The background of the slide is a dark blue color with a faint, light blue molecular structure overlaid. The structure consists of interconnected lines forming a network of hexagonal and pentagonal rings, resembling a crystalline lattice or a complex organic molecule. The lines are thin and the overall appearance is that of a technical or scientific diagram.

Atoms and Elements:
*Historical Ideas About the
Nature of Matter*

OUTCOME QUESTION

S1-2-01:

How did each person contribute to the understanding of matter?

Do you know the difference between a philosopher and a scientist?

P - try to explain the world
S - try to explain, and try to prove with experiments

Early Philosophers (*not Scientists*)

1. Empedocles (450 BCE)

Hypothesis:

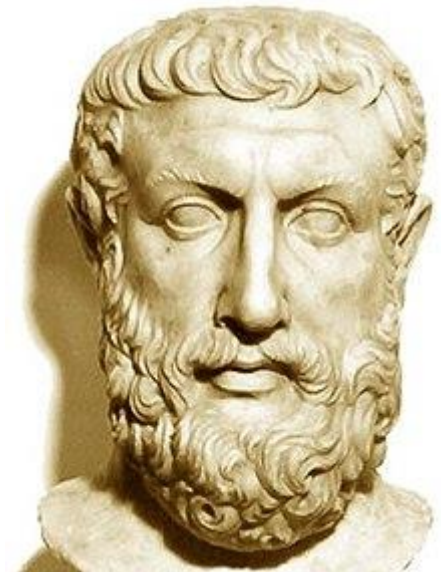
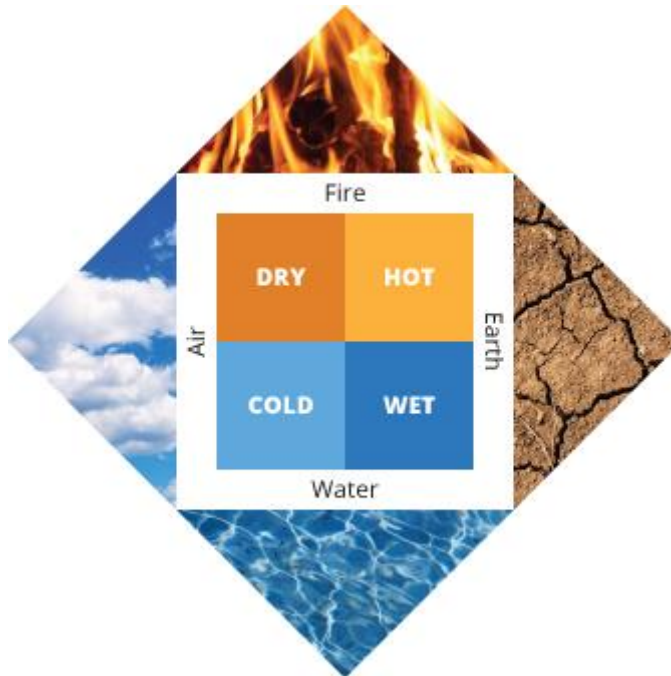
Matter is composed of 4 main elements:

-Earth

-Water

-Air

-Fire



Early Philosophers (*not Scientists*)

2. Democritus (400 BCE)

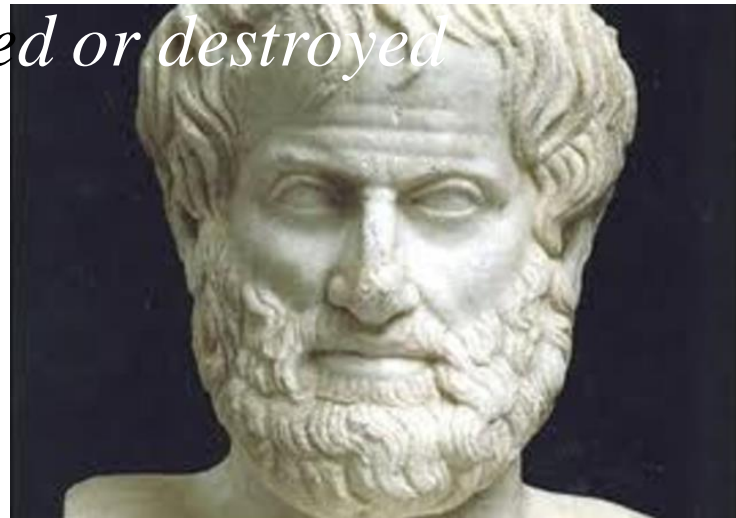
Hypothesis:

“**atomos**” – means *indivisible*

Matter is composed of **tiny particles** in constant motion – **atomos**

- Cannot be broken apart – **solid**
- **Eternal** - *cannot be created or destroyed*

Democritus was not the student of the famous Plato.
Do you think the world believed him?



