Inorganic Chemistry
Lesson 7
Acidic oxides. Acids. Chemical calculations.

October 28, 2017

Mole

One of the most common operations any chemist is doing routinely is as follows: "How much of the substance A is needed to produce a substance B?", or "How much of the substance B is needed to react with the substance A?"

For example, consider the following reaction:

$$Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_{2(g)} \tag{1}$$

In this reaction, zinc (atomic weight 65 Da) interacts with sulfuric acid (molecular weight 98 Da). Obviously, since one molecule of zinc[1] reacts with one molecule of sulfuric acid, we may replace Daltons with grams, and conclude 65 *grams* of zinc are needed to react with 98 *grams* of sulfuric acid. In other words, the amount of particles (molecules) in 65 grams of zinc is equal to the amount of particles in 98 grams of sulfuric acid. Generally speaking, from the chemist's point of view, the amount of matter in 65 grams of zinc and in 98 grams of H_2SO_4 is the same. Indeed, we chemists are more interested in looking at molecules, and we do not care too much about their weight, because it is the number of molecules that matters, not their weight. That is why for us it is much more convenient to measure matter not in grams, but in other units that take into account the number of molecules. This unit is called a *mole*.

One mole of any substance is the amount of this substance in grams that is numerically equal to the molecular weight of this substance in daltons. For example, the molecular weight of hydrogen (H_2) is 2 Da, and, accordingly, one mole of hydrogen weighs 2 grams. Accordingly, one mole of nitric acid (HNO_3, MW = 63) is 63 grams, one mole of calcium carbonate ($CaCO_3$, MW = 100 Da) is 100 grams, and so on.

The concept of mole is one of the most fundamental chemical concepts. It makes chemical calculations much easier, and we will be using this concept very frequently.

[1]Since metals do not form polyatomic molecules, for our purposes, zinc atom and zinc molecule is the same thing. This is true for all other metals.

Homework

1. Draw the structural formulas of the following compounds:

   HNO_3, H_3BO_3, Cr_2O_3, Cl_2O_7, C_2H_6, K_2SO_4.

   Based on these structural formulas, decide which compounds from this list are acids, and name these acids using the rules we discussed in the class (the rules are available in the previous class reading materials).

2. Draw structural formulas for the following acids:

   a) phosphoric acid, b) nitric acid, c) chloric acid[2], d) sulfurous acid, e) silicic acid.

3. Iodine is the element that can exist in four different valence states. Can you tell, what is the relationship between the term "periodic acid" and the term "periodicity"?

4. A 20 g sample of the mixture of quartz sand[3], iron shavings, and graphite was treated with dilute sulfuric acids, and the gas formed was collected. When evolution of the gas has ceased, more acid has been added to the sample, but no reaction was observed after that. The total volume of the gas was 4 L. What is the content of iron shavings (in percents) in the mixture[4]?

5. You have four pieces of different metals: calcium, magnesium, iron, and zinc. The mass of each piece is 40 g. Which piece contains the biggest and the smallest number of atoms? If you add an excess of dilute H_2SO_4 to each piece, what will be the volume of hydrogen that forms in each case?

As usually, I would be grateful if you sent me your homework by evening of next Saturday. My e-mail is mark.lukin@gmail.com.

[2]Chlorine is pentavalent in chloric acid.

[3]Quartz is a crystalline silicon oxide.

[4]At room temperature and under atmospheric pressure, two grams of hydrogen occupy 22.4 L.