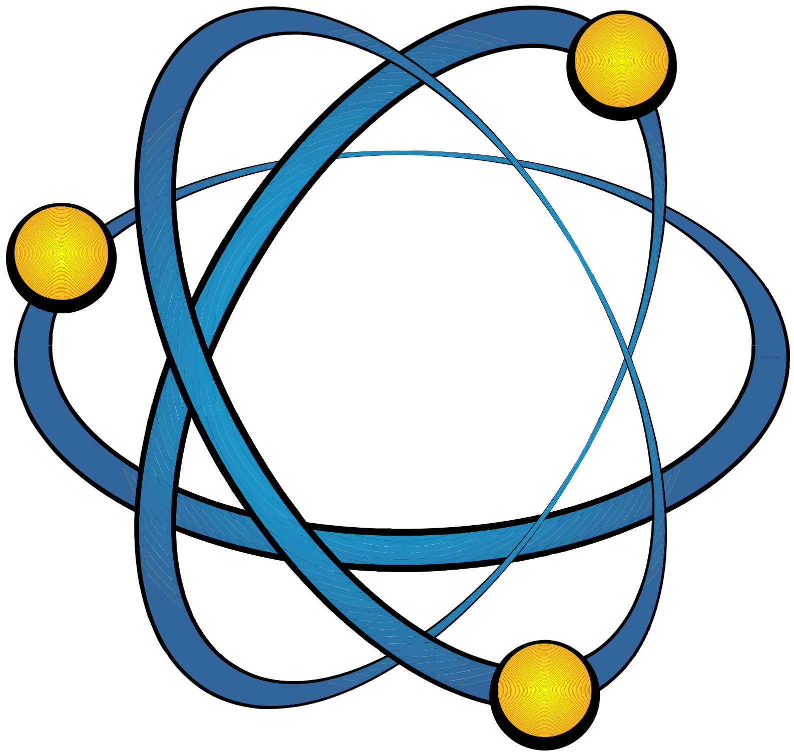
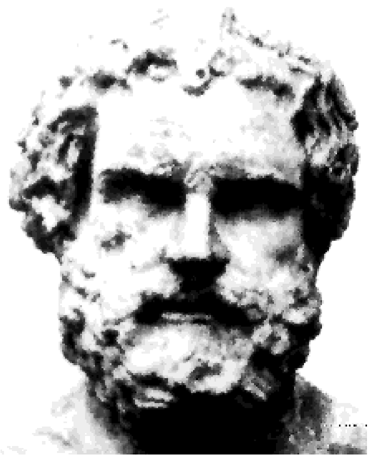
Models of the Atom



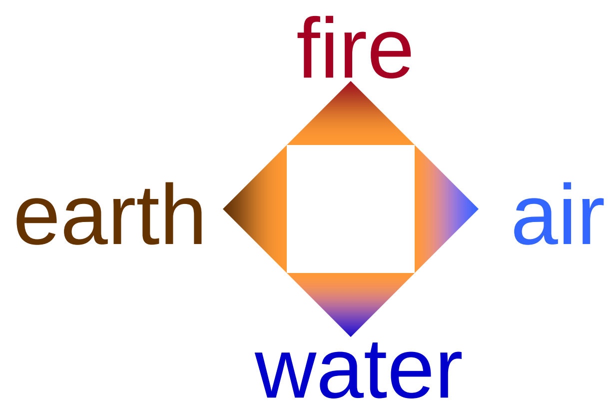
a Historical Perspective

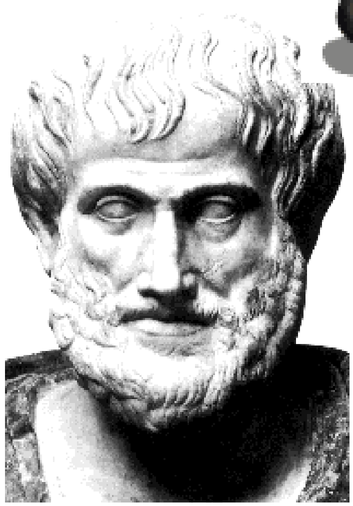
Early Greek Theories



Democritus

- 400 B.C. - Democritus thought matter could not be divided indefinitely.
- This led to the idea of atoms in a void.





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

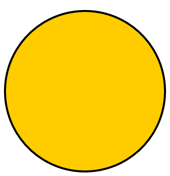
- 1800 -Dalton proposed a modern atomic model based on experimentation not on pure reason.

