

What's a mole?

So, you've finally heard about moles. I'm not talking about those little creatures that live underground and come up to feed on the blood of the innocent at night – I'm talking about the chemistry type that comes up to feed on the blood of chemistry students at night.



Contrary to popular belief, the mole sauce used in Mexican food does not contain any of the underground type of mole. Though it does burrow through me pretty quickly.

Let's learn a bit more about our friend the mole, and how it can make your chemistry life wonderful in every way.

What's a mole?

Pop quiz: If I'm wearing a pair of shoes, how many shoes am I wearing?

Answer: If you said "two shoes", you're absolutely right! Give yourself a gold star!



Mom will be so proud!

Other things that come in pairs include glasses (it has two pieces of glass), a pair of pants (each leg used to be called a "pant"¹), and a pair of binoculars contains two monoculars.² If you think about it, the word "pair" really just means "two."

If I were to tell you that I bought a dozen eggs, you'd probably assume (rightly) that I bought 12 eggs. Likewise, if you go down to Krispy Kreme and buy a dozen doughnuts, they'll give you a box containing 12 doughnuts.³ In fact, if you refer to a dozen of anything, people know you're talking about 12 of them. In other words, "dozen" = "12".

Similarly, the word “score” refers to 20 of something (“four score and seven years” is just 87 years) and the word “gross” refers to 144 of something.



Hey, don't get me involved in all this.

Now, let's turn our attention to the word “mole.” Just like a pair of shoes has two shoes in it, a dozen doughnuts contains 12 doughnuts, and a gross of pencils contains 144 pencils, the word mole just refers to a number. This number is 602,214,129,000,000,000,000,000. Which is a really, really big number. You can make it seem a little easier to manage by putting it into scientific notation (we usually round to 6.02×10^{23}), but that doesn't change the fact that 1 mole = a whole lot of things.

How many things is it? Let's have a look:

- 1 mole of moles (the little furry animals) would cover the earth to a depth of about 80 km or, if shot into orbit, make a small planet about the size of the moon (check out [this article](#) for the calculations).
- 1 mole of unpopped popcorn kernels would form a sphere about the size of Florida (an interesting article is [here](#)).
- 1 mole of basketballs would form a sphere the size of the Earth (a good video about moles can be found [here](#)).



You are here

You get the idea: 1 mole is a great big bunch of stuff.

Which is why you've never heard of a mole until now. It's not like you can walk down to the store and buy a mole of candy bars, or go play with that mole of Legos that Uncle Al gave you for Christmas. If you can see individual things, it's not really possible to get a mole of them together in one place. Even the universe only holds about a [tenth of a mole of stars](#), and it's a *really* big place.

Simply put, moles have been completely irrelevant to you before now.

An aside: Mole day

When I was in high school, I had a teacher who used to celebrate something he called "Mole Day" on October 23. We hadn't gotten to the concept of the mole yet, so it made absolutely no sense that 10/23 would correspond to the exponent after a supposedly important number we'd never heard of. He seemed to like it, though.

Nowadays, Mole Day falls during National Chemistry Week, an event held by the American Chemical Society to celebrate the many ways in which chemistry has made our lives better. Some high school chemistry teachers use Mole Day as an occasion to get their students excited about chemistry. Wearing t-shirts with comic moles and carrying stuffed moles, they go all-out to bring the wonders of mole day to their students.

Nerds.

So why should I care about moles all of a sudden?

It turns out that, while a mole of hot dogs is way more than you could ever eat, a mole of water isn't the same way. If you have 6.02×10^{23} molecules of water, that's a moderate-sized sip of water. Though one mole is a *really really big* number, molecules are *really really small*. Unlike eggs, where collecting a mole of them would be insane, a mole of molecules is something that you can work with in the laboratory.

And, because molecules and atoms combine with each other in whole-number ratios during chemical reactions, it's handy to know how many we've got in one place. We could use the actual number of molecules that's present (the math would be the same), but people have lots of problems visualizing 602,214,129,000,000,000,000 atoms. It's much easier on our little brains to just say that we have a mole of them.

In the next tutorial, I'll discuss how to use moles in calculations. For now, please remember that the chemical idea of the mole just refers to a number. It's nothing mysterious or scary.



Not like this mole, who feeds on the souls of small children.

Footnotes:

1. There is actually a little bit of controversy about where the term “pair of pants” came from, suggesting that people spend too much time in front of the computer trying to argue about things and not enough time out in the real world. The comments on this explanation page are funny: <http://www.word-detective.com/2008/02/pair-of-pants-etc/>. Oddly, there's no particular controversy about “pair of glasses” or “pair of scissors” – it's usually assumed that the reasoning for these is the same as the reasoning as that for pants.
2. Binocular is an interesting word, because the term “binocular” already suggests that there are two of something (in this case, little telescopes called monoculars). By this reasoning, a “pair of binoculars” should really contain enough binoculars for two people to use at the same time. No wonder people have such a hard time learning English.
3. I once went down to the local supermarket to take advantage of a deal where a “baker's dozen” of bagels was being sold for \$3. Given that the term “baker's dozen” refers to 13 of something rather than 12, I took my bagels on down to the cashier along with \$3. The cashier had never heard of the term, so called the manager over to deal with me. Though he agreed that the ad said “baker's dozen”, he also believed that this referred to 12 and not 13 bagels. We went back and forth like that for a while, and he finally got tired of me and said “Well, if you're going to be an jerk about it, just take the extra bagel.” So I took the extra bagel. Yay, me!

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2. Gold star: By Caihua + Lilyu for SVG. The source code of this SVG is valid. This vector image was created with Inkscape. (File:Fairytale bookmark gold.png (LGPL)) [LGPL (<http://www.gnu.org/licenses/lgpl.html>)], via Wikimedia Commons.
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