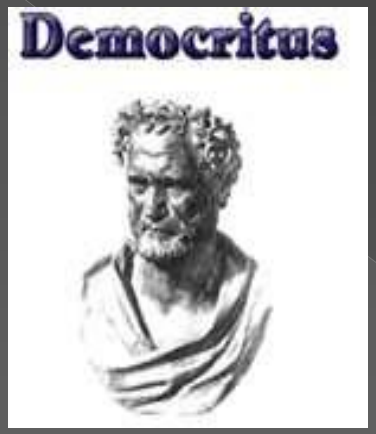
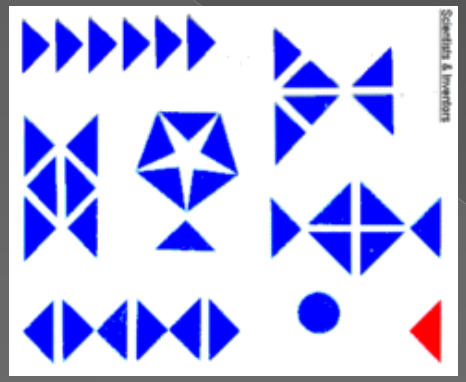
Historical Perspective

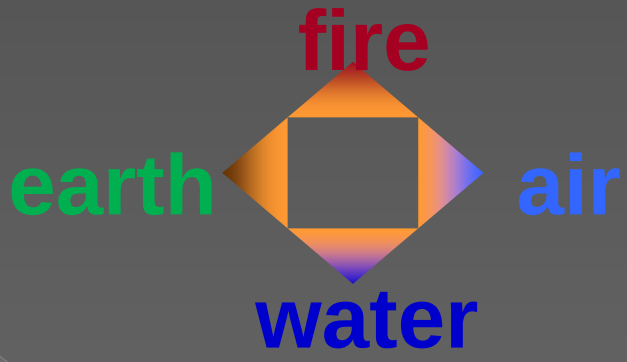
THE ATOM

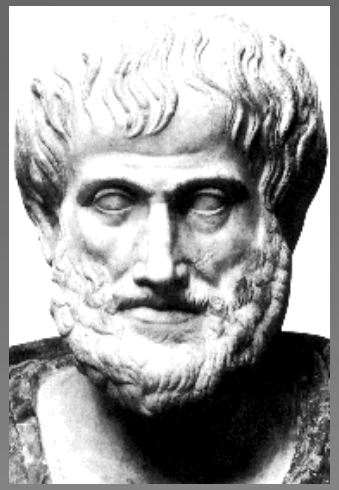


Early Greek Theories

- 400 B.C. - Democritus thought matter could not be divided indefinitely.
- This small particle he called “atomos”.





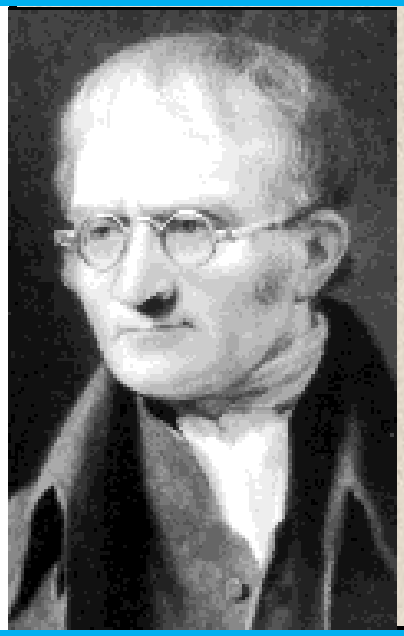


Aristotle

- 350 B.C - Aristotle modified an earlier theory that matter was made of four “elements”: earth, fire, water, air.
- Aristotle was wrong. However, his theory persisted for 2000 years.

JOHN DALTON

- 1808 -Dalton proposed a modern atomic model based on experimentation not on pure reason.



- All matter is made of atoms.
- Atoms of an element are identical.
- Atoms of different elements are distinctively different
- Atoms are rearranged in chemical reactions
- Atoms of different elements combine in constant ratios to form compounds.
- Atoms of one element cannot be changed into an atoms of different elements.

