Introduction to Moles Lab Activity

Name:

Prd:

Part 1: Clucksters

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		10			
438		438			
1 dozen		1 dozen			
1 million		1 million			

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

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

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

2. Use a calculator to complete the table in Model 1. 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?

   b. How many times heavier would that basket be?

   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.

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?

   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?

5. The farmer makes up a new counting unit called a "cluckster."
   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?

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

Part II The PCU:

Objective: To come up with a new counting unit, use it in calculations, and compare it to the use of the mole.

Materials:

- Popcorn Kernels
- Navy beans
- Paper cups
- Macaroni
- Digital Balance
- Lentils

1. Count out 32 popcorn kernels and determine their mass. This number will be called "1 PCU"

1PCU =	32 kernels	= __________ g of kernels

2. Complete the following equation based on your data:

a) Show how you would calculate the number of kernels in 3PCUs:

Show setup and final answer:

b) Show how you would calculate the number of kernels in 20.00g of popcorn:

Show setup and final answer:

c) Show how you would calculate the mass, in grams, of 100 popcorn kernels:

Show setup and final answer:

We can use a PCU just like a dozen is used.

3. Would you expect 1 dozen apples to weigh the same as 1 dozen popcorn kernels?
Explain why or why not.

4. How many popcorn kernels is 1 PCU? ________Therefore…

If you were counting out 1PCU of marbles, how many marbles would you count out? _______

If you were counting out 1PCU of each type of bean/pea, how many of each would you count out? _______

Part III: Using a PCU to compare differences among materials

1. Count out 1PCU of each of the following materials.
2. Use a balance to determine the mass of 1PCU of each sample and record it in the table.
3. Complete the table, **keeping in mind that the number of particles in a PCU is always the same.**

Type of "particle"	Number of "particles" in 1 PCU	Mass of 1 PCU
Macaroni		
Navy Beans		
Lentils		

1. Would you expect 1 PCU of marbles to weigh the same as 1 PCU of popcorn kernels?
   Explain your answer.

2. Circle the correct answer
   a. Is the number of navy beans in 1 PCU (more than, less than, or equal to) the number of macaroni in 1 PCU?
   b. Is the mass of 1 PCU of navy beans (more than, less than, or equal to) to the mass of 1 PCU of macaroni?
   c. Is 1.0 g of macaroni (more than, less than, or equal to) 1 PCU of macaroni pieces?

3. Calculate the mass of 3 PCU of lentils.

Show setup and final answer

4. Calculate the number of PCU's in 15.50 g of navy beans.
Show setup and final answer

Part IV: The Mole as a Counting Unit:
In chemistry the particles being counted are usually atoms or molecules, so even 500 or 1000 is too small of a counting unit to be useful. Instead, scientists use a very large counting unit known as the mole. The mole is useful tool for chemist because it provides a relationship between the number of atoms or molecules in a substance (which we can not measure easily) and their mass (which we can measure easily)

1 mole = 6.02×10^{23} particles = 602,000,000,000,000,000,000,000 particles
(more than you could count in a lifetime!)

How many atoms are in 1 mole of carbon? ____________________
How many molecules are in 1 mole of carbon dioxide? _____________________
How many electrons are in 1 mole of electrons? ____________________
How many Skittles are in 1 mole of Skittles? ____________________

Part V: Applying to Atoms

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).

Model 2 – Atoms

Oxygen		Sulfur		Ratio of numbers of atoms	Ratio of masses of atoms
Number of atoms in the sample	Mass of the sample	Number of atoms in the sample	Mass of the sample		
1	16.00 amu	1	32.00 amu		
10		10			
1 dozen		1 dozen			
1 million		1 million			
1 mole	16.00 grams	1 mole	32.00 grams		

Note: The masses shown for oxygen and sulfur have been rounded to make the arithmetic a bit easier.

1. What is the ratio of the mass of an oxygen atom to the mass of a sulfur atom?

2. Fill in the table in Model 2 in a similar fashion to the eggs table in Model 1. Reduce all ratios to the lowest whole numbers possible.

3.

Circle the phrase below that completes the sentence.

When two samples contain the same number of atoms ________________________.

the masses of the samples will be equal.

the ratio of the sample masses will be equal to the ratio of the atom's masses.

the masses are unrelated.

4. Explain why it is not necessary to know how many atoms are in "1 mole" to finish the last row of the table in Model 2.

5. How would the number of oxygen atoms in a 16.00 lbs sample compare to the number of sulfur atoms in a 32.00 lbs sample?

Record the chemical symbol, atomic number, and atomic mass of each element in the table below using your periodic table.

Element	Symbol	Atomic Number	Atomic Mass (to the nearest 100th)	Mass of sample + container	Mass of container	Mass of sample (1 mole)
Sulfur						
Silicon						
Carbon						
Copper						

6. Use the balance to find the mass of each sample, which contains approximately 1 mole of the element, including the container. Be sure to also record the mass of the container as indicated on the label.
7. Find the mass of 1 mole of the substance by subtracting the container mass from the total mass. Record in the table.
8. Compare the mass of a mole of each element to its atomic mass. What pattern do you observe?