

What is Everything Made Of?

Setup: put periodic table on bulletin board, set out measuring cup, 500-mL clear measuring container, glass for marbles, marbles, ethanol, water.

key words:

atom

molecule

element

(ore)

metal

periodic table

chemical reaction

I. Introduction (10 minutes)

- Who am I?

I'm a chemist from UC Berkeley. I'm from Texas, and I went to school at MIT in Boston, MA, where I received my degree in chemistry with minors in French and Brain and Cognitive Science in 2002. Then I moved to Toulouse, France, to work for Motorola as an English teacher for 1 year. Now I'm working on my PhD.

Where are you from? Have you been to Boston/Texas/France?
What do you think "chemistry" is? What have you heard about it?

- Inspiration

Chemistry as the central science: biology chemistry physics.
Physics deals with the mathematical expression of the basic laws of the universe, like gravity. Abstract.
Biology deals with living organisms, cells, and macromolecules like proteins. Easy to see.

Chemistry connects these two disciplines by studying the molecules described by physics and used by biologists.
(draw on the board a circle to represent an atom, draw integral $\int f(x) dx$ before and many circles after to represent physics and biology)

Chemistry is the air we breathe, the food we eat, the clothes we wear, the medicine we take.

Modern chemistry started in the 1600s. (Boyle, then Lavoisier in 1700s)

- Background

(Pass out periodic tables).

What we know about chemistry is organized in the periodic table.
Put together by Mendeleev in 1869, we've been adding to it ever since.

All matter is made of atoms, and each element is a different kind of atom. Atoms are made of smaller particles, but not broken down into these particles under everyday conditions.

They are the smallest bits of matter that can exist independently.

element – specific kind of atom. material that cannot be decomposed by existing means. (Lavoisier). Not made up of any other element.

rhenium - last naturally occurring element to be found
technetium – first element to be artificially made (1937)

names of elements are beautiful and fascinating:

tellurium named after the Earth (terra)

cobalt from kobold (goblin) because hard to get pure
nickel means devil

Tantalus (tortured in hell, water retreated from him) and Niobe – mythical father and daughter, elements Tantalum (doesn't dissolve in acid water) and Niobium always found together.

town of Ytterby in Sweden named 4 elements: ytterbium, terbium, erbium, yttrium

palladium and cerium after asteroids pallas and ceres
Uranium?

Tungsten, W, highest melting point of all the metals, tougher than steel. W for Wolfram, because steals tin like a wolf.

Some elements named for famous people and places: Seaborgium, Berkelium, Einsteinium, etc.

Elements fascinating:

gallium melts in your hand.

aluminum is bendable and “cries”

magnesium can burn under water, but we also made airplanes with it.

“stinkogens” – sulfur, etc rotten eggs. garlic, onion

(chalk – calcium carbonate, maj. component of earth's crust.
“limelight” – the green glow of lime, or calcium oxide, used to light theaters in the 1820s.)

Elements are made in exploding stars – supernova! intense heat and pressure. Hydrogen primordial element – from it all others were made.

2 or more elements bonded together gives you a molecule or a compound.

like ethanol – CH₃CH₂OH.

do you know this one? H₂O.

Water molecules interact in a special way based on the properties of H and O. There is space between water molecules.

II. Main Presentation (30-40 min.)

- Demonstration – How can we see the space between the water molecules?

1 cup (250mL) water.

1 cup (250mL) alcohol.

If I pour this alcohol in this water, what do you think the final volume will be?

(Now show a glass of marbles). These represent water molecules. See the spacing between them?

Now fill the glass with alcohol. When you pour in the alcohol to the water, it fills the spaces between the molecules, like so.

- Hands-On – What elements make up the things around us in everyday life?

Pass out the Common Object table and the index cards with string attached. (I keep the pushpins and tape).

We want to find what elements make up the objects you see on your cards. Look for your object on the table I gave you. Then find your elements on the periodic table. When everyone is finished, we will each come up to the board and connect our object to its element or elements.

(Keep one index card for myself)

When the kids are finished, I take my card, show them the object and what it's made of, find the element(s) on the periodic table, tape or push-pin my card to the board, and connect the string from the card to the element with a push-pin.

Who wants to try now?

- Discussion/Wrap-Up

What did you learn from this exercise?

What surprised you? (notice that graphite and diamond are the same element! by the way – diamonds are as old as the Earth. formed deep inside the earth. we can't make them because we can't duplicate the required temperature and pressure – that's why they're so expensive.)

What elements did we use the most today? In what kinds of things are they found?

All living things contain hydrogen, oxygen, carbon, and nitrogen. These 4 elements make up more than 95% by weight of all the living matter on Earth. why? H and O due to abundance of water on Earth. C and N harder because relatively rare on Earth. Special properties – able to store information in complex molecules.

Can you think of other everyday objects that you would like to know more about? What about sand and glass? (chalk – calcium carbonate, maj. component of earth's crust.

“limelight” – the green glow of lime, or calcium oxide, used to light theaters in the 1820s.)

The next step in chemistry is to ask yourselves: how can the same elements have such different appearances?

Why does the periodic table stop where it does?

Cleanup! (leave table on board with cards?)

Web elements site: history, description, pictures of all the elements.

<http://www.webelements.com/webelements/scholar/index.html>

More about C, H, O, N and other elements:

<http://www.physics.hku.hk/~tboyce/sfseti/07elements.html>

Great Reading Material:

Uncle Tungsten – Oliver Sacks

The Curious Cook – Harold McGee

Oxygen – play, Roald Hoffman and Carl Djerassi