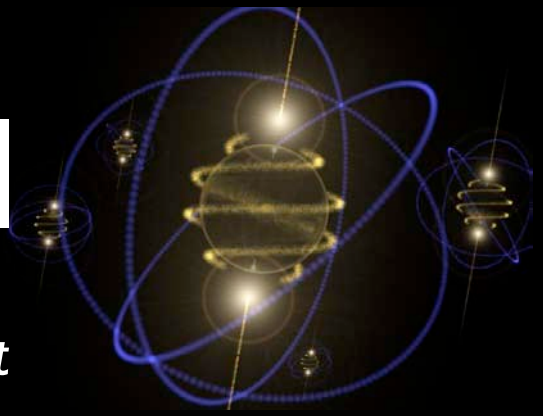
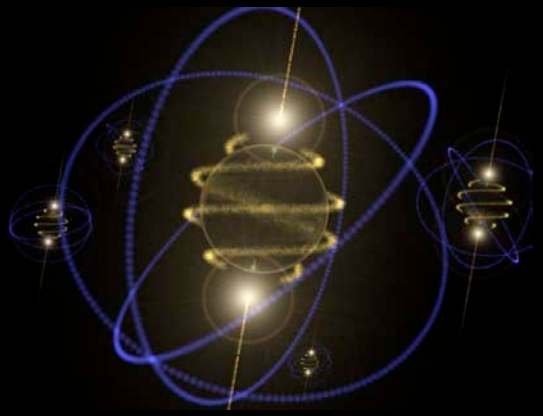
Atomic Structure I

