PSI AP CHEMISTRY
Summer Assignment Review Unit
Free Response

Atomic Theory and Models of the Atom

Classwork:

1. An atom has 65 neutrons and a mass of 122 u. Write the proper nuclide symbol.

2. Atom "A" has 11 neutrons and Atom "B" also has 11 neutrons. Are these atoms isotopes? Explain.

3. Which component of Dalton's atomic theory reflects his understanding of the law of conservation of mass for chemical processes? Why?

4. The atomic masses of elements are generally not whole numbers. Explain why.

5. Gallium has two stable isotopes: Ga - 69 (68.92 u) and Ga-71 (70.92 u). Using the average atomic mass of gallium, what is the % abundance of the heavier of the two isotopes?

6. Naturally occurring chlorine is 75.78% Cl - 35 (34.9689 u) and 24.22% Cl - 37 (36.9659 u). Calculate the average atomic mass.

7. What conclusions were made from Rutherford's "Gold Foil Experiment"? How did this experiment change the atomic model?

8. Explain why the Bohr model was insufficient and how the quantum model explained this deficiency. How is the electron viewed differently in each model?

9. Consider the equations relating wavelength, frequency and energy of electromagnetic radiation. How is the energy of a photon related to its frequency and wavelength?

10. Calculate the frequency of an X ray that has a wavelength of 8.21 nm.

11. What is the frequency of a photon that has an energy of 3.7×10^{-18} J

12. Provide a brief explanation for what each of the four quantum numbers describes.

Homework:

1. Radioactive americium - 241 is used in household smoke detectors and in bone mineral analysis.

      a) Give the number of electrons, protons, and neutrons in an atom of americium - 241.

      b) Write the proper nuclide symbol.

2. What characteristics do atoms of carbon-12, carbon-13, and carbon-14 have in common? IN what ways are they different?

3. Identify the isotope that has atoms with

      a) 117 neutrons, 77 protons, and 77 electrons

      b) 30 neutrons, 28 protons, and 28 electrons

4. How did the discovery of isotopes conflict with Dalton's atomic theory?

5. The average mass of any large number of atoms of a given element is always the same for a given element. Explain.

6. . Naturally occurring boron is 19.9% B - 10 (mass = 10.01294 u) and 80.1% B - 11 (mass = 11.0093 u). Calculate the average atomic mass.

7. Uranium has an atomic mass equal to 238.0289. It consists of two isotopes: uranium -235 with an isotopic mass of 235.044 u and uranium-238 with an isotopic mass of 238.051 u. Calculate the % abundance of the uranium-235 isotope.

8. How did Rutherford interpret the deflection of α-particles in his gold foil experiment? Did these findings support or disprove the plum pudding model of the atom? Explain.

9. How does Bohr's model of the atom explain the existence of line spectra? How are spectral lines produced?

10. What is the energy of a photon that has a wavelength of 8.33×10^{-6} m?

11. What is the wavelength of a photon that has an energy of 5.25×10^{-19} J

12. How does the quantum model describe the location of an electron?

Periodic Table

Classwork:

1. An element is found to gain three electrons when it forms an ion.
   a) What group number would this element be found in?
   b) Is there enough information provided to determine what period it is in?

2. Look at the average atomic mass of Ar and K.
   a) Explain why early scientists might have been tempted to have K follow Cl on the periodic table.
   b) Propose two reasons as to why they placed Ar after Cl instead of K.

3. Identify the following elements:
   a) An alkali metal in the 5th period.
   b) A transition metal
   c) An atom in the 3rd period that forms a stable ion with a -1 charge.

4. Explain why atoms tend to gain or lose electrons relative to the number of valence electrons.

5. What ions are the following elements likely to form?
   a) Nitrogen
   b) Calcium
   c) Sulfur

6. Explain why the noble gases are inert (unreactive).

7. Why are the charges of transition metals (d-block) difficult to predict?

8. Write the formulas for the following binary ionic compounds.
   a) magnesium oxide
   b) manganese(II) chloride
   c) calcium phosphide
   d) copper(I) sulfide

9. Write the formulas for the following polyatomic ionic compounds.
   a) potassium sulfate
   b) aluminum phosphate
   c) iron(III) carbonate
   d) aluminum hydroxide

10. Aluminum reacts with a certain nonmetallic element to form a compound with the general formula Al_2X_3. Element X must be from which group on the periodic table?

Homework:

1. What accounts for similarities of chemical properties for elements in the same group (family)?

2. Provide the group names for the elements in Group 1, 2, 17 and 18. Provide and example of an element in each of the above groups.

3. Identify the following elements:
    a) A halogen in the 3rd period.
    b) A metalloid
    c) An atom in the 4th period that forms a stable ion with a +1 charge.

4. Locate the following elements on the periodic table and indicate which orbital type is occupied by its valence electrons
    a) Lithium
    b) Silicon
    c) Copper

5. What ions are the following elements likely to form?
    a) Oxygen
    b) Sodium
    c) Bromine

6. A main group element in Period 4 forms the molecular compound H_2E and the ionic compound Na_2E.
    a) To which group does the element belong?
    b) Write the name and symbol of the element.

