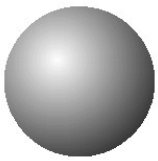
Unit 2: Atomic Discoveries

Name: _____

Democritus

- *atomos*, initial idea of atom
- all matter is made of tiny particles



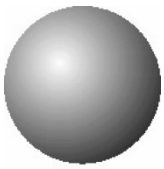
Democritus (400 B.C.)

Dalton

solid sphere model of atom

Atomic Theory

- All elements are made of atoms
- All atoms of an element are identical
- Atoms are not created or destroyed



Dalton 1803-1805

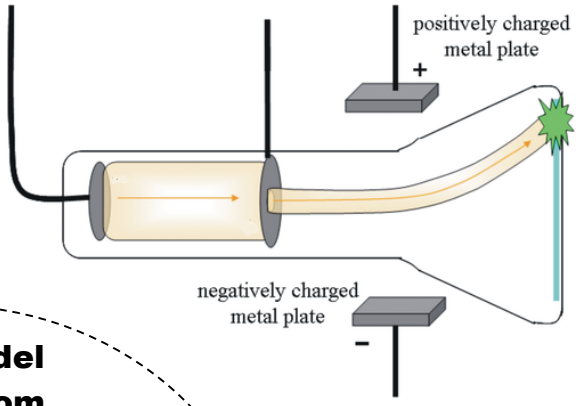
Thomson

1896

discovery of the electron

Cathode Ray Tube experiment

- cathode ray tube sends beam
- beam is put between charged plates
- beam is attracted to positive plate
- the beam must be made of negatively charged particles!

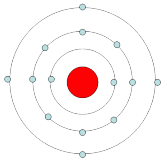


Plum Pudding model

Bohr model of the atom

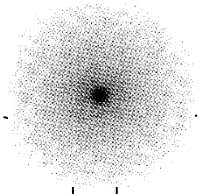
1913

"planetary model"



Quantum Mechanical Model

"electron cloud"



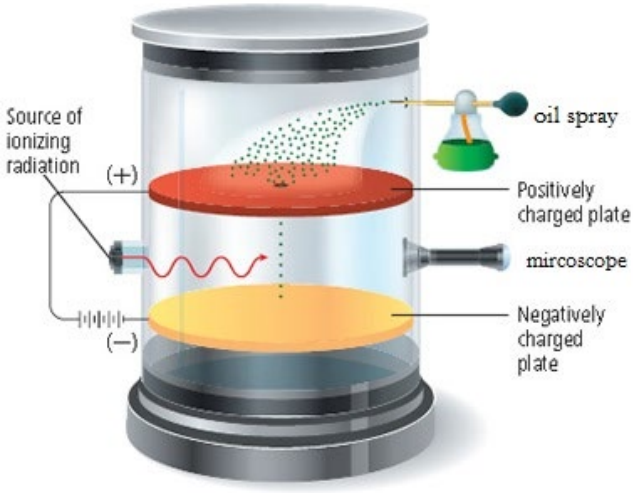
Millikan

1909

discovery of charge of electron

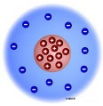
Oil Drop experiment

- sprayed oil drops
- gave drops negative charge
- changed speed of the falling drops



Rutherford

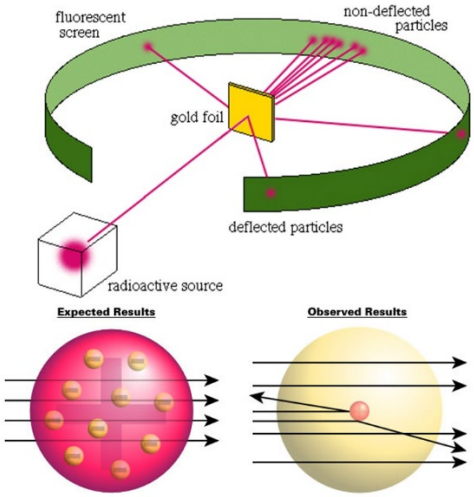
1910



discovery of the nucleus
the atom is mostly empty space

Gold Foil experiment

- fired particles at thin gold foil
- expected shooting particles to go through foil
- most did BUT some bounded back