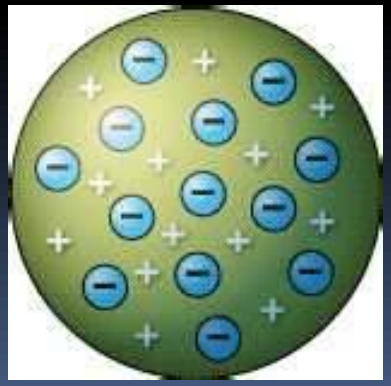
- His ideas account for the law of conservation of mass (atoms are neither created nor destroyed) and the law of constant composition (elements combine in fixed ratios).

HISTORY OF THE ATOM

1856 -1940

Joseph John Thompson

In 1904, Thompson develops the idea that an atom was made up of electrons scattered unevenly within an elastic sphere surrounded by a soup of positive charge to balance the electron's charge



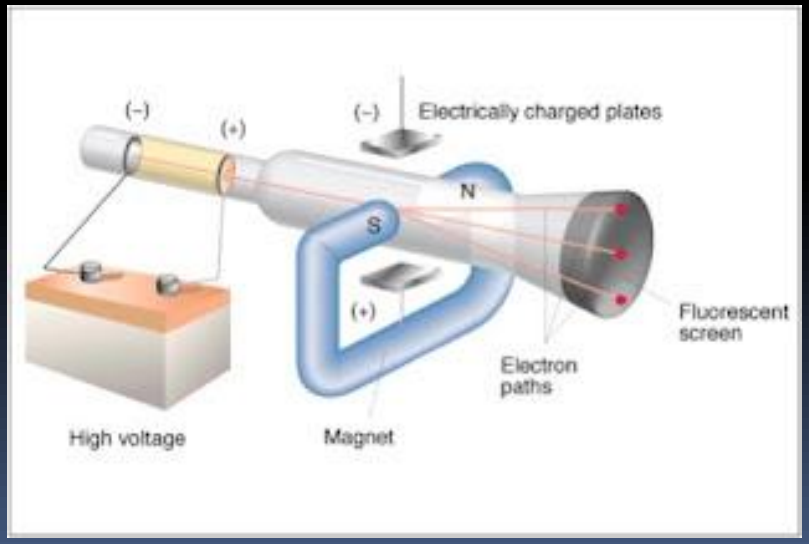
It is called the plums pudding model.

He was awarded a Nobel Prize in 1906 for discovering the Electron.

HISTORY OF THE ATOM

Cathode Ray Tube

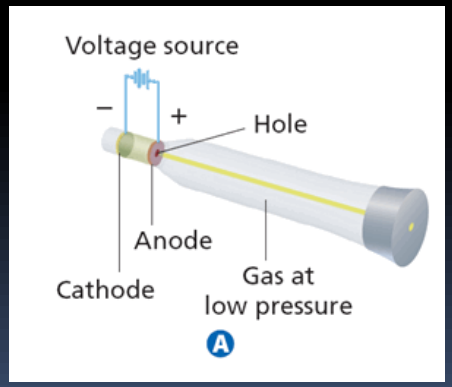
•The **cathode ray tube** (**CRT**) is a vacuum tube containing a gas at (low pressure) with an electron emitter and a fluorescent screen used to view images. It has a means to accelerate and deflect the electron beam onto the fluorescent screen to create the images

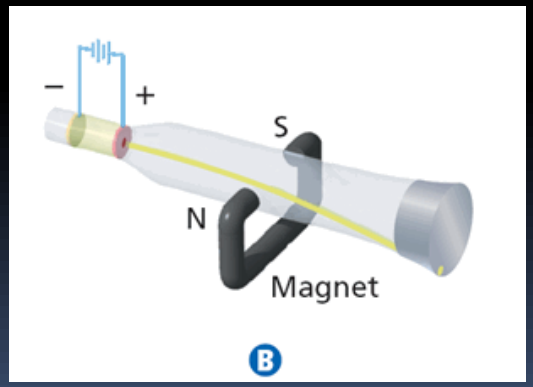


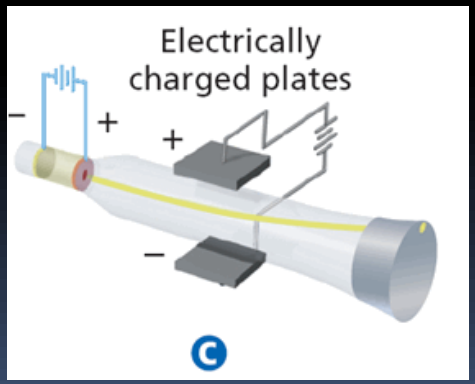
HISTORY OF THE ATOM

Joseph John Thompson

- Thompson discovered by mathematical means that these rays have a small mass and are negative.
- Thompson noted that these negative subatomic particles were a fundamental part of all atoms.







