WKS
Relative masses of Gases

Name Answer Key
Period ______ Date________

Introduction:
Suppose one has a variety of gas samples-- all with the same volume. Since the volumes are the same, according to Avogadro's hypothesis, the number of molecules in each sample must also be the same.

Suppose the mass is measured for each gas sample. It turns out that each gas sample has a different mass. Ummm??? Each sample contains the same number of molecules, but each sample has a different mass. Why is this the case???? Ahhhh, of course, each molecule has different mass

Purpose: Using the experimental data given, determine the relative mass of each gas.

Analysis of Data:
1) Determine the relative mass of each gas by filling in the chart below

Gas Sample	**Mass of gas samples** (all samples have the same volume)	**Relative masses of gases** *(Mass of H_2 is assigned a value of 1.00)*	**Relative masses of gases with H_2 assigned a value of 2.00** *(This gives one H atom a mass of 1.0) ** Please round values to 2 sig figs-- there is considerable error.*
hydrogen gas (H_2)	0.0883 g ÷ 0.0883 =	1.00 × 2 =	2.0
helium gas (He)	0.176 g	1.99	4.0
oxygen gas (O_2)	1.40 g	15.9	32
nitrogen gas (N_2)	1.23 g	13.9	28
carbon dioxide gas (CO_2)	1.93 g	21.9	44
ammonia gas (NH_3)	0.743 g	8.41	17
methane gas (CH_4)	0.706 g	8.00	16
hydrogen bromide(HBr)	3.54 g	40.1	80.
air (a mixture of what?)	1.28 g	14.5	29

2) In the last column, a H_2 gas was assigned a value of 2.0. This gave one hydrogen atom a value of 1.0.
Using this relative scale, determine the relative masses of the following atoms:
   a) helium (He) atom 4.0
   b) oxygen (O) atom 16
   c) nitrogen (N) atom 14
   d) carbon (C) atom 44 – 32 = 12
   e) bromine (Br) atom 80. – 1.00 = 79

3) Look on your periodic table. The numbers that have the decimals are your relative masses for each element. Do your experimental masses for the atoms in #2, match those (or are close) on the periodic table?
H: 1.008; O: 16.00; N: 14.01; C: 12.01; Br: 79.9. Yes, they match (or are very close).

Introduction to the mole

- What is the same about each of these samples of atoms?

  1 g of H atoms 4 g of He atoms 12 g of Carbon atoms 14 g of nitrogen atoms

  ANSWER: You guessed it-- they all contain the same number of atoms

- What is the same about each of these samples of molecules?

  2 g of H_2 28 g of N_2 32 g of O_2 44 g of CO_2 16 g of CH_4

  ANSWER: You guessed it again-- they all contain the same number of molecules.

- In actuality, every sample listed above has the same number of particles (either atoms or molecules). Avogadro thought life would be very simple, if he gave a name to that particular number of particles.

  He called this number of particles a MOLE of particles!!!!!

- Now, I am sure you have noticed, that all of the values in grams above, are the same numbers you determined for their relative masses (when H= 1). Thus, when you have a **mole** of any substance, the mass of the sample is its relative mass expressed in **grams**!!!

  Now, we have just defined **Molar Mass--** the mass (in grams) of a mole of a substance. For example:

  Molar Mass of H = 1.008 g/mole
  Molar mass of C = 12.01 g/mole
  Molar mass of O = 16.00 g/mole
  Molar mass of O_2 = 32.00 g/mole

- The molar masses of all elements are listed on your periodic table. (Again-- the #'s with the decimals.)

  For example, Molar mass of Cl = 35.45 g/mole
  Molar mass of Na = 23.01 g/mole

- To find the molar masses of molecules, just add up the masses of all of the atoms in the molecule. For example,

  Molar Mass of NaCl = 1 Na + 1 Cl = 22.99 + 35.45 = 58.43 g/mole
  Molar mass of H_2O = 2 H's + 1 O = 2(1.008) +16.00 = 18.02 g/mole

4) Use your periodic table, to determine the molar masses of the following atoms or molecules. Round all masses to FOUR SIG FIGS. (For molecules, just add up the molar masses of the individual atoms.)

   Note: MM = molar mass

   a) MM of Al = 26.98 g/mol
   b) MM of Ca = 40.08 g/mol
   c) MM of Fe = 55.85 g/mol
   d) MM of NO_2 14.01 + 2(16.00) = 46.01 g/mol
   e) MM of $AlCl_3$ 26.98 + 3(35.43) = 133.3 g/mol
   f) MM of $Ca(NO_3)_2$ 40.08 + 2(14.01) + 6(16.00) = 164.1 g/mol

5) Now put the FACTOR LABEL method to work. Since molar mass has units of **g/mole**, we can use molar masses to convert from grams to moles or from moles to grams. See if you can solve the following calculations-- use factor label!!!

   a) 25 g of Fe = ? moles of Fe

   $$? \text{ mol Fe} = 25 \text{ g Fe} \times \frac{1 \text{ mol Fe}}{55.85 \text{ g Fe}} = 0.4476 \text{ mol Fe} = \boxed{0.45 \text{ mol Fe}}$$

   b) 1.5 moles of NO_2 = ? grams of NO_2

   $$? \text{ g } NO_2 = 1.5 \text{ mol } NO_2 \times \frac{46.01 \text{ g } NO_2}{1 \text{ mol } NO_2} = 69.02 \text{ g } NO_2 = \boxed{69 \text{ g } NO_2}$$