Lesson 16 Ratios

You know how to do ratios. Now we are going to derive equations from ratios in order to solve for missing information. In most of the problems in this lesson, the key will be to find all the possible ratios and then to choose the right one to find the correct answer. Let's do some problems to learn these two important concepts.

Example 1 There are 72 motor vehicles in the parking lot comprised entirely of motorcycles and cars. The ratio of cars to motorcycles is 3 to 1. How many cars are there? You can derive 3 ratios from this information. They are listed below. Only one was given, the cars to cycles, but we can also derive the cars to the total and the cycles to the total.

Cars to Cycles $\frac{\text{Cars}}{\text{Cycles}} = \frac{3}{1}$

Cars to Total Vehicles $\frac{\text{Cars}}{\text{Total}} = \frac{3}{4}$

Cycles to Total Vehicles $\frac{\text{Cycles}}{\text{Total}} = \frac{1}{4}$

Of the 3 ratios, which one uses the information given (total vehicles) and the information requested (number of cars)? The second ratio, cars to total vehicles, is the one to use.

$$\frac{\text{Cars}}{\text{Total}} = \frac{3}{4} \longrightarrow \frac{\text{Cars}}{72} = \frac{3}{4} \longrightarrow \text{Cars} = \frac{3 \cdot 72}{4} = 54$$

We can use this information to deduce that there are 18 cycles, since cars + cycles = 72.

You can also use what you know about atomic weights and ratios to find how many grams of each element are present in a given amount of that compound. Water has an atomic weight of 18 (2 hydrogens at 1 each and 1 oxygen at 16). There are three possible ratios to derive from this compound. Find out the mass of hydrogen if there are 1,440 grams of water.

Example 2

Hydrogen to Water $\frac{H_2}{H_2O} = \frac{2}{18}$

Oxygen to Water $\frac{O}{H_2O} = \frac{16}{18}$

Hydrogen to Oxygen $\frac{H_2}{O} = \frac{2}{16}$

Now if we know there are 1,440 grams of water, we can use our ratios to find the mass of the hydrogen present and the mass of the oxygen present. To find hydrogen's mass, choose the ratio which has water and hydrogen, since we have been given the amount of water, and we are looking for the amount of hydrogen.

$$\frac{H_2}{H_2O} = \frac{2}{18} \longrightarrow \frac{H_2}{1440} = \frac{2}{18} \longrightarrow H_2 = \frac{2 \cdot 1440}{18} \longrightarrow H_2 = 160 \text{ grams}$$

Example 3 Find the mass of carbon in CS_2. There are 1,596 grams of the compound.

Carbon to Compound $\frac{C}{CS_2} = \frac{12}{76}$

Carbon to Sulfur $\frac{C}{S_2} = \frac{12}{64}$

Sulfur to Compound $\frac{S_2}{CS_2} = \frac{64}{76}$

Of the 3 ratios, which one uses the information given (total grams of the compound) and the information requested (mass of the carbon)? The first ratio, carbon to compound, is the one to use.

$$\frac{C}{CS_2} = \frac{12}{76} \longrightarrow \frac{C}{1596} = \frac{12}{76} \longrightarrow C = \frac{12 \cdot 1596}{76} \longrightarrow C = 252 \text{ grams}$$

Sometimes there are 3 elements in a compound, which increases the number of ratios you can have. Choose the best one.

Practice Problems

1) The oak tree has 56 birds singing and sitting on its branches. A close look reveals only bluebirds and cardinals are present. The ratio of bluebirds to cardinals is 3 to 5. How many cardinals are there?

2) In Atlanta 42,000 fans came to the game. Braves' fans outnumbered Pirates' fans 2 to 1. How many intrepid Pirates' fans were at the game?

3) Find the mass of carbon in KCN. There are 455 grams of the compound.

4) Find the mass of nitrogen in KCN. There are 455 grams of the compound.

5) Find the mass of oxygen in MgO. There are 1,560 grams of the compound.

6) Find the mass of magnesium in MgO. There are 1,560 grams of the compound.

Solutions

1) $\frac{\text{Blue}}{\text{Card}} = \frac{3}{5}$ $\frac{\text{Blue}}{\text{Total}} = \frac{3}{8}$ $\frac{\text{Card}}{\text{Total}} = \frac{5}{8}$

$\frac{\text{Card}}{\text{Total}} = \frac{5}{8} \rightarrow \frac{\text{Card}}{56} = \frac{5}{8} \rightarrow \text{Card} = \frac{5 \cdot 56}{8} = 35$

2) $\frac{\text{Brave}}{\text{Pirates}} = \frac{2}{1}$ $\frac{\text{Brave}}{\text{Total}} = \frac{2}{3}$ $\frac{\text{Pirates}}{\text{Total}} = \frac{1}{3}$

$\frac{\text{Pirates}}{\text{Total}} = \frac{1}{3} \rightarrow \frac{\text{Pirates}}{42{,}000} = \frac{1}{3} \rightarrow \text{Pirates} = \frac{1 \cdot 42{,}000}{3} = 14{,}000$

3) $\frac{K}{KCN} = \frac{39}{65}$ $\frac{C}{KCN} = \frac{12}{65}$ $\frac{N}{KCN} = \frac{14}{65}$

$\frac{C}{KCN} = \frac{12}{65} \rightarrow \frac{C}{455} = \frac{12}{65} \rightarrow C = \frac{12 \cdot 455}{65} = 84 \text{ g}$

With three elements present, there are other ratios between the elements themselves, such as

$\frac{K}{C} = \frac{39}{12}$ $\frac{K}{N} = \frac{39}{14}$ $\frac{N}{C} = \frac{14}{12}$

4) $\frac{K}{KCN} = \frac{39}{65}$ $\frac{C}{KCN} = \frac{12}{65}$ $\frac{N}{KCN} = \frac{14}{65}$

$\frac{N}{KCN} = \frac{14}{65} \rightarrow \frac{N}{455} = \frac{14}{65} \rightarrow N = \frac{14 \cdot 455}{65} = 98 \text{ g}$

5) $\frac{Mg}{MgO} = \frac{24}{40}$ $\frac{O}{MgO} = \frac{16}{40}$ $\frac{O}{Mg} = \frac{16}{24}$

$\frac{O}{MgO} = \frac{16}{40} \rightarrow \frac{O}{1560} = \frac{16}{40} \rightarrow O = \frac{16 \cdot 1560}{40} = 624 \text{ g}$

6) $\frac{Mg}{MgO} = \frac{24}{40}$ $\frac{O}{MgO} = \frac{16}{40}$ $\frac{O}{Mg} = \frac{16}{24}$

$\frac{Mg}{MgO} = \frac{24}{40} \rightarrow \frac{Mg}{1560} = \frac{24}{40} \rightarrow Mg = \frac{24 \cdot 1560}{40} = 936 \text{ g}$