- All matter is made of atoms.
- Atoms of an element are identical.
- Each element has different atoms.
- Atoms of different elements combine in constant ratios to form compounds.
- Atoms are rearranged in reactions.

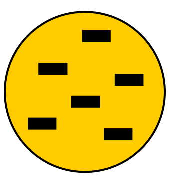
- His ideas account for the law of conservation of mass (atoms are neither created nor destroyed) and the law of constant composition (elements combine in fixed ratios).

Adding Electrons to the Model

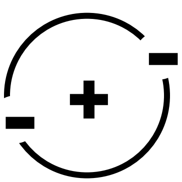
Materials, when rubbed, can develop a charge difference. This electricity is called "cathode rays" when passed through an evacuated tube (demos). These rays have a small mass and are negative. Thompson noted that these negative subatomic particles were a fundamental part of all atoms.



1) Dalton's "Billiard ball" model (1800-1900)
   Atoms are solid and indivisible.



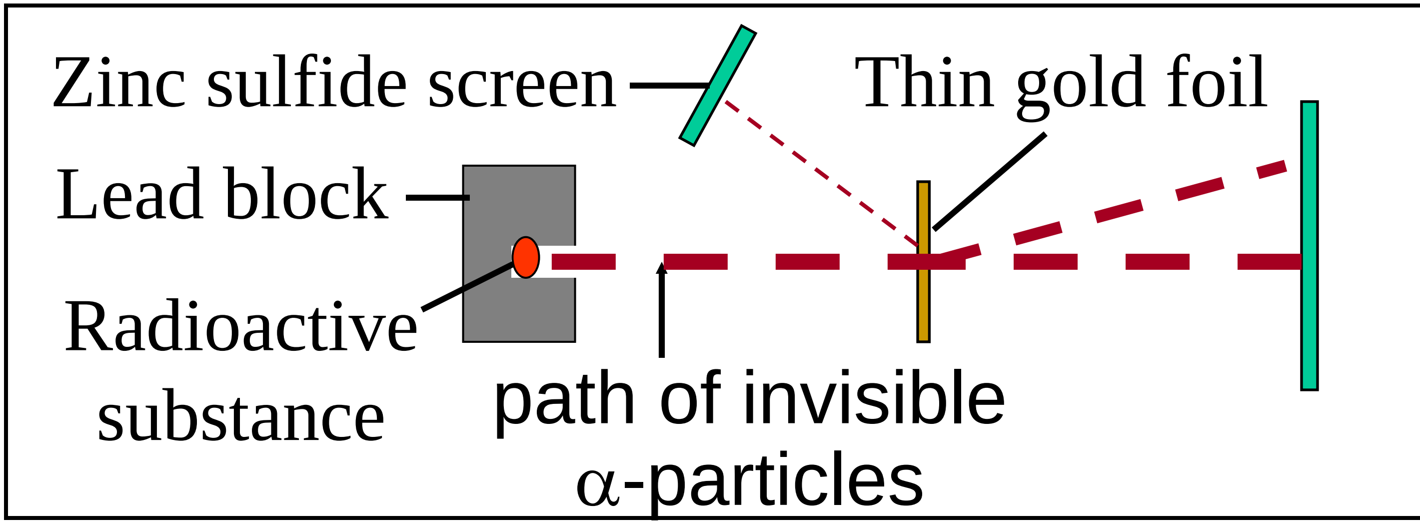
2) Thompson "Plum pudding" model (1900)
   Negative electrons in a positive framework.

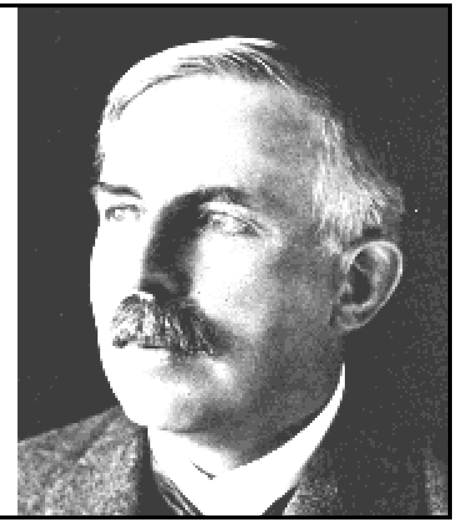


3) The Rutherford model (around 1910)
   Atoms are mostly empty space.
   Negative electrons orbit a positive nucleus.