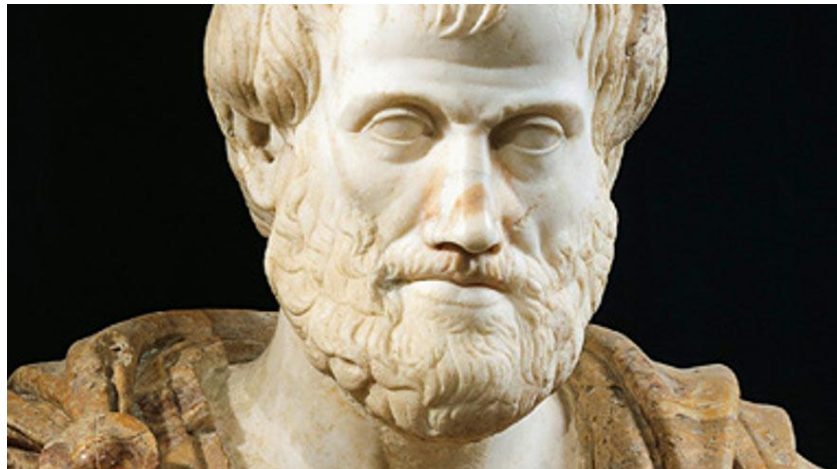
Early Philosophers (*not Scientists*)

3. Aristotle (350 BCE)

Hypothesis:

- Rejected Democritus' idea of atoms, and adopted the “4 element” model
- *This influenced and dominated the scientific world for almost 2000 years!*

Aristotle was the student of the famous Plato.
Do you think the world believed him?



4. The Alchemists (500 – 1600 CE)

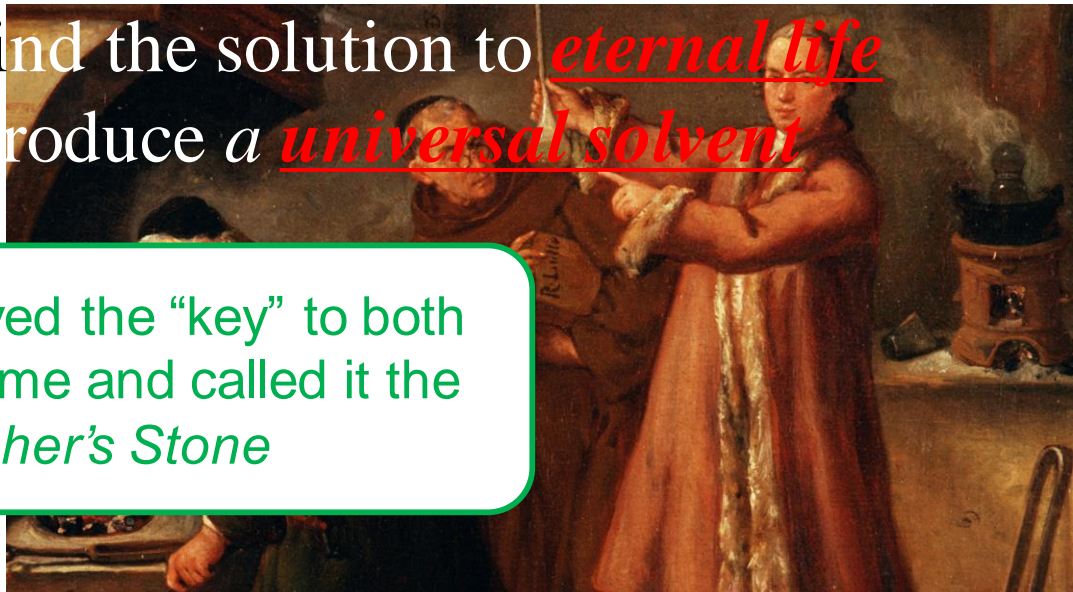
- First recorded use of the **“scientific method”**
(*observation, experimentation, measurement and classification*)

Alchemists are considered the first “scientists”

Beliefs

1. Elements could be **changed** into others
2. Wanted to find the solution to **eternal life**
3. Wanted to produce a **universal solvent**