Cathode Ray Tube (CRT)

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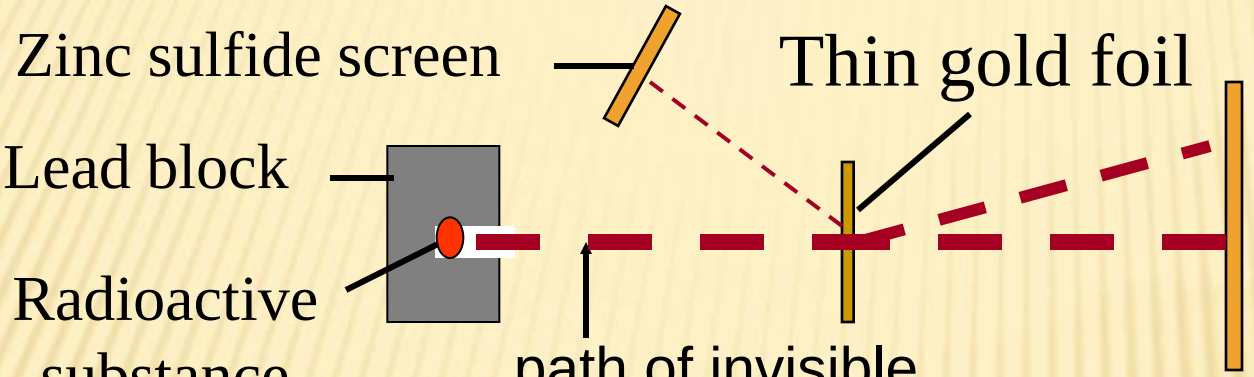
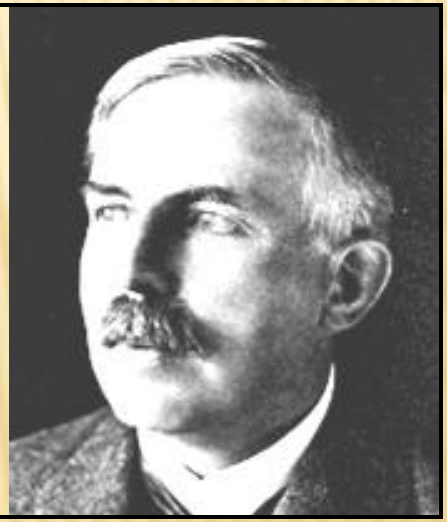
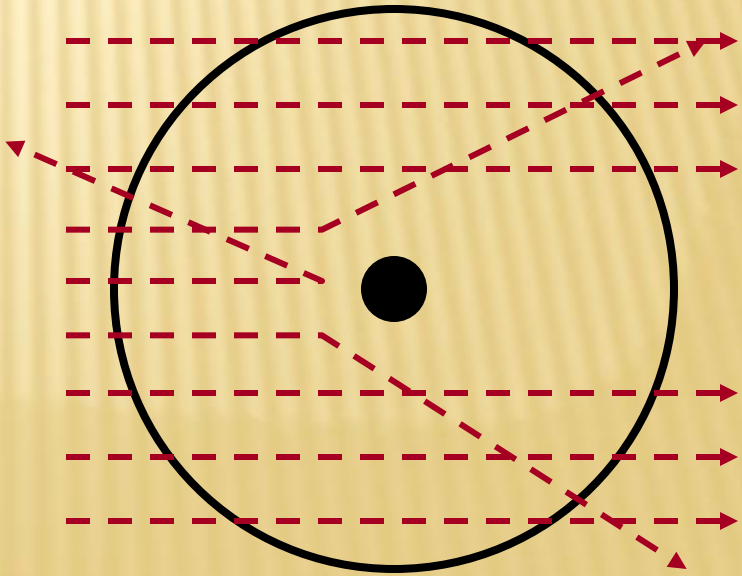
ERNEST RUTHERFORD

- Rutherford shot alpha (α) particles at gold foil.





