

Tutorial 1

---

1. Give an example for each of the following terms:  
a. Matter    b. Substance    c. Mixture
2. Give an example of homogeneous mixture and an example of heterogeneous mixture.
3. Explain the difference between a physical property and chemical property.
4. As the following statements describe chemical and physical property.  
a. Water boils below 100 °C on top of a mountain.  
b. Lead is denser than aluminum.  
c. Sugar tastes sweets.
5. Give the SI units for expressing the following:  
a. Length    b. volume    c. mass    d. time    e. energy    f. temperature
6. Write the numbers presented by the following prefixes:  
a. mega-    b. kilo-    c. deci-    d. centi-    e. milli-    f. micro-    g. nano-    h. pico-
7. An oversea flight leaves New York in the late afternoon and arrives in London 8.50 hours later. The airline distance from New York to London is about  $5.6 \times 10^3$  km. What is the average speed of the plane in kilometers per hours?  
(658.8 km/h)
8. Express normal body temperature, 98.60 °F in °C and Kelvin.  
(37.0 °C, 310.15 K)
9. Carry out the following conversions.  
a. 76.3 mm to meters  
b. 482.2 in<sup>3</sup> to cubic centimeters?  
c. 476 cm<sup>2</sup> to square inches  
(0.0763 m)  
(7902 cm<sup>3</sup>)  
(73.8 in<sup>2</sup>)
10. An average adult has 5.2 L of blood, what volume of blood in m<sup>3</sup>?  
( $5.2 \times 10^{-3}$  m<sup>3</sup>)
11. A person's average daily intake of glucose (a form of sugar) is 0.0833 pound (lb), what is this mass in milligrams (mg)?  
( $3.78 \times 10^4$  mg)
12. To determine the density of ethyl alcohol, a student pipettes a 5.00 mL sample into an empty flask weight 15.246 g, he finds that the mass of the flask + ethyl alcohol = 19.171g. Calculate the density of ethyl alcohol.  
(0.785 g/mL)
13. The density of ethanol, a colorless liquid is 0.798 g/mL. Calculate the mass of 17.4 mL of the liquid?  
(13.9 g)
14. Carry out the following conversions  
a. 90.0 km/h to meters per second.  
b. 4.17 g/s to kilograms per hour.  
c. 1.39 ft/s to kilometer per hour.  
(25.0 m/s)  
(15.0 kg/h)  
(1.53 km/h)
15. The commonly accepted measurement now used by dietary specialist in assessing whether a person is overweight is the body mass index (BMI). BMI is based on a person's weight and height. It is the mass, in kilograms, divided by the square of the height in meters, which is, expressed in kg/m<sup>2</sup>. Generally speaking, if the BMI exceeds 25, a person considered overweight. What is the BMI of a person is 69.0 inches tall and weight 158 lb?  
(23.3 kg/m<sup>2</sup>)

