6.2   Whiz and Bang Marvel at Moles

Taking a break in the school cafeteria, Whiz and Bang are discussing the mole concept.

Whiz: Hello, Bang! You look depressed, did someone take your cookie or
something?

Bang: No, I am completely confused in chemistry right now. We are learning this
mole stuff and it is like the teacher is talking in a different language.

Whiz: If you would like, I can help you. I am a little bit of a "whiz" in chemistry.
Get it Bang? I am a "whiz" in chemistry. *(sitting down next to Bang and nudging
him on the shoulder)*

Bang: Ha, ha, I get it. I am so perplexed, my brain is tired, and I have a quiz 8th
hour.

Whiz: Let's use some analogies. Sometimes using real everyday objects and ideas
helps us understand what is happening on the submicroscopic level a little easier.

Bang: Now you are talking in a different language. If I wanted a foreign language
I would have taken Spanish like my mom wanted me to.

Whiz: Díos mío! *(oh my goodness)* It isn't that difficult. Chemists talk about the
submicroscopic because all the chemistry magic in reactions and with elements
and compounds happens at a level so small that you can't even see it with high
powered microscopes. The submicroscopic. What do you remember about the
mole Bang?

Bang: I know that it is some sort of number that has an exponent in it and somehow is
related to the periodic table or something.

Whiz: Good, we are half way there. A mole is a counting number like a dozen equals
12. A mole is equal to 6.02×10^{23rd}. That is 602 with 21 zeroes after it, the reason
it is in exponential notation is because it is so big. Chemists need a number so
big because atoms and molecules are so small. In order to measure atoms out
on our lab equipment we need to work with a large quantity of them.

Bang: So, how big of a number is that? I can't picture it; I know what a dozen cookies
taste like.

Whiz: A mole of marshmallows (6.02×10^{23rd} marshmallows) would cover the United
States to a depth of 6500 miles (105,000 km) with marshmallows.
Astronomers estimate that there is approximately a mole of stars in the universe.
If you counted 1 mole of sheep as you were trying to fall asleep, it would take you
19 billion years, and that is counting by a million sheep per second and never
falling asleep.

Bang: Wait a minute, hold up. If a mole is that large of a number, how the heck can we use our lab equipment in class to measure it?

Whiz: That's the thing Bang, it is an analogy. I can fit a mole of carbon atoms in the palm of my hand, yet a mole of marshmallows covers the United States in a gooey mess. So what is the difference in size between a marshmallow and a carbon atom?

Bang: I got it Whiz; atoms are really, really small compared to marshmallows.
Even if you have a lot of them they still don't take up much space. But what does this have to do with the periodic table?

Whiz: This is where things get really cool. Do you remember the unit label for the mass numbers on the periodic table?

Bang: Yeah, it was a.m.u. or atomic mass unit or something, but those units didn't make any sense because none of our scales measure in a.m.u.'s.

Whiz: Exactly, the a.m.u. was the unit label for just one atom of an element. We just learned that in order to work with atoms you need a lot of them, how about using a mole of atoms? So if I had a mole of carbon atoms, how many atoms would that be?

Bang: Let me think, a dozen atoms would be 12 so a mole would be 6.02×10^{23} atoms.

Whiz: Awesome, you got it. So, what we know is that number on the periodic table works with the unit a.m.u.'s but we can change the unit label to grams when we are talking about a mole of atoms. One atom of carbon has a mass of 12.0 amu's but 6.02×10^{23rd} atoms of carbon has a mass of 12.0 g. Scientist use this molar mass number as a conversion factor to change units from atoms to moles to grams.

Bang: Hey, that is what the next problem is. How in the world do I do that?

Whiz: Let's use an analogy again. Say there are 40 nickels = 1 roll of nickels and each nickel = 5 cents. So, if you have 3 rolls of nickels, how many nickels do you have?

Bang: I am going to set this up the way we did in chemistry class.
3 rolls of nickels x $\underline{40 \text{ nickels}}$ = 120 nickels.
$\qquad\qquad\qquad$ 1 roll

Whiz: You have it, if each nickel is worth 5 cents, how much money is that 3 rolls of nickels worth?

Bang: Again set it up like we did before. 120 nickels x $\underline{5 \text{ cents}}$ = 600 cents
$\qquad\qquad\qquad\qquad\qquad\qquad$ 1 nickel

Whiz: Now let's use carbon. If you know that 1 mole of carbon = 6.02 x 10^{23} atoms of carbon, how many atoms do you have if you have 5 moles of carbon?

Bang: 5 moles of carbon x $\underline{6.02 \times 10^{23} \text{ atoms of carbon}}$ = 3 x 10^{24} atoms of Carbon
                                        1 mole of carbon

I think I can even turn that into grams for you also.
I know that 1 mole of carbon = 12.0 grams.
So: 5 moles of carbon x $\underline{12.0 \text{ g of carbon}}$ = 60 grams of carbon
                                 1 mole of carbon

Whiz: Bang, I think you are going to do a "Bang up" job on that quiz today. Get it, "bang up" job.

Bang: *(chuckling)* Thanks for your help, Whiz, this mole stuff is marvelous.

Author – Nancy Smith   © Moose Moss Press 2013