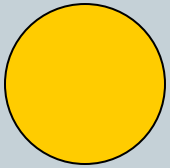
- **He thought particles would pass through and most particles did. So, atoms are <u>mostly empty</u>.**
- **But some <u>positive α-particles</u> deflected or bounced back!**
- **He concluded that a "nucleus" existed, is positive and holds most of an atom's mass.**



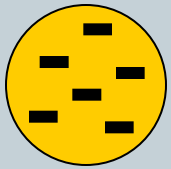
ERNEST RUTHERFORD

- http://www.youtube.com/watch?v=bSEOOMs5VNU&safety_mode=true&persist_safety_mode=1&safe=active

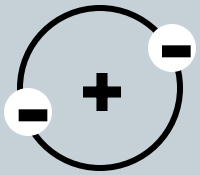
Evolving Electrons Model



1) Dalton's "Billiard ball" model (1808)
Atoms are solid and indivisible.



2) Thompson "Plum pudding" model (1904) Negative electrons in a positive framework.

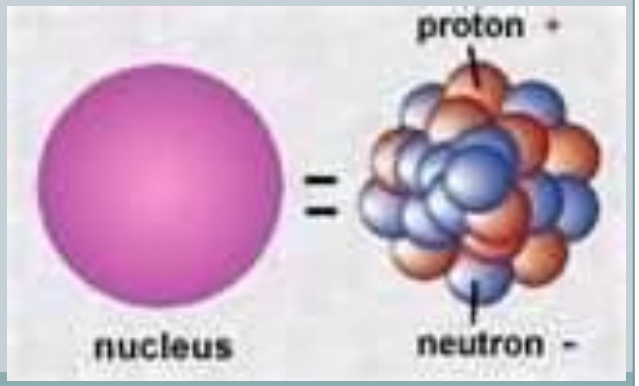


3) The Rutherford model (around 1911)
Atoms are mostly empty space.
Negative electrons orbit a positive nucleus.

The Nucleus of an Atom

Beryllium Experiment

- In 1932, Chadwick observed that beryllium, when exposed to bombardment by alpha particles, released an unknown radiation that in turn ejected protons from the nuclei of various substances.
- Chadwick interpreted this radiation as being composed of particles of mass approximately equal to that of the proton.
- These newly discovered particles were <u>neutrons</u>.



The Atom

- The nucleus of an Atom contains PROTONS and NEUTRONS
- Protons are Positive and Neutrons are Neutral
- The **ELECTRONS** in an atom are responsible for the chemical properties of the element
- The **PROTONS** and **NEUTRONS** make up the mass of an atom and are responsible for the stability of the atom.
- The identity of an atom is determined by the number of **PROTONS**.
- Atoms of an element with different numbers of **NEUTRONS** are called **ISOTOPES**.

Atomic numbers, Mass numbers

- There are 3 types of subatomic particles:
  Electrons (e^-) Protons (p^+) and Neutrons (n^0).
- Neutrons have no charge and a mass similar to protons
- Elements are often symbolized with their **mass number** and **atomic number**

E.g. Oxygen: $^{16}_{8}O$

- These values are given on the periodic table.
- For now, round the mass # to a whole number.
- These numbers tell you a lot about atoms.
  # of protons = # of electrons = atomic number
  # of neutrons = mass number – atomic number

Atomic Information

1. The **Atomic Number** of an atom
   = number of protons in the nucleus.

2. The **Atomic Mass** of an atom
   = number of Protons + Neutrons in the nucleus

3. The number of **Protons**
   = Number of **Electrons**.

4. **Electrons** orbit the nucleus in shells.

5. Each shell can only carry a set number of electrons.

Review

	Atomic	Mass	p^+	n^0	e^-
Ca	20	40	20	20	20
Ar	18	40	18	22	18
Br	35	80	35	45	35

Isotopes and Radioisotopes

- Atoms of the same element that have different numbers of neutrons are called isotopes.
- Due to isotopes, mass #s are not round #s.
- Li (6.9) is made up of both ^{6}Li and ^{7}Li.
- Often, at least one isotope is unstable.
- It breaks down, releasing radioactivity.
- These types of isotopes are called radioisotopes

Q- Sometimes an isotope is written <u>without</u> its atomic number - e.g. ^{35}S (or S-35). Why?

A- The atomic # of an element doesn't change Although the number of neutrons can vary, atoms have definite numbers of protons.