Tutorial 2

---

1. Compare the properties of the following: proton, neutron and electron? And describe the structure of the atom?
2. What is the difference between an atom and a molecule?
3. Explain the meaning of each term in the symbol  ${}^A_ZX$
4. Give the number of protons, neutrons and electrons in each of the following species  
a)  ${}^{17}_8\text{O}$    b)  ${}^{199}_{80}\text{Hg}$    c)  ${}^{200}_{80}\text{Hg}$    d)  ${}^{14}_7\text{N}^{3-}$    e)  ${}^{54}_{26}\text{Fe}^{2+}$    f)  ${}^{31}_{15}\text{P}^{3-}$    g)  ${}^{130}_{53}\text{I}^-$    h)  ${}^{107}_{47}\text{Ag}^+$
5. Write the names and symbols for four elements in each of the following categories:  
a) nonmetal                      b) metal                      c) metalloid
6. Define with two examples, the following terms:  
a) alkali metals                      b) alkaline earth metals                      c) halogens                      d) noble gases
7. Give an example of each of the following:  
a) a monatomic                      b) a monatomic anion                      c) a polyatomic cation                      d) a polyatomic anion
8. Identify the following as elements or compounds:  $\text{NH}_3$ ,  $\text{N}_2$ ,  $\text{S}_8$ ,  $\text{NO}$ ,  $\text{CO}$ ,  $\text{CO}_2$ ,  $\text{H}_2$ ,  $\text{SO}_2$
9. Give three number of protons and electrons in each of the following common ions:  $\text{Na}^+$ ,  $\text{Ca}^{2+}$ ,  $\text{Al}^{3+}$ ,  $\text{Fe}^{2+}$ ,  $\text{I}^-$ ,  $\text{F}^-$ ,  $\text{S}^{2-}$ ,  $\text{O}^{2-}$ ,  $\text{N}^{3-}$ ,  $\text{K}^+$ ,  $\text{Mg}^{2+}$ ,  $\text{Fe}^{3+}$ ,  $\text{Br}^-$ ,  $\text{Mn}^{2+}$ ,  $\text{C}^{4-}$ , and  $\text{Cu}^{2+}$
10. Define molecular formula and empirical formula. What are the similarities and differences between the empirical formula and molecular formula of a compound?
11. What are the empirical formulas of the following compounds:  
a)  $\text{C}_2\text{N}_2$                       b)  $\text{C}_6\text{H}_6$                       c)  $\text{C}_9\text{H}_{20}$                       d)  $\text{P}_4\text{O}_{10}$                       e)  $\text{B}_2\text{H}_6$                       f)  $\text{Al}_2\text{Br}_6$                       g)  $\text{Na}_2\text{S}_2\text{O}_4$
12. Explain why the formula  $\text{HCl}$  can represent two different chemical systems?
13. Name the following compounds:  
a)  $\text{HBr}$                       b)  $\text{Al}(\text{OH})_3$                       c)  $\text{HNO}_2$                       d)  $\text{Fe}_2\text{O}_3$                       e)  $\text{CaCl}_2$                       f)  $\text{Li}_3\text{N}$   
g)  $\text{NH}_4\text{NO}_2$                       h)  $\text{H}_2\text{O}$                       i)  $\text{KMnO}_4$                       j)  $\text{Na}_2\text{S}_2\text{O}_4$                       k)  $\text{K}_2\text{Cr}_2\text{O}_7$                       l)  $\text{TiCl}_4$
14. Write the formulas for the following compounds:  
a) Potassium chloride                      b) Ammonia                      c) barium iodide                      d) hydrogen bromide  
e) Sodium chlorate                      f) titanium (IV) oxide                      g) nitric acid                      h) hydrobromic acid
15. Predict the formula and name of a binary compound formed from the following element:  
a) Na and H                      b) B and O                      c) Al and F                      d) Na and S  
e) F and O                      f) Sr and Cl

