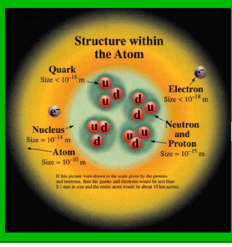
Lect4: The Atom!!!



Reviewing Isotopes & Sec 2

With help from: **From Rader's Chem4kids:** http://www.chem4kids.com/files/atom_orbital.html

10. Eureka: The Atom

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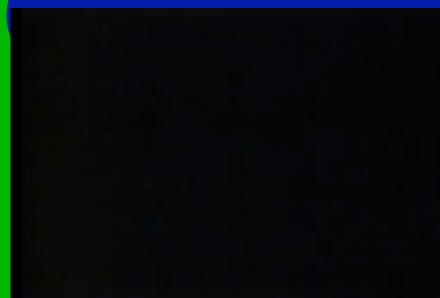
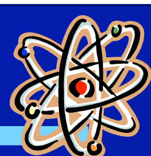


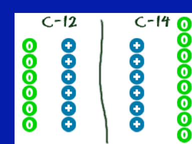
Neutron Madness



- Not all atoms are perfect.
- Let's say an atom is missing a neutron or has an extra neutron.
- That type of atom is called an **isotope**.
- It's still the same atom, it's just a little different from every other atom of the same element.

Isotope Example #1: Carbon

- There are a lot of carbon atoms in the universe.
- The normal ones are **carbon-12**.
  - Those atoms have 6 neutrons, 6 protons, & 6 electrons
- There are a few straggler atoms that don't have 6.
- Those odd ones may have 7 or even 8 neutrons.
- Carbon-14 actually has 8 neutrons (2 extra).



Isotope Example #2: Neon

- Neon usually has 10 neutrons.
- But, sometimes a neon atom has 11 or 12 neutrons.
- So we have 3 different versions of neon:
  1) 10 protons, 10 neutrons
  2) 10 protons, 11 neutrons (1 extra)
  3) 10 protons, 12 neutrons (2 extra)
- All 3 can occur in nature, but Ne-20 is way more common than the other 2 versions.

^{20}Ne	^{21}Ne	^{22}Ne
19.9924	20.9924	21.9913
90.48%	0.27%	9.25%
Stable	Stable	Stable

Everything Else Stays the Same

- In an isotope, the number of protons & electrons stays the same.
- Only the number of neutrons changes.
- What would happen if an atom lost or gained a proton?
  - **It would become a different element!!!**
- What would happen if an atom lost or gained an electron?
  - **It would become charged, or an ion.**

Learning about isotopes

- OK, this is where it gets confusing.
- What happens to the mass of an atom if it has an extra **neutron**?
  - It gets **heavier.**
- Remember, **neutron** each have a mass of 1 amu, so if you add an extra… it raises the atomic mass by 1.

13 Protons neutrons, electrons & isotopes

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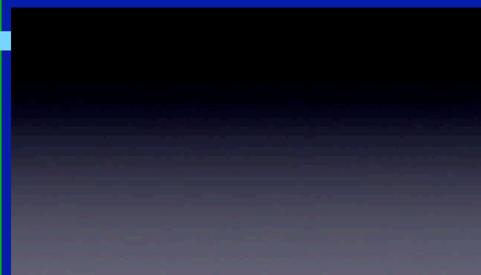
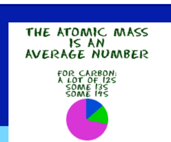
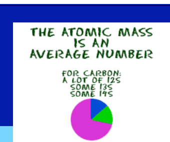


Messing with Mass



- If you've looked at another periodic table, you may have noticed that the atomic mass of an element is rarely an even number.
- That happens because of the isotopes.
- Atomic masses are calculated by figuring out how many atoms of each type are out there in the universe.
- For carbon, there are a lot of C-12, some C-13, and a few C-14 atoms.

Messing with Mass

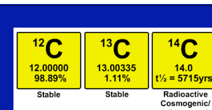


- When you average out all of the masses, you get a number that is a little bit higher than 12 (the weight of a C-12 atom).
- The mass for element is actually 12.011.
- Since you never really know which C atom you are using in calculations, you should use the mass of an average C atom.