Unit 2: Atomic Structure

Name: _____

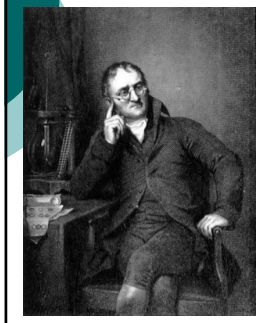
Particles Protons Neutrons Electrons	 1 amu, +1 charge 1 amu, no charge 0 amu, -1 charge
Mass number	Protons + neutrons
Atomic number	Number of protons Determines the identity of the atom
Why does the atom stay together?	• Attraction between electrons and the positive nucleus • Neutrons are the glue that hold the nucleus together. They separate the protons from each other so they do not repel and "fly into space."
Neutral atoms	protons = electrons
Ion Cation Anion	Atom with a charge + charge, lost electrons - charge, gained electrons
Solve for charge	charge = p – e think of charge as a balance of positive and negative charges
Isotope Isotope symbol	• Different versions on an element • Same number of protons, different numbers of neutrons Method A: Nitrogen-14 ←mass number N-14 ←mass number Method B: mass# → 14 atomic# → 7 N-3 ← charge
Solve for neutrons	Mass number – atomic number (p+n) (p)
Atomic Mass	A weighted average of all isotopes of an element, with respect to their percent abundance in nature. $\text{Atomic Mass} = (\text{mass number } A \times \text{abundance } A) + (\text{mass number } B \times \text{abundance } B) + \cdots$

Atomic Discoveries

Early Scientists

- Democritus – all matter is made of tiny invisible particles
  - 450 BC

John Dalton – Atomic Theory



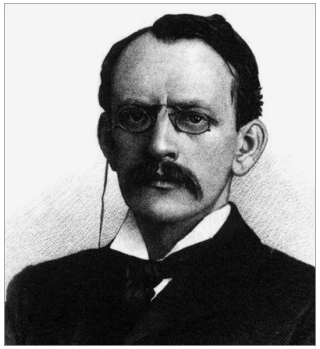
- 1803

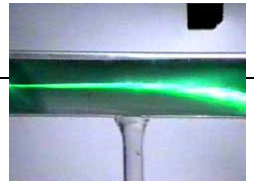
1. All elements made of atoms
2. All atoms of element are identical
3. Atoms not created or destroyed

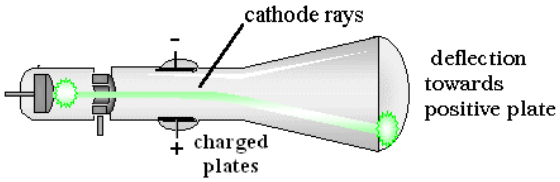
- "solid sphere model"

J.J. Thomson

- 1896







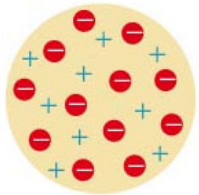
Thomson – "Cathode Ray Tube"

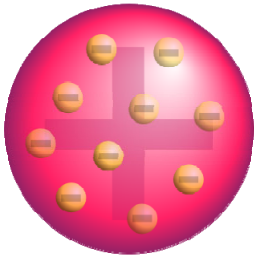
- Cathode ray tube sends beam
- Put between charged plates
- Beam drawn to positive plate
- Conclusion:
  - Beam made of negatively charged particles
  - DISCOVERED THE ELECTRON

Plum Pudding

Thomson's model of atom

- Positive goo
- Electrons floating in goo



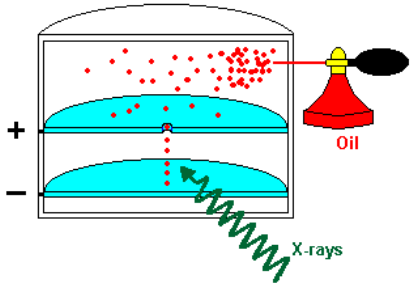


"Plum Pudding"

"Chocolate Chip Cookie Model"

Millikan

- 1909



Millikan – Oil Drop Experiment

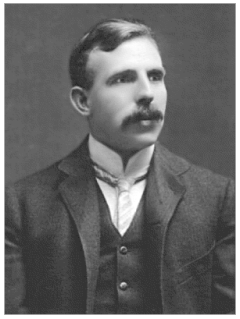
- Sprayed oil drops
- Gave drops negative charge
- Changed speed of the falling drops
- Conclusion:
  - DISCOVERED CHARGE & MASS OF THE ELECTRON

