The ATOM

By Ms Toal

How small is an atom?

- Remember the metric staircase from the beginning of the year?
- "Millimeter" is .001 M and it is three steps to the right from the base unit.
- Basically Chemistry goes DOWN the metric staircase (very small)
- Well the size of an atom can vary but its approximately .000000001 M – a 10^{-9} nanometer.
- An atom is a million times smaller than the thickest human hair

How big and small can the metric staircase go?

The Metric System Prefixes				
Prefix	**Label**	**Decimal Value**	**Scientific**	**Colloquial**
yocto	y	0.000 000 000 000 000 000 000 001	10^{-24}	septillionth
zepto	z	0.000 000 000 000 000 000 001	10^{-21}	sextillionth
atto	a	0.000 000 000 000 000 001	10^{-18}	quintillionth
femto	f	0.000 000 000 000 001	10^{-15}	quadrillionth
pico	p	0.000 000 000 001	10^{-12}	trillionth
nano	n	0.000 000 001	10^{-9}	billionth
micro	μ	0.000 001	10^{-6}	millionth
milli	m	0.001	10^{-3}	thousandth
centi	c	0.01	10^{-2}	hundredth
deci	d	0.1	10^{-1}	tenth
---	---	1	10^{0}	one
deka	da	10	10^{1}	ten
hecto	h	100	10^{2}	hundred
kilo	k	1 000	10^{3}	thousand
mega	M	1 000 000	10^{6}	million
giga	G	1 000 000 000	10^{9}	billion
tera	T	1 000 000 000 000	10^{12}	trillion
peta	P	1 000 000 000 000 000	10^{15}	quadrillion
exa	E	1 000 000 000 000 000 000	10^{18}	quintillion
zetta	Z	1 000 000 000 000 000 000 000	10^{21}	sextillion
yotta	Y	1 000 000 000 000 000 000 000 000	10^{24}	septillion

What holds an atom together?

There are 4 forces:

1. The strong force
2. The electromagnetic force
3. The weak force
4. gravity

How do we know what an atom looks like?

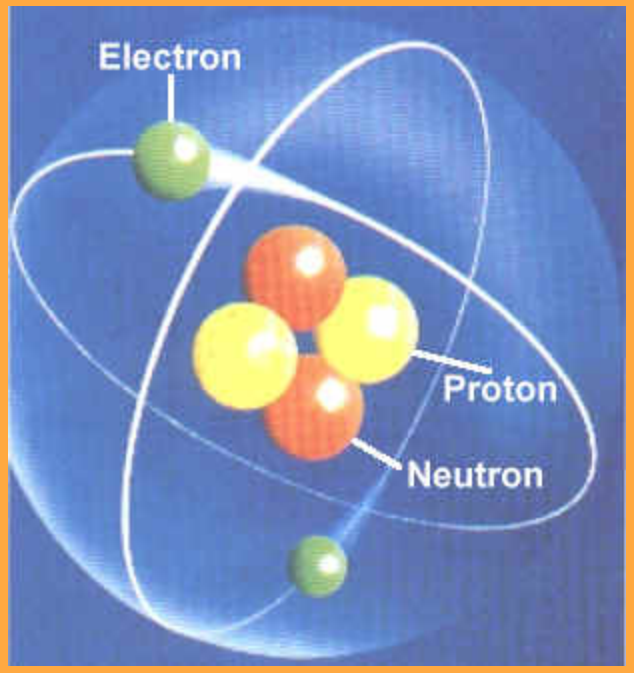
- Many scientists wondered what is matter made of:
  - John Dalton
  - JJ Thompson
  - Ernest Rutherford
  - Bohr (most common atomic model)

- What is an ATOM?
- ATOM = smallest particle of an element
- What is an element?
- ELEMENT – a PURE substance in which all the atoms are alike and cannot be broken down into any other substances
- What is an example of an element?
- Examples of an ELEMENT = aluminum, gold, silver, neon, helium

Only think about this…

- Aluminum foil is made up of one element, but there are billions of aluminum atoms that make up even a small piece of aluminum.

Structure of an atom



What is an atom made of?

- The atom is made up of even smaller particles called SUBATOMIC particles
- Sub = under or below (so it's a lower level, smaller than the atom)
- The subatomic particles are :
  - Proton (+ charge)
  - Neutron (neutral)
  - Electron (- charge)

  It is time to start watching Jimmy Neutron!