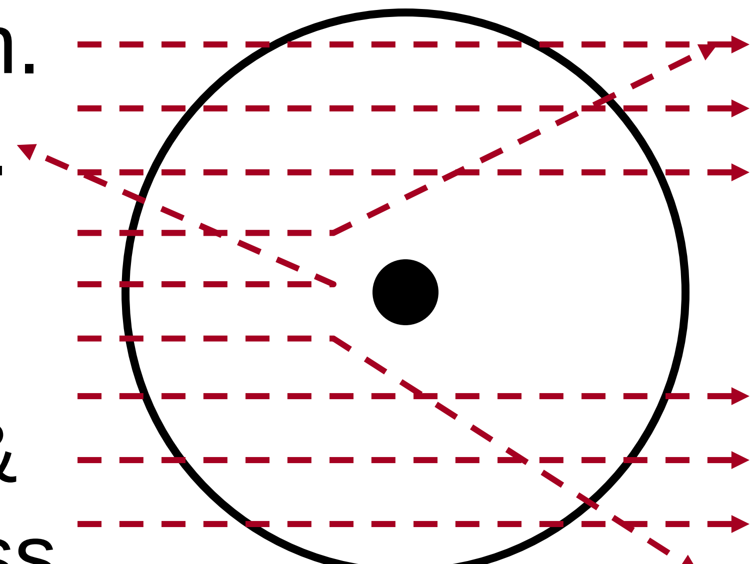
Ernest Rutherford (movie: 10 min.)

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



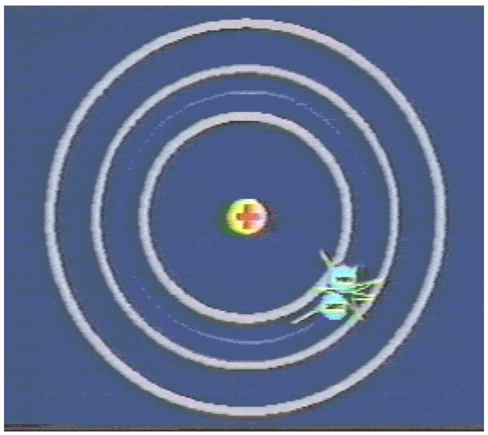


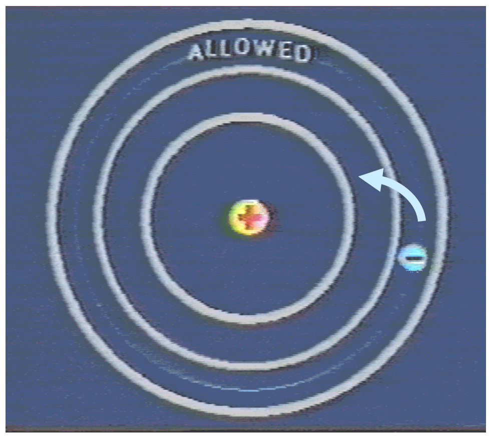
Most particles passed through.
So, atoms are mostly empty.
Some positive α-particles
deflected or bounced back!
Thus, a "nucleus" is positive &
holds most of an atom's mass.

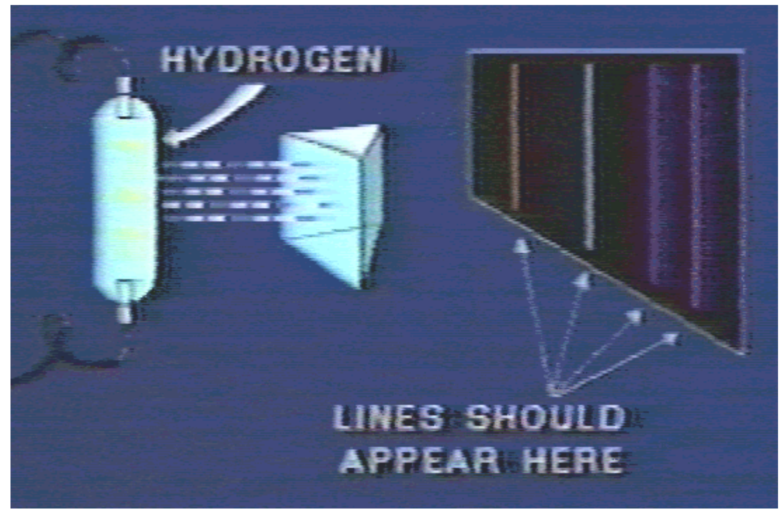


Bohr's model

- 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).