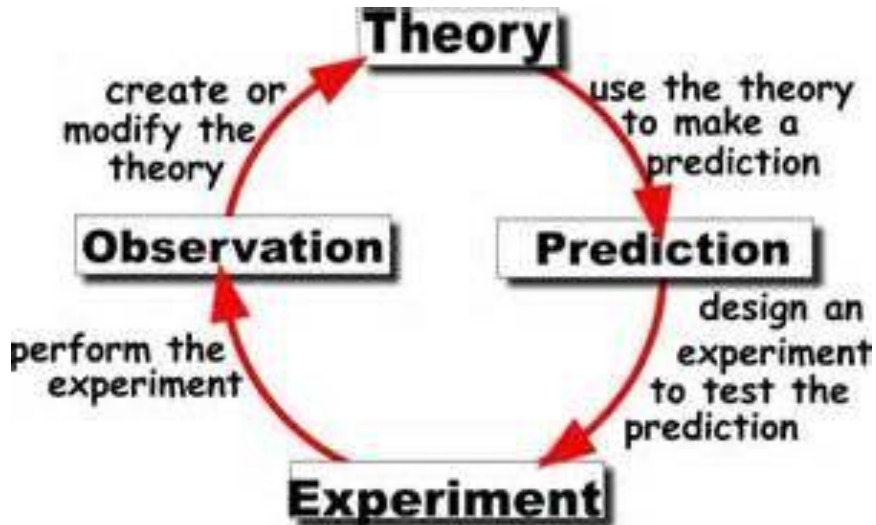
Alchemists believed the “key” to both goals was the same and called it the *Philosopher’s Stone*



Early Scientists

1. Sir Francis Bacon (1600s)

- First scientist to develop new knowledge because of experimentation



2. Robert Boyle (1650)

- Wanted to improve the “4 Element Theory”
- Published *Skeptical Chemist* and defined the term “element”
- Element = certain simple unmingled body
- Found elements combined to form compounds



3. Joseph Priestly (1700s)

- Isolated oxygen
- Did not realize that oxygen was an element!

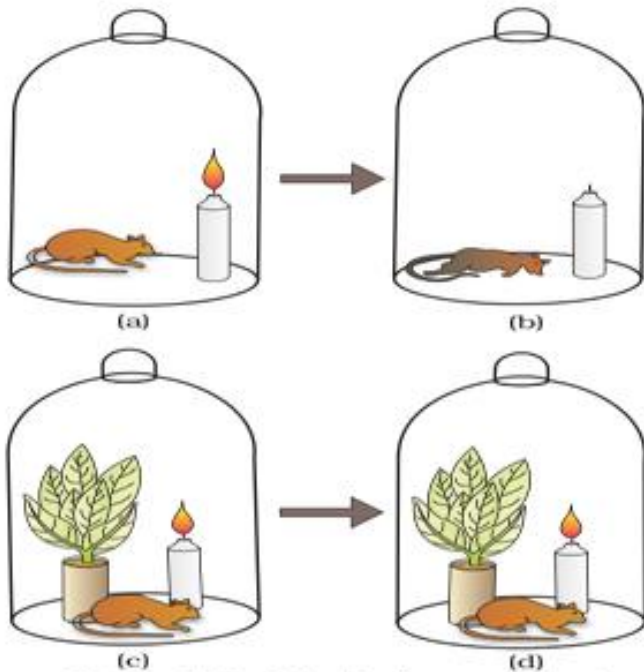
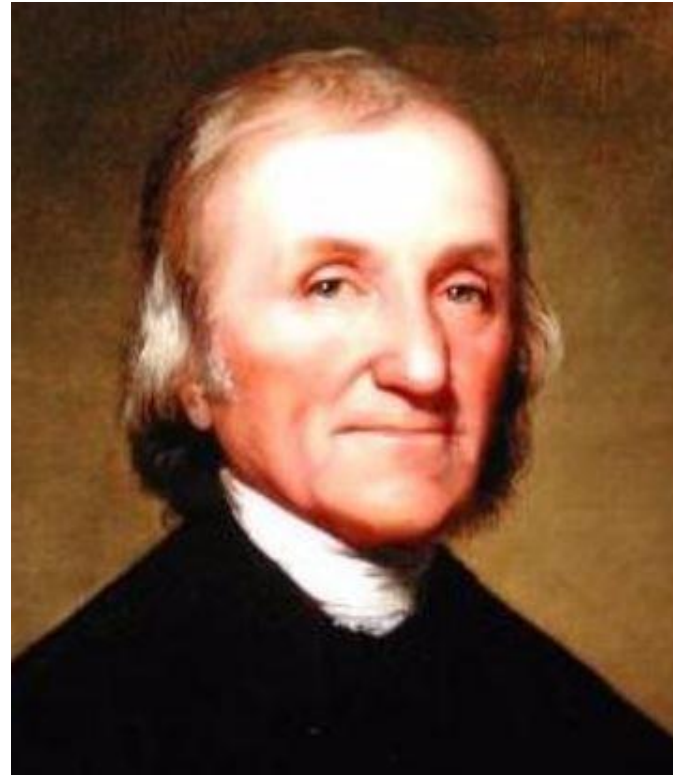


