonate   phosphoric acid   hydrobromic acid
    nitrogen trihydride   potassium hydroxide   chlorous acid
    copper (II) chloride decahydrate   lithium hydride

2. CO HCl
   $Ca(OH)_2$ $Sr(FO_2)_2$
   CCl_4 Si_3P_4
   $H_2S_{(aq)}$ FeO
   $MnCl_4$ $BaCO_3$
   Na_2SiO_3 $HBrO_{3(aq)}$
   N_2O $H_2SO_{2(aq)}$
   $AgNO_3$ $AuBr$
   $KCrO_4$ $AlPO_2$
   $Cu_2SO_4 \cdot 6H_2O$ $Ca(CH_3COO)_2$

SOLUTIONS
1. 6.85 g   2. 12.5 mL   3. 2.38×10^{-2} mol/L
4a. 21.81 g   4b. 3.99 L   5. 6.76×10^{-2} mol/L
6. 0.96 mol/L   7. 0.165 mol/L

8. Diagram should show positive potassium cations surrounded by the negative end of many water molecules and the negative bromide anions surrounded by the positive end of many water molecules.
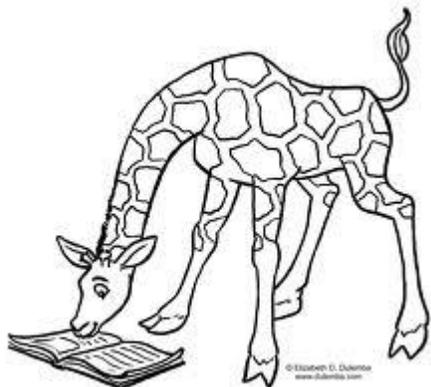
9. 76 g   10. 5.0%   11. 0.011 g

12. Gasoline is a non-polar substance with only weak dispersion forces of attraction between molecules. Water is a polar substance with much stronger hydrogen bonds between the molecules. In order for the two substances to mix, the strong hydrogen bonds would have to be broken and only weak forces of attraction would be formed (dispersion-dipole) instead. This will not happen. The two substances mixing must have similar strength intermolecular forces in order for them to be miscible with each other.

13. b   14. b   15. d   16. e   17. d   18. c

GASES
1. 1.10×10^2 L—Boyle's Law   2.   71.4 L
3.   TEMP INCREASE 5 TIMES   4.   PRESSURE WILL INCREASE 2.5 TIMES
5.   14.8 L   6.   241 K which is -32°C
7.   0.63 L   8.   78 g/mol
9.   0.651 g/L   10a.   491 L NH_3 10b   245 L CO_2.

study hard if you want results