Isotopes

	Atomic	Mass	p^+	n^0	e^-
O-16	8	16	8	8	8
H-2	1	2	1	1	1
C-13	6	13	6	7	6

Average Atomic Mass

- **The mass of each element is a weighted average of the Isotopes in the element.**
- **Example 1:**
- **Silicon has three stable isotopes. The following information is available for the three isotopes: isotopes of the element.**

Isotope	Mass (amu)	Fractional Abundance (%)
Silicon - 28	27.977	92.21
Silicon - 29	28.976	4.70
Silicon - 30	29.974	3.09

Average Atomic Mass

- **Example 2:**
- **Iron has four stable isotopes. The following information is available for the four isotopes**

Isotope	Mass (amu)	Fractional Abundance (%)
Iron - 54	53.9396127	5.845
Iron - 56	55.9349393	91.754
Iron - 57	56.9353958	2.119
Iron - 58	57.9332773	0.282

Average Atomic Mass

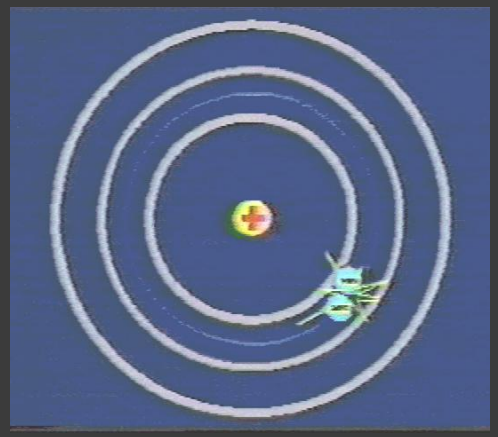
- http://www.youtube.com/watch?v=xirPkCI1sMA&feature=related&safety_mode=true&persist_safety_mode=1&safe=active

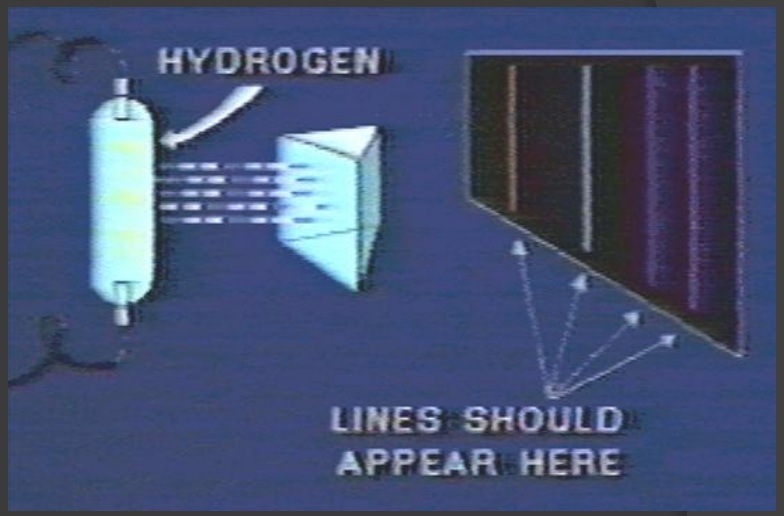
ATOM SONG

- http://www.youtube.com/watch?v=vUzTQWn-wfE&feature=related&safety_mode=true&persist_safety_mode=1&safe=active

Bohr's model

- Electrons orbit the nucleus in "shells"
- Electrons can be bumped up to a higher shell if hit by an electron or a photon of light.