## Tutorial 3

- There are three naturally occurring isotopes of neon. Their percent abundances are: neon-20 (90.51%), neon-21 (0.27%), neon-22 (9.22%). Calculate weighted average atomic mass of neon. (20.19 g/mol)
- The atomic masses of  ${}^6\text{Li}$  and  ${}^7\text{Li}$  are 6.0151 amu and 7.0160 amu, respectively. Calculate the neutral abundances of these two isotopes. The average atomic mass of Li is 6.941 amu. (92.5%, 7.5%)
- Calculate the formula masses of:  
a)  $\text{Li}_2\text{O}$    b)  $\text{BaCl}_2$    c)  $\text{Mg}(\text{NO}_3)_2$    d)  $\text{Al}_2\text{Br}_6$    e)  $\text{K}_2\text{Cr}_2\text{O}_7$    f)  $\text{Ba}(\text{OH})$    g)  $\text{NaHCO}_3$    h)  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$
- Calculate
  - the mass, in gram, of 0.155 mol  $\text{C}_3\text{H}_8$
  - the mass, in milligrams, of  $2.45 \times 10^{-4}$  mol of ethane,  $\text{C}_2\text{H}_6$
  - the number of moles of  $\text{C}_4\text{H}_{10}$  in a 165 kg sample
  - the number of moles of phosphoric acid in a 760 mg sample.
- Calculate
  - The number of moles of aluminum in cube of the metal 5.5 cm an edge ( $d = 2.70 \text{ g/cm}^3$ )
  - The volume occupied by 1.38 mol carbon tetrachloride, a liquid with a density of 1.59 g/mL
- Phenol has composition 76.57% C, 6.43% H and 17.00% O. Determine its empirical formula.
- Resorcinol, used in manufacturing resins drugs and other products, is 65.44% C, 5.49% H, and 29.06% O by mass. Its molecular mass is 110 g/mol. What is its molecular formula?
- Balance the following equation:
  - $\text{PCl}_5(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_3\text{PO}_4(\text{aq}) + \text{HCl}(\text{aq})$
  - $\text{PbO}(\text{s}) + \text{NH}_3(\text{g}) \rightarrow \text{Pb}(\text{s}) + \text{N}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$
  - $\text{Mg}_3\text{N}_2(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{Mg}(\text{OH})_2(\text{s}) + \text{NH}_3(\text{g})$
  - $\text{Fe}(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{Fe}_2\text{O}_3(\text{s})$
- All Alkali metals react with water to produce hydrogen gas and the corresponding alkali metal hydroxide. A typical reaction is that between lithium and water.
$$\text{Li}(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{LiOH}(\text{aq}) + \text{H}_2(\text{g}) \text{ (not balanced)}$$
  - How many moles of  $\text{H}_2$  will be formed by the complete reaction of 6.23 moles of Li with water?
  - How many grams of  $\text{H}_2$  will be formed by the complete reaction of 80.57 g of Li with water?
  - How many grams of LiOH will be formed by the complete reaction of 80.57 g of Li with water?
- Urea  $[(\text{NH}_2)_2\text{CO}]$  is prepares by reacting ammonia with carbon dioxide:
$$\text{NH}_3 + \text{CO}_2 \rightarrow (\text{NH}_2)_2\text{CO} + \text{H}_2\text{O} \text{ (not balanced)}$$
In one process 637.2 g of  $\text{NH}_3$  are allowed to react with 1142 g of  $\text{CO}_2$ .
  - Which of the reactants is limiting reagent?
  - Calculate, the mass of  $(\text{NH}_2)_2\text{CO}$  formed? And excess reagent (in grams) is left at the end of the reaction?
- What is the molarity of an 85.0 mL ethanol ( $\text{C}_2\text{H}_5\text{OH}$ ) solution containing 1.77 g of ethanol?
- The label of a stock bottle of aqueous ammonia indicates that the solution 28%  $\text{NH}_3$  by mass and has density of 0.898 g/mL. Calculate the molarity of solution.
- Describe how you would prepare  $5.00 \times 10^2$  mL of 1.75 M  $\text{H}_2\text{SO}_4$  solution starting with an 8.61 M stock solution of  $\text{H}_2\text{SO}_4$
- How many milliliter of a 0.610 M NaOH solution are needed to neutralize 20.0 mL of a  $\text{H}_2\text{SO}_4$  solution?
$$\text{NaOH} + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + \text{H}_2\text{O} \text{ (not balanced)}$$

## Tutorial 4

- Describe the four quantum numbers used to characterize an electron in an atom.
- An electron in an atom is in the  $n = 3$  quantum level. List the possible values of  $l$  and  $m_l$  that it can have.
- What is electron configuration? Describe the role that the Pauli exclusion principle and Hund's rule play in writing the configuration of elements.
- Explain the meaning of the symbol  $4d^6$ .
- How many electrons are permitted in each of the following subshells
  - 2s
  - 4d
  - 6p
  - fifth shell
  - 5f
- Write detailed electron configurations and an orbital diagram for the following atoms and ions:

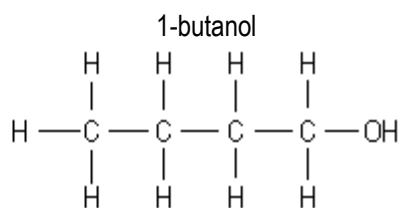
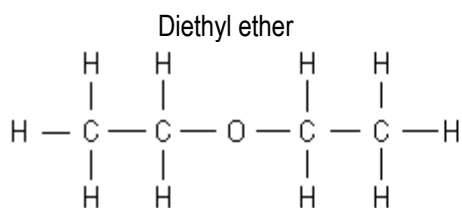
a. K	b. $Mn^{2+}$	c. P	d. $O^{2-}$	e. C	f. N
g. $Fe^{2+}$	h. $Fe^{3+}$	i. $Ca^{2+}$	j. Li	k. Cu	l. $Cu^+$
m. B	n. Ne	o. Cl	p. $Cl^-$	q. Na	r. $Na^+$
- What neutral atom is presented by each of the following configurations
  - $1s^2 2s^2 2p^6 3s^2 3p^2$
  - $1s^2 2s^2 2p^1$
  - $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$
- Explain the meaning of diamagnetic and paramagnetic.
- Define the magnetic properties (paramagnetic or diamagnetic) for the following atoms.

a. K	b. $Mn^{2+}$	c. P	d. C	e. Li	f. N
g. $Fe^{2+}$	h. $Fe^{3+}$	i. $Ca^{2+}$	j. Cu	k. Sr	l. Ar
- Which of the following elements are metals, nonmetals or metalloids?

a. As	b. Xe	c. Fe	d. Li	e. B	f. Cl
g. Ba	h. P	i. I	j. Si	k. Sr	l. Ar
- What is representative element? Give names and symbols of for four representative elements.
- A neutral atom of certain element has 20 electrons. (a) Write the ground-state electron configuration of the element, (b) classify the element, and (c) determine whether the atoms of these elements are diamagnetic or paramagnetic.
- Write the outer electron configurations for the
  - alkali metals
  - alkaline earth metals
  - halogens
  - noble gases
- Specify the group of the periodic table in which each of the following elements is found:
  - $[Ne] 3s^1$
  - $[Ne] 3s^2 3p^3$
  - $[Ne] 3s^2 3p^6$
  - $[Ar] 4s^2 3d^8$
- Group the species that are isoelectronic:  $Be^{2+}$ ,  $F^-$ ,  $Fe^{2+}$ ,  $N^{3-}$ , He,  $S^{2-}$ ,  $Co^{3+}$ , Ar

Tutorial 5

- Use the second member of each group from Group 1A to Group 7A to show that the number of valence electrons on an atom of the element is the same as its group number.
- Use Lewis dot symbol to show the formation of aluminum oxide ( $\text{Al}_2\text{O}_3$ )
- Explain what an ionic bond is? And name five metals and five nonmetals that are very likely to form ionic compounds
- Show the formulation of ionic bonds between these following atoms. What are the name and formula of the compound that results
  - Barium and iodine
  - Aluminum and oxygen
- What is Lewis's contribution to our understanding of the covalent bond?
- Show the formation of covalent bonds between these following atoms. What are the name and formula of the compound that result
  - 1 carbon, 3 hydrogen and 1 chlorine
  - 1 nitrogen and 3 hydrogen
- Write Lewis structures for the following molecules:
  - $\text{ICl}$
  - $\text{PH}_3$
  - $\text{BF}_3$
  - $\text{CO}_3^{2-}$
  - $\text{N}_2\text{H}_4$
- Determine whether each of the following is polar or non polar
  - $\text{SO}_2$
  - $\text{BF}_3$
  - $\text{CO}_2$
- Give an example for each type of intermolecular forces.
  - dipole-dipole interaction
  - dipole-induced dipole interaction
  - ion-dipole interaction
  - dispersion forces
  - van der Waals forces
- Arrange the following sets of atoms in the expected order of increasing electronegativity, that is from lowest to highest electronegativity value
  - Cl, Mg, Si, Al
  - P, As, N, Sb
  - As, Se, Br
- Indicate the polar nature ( $\delta^+$  and  $\delta^-$ ) of the following bond.
  - $\text{Br} \text{---} \text{Cl}$
  - $\text{H} \text{---} \text{Cl}$
  - $\text{I} \text{---} \text{Cl}$
  - $\text{Cl} \text{---} \text{F}$
- Which of the following can form hydrogen bonds with water?  $\text{CH}_3\text{OCH}_3$ ,  $\text{CH}_4$ ,  $\text{HF}$ ,  $\text{CHOOH}$
- Which of the following species are capable of hydrogen bonding among themselves?  $\text{H}_2\text{S}$ ,  $\text{C}_6\text{H}_6$ ,  $\text{CH}_3\text{OH}$
- Diethyl ether has a boiling point of  $34.5^\circ\text{C}$  and 1-butanol has a boiling point of  $117^\circ\text{C}$ :