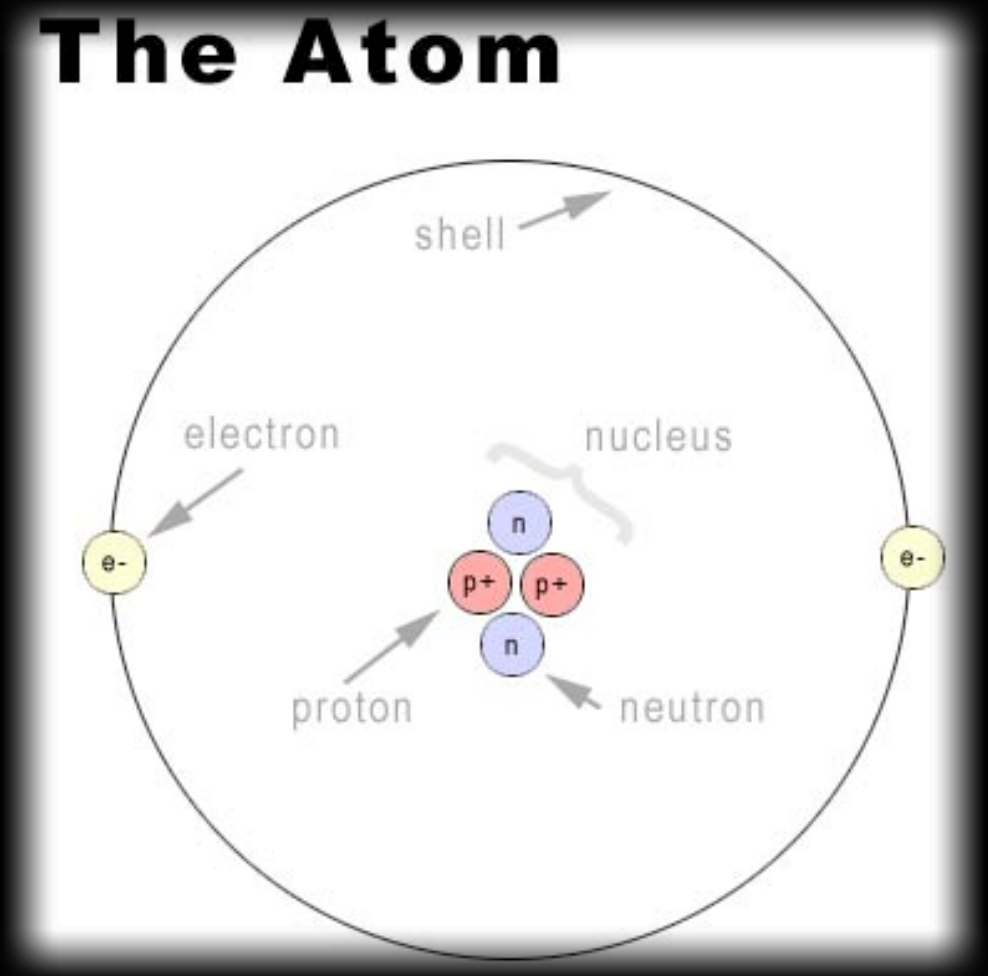
Big Idea: Man & his environment



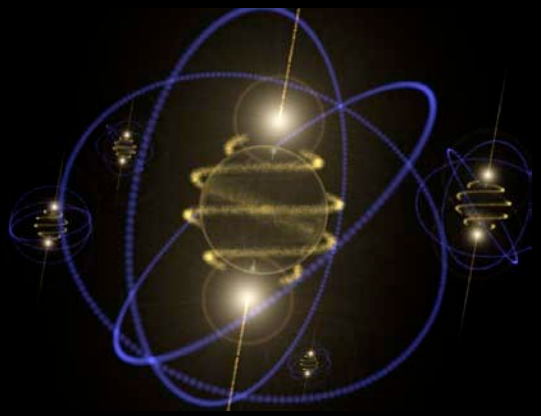
What is an atom?
Why is it important?



