

MANCHESTER COLLEGE
Education Department

Lesson Plan by: Anthony Herber

Lesson: Introducing the mole (Avogadro's number) and Molecular Mass

Length: 70 minutes

Grade: Chemistry I

Academic Standard(s):

C.1.14 Use Avogadro's law to make mass-volume calculations for simple chemical reactions.

C.1.15 Given a chemical equation, calculate the mass, gas volume, and/or number of moles needed to produce a given gas volume, mass, and/or number of moles of product.

Performance Objectives:

1. While working in groups of two or three, students will calculate the size of a mole of common items, such as Starburst candy, pennies, and sand, given a worksheet to complete. This should be done with at least 75% accuracy.
2. Given a worksheet of compounds and a periodic table, students will calculate the molecular mass of compounds with at least 85% accuracy.

Advanced Preparation by Teacher:

The teacher will need enough molecular model sets for each group to share a kit. They will need to have adequate copies of the worksheet that they have prepared, and they will also need one mole amounts of several substances. The teacher will also need a bag of Starbursts candies, and a ruler for each group.

Procedure:

Introduction/Motivation:

1. The teacher (while dramatically putting one grain of sand on their fingertip) will introduce the lesson by asking students "to examine the grain of sand and predict how many atoms are there in one single, solitary grain of sand." After students have given a few answers, with numbers ranging from a few to a few million, the teacher will tell the students that today, we are going to find out exactly how many atoms there are in a grain of sand.

Step by Step Plan:

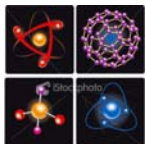
1. While the students are seated at their desks, the teacher will ask them if they can think of words that stand for a set number of things (prior knowledge) (Bloom's-Knowledge). The teacher will give the example of a dozen. "No matter what you are talking about, a dozen of ANYTHING is exactly 12," the teacher can say. Write student responses on the board, half-dozen, gross, pair, trio, a ream, etc.

2. The teacher will ask students, "If I have a dozen *gumballs* in my hand, and Bob has a dozen *sticks* of gum in his hand, who has more *pieces* of gum?" (Bloom's Comprehension)
3. The teacher will then extend this to the context of chemistry, and say that since atoms and molecules are different sizes, scientists came up with a word to describe a set number of them. Just as a dozen is ALWAYS 12 of something, a MOLE is the same number regardless of what you are talking about. A mole is always 6.02×10^{23} . That is 602,000,000,000,000,000,000,000. This number was first used because it is the number of carbon atoms in a pure sample of carbon-12. The teacher will explain that this is called Avogadro's number. To help reinforce this concept, the teacher will rapidly call on students, asking them how many doughnuts are in a mole. (Cats, t-shirts, lima beans, cell phones, opossums, atoms, molecules). To each, students should respond 6.02×10^{23} doughnuts, cats, t-shirts, etc.
4. The teacher will ask if anyone can think of a conversion factor that could be used to convert between moles and particles. (Bloom's Synthesis) 6.02×10^{23} atoms/ 1 mole. The teacher can explain that this (like all conversion factors) can be flipped (inversed) to get the units to cancel for the calculation being done. The teacher will then work a simple example to help students grasp the concept.
5. The students will then get in groups of two or three to complete the worksheet "How Big is a Mole?" (Gardner's Spatial-Visual and Logical Mathematical and Bloom's Analysis).
6. Once students have completed to first half of the worksheet, they will return to their regular seats and the teacher will introduce the concept of molecular mass.
7. The teacher will ask the students if they would expect one dozen cars to weight the same as one dozen baseball hats. When the obvious reply is no, the teacher will ask if mole of Helium gas would weight the same as one mole of copper metal. The teacher can then explain that since atoms have different compositions (different amounts of protons, neutrons, and electrons) we should not expect them to weigh the same amount either, and thus molar mass is born.
8. The teacher will further explain by indicating on the periodic table where the molar mass can be found. Since it is the same as the atomic mass, the teacher will ask the students what this number signifies (from prior knowledge, they should say that it is the mass of one atom in amu's). (Bloom's Comprehension)
9. At this point the teacher will explain that this point that they are both correct. Ask the students to look at an element, say aluminum, and find its atomic mass... it is 26.98 amu's, and then its molar mass is 26.98 g/mole. Propose this question to the students: If I weigh out 26.98 g of Al, how many atoms do I have on the scale? (Bloom's Analysis). For a hint, remind the students of the work they just did with moles.
10. Explain the molar mass for atoms is ALWAYS the atomic mass, with units of g/mole instead of amu.
11. Ask the students how you might find the molar mass of *compound* using the periodic table. For a simple example, ask them to find the molar mass of HF and MgSO₄. These can be worked out on the board, with students using the board to work them out.
12. At this time, have students form into groups again and complete the bottom portion of the worksheet (Gardner's Interpersonal).

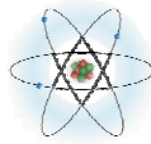
Closure:

If the students are still working when the period is nearly over, have them move back to their regular seats, straightening out the desks if they are not in line. Ask the students if they have a better understanding of how small atoms are after today's activities, and answer any last minute questions. The molar mass worksheet should be handed out as homework.

Adaptations/Enrichment:**Self-Reflection:**



How BIG is a mole?



In this activity, we will call an individual Starburst candy one atom. So, if we had a mole of Starbursts, we want to know how big (what volume) this is. We will assume that the atoms stack nicely next to and on top of each other.

What is the volume of one Starburst? _____
(You may want to convert to meters from cm before calculating the volume.)

What volume (in m^3) would one mole of Starbursts occupy? _____
Does this answer make sense? The volume of Lake Michigan is $4.92 \times 10^{12} \text{ m}^3$. How does your answer compare?

Now we are going to calculate how many molecules are in a grain of sand (SiO_2). Here's what we know or can assume: 1 average grain of sand has a volume of 1 mm^3 and a mass of $2.4 \times 10^{-3} \text{ g}$. Also, there are always 6.02×10^{23} molecules/mole. Here's what you need to calculate: the molar mass of sand. Use this to find out how many SiO_2 molecules are in one grain of sand.

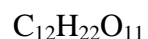
Determining Molar Mass & Working with Moles

Name _____

Period _____

Date _____

Calculate the molar mass of the following compounds



Calculate the number of moles present in 100.0 g of carbon.

How many moles are present in 155.0 g of CaCl_2 ?

What is the weight of 1.9 moles of LiOH ?

Why does 1 mole of cobalt weigh more than 1 mole of boron?

Explain, in complete sentences, how to determine the number of atoms present in a 200.0 g sample of KBr .

Why do scientists tend to work with molar amounts instead of masses (weight) of substances?