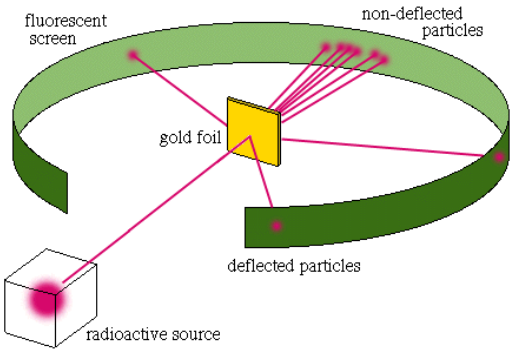
(you do not have to write this down)

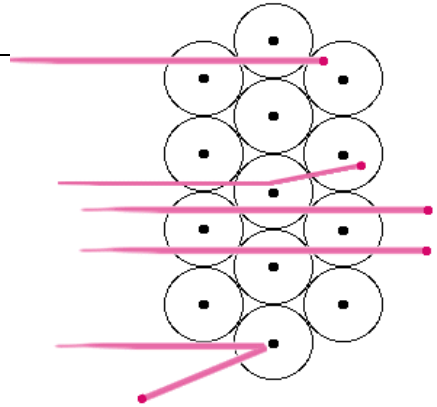
- Charge of electron = 1.6×10^{-19} C
- Mass of electron = 9.11×10^{-28} g

Rutherford

- 1909







Rutherford – Gold Foil Experiment

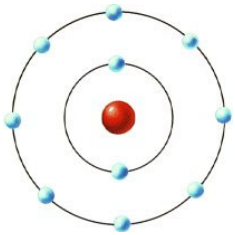
- Expected shooting particles to go through gold foil
- Instead, some bounced back
- Conclusions:
  - DISCOVERED NUCLEUS in center of atom
  - Atom is mostly empty space

Niels Bohr

- 1913

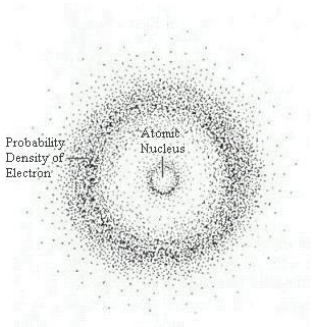
Bohr Model of Atom

- "planetary model"
- electrons circling nucleus



TODAY – Quantum Mechanical Model

AKA – "Electron cloud"



Review

Scientist	Title of Experiment?	Discovered?
Thomson		
Millikan		
Rutherford		

- Name each scientist's model of the atom:
  - Dalton, Thomson, Bohr

Review

Scientist	Name of model of atom	Description of atomic model
Dalton		
Thomson		
Bohr		

Review

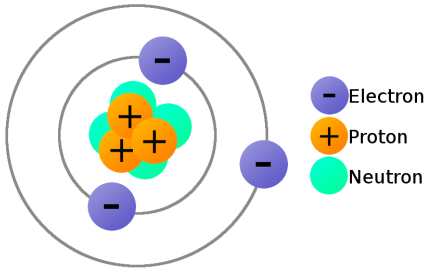
Scientist	Title of Experiment?	Discovered?
Thomson	Cathode ray tube exp	Electron
Millikan	Oil drop experiment	Charge of electron
Rutherford	Gold foil experiment	Nucleus

- Name each scientist's model of the atom:
  - Dalton = "solid sphere"
  - Thomson = "plum pudding"
  - Bohr = "planetary model"

Beyond the Basics: Ions, Isotopes, and Atomic Mass

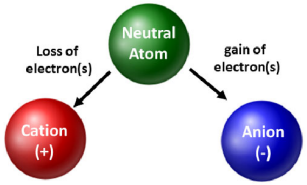
Neutral Atoms

- # protons = # electrons



Ion

- Atom with a charge
  - Cation = positive charge, lost electrons
  - Anion = negative charge, gained electrons



How to determine charge or number of electrons

- charge = p – e

OR

- Balance of positive or negative charges

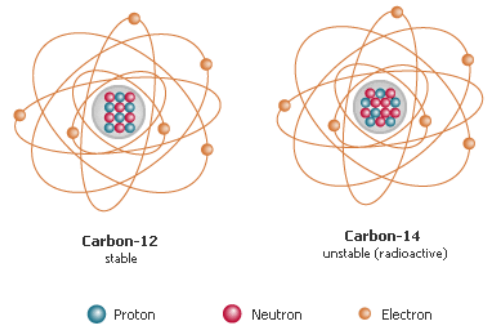
OR

- Loss or gain of electrons

Isotopes

- Different versions of the same element
  - atoms have <u>same # of protons</u>
  - BUT <u>different # neutrons</u>
- Impact on the atom:
  - more neutrons = more mass