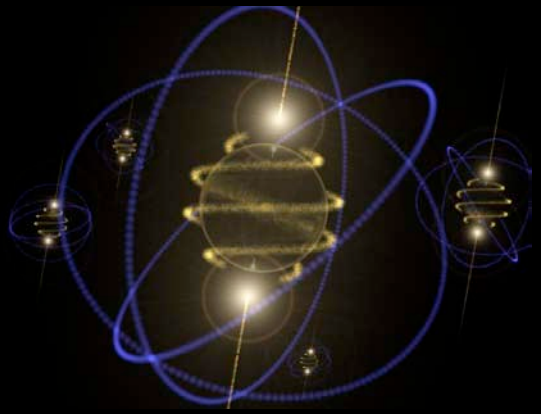
A brief overview

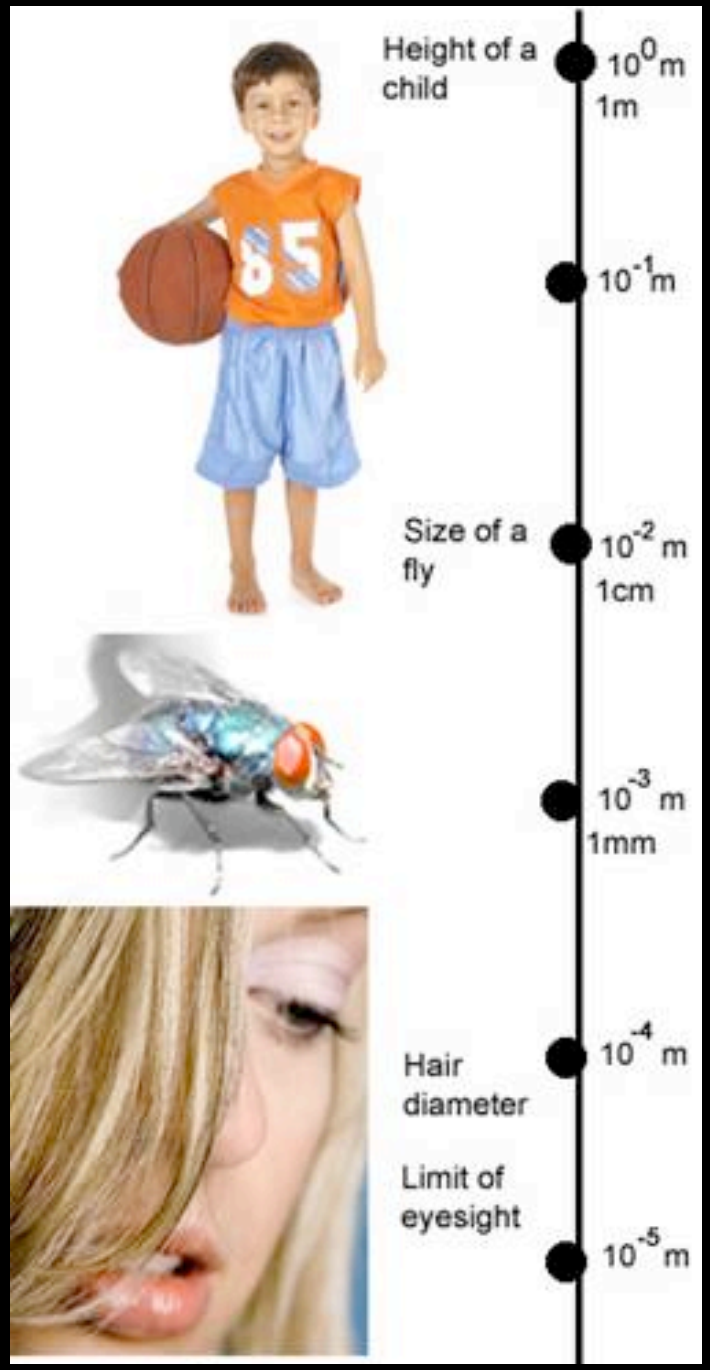


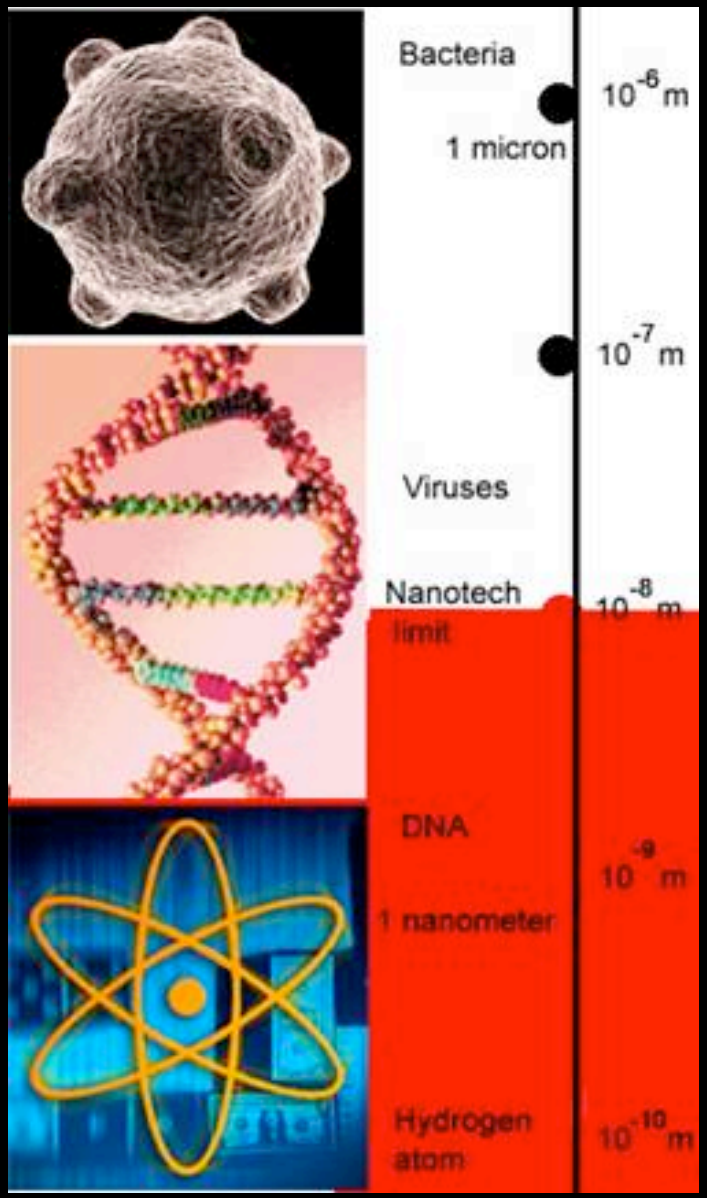
Who ‘discovered’ the atom?



How small is an atom?
Can we see an atom?