Figure 13.1 Priestley's experiment



4. Antoine de Lavoisier (late 1700s)

- Defined an element as a pure substance
- Discovered and identified 23 elements
- Recognized mixtures exist

TABLE OF SIMPLE SUBSTANCES.

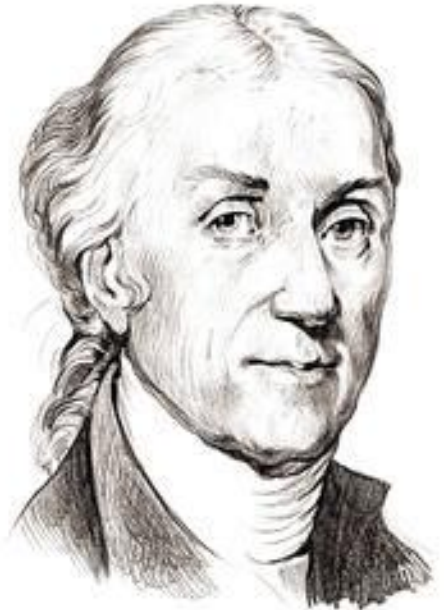
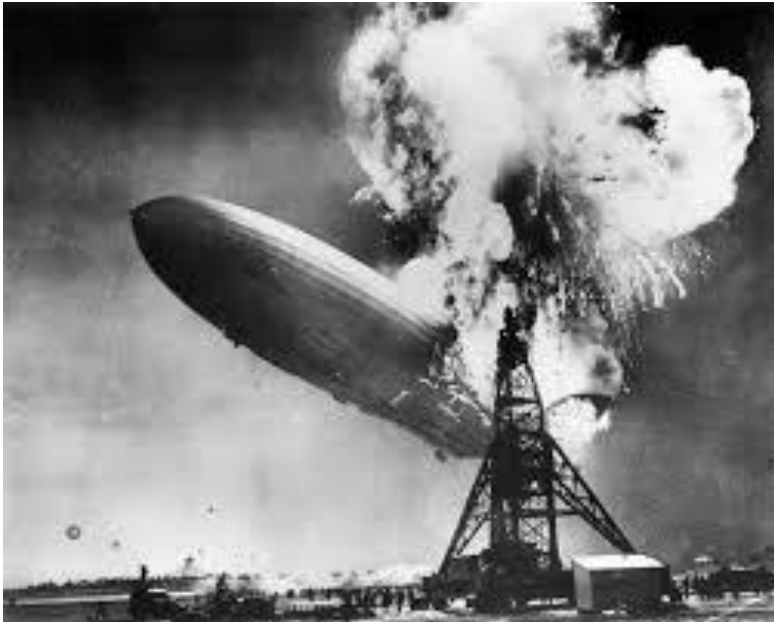
Simple substances belonging to all the kingdoms of nature, which may be considered as the elements of bodies.

	<i>New Names.</i>	<i>Correspondent old Names.</i>
Light	- - -	Light.
Caloric	- - -	Heat.
		Principle or element of heat.
		Fire. Igneous fluid.
Oxygen	- - -	Matter of fire and of heat.
		Dephlogificated air.
		Empyrean air.
		Vital air, or
Azote	- - -	Base of vital air.
		Phlogificated air or gas.
		Mephitic, or its base.
Hydrogen	- - -	Inflammable air or gas, or the base of inflammable air.
Oxydable and Acidifiable simple Substances not Metallic.		
	<i>New Names.</i>	<i>Correspondent old names.</i>
Sulphur	- - -	} The same names.
Phosphorus	- - -	
Charcoal	- - -	
Muriatic radical	- - -	} Still unknown.
Fluoric radical	- - -	
Boracic radical	- - -	



5. Henry Cavendish (late 1700s)

- Mixed metal with acid and produced hydrogen
- Found it would burn in oxygen to produce water
– proved water was a mixture!



Atoms and Elements

Models of Matter

History

OUTCOME QUESTION(S):

S1-2-01:

How did each person contribute to the understanding of matter?