Why doesn't an atom have a charge?

- The atom is made up of positive protons and negative electrons.
- If there are the same of positively charged protons (+) and the same number of negatively charged electrons (-),
- the charges cancel each other out and the overall charge of the atom is neutral.
- Neutral means no charge.
- Example: 10 (p+) + 10 (e-) = neutral charge

What is the:

NUCLEUS → center of the atom; it contains **protons and neutrons.**

- PROTON → a small, **positively** charged particle in the nucleus. (p+)
- NEUTRON → small, **neutral** particle in the nucleus (n)
- ELECTRON → **very** small, **negatively** charged particle, located outside of the nucleus. (e-)

The electron

A "Valence" Electron

- The electron is 2000 times smaller than the proton!
- It always has a negative charge!!!
- VALENCE ELECTRON – the electrons that are farthest away from the nucleus of the atom. These electrons are involved in chemical reactions.

How many electrons does an atom have?

- There are the same number of electrons as there are protons.
- Sometimes electrons like to transfer but we'll worry about that later…
- ELECTRON SHELL RULES:
- 1st shell: holds maximum 2 e-
- 2nd shell: " " " 8 e-
- 3rd shell: " " " 8 e-
- 4th shell: " " " 18 e-

Electron = e-

Comparison

The Atom

- The atom has a center, the nucleus.
- Electrons zoom or "orbit" around the nucleus.
- The atom can have large number of electrons orbiting its nucleus.
- 99% of atom's mass comes from its nucleus – the proton and the neutron.

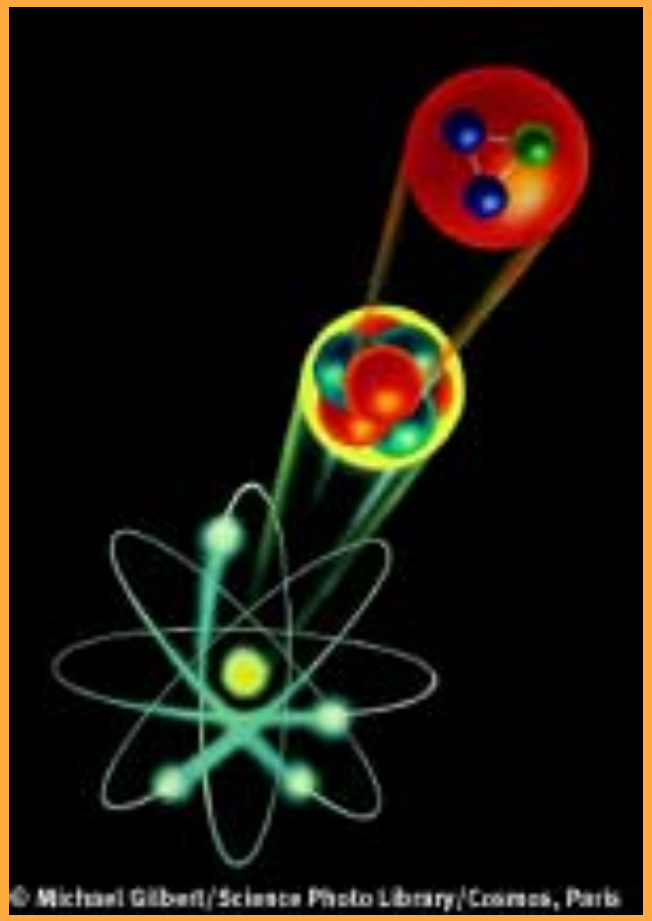
The Solar System

- Solar system nucleus is the sun.
- The moon orbits the earth and the planets orbit the sun.
- Just like the sun can have many planets/asteroids orbitting the sun.
- 99% of the mass of the solar system comes from the sun.

Is there anything smaller than a proton or neutron or electron?

- Yes!
- If you could cut the protons and neutrons in half, then you would see that each proton and each neutron contain even smaller particles called GLUONS and QUARKS

Atom →nucleus →proton/neutron →2 blue quarks and 1 green gluon



THE END

- Break time
- But first – a few quick links
- http://micro.magnet.fsu.edu/primer/java/scienceopticsu/powersof10/index.html

- http://www.youtube.com/watch?v=TCUK93s1jUY
- http://www.youtube.com/watch?v=vUzTQWn-wfE