7. Write the formulas for the following binary ionic compounds.
    a) sodium sulfide
    b) cobalt(II) chloride
    c) lithium nitride
    d) Tin(IV) oxide

8. Write the formulas for the following polyatomic ionic compounds.
    a) barium nitrate

     b) calcium phosphite

     c) iron(II) chromate

     d) potassium permanganate

9. How many total ions (cations and anions) are present in the following ionic compounds?

     a) sodium acetate

     b) aluminum nitrate

     c) Copper(II) chloride

10. The most common charge associated with silver in its compounds is +1. Indicate the formulas you would expect for the ionic compounds formed between silver and the following elements.

     a) iodine

     b) sulfur

     c) phosphorous

Mole Concept

Classwork:

1. Answer the following questions for the compound aluminum sulfate.

     a) What is the molar mass of this compound?

     b) What is the mass of a 1.5 mole sample?

     c) How many oxygen atoms are present in the 1.5 mol sample

2. What mass of rhodium contains as many atoms as there are in

     a) gallium atoms in 36.0 g gallium

     b) indium atoms in 36.0 g indium

3.   a) Calculate the mass in grams, of 0.433 mol of calcium nitrate.

     b) How many formula units of calcium nitrate are present?

     c) How many nitrate ions are present?

4. Carbon has two isotopes C-12 (99%) and C-13 (1%).

     a) How many atoms of C would be present in a 34 gram sample of pure diamond (pure carbon)?

     b) How many atoms of those are C-13 atoms?

5. A sample of $Ni(CO)_4$, a toxic transition-metal complex, has 5.23×10^{24} atoms of carbon. How many atoms of Ni does it contain?

6. How many grams of CO_2 are in 7.50 liters of CO_2 at STP?

7. Without doing any detailed calculations, rank the following samples in order of increasing number of atoms: 0.50 mol H_2O; 23 g Na; 6.0×10^{23} N_2 molecules.

8. A reaction produces 0.0891 grams of ammonia gas (NH_3).
    a) How many grams of N_2 must have reacted to produce this ammonia gas?
    b) Assuming N_2 gas was the entire source of N and all of it was converted to ammonia, how many L of N_2 gas reacted assuming the reaction was carried out at STP conditions?
    c) How many L of ammonia were produced assuming the reaction was carried out at STP conditions?

9. Calculate the following quantities for 0.200L of a 0.400M Calcium Iodide (CaI_2) solution.
    a) moles of CaI_2
    b) grams of CaI_2 required to prepare the solution
    c) moles of I^-

10. What is the concentration (M) of a NaCl solution prepared by dissolving 9.3 g of NaCl in sufficient water to give 350 mL of solution?

11. a) How many moles of sodium ions are present in 150mL of a 0.75 M sodium phosphate solution?
    b) What is the molarity of sodium ions?

Homework:

1. Answer the following questions for a 3.50g sample of $C_6H_{12}O_6$.
    a) What is the molar mass of this compound?
    b) How many moles are in the sample?
    c) How many hydrogen atoms are present in the sample?

2. a) Calculate the number of moles in 1.75 grams of sodium carbonate.
    b) How many formula units of sodium carbonate are present?
    c) How many sodium ions are present?

3. Boron has two isotopes B-10 (19.9%) and B-11 (80.1%).
    a) How many atoms of B would be present in a 50 gram sample of pure boron?
    b) How many atoms of those are B-10 atoms?

4. A sample of $C_{12}H_{22}O_{11}$ contains 0.4662 moles of carbon atoms. How many moles of hydrogen atoms are in the sample?

5. Without doing any detailed calculations, rank the following samples in order of increasing number of atoms: 3.0×10^{23} molecules H_2O_2; 2 mol CH_4; 32 g O_2

6. One component of smog is nitrogen monoxide, NO. A car produces about 8.0 g of this gas per day. What is the volume at STP?

7. A reaction produces 100 grams of water.
    a) How many grams of H_2 must have reacted to produce this amount of water if 1 mol of H_2O is produced for every 1 mol of H_2 that reacts?
    b) Assuming H_2 gas was the entire source of H and all of it was converted to water, how many L of H_2 gas reacted assuming the reaction was carried out at STP conditions?
    c) How many molecules of H_2 reacted, assuming the reaction was carried out at STP conditions?

8. Calculate the following quantities for 343 mL of a 1.27M Na_2SO_4 solution.
    a) Moles of Na_2SO_4
    b) grams of Na_2SO_4 required to prepare the solution
    c) moles of Na_+

 9. What is the molarity of a 750 mL solution containing 50.0 g KCl?

10.   a) How many moles of hydroxide ions are present in 300mL of a 2.50M $Ca(OH)_2$ solution?
    b) What is the molarity of hydroxide ions?