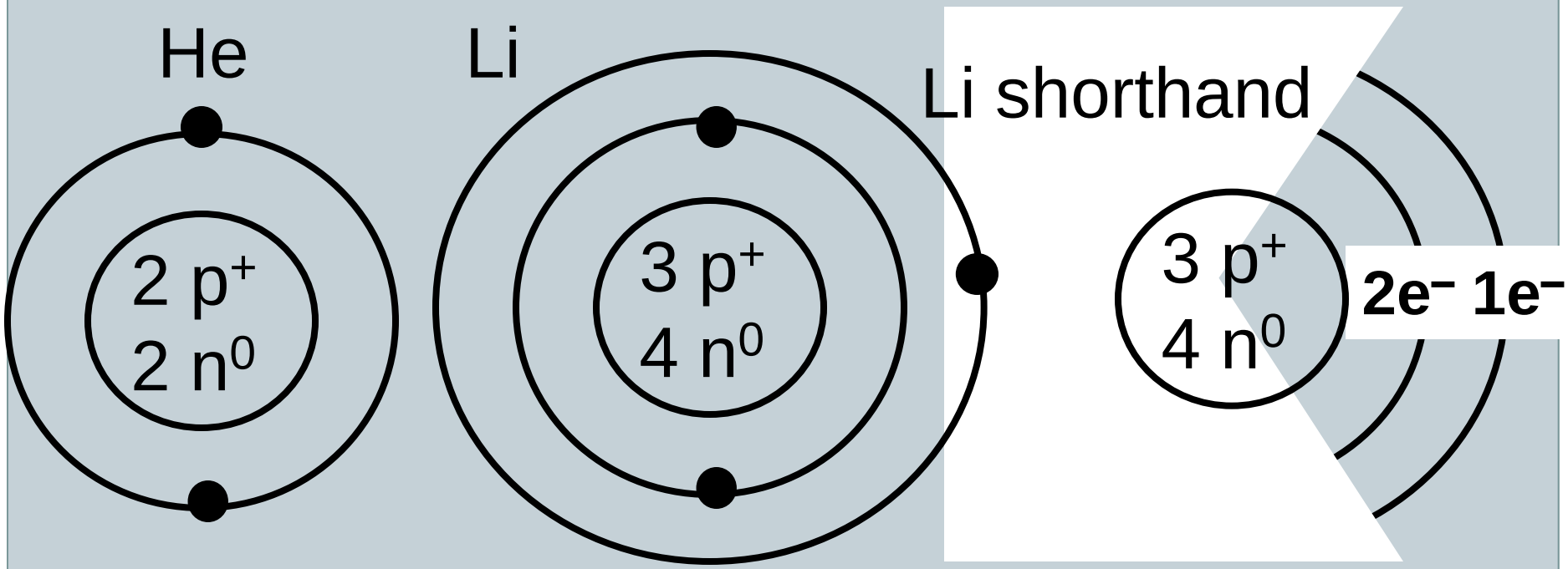




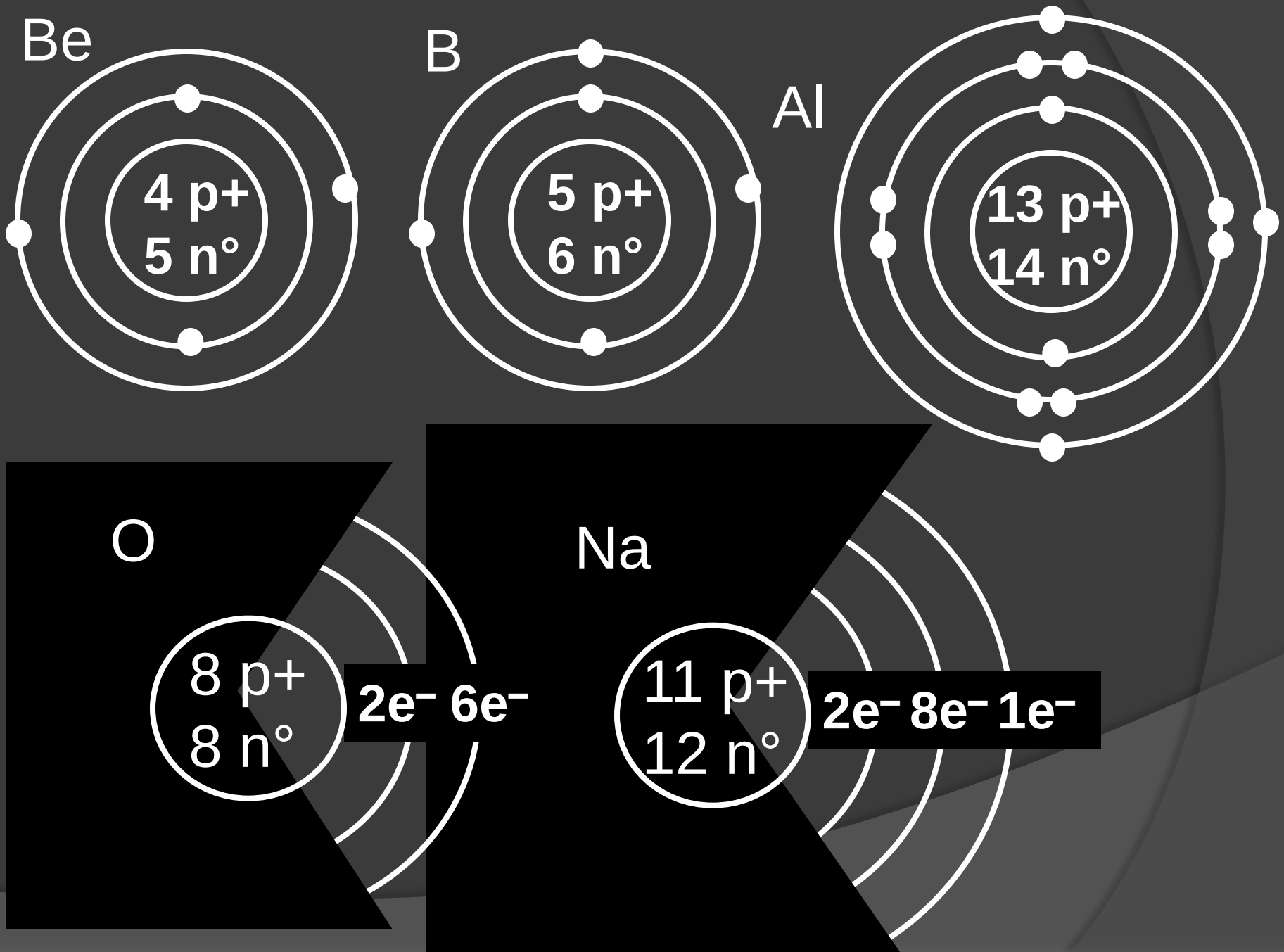
There are 2 types of spectra: continuous spectra & line spectra. It's when electrons fall back down that they release a photon. These jumps down from "shell" to "shell" account for the line spectra seen in gas discharge tubes (through spectroscopes).