S1-2-02:

What is the basic subatomic structure of an atom?

Who have we already talked about?

1. John Dalton (1800)

- Was a meteorologist
- Studied gases, and discovered properties of gases that he applied to all matter
- His model: *Billiard Ball Model*



1. John Dalton (1800)

Wrote the *FIRST Atomic Theory:

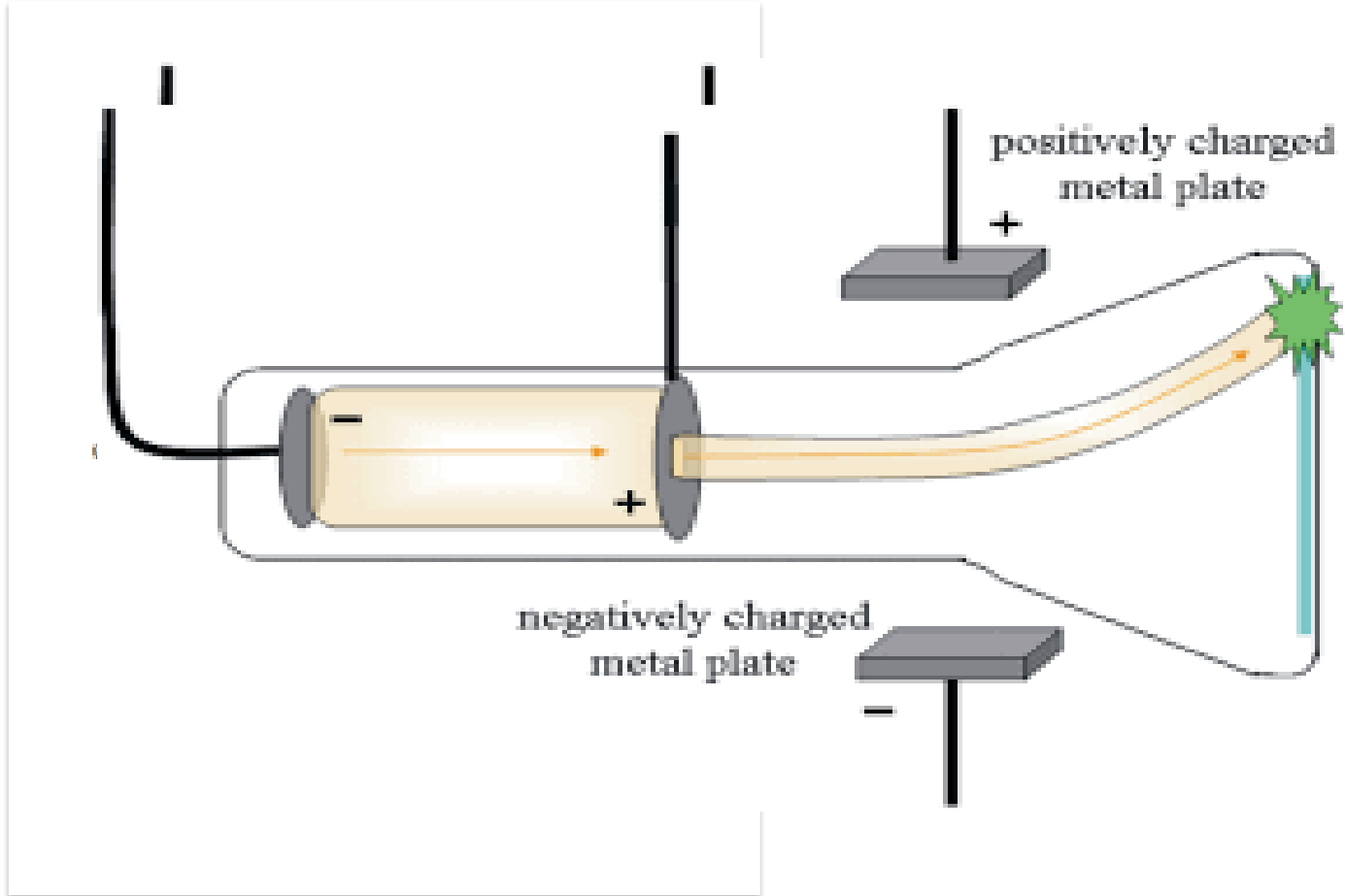
1. All matter made of indivisible particles – atom
2. Atoms of elements are unique: differing by mass
3. Compounds are combinations of *elements*
4. Atoms cannot be *created or destroyed*



Dalton's "atoms"