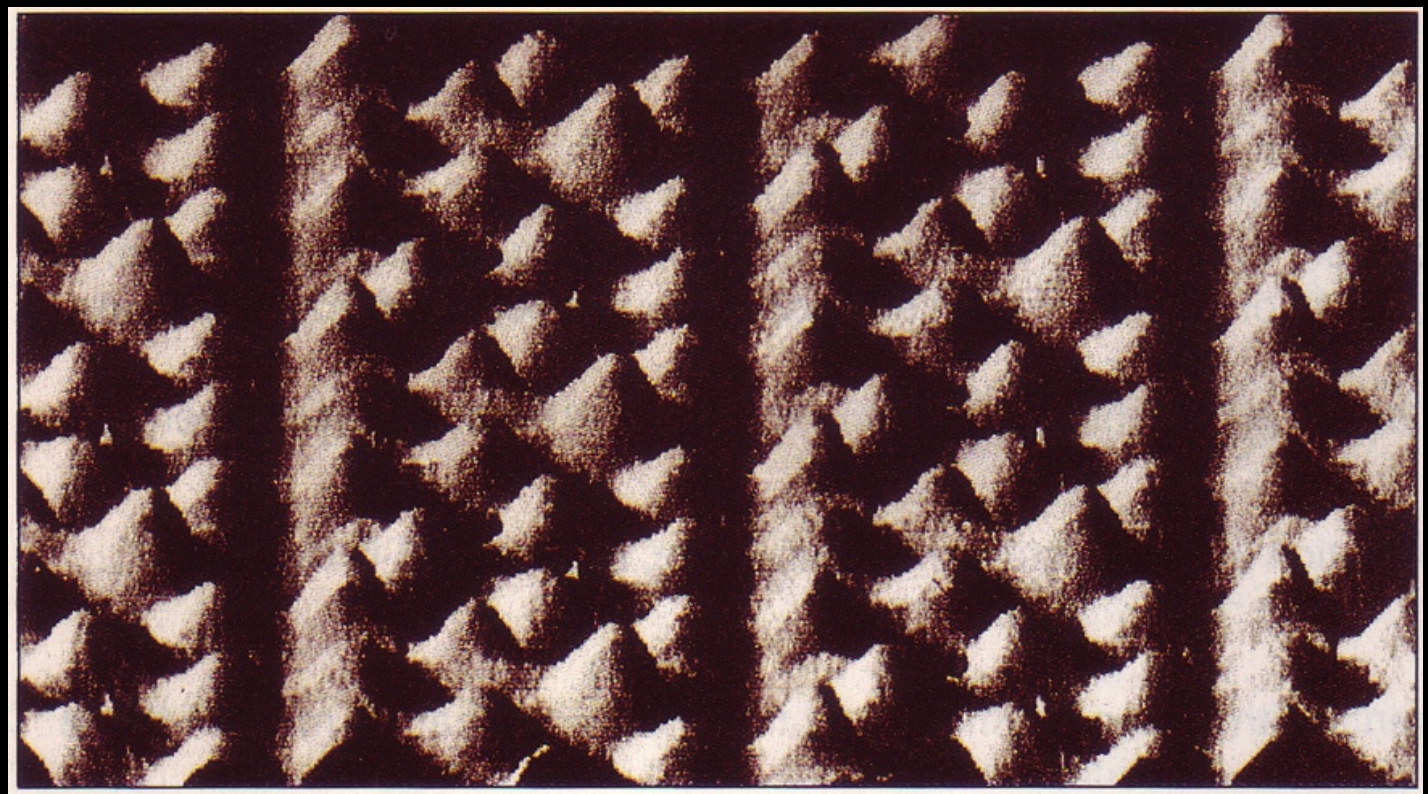






That's 0.000 000 000 001cm!

The closest we can get...



▲ **Fig. 4.2** *The bumps are individual atoms on the surface of a crystal of silicon. This is the best picture of atoms taken so far. A special electron microscope was used.*

People have long asked,

"What is the world made of?"

What have we found out so far?