Mass Number vs. Atomic Mass

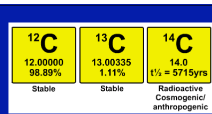
- So basically, I've been misleading you over the past few days.
- Atomic mass is actually a **weighted average** of the the isotopes' mass (protons + neutrons)
- **Mass Number** is protons + neutrons.
- Read the fine print on our periodic table…
- (be sure you know this on the final)

Returning to Normal



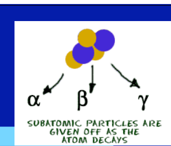
- If we look at the C-14 atom one more time we can see that C-14 does not last forever.
- There is a point where it loses those extra neutrons and becomes C-12, which is **stable**.
- That loss of the neutrons is called **radioactive decay**.
- That decay happens regularly like a clock.

Returning to Normal



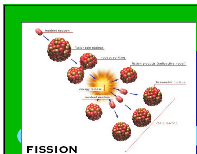
- For carbon, the decay happens in a couple of thousand years.
- Some elements take longer and others have a decay that happens over a period of minutes.
- The term **half-life** describes the time it takes for the amount of radioactivity to go down by one half.

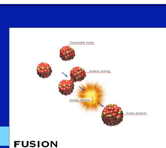
Dangerous Particles



- Radioactivity occurs when an atomic nucleus breaks down into smaller particles.
- There are three types of particles: alpha, beta, and gamma.
- Alpha particles are positively charged, beta particles are negatively charged, and gamma particles have no charge.
- The particles also have increasing levels of energy, first Alpha, then Beta, and finally Gamma, which is the fastest and most energetic of all the emission particles.

Harness that Energy





- Nuclear energy is the energy released when the nuclei of atoms split or are fused.
- **Fusion** is when two nuclei come together.
- **Fission** is when one nucleus is split into two or more parts, causing a chain reaction.
- Huge amounts of energy are released when either of these reactions occurs.
- Fusion reactions create much of the energy given off by the Sun.
- Nuclear power involves uranium-235 and nuclear fission.

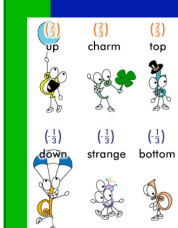
Why is radioactivity bad?

- Radiation is bad for humans because it can sometimes kill or damage cells in our bodies.
- Being exposed to most radioactive isotopes will make you very sick and probably kill you.
- UV waves are a type of *radiation*, which is why it is bad for your skin to lay out in the sun without sunscreen.

Why is radioactivity bad?

- X-Rays and other instruments used my doctors may also damage parts of our body, but the benefits typically outweigh the risks.
- In some cases, radiation is good.
- Cancer patients use chemotherapy radiation treatments to target and kill the deadly cancer cells.

Really Complex Stuff



- Protons & neutrons are made of smaller bits called **quarks**.
- There are 6 quarks, but physicists usually talk about them in terms of three pairs.
- A quark has a fractional electric charge, unlike the proton and electron

8. Quarks, Inside the Atom

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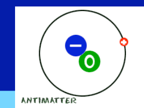
Really Complex Stuff

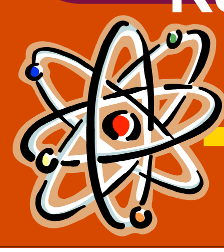


- Then there's **antimatter**.
- Scientists have proved that it is real, it's not just in movies.
- While a regular atom has positive and neutral pieces (protons/neutrons) in the nucleus and negative pieces in orbiting clouds (electrons), antimatter is just the opposite.
- Antimatter has a nucleus with a negative charge and little positive pieces in the orbits.
- Those positively charged pieces are called **positrons**.

Really Complex Stuff

- And that's not all!
- Atoms are also made out of hadrons, baryons, mesons, leptons, neutrinos!
- The list goes on & we're discovering more about atoms every day.
- It's not a bad time to be a particle physicist!
- Want more info: http://www.particleadventure.org

The Atom Review



14. Inside the atom

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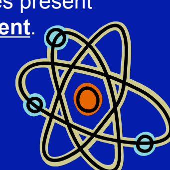
What makes one atom different from another?