Bohr - Rutherford diagrams

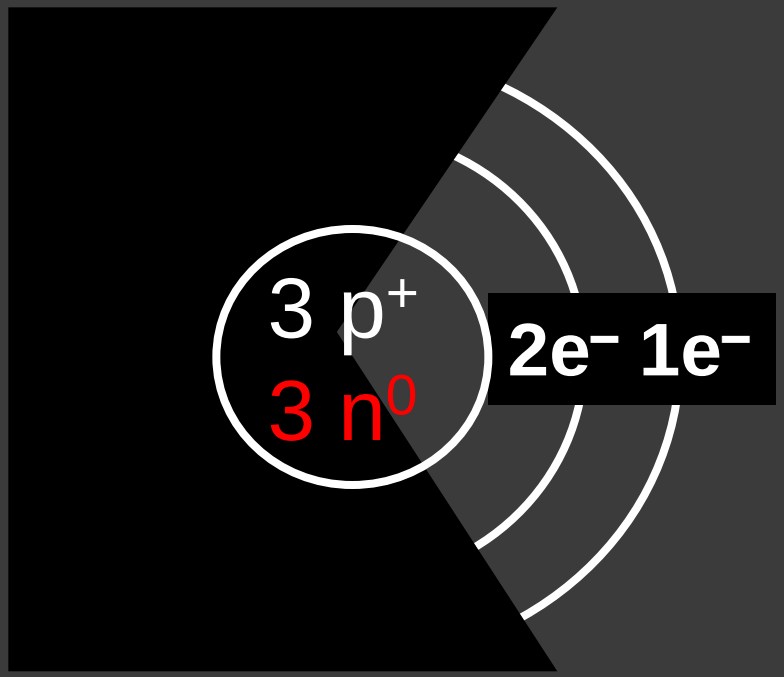
- Putting all this together, we get B-R diagrams
- To draw them you must know the # of protons, neutrons, and electrons (2,8,8,2 filling order)
- Draw protons (p^+), (n^0) in circle (i.e. “nucleus”)
- Draw electrons around in shells



Draw Be, B, Al and shorthand diagrams for O, Na


Be
4 p+
5 n°
B
5 p+
6 n°
Al
13 p+
14 n°
O
8 p+
8 n°
2e⁻ 6e⁻
Na
11 p+
12 n°
2e⁻ 8e⁻ 1e⁻

^{6}Li



^{7}Li