Isotopes



How to determine number of neutrons

- Neutrons = mass number - protons

Symbol	P	E	N	Mass#
Ir	77	75	115	
Zr		37	51	91
Cu		30	35	
Ag	47	47		108
Na		11		23

Communicating Information about Isotopes

Method A:

Nitrogen-14 ←mass number

N-14 ←mass number

Method B:

mass#→14
atomic#→7
N-3←*charge*

Abundance in Nature

- Out of 100 carbon atoms found in nature…
  - 99 of them will be C-12
  - 1 of them will be C-13
  - 0.0000000001% of the time you'll find C-14
- So what should we report as the average mass of carbon?
- What would be wrong with averaging 12, 13, 14?
- Must use a <u>weighted</u> average

Atomic mass

Atomic Mass =

(mass A)(%abundance A) + (mass B)(%abundance B) +…. etc

- <u>Comparison:</u>
  - Mass number = p + n
  - Atomic mass = a weighted average of all isotopes of an element, with respect to their percent abundance

Practice #1:

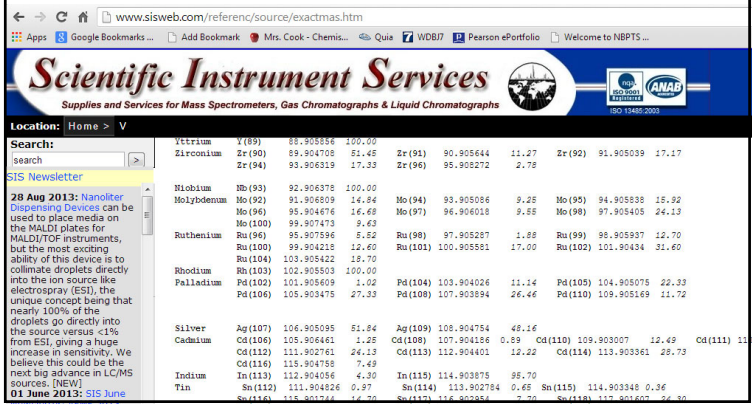
- Find the average atomic mass of carbon:
- C-12 = 99% abundant
- C-13 = 1% abundant

Atomic Mass =

(%abundance A)(mass A) + (%abundance B)(mass B) +…. etc

- 12.01 amu
- Check the Periodic Table!

What is the difference between <u>atomic mass</u> & <u>mass number</u>?



Practice #2

- What is the average atomic mass of Boron if Boron-10 is 19.8% abundant and Boron-11 is 80.2% abundant?

Practice #3

- An unknown element has three isotopes. Isotope A has a mass of 13 and is 15% abundant. Isotope B has a mass of 15 and is 10% abundant. Isotope C has a mass of 16 and is 75% abundant. What is the average atomic mass?

The Fine Print

More details about our vocabulary terms.

Comparison and Clarification

- What is the difference between an **ion** and an **isotope**?

Comparison and Clarification

- What is the difference between an **ion** and an **isotope**?
- Example: $^{23}_{11}Na^{+1}$

  $^{220}_{88}Ra$

How do I find neutrons if no mass number is given??

- Find the number of neutrons for Al^{+3}
- How many neutrons are in Copper?

How do I find neutrons if no mass number is given??

- Examples:

	Element	Protons	Neutrons	Electrons	Charge	Mass #
1.	Sc				0	
2.		15			-3	
3.		38		36		
4.	K				+1	

- Counter Examples:

	Element	Protons	Neutrons	Electrons	Charge	Mass #
5.	O				-2	15
6.		26			+3	54

What is the difference between <u>atomic mass</u> & <u>mass number</u>?

What is the difference between <u>atomic mass</u> & <u>mass number</u>?

- Example:
- Look up Tin (Sn) on the periodic table.
  - Atomic mass = 118.71 amu
  - Mass number of a specific isotope of Tin:

Sn-120

What is the difference between <u>atomic mass</u> & <u>mass number</u>?

- Tin:

Tin	Sn(112)	111.904826	0.97	Sn(114)	113.902784	0.65	Sn(115)	114.903348	0.36
	Sn(116)	115.901744	14.70	Sn(117)	116.902954	7.70	Sn(118)	117.901607	24.30
	Sn(119)	118.903310	8.60	Sn(120)	119.902199	32.40	Sn(122)	121.903440	4.60
	Sn(124)	123.905271	5.60						