Atomic numbers, Mass numbers

- There are 3 types of subatomic particles. We already know about electrons (e^-) & protons (p^+). Neutrons (n^0) were also shown to exist (1930s).
- They have: no charge, 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.

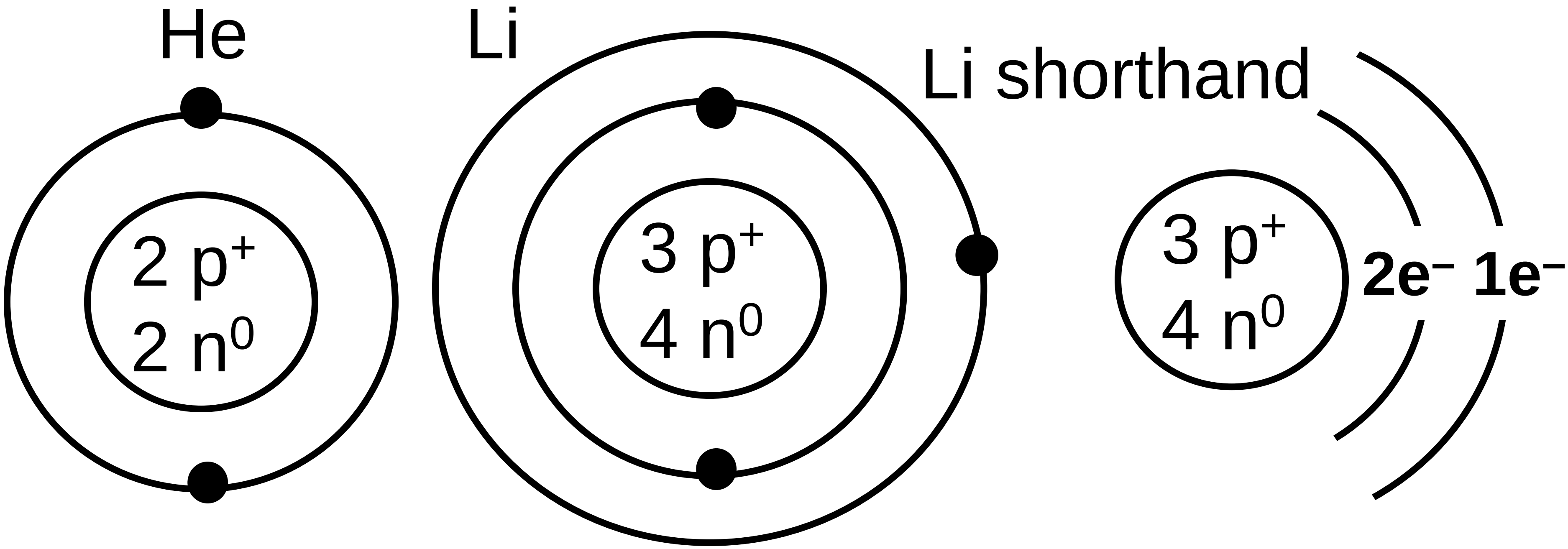
  # of protons = # of electrons = atomic number