2. J. J. Thomson (1890)

- *Experiments proved first subatomic particle:*



2. J. J. Thomson (1890)

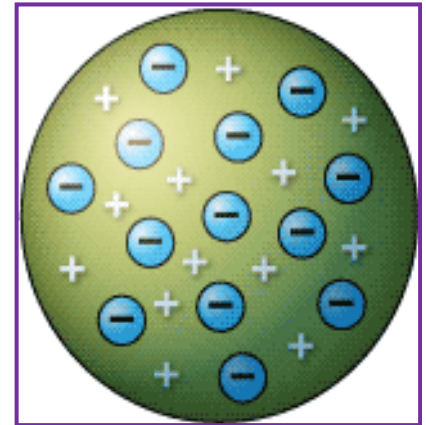
Discovery:

- **Electrons**: *small, negative* electric charges. Electrons are so *small* they are considered “**mass-less**”

Hypothesis for his Plum Pudding:

Atoms are **spheres** with **(+) charges** mixed with the *same number* of **(-) electrons**.

- Overall an atom is **neutral**

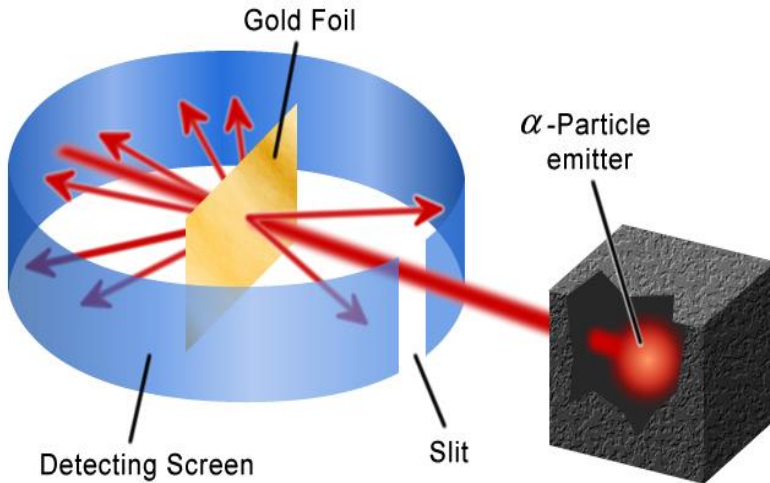


Thomson's "atoms"

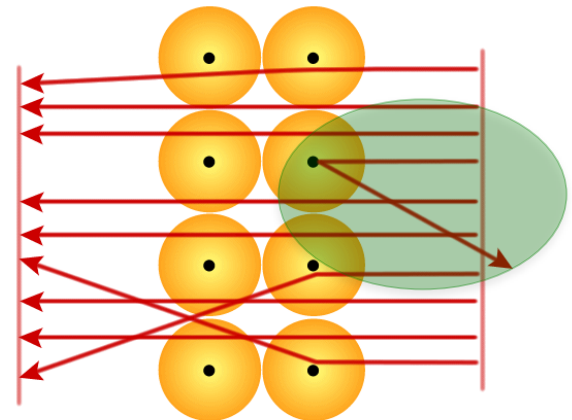
3. Ernest Rutherford (1910)

“*Gold Foil*” experiment discovered *atomic nucleus*

Rutherford basically shot tiny “bullets” at a sheet of gold expecting them to slice right through the thin sheet – *but some bounced straight back!*



Gold Foil



Gold Description

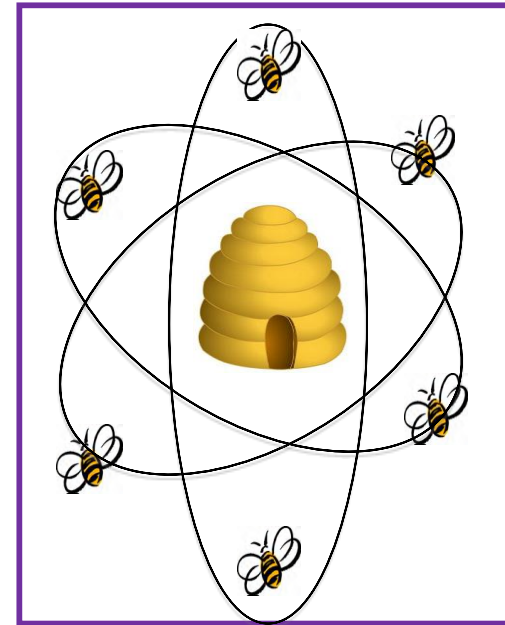
©NCSSM 2002

Hypothesis for his Nuclear Model:

Atoms composed of *empty space* with a dense *(+) nucleus* and tiny *(-) electrons* flying around.