- Answer: the amount of protons, neutrons and electrons present in each atom.
- The amount of these particles present determines the type of **element**.



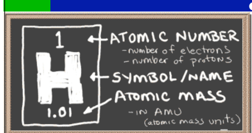
Of Elements and Atoms

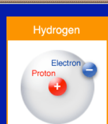
- The number of protons in an atom is also the atomic number.
- AGAIN, **ATOMIC #** = **# OF PROTONS**!!!
- Also, since there is almost always an equal # of protons & electrons in an atom: ***atomic # = # of electrons***

What's this periodic table thing?

- Unfortunately, we haven't talked about the periodic table yet, but here's a quick intro.

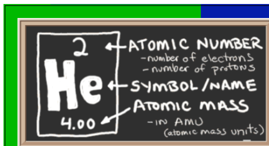
The #1 Element: Hydrogen

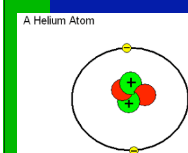




- Look at hydrogen. It's atomic number is 1, which means it has **1 proton** in the center of the atom.
- Because the atom should be neutral, we need to add **1 electron** to the outside.
- The two opposite charges cancel and we're left with one happy, neutral atom.
- It's all about the balance, inner peace, karma, the ying & yang, you get it.

Let's make a Helium!

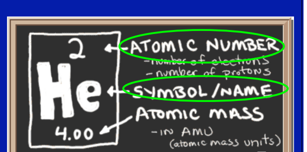




- **Step 1:** add 2 protons
  - (since the atomic # is 2)
- **Step 2:** add 2 neutrons
  - (since the 2 protons repel one another, the nucleus is unhappy & needs some inner peace)
- Step 3: add 2 electrons (-2)
  - (since we want a happy atom & we need two negatives to balance the two positives)

One more thing…

- Let's look at this Helium atom again.
- So far we've learned about:
  - Atomic Number
  - Symbol/Name
- What's this atomic mass thing???
- It's the atom's mass.
  - Candy to the first person who can explain why Helium's atomic mass is 4 amu!!!!



Atomic Mass

- Think of it this way… what are the only two parts of an atom that have any mass at all?
  - Protons & Neutrons!
  - Electrons are so teeny they don't weigh anything.
- So, to find the mass of the atom, add the two together.
- Atomic Mass is the number of **protons + neutrons**.

Group Challenge: Atomic Math

- Using the periodic table, & the information just learned, be the first group to accurately complete the table below.

	Element	Atomic #	Protons, Electrons	Atomic Mass	Neutrons
Example	*Lithium*				
	Boron				
		7			
			10		
				31	
					35

Group Challenge: Atomic Math

- Using the periodic table, & the information just learned, be the first group to accurately complete the table below.

	Element	Atomic #	Protons, Electrons	Atomic Mass	Neutrons
Example	*Lithium*	*3*		*7*	
	Boron				
		7			
			10		
				31	
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Group Challenge: Atomic Math

- Using the periodic table, & the information just learned, be the first group to accurately complete the table below.

	Element	Atomic # =	Protons, Electrons	Atomic Mass	Neutrons
Example	*Lithium*	*3*	*3*	*7*	
	Boron				
		7			
			10		
				31	
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Group Challenge: Atomic Math

- Using the periodic table, & the information just learned, be the first group to accurately complete the table below.

	Element	Atomic #	Protons, Electrons	Atomic Mass	Neutrons
Example	*Lithium*	*3*	*3*	- # protons = *7*	*4*
	Boron				
		7			
			10		
				31	
					35

Group Challenge: Atomic Math KEY

Element	Atomic #	Protons, Electrons	Atomic Mass	Neutrons
Lithium	*3*	*3*	*7*	*4*
Boron	5	5	11	6
Nitrogen	7	7	14	7
Neon	10	10	20	10
Phosphorous	15	15	31	16
Zinc	30	30	65	35

15. Tomorrow we begin The Periodic Table