  # of neutrons = mass number – atomic number
- Calculate # of e^-, n^0, p^+ for Ca, Ar, and Br.

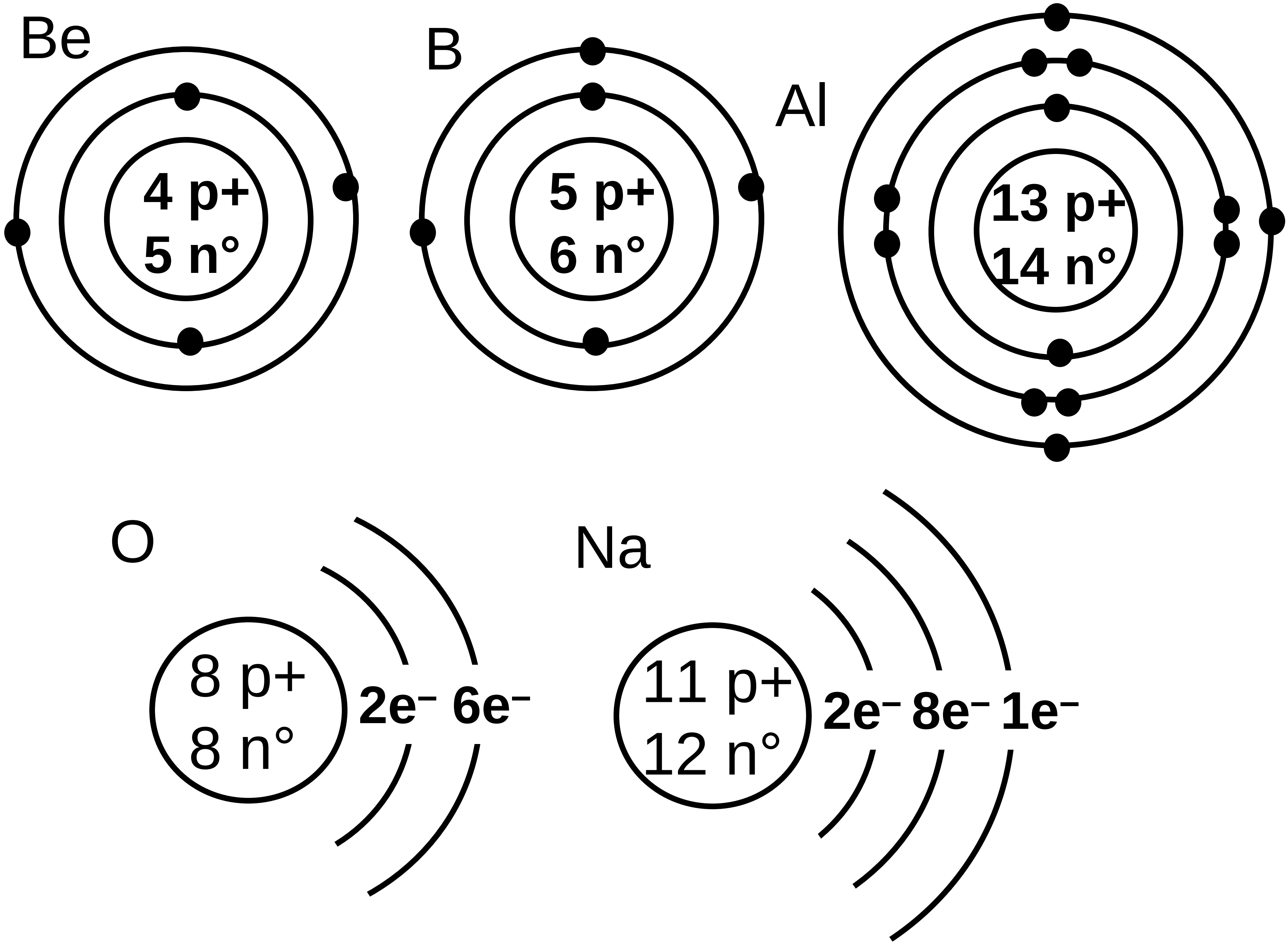
	Atomic	Mass	p^+	n^0	e^-
Ca	20	40	20	20	20
Ar	18	40	18	22	18
Br	35	80	35	45	35

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⁻

Isotopes and Radioisotopes

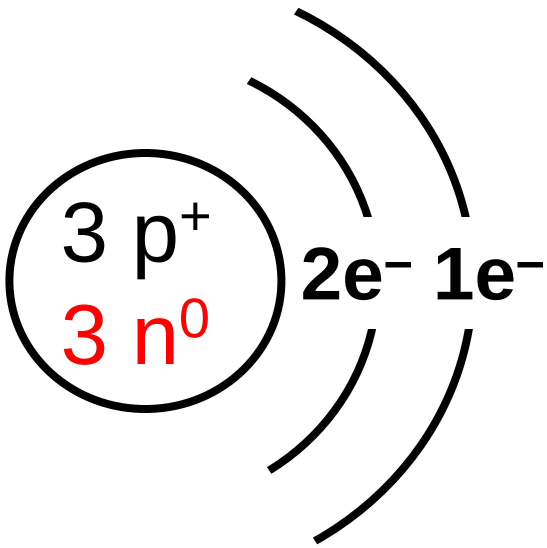
- Atoms of the same element that have different numbers of neutrons are called isotopes.
- Due to isotopes, mass #s are not round #s.
- Li (6.9) is made up of both ^{6}Li and ^{7}Li.
- Often, at least one isotope is unstable.
- It breaks down, releasing radioactivity.
- These types of isotopes are called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

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

Q- Draw B-R diagrams for the two Li isotopes.

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

^{6}Li



^{7}Li