Second subatomic particle:

Proton: *positive electric charge,*
found in nucleus.



Rutherford's "atoms"

Rutherford's model is
also called the
"bee hive" model



4. Niels Bohr (1913)

Experiment:

The Flame Test



Hydrogen Absorption Spectrum



Hydrogen Emission Spectrum



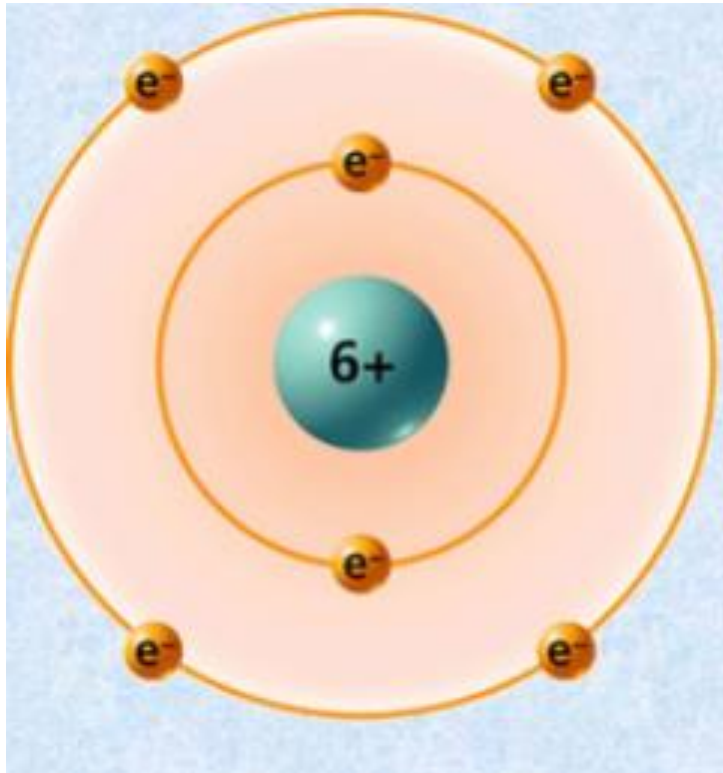
400nm

700nm

H Alpha Line

4. Niels Bohr (1913)

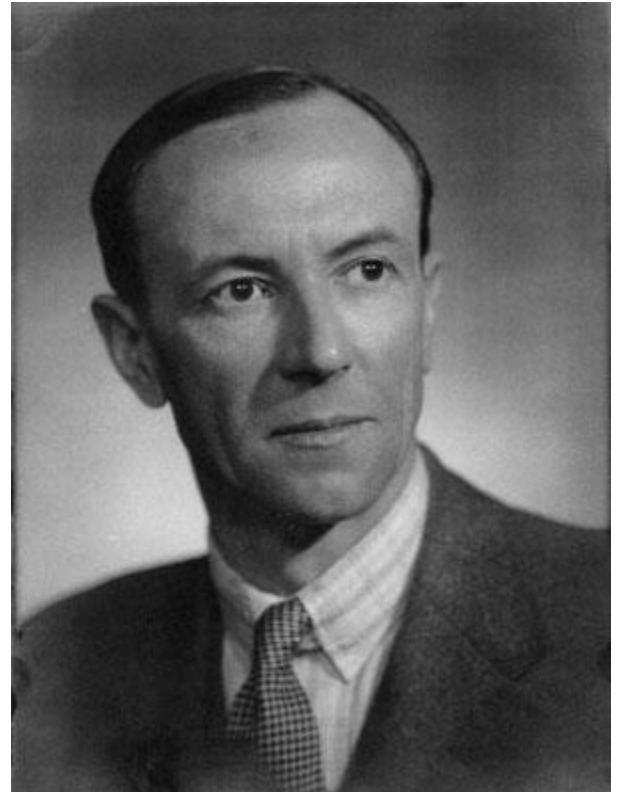
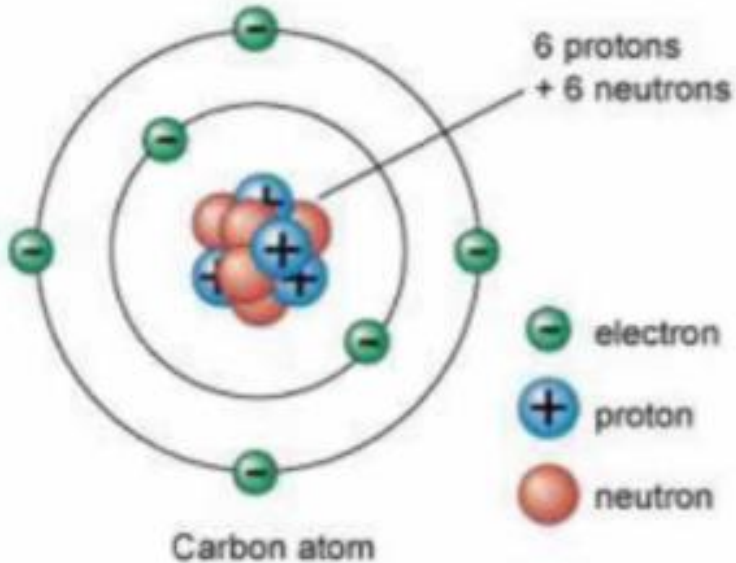
- Improved Rutherford's Model by placing electrons on orbitals (energy levels)



