Key.

Relative Mass and the Mole

How can atoms be counted using a balance?

Why?

Consider the following equation for a chemical reaction: $2H_2 + O_2 \rightarrow 2H_2O$

This can be interpreted as two molecules of hydrogen and one molecule of oxygen combining to form two water molecules. But how often do chemists limit their reactions to one or two molecules? Usually a reaction is done with an unimaginable number of molecules. How then do chemists know they have the right mix? The molecules need to be quickly counted! How do we count molecules? The answer is the unit called the **mole**. This activity will start by considering two egg farmers (a chicken farmer and a quail farmer). They produce such large numbers of eggs that they can't count them all individually, so they count in dozens of eggs in some cases, while in other cases they use mass. Weighing is often easier than counting!

Model 1 – Eggs

Chicken		Quail		Ratio of numbers of eggs	Ratio of masses of eggs
Number of eggs in the sample	Mass of the sample	Number of eggs in the sample	Mass of the sample		
1	37.44 g	1	2.34 g	1 : 1	16 : 1
10	374.4 g	10	23.4 g	10:10 → 1:1	16 : 1
438	16,387.2 g	438	1,024.92 g	1:1	16 : 1
12 = 1 dozen	449.28 g	1 dozen	28.08 g	1:1	16:1
1 million	37,440,000 g	1 million	2,340,000 g	1:1	16:1

Chicken ↑ ↑ quail

1. Consider the data in Model 1.
   a. What is the mass of a standard chicken egg?

      37.44 g

   b. What is the mass of a standard quail egg?

      2.34 g

   c. Show mathematically how the 16:1 ratio of masses was calculated in the last column of Model 1.

      $\frac{37.44\text{ g}}{2.34\text{ g}} = 16$ $\quad \frac{2.34\text{ g}}{2.34\text{ g}} = 1$

2. Use a calculator to complete the table in Model 1. Divide the work among group members. Reduce all ratios to the lowest whole numbers possible.

3. Imagine you have two baskets—one filled with quail eggs and one filled with the same number of chicken eggs.
   a. Which basket would be heavier?

      Chicken

   b. How many times heavier would that basket be?

      16 times heavier

   c. Explain mathematically how it is possible for you to answer part *b* with confidence, even though you don't know the actual number of eggs. Each individual chicken egg is heavier, so if there are the same # of eggs in each basket, the total mass of the chicken egg basket will be greater.

4. A farmer weighs out 32.0 kg of chicken eggs.
   a. What mass of quail eggs would he need to weigh out to have the same number of eggs in both samples?

      quail → $\frac{1}{16} = \frac{x}{32.0\text{kg}}$ → $x = 2.0\text{kg}$
      chicken →

   b. If the farmer had weighed out 32.0 pounds of chicken eggs (rather than kilograms), what mass of quail eggs would he need to weigh out to have the same number of eggs in both samples?

      2 Pounds. work: $32\text{ pounds} \times \frac{1\text{ Pound Quail}}{16\text{ pound of chicken}} = 2$

5. A farmer makes up a new counting unit called a "clucksters."
   a. If the farmer had 3 clucksters of chicken eggs and 3 clucksters of quail eggs, what could you say about the ratio of their masses?

      The 3 clucksters of chicken eggs will be 16-times heavier than the 3 clucksters of quail eggs

   b. Does it matter in this problem how many eggs are in a "cluckster"? Explain.

      STOP It doesn't matter how many eggs are in a "cluckster". the 16:1 ratio will always be true as long as the # of eggs is the same.

Read This!

Let's take what we learned in the egg model and apply it to atoms. Like eggs, atoms of the same element may have slightly different masses (remember isotopes). The periodic table lists an average atomic mass for the atoms in a sample of each element. These masses are recorded in "atomic mass units" where 1 amu is approximately equal to the mass of a proton (or neutron).