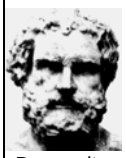
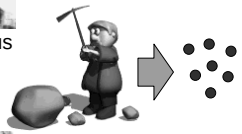
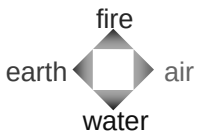
# Models of the Atom: a Historical Perspective

## 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.





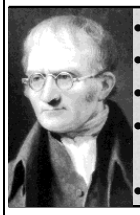


Aristotle

- 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.

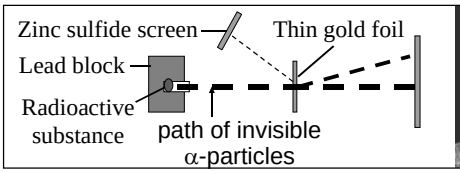

1) Dalton's "Billiard ball" model (1800-1900)
Atoms are solid and indivisible.

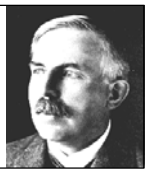

2) Thompson "Plum pudding" model (1900)
Negative electrons in a positive framework.


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

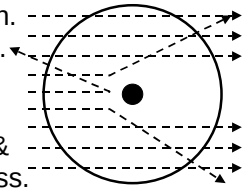
## Ernest Rutherford (movie: 10 min.)

- Rutherford shot alpha ($\alpha$) particles at gold foil.

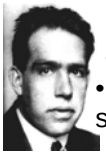


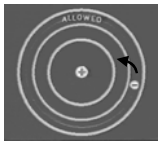
Most particles passed through.
So, atoms are mostly empty.
Some positive $\alpha$-particles deflected or bounced back!
Thus, a "nucleus" is positive & holds most of an atom's mass.

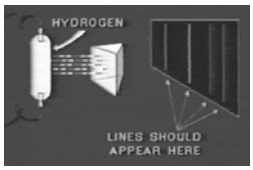


## Bohr's model



- 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.

## 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

## 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 without its atomic number - e.g. $^{35}$S (or S-35). Why?

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