5. Sir James Chadwick (1932)

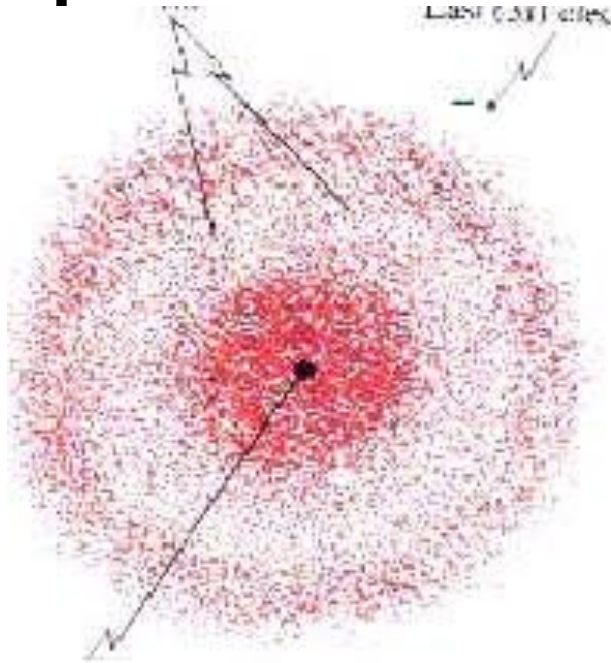
- Discovered the **third subatomic particle**:

Neutron: found in nucleus, *NO* charge, the size of protons.

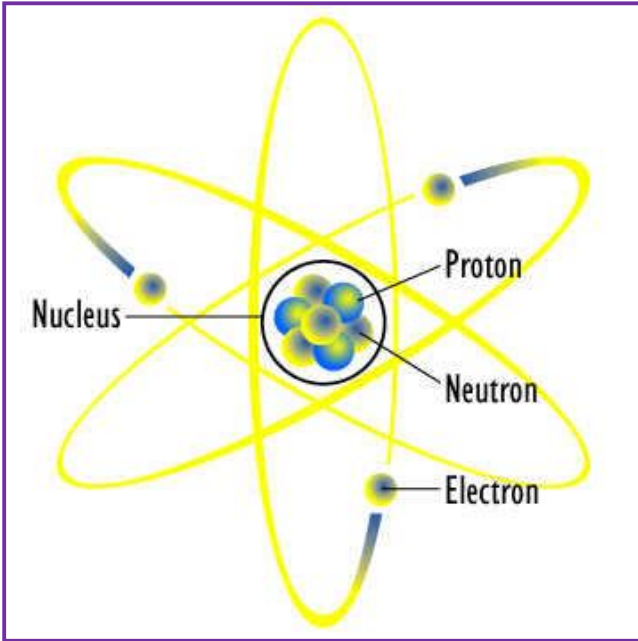


6. Quantum model

- **Electrons don't move in a particular orbit**
- **Cannot determine where an electron is at a specific moment in time.**
- **Electron's position is based on its energy**



Summary:



- The model of an atom took many years to discover
- Many scientists continued to research atoms to come up with a better understanding of matter.
- Scientists are continuing research with atoms and are still discovering new information

What do you need to know about atoms?

- What they are made of (subatomic particles):

Subatomic Particle	Electric Charge	Mass	Location
Protons →	Positive charge	1 amu	Found in the nucleus
Neutrons →	No charge	1amu	Found in the nucleus
Electrons→	Negative charge	No mass	Found around the nucleus

