HW—You need your book.
History of the Mole

Name Answer Key
Period _____ Date _____

Part A: Read in your *Modern Chemistry* text book on pages 65-67 to fill in the requested information.

1) **400 B.C. Democritus**-- A Greek philosopher who thought that everything was made up of atoms or "atomos" in Greek. What does "atomos" mean? indivisible

2) **Soon after- Aristotle**-- A Greek philosopher who did not believe in atoms.
How did Aristotle describe the makeup of matter? continuous matter—thought could indefinitely cut matter in half until reached atom of material

3) **1800's:** Scientists start to do actual experiments
   a) **Law of Conservation of Mass**: mass is neither created nor destroyed in chemical reactions.
      Total mass of reactants = Total mass of products
      1. What equipment in the 1800's allowed scientists to determine this law? balance
      2. Knowing that matter is made up of atoms, what has to happen to atoms in a chemical reaction to keep mass conserved? atoms are rearranged

   b) **Law of Definite Proportions:** The mass ratio of the elements of a compound is always the same.
      1. For the compound, sodium chloride, the mass ratio of the elements is always:
         39.34 % is Na and 60.66 % is Cl (See book.)
      2. Thus, if you had a 100 g sample of sodium chloride, how many grams of each element would you have? 39.34 g Na and 60.66 g Cl
      3. What if you had a 15 g sample of sodium chloride? 5.9 g Na and 9.1 g Cl
         (15 g)(.3934) =5.9 g; (15 g)(.6066) = 9.1 g
      4. Knowing that matter is made up of atoms, what does this law suggest about every compound?
         Fixed ratio of masses suggests fixed ratio of atoms—formula

   c) **Law of Multiple Proportions:** It is possible to have 2 different compounds that are made up of the same elements, but they have different mass ratios of those elements. More specifically, the mass ratio of the elements of one compound is a multiple of the mass ratio of the other.

      1. There are two compounds containing carbon and oxygen. Fill in the mass ratios for each:
         Carbon dioxide: 1 g of C and 2.66 *g of oxygen (See book.)*
         Carbon monoxide: 1 g of C and 1.33 *g of oxygen*
      2. Thus, if carbon monoxide has a formula of CO, what is the formula of carbon dioxide? CO_2
      3. Water and hydrogen peroxide both contain only hydrogen and oxygen. The mass ratios of each are as follows: *Water: 1 g H and 8 g of O*
         Hydrogen peroxide: 1 g H and 16 g O
         Knowing that water has the formula H_2O, what is the formula for hydrogen peroxide? H_2O_2

4) **1808- John Dalton**: Developed a theory to explain the laws above. Fill in the statements that make up his Atomic Theory.
   a) All matter is made up of atoms
   b) Atoms of a given element are the same in size, mass and other properties. Atoms of different elements differ in size, mass, and other properties. (isotopes)
   c) Atoms cannot be created or destroyed (exception: nuclear rxn)
   d) Atoms of different elements combine in whole-number ratios (formula).
   e) In chemical reactions, atoms are combined, separated or rearranged.

Part B: Read in your text book on pages 333-334 and fill in the requested information.

5) **1808- Gay Lussac--** A French balloonist that did lots of experiments with gases.

a) Fill in the data that he collected for the following reactions:

1. hydrogen gas + oxygen gas → water vapor

2 L	1 L	2 L
2 vol	1 vol	2 vol

*Only works for gases because molecules are very far apart

2. hydrogen gas + chlorine gas → hydrogen chloride gas

1 L	1 L	2 L
1 vol	1 vol	2 vol

b) What did Gay-Lusac conclude based on his data about gases?
Gases react in whole # ratios of the volumes—found it interesting

6) **1811—Amadeo Avogadro**-- Italian scientist—his law eventually leads to the concept of the MOLE!!!

a) Using Gay-Lusac's data, Avogadro came up with his law (hypothesis) that stated---
Equal volumes of gases at the same temperature and pressure have the same # of molecules (particles).

b) Though Avogadro's law seems relatively intuitive today, Avogadro's law was not quickly accepted by the scientific community. This is partly because it conflicted with John Dalton's view that elements had to exist as single atoms. For example, Dalton thought that hydrogen and oxygen gases were made up of single atoms. Thus, he came up with the reaction below for the formation of water. (Notice how his predicted volumes of gases conflict with actual experimental data.)

How Dalton wrote the reaction for the formation of water:	$2H_2$ (g)	$+1O_2$ (g)	$\rightarrow 2H_2O$ (g)
Volumes of gases that would be predicted assuming Dalton's formulas:	1 L	1 L	1 L
Volumes of gases determined by experiment:	2 L	1 L	2 L

c) The conflict can be resolved if one allows for the existence of diatomic elements. Fill in the simplest formulas for the substances in these reactions while staying consistent with Avogadro's law and experimental volumes.

1. Hydrogen gas + chlorine gas → hydrogen chloride gas

1 H_2	1 Cl_2	2 HCl
1 L	1 L	2 L

2. hydrogen gas + oxygen gas → water vapor (hydrogen oxide)

2 H_2	1 O_2	2 H_2O
2 L	1 L	2 L

(need ½ as much O as H in formula for water)

d) Once Avogadro's Law was accepted, this led to the determination of the relative masses of gases. We will explore this concept next.