Both of these compounds have the same number and types of atoms. Explain the difference in their boiling points

Tutorial 6

---

1. What is a phase change? Name all possible changes that can occur among the vapor, liquid, and solid phases of a substance.
2. List the physical characteristic of gas. Name five element and five compounds that exist as gases at room temperature.
3. What is the pressure in atmospheres of a gas that supports a column of mercury to a height of 808 mm  
(1.06 atm)
4. A 4.0 L sample of gas at 700 torr pressure is changed at constant temperature until its pressure is 1.315789 atm. What is its new volume?  
(2.80 L)
5. A sample of chlorine gas occupies a volume of 946 mL at a pressure of 726 mmHg. Calculate the pressure of the gas (in mmHg) if the volume is reduced at constant temperature to 154 mL.
6. A 6.50 L sample of gas is warmed at constant pressure from 2 °C to 77 °C. What is its final volume  
(8.27 L)
7. A sample of carbon monoxide gas occupies 3.20 L at 125 °C. Calculate the temperature at which the gas will occupy 1.54 L if the pressure remains constant.
8. Sulfur hexafluoride, SF<sub>6</sub> is a colorless, odorless, very unreactive gas. Calculate the pressure exerted by 1.82 moles of gas in steel vessel of volume 5.43 L at 69.5 °C
9. What volume will 7.00 g of O<sub>2</sub> occupy at STP?  
(4.91 L)
10. If 0.00206 kg of a gas occupies 3.33 L at 17 °C and 700 torr. What is the molar mass of the gas?  
(16.0 g/mol)
11. Calculate the density of carbon dioxide in grams per liter (g/L) at 752 mmHg and 55 °C.
12. What volume does the oxygen gas liberated by heating 3 x 10<sup>-4</sup> kg of KClO<sub>3</sub> until it completely decomposition to KCl and O<sub>2</sub> occupy? The gas is collected at STP  
(0.0827 L)
13. Ethanol (C<sub>2</sub>H<sub>5</sub>OH) burn in air.  
$$\text{C}_2\text{H}_5\text{OH} (l) + \text{O}_2 (g) \rightarrow \text{CO}_2 (g) + \text{H}_2\text{O} (l)$$
  
Balance the equation and determine the volume of air in liters at 35.0 °C and 790 mmHg required to burn 227 g of ethanol. Assume that air is 21.0 percent O<sub>2</sub> by volume.
14. Explain why liquids unlike gases, are virtually incompressible.
15. What is surface tension? What is the relationship between intermolecular forces and surface tension?
16. What is viscosity? What is the relationship between intermolecular forces and viscosity?
17. Describe and give examples of the following types of crystals.  
a. ionic crystals      b. covalent crystals      c. molecular crystals      d. metallic crystals
18. Explain why diamond is harder than graphite. Why graphite is an electrical conductor but diamond is not?
19. What is an amorphous solid? How does it differ from crystalline solid?