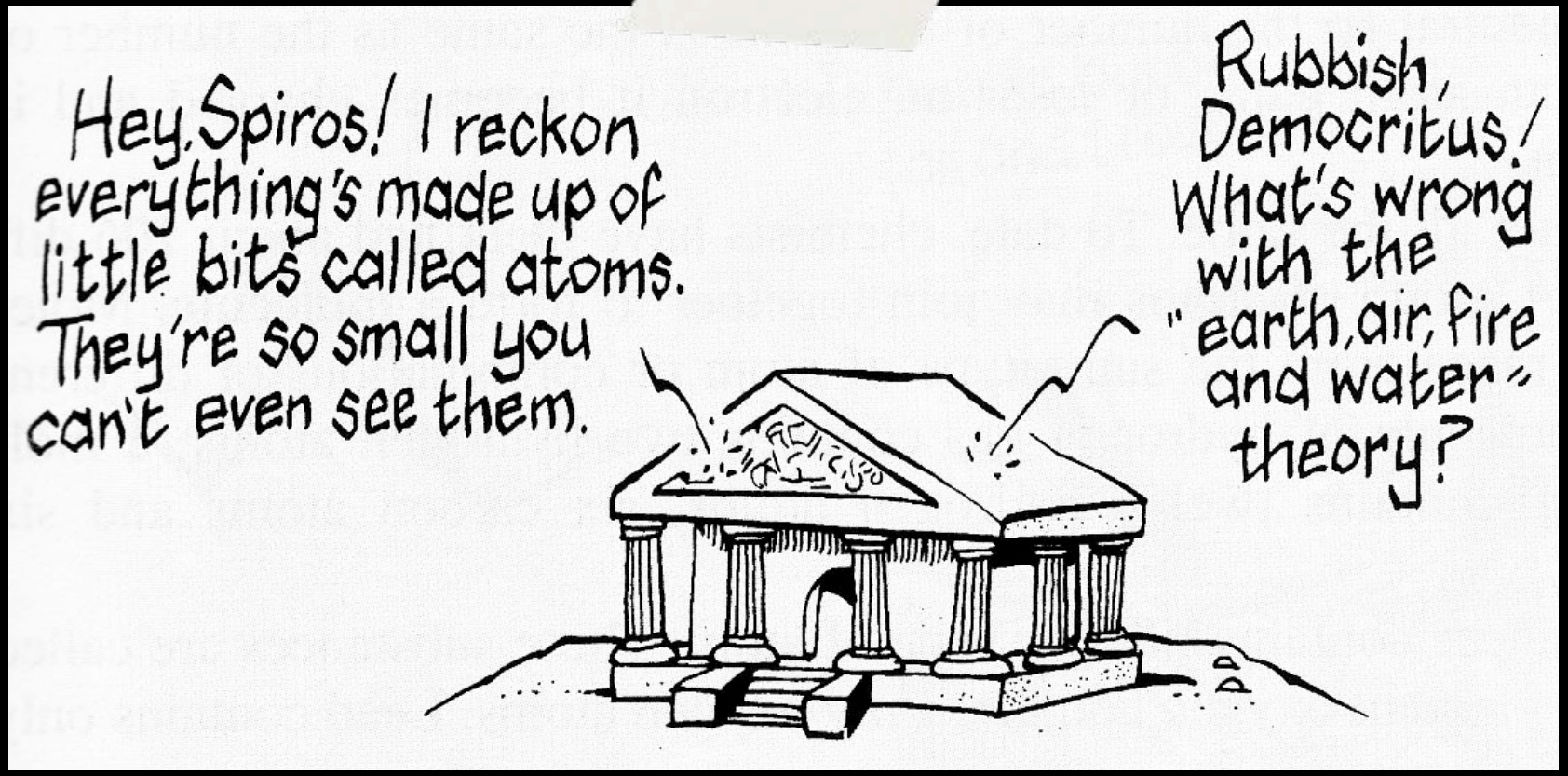
What is the world made of?

- In ancient times, people sought to organize the world around them into fundamental elements, such as earth, air, fire, and water...
- [And that's how Captain Planet came about!]

Development of the Atomic Theory

- Then a fifth century B.C. Greek philosopher called Democritus proposed that...

...all matter was composed of indivisible particles called *atoms*, which means *"uncuttable"* in Greek.



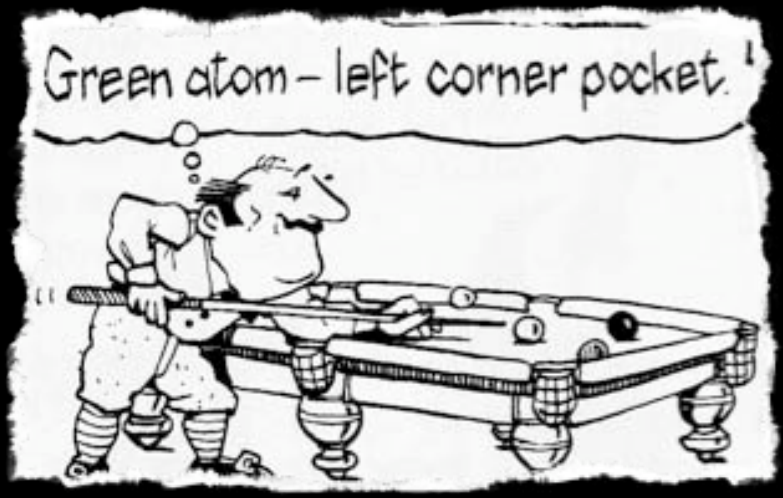
- What does this comic tells us about Democritus' proposed idea of an 'atom' (or '*atomos*' in Greek)?

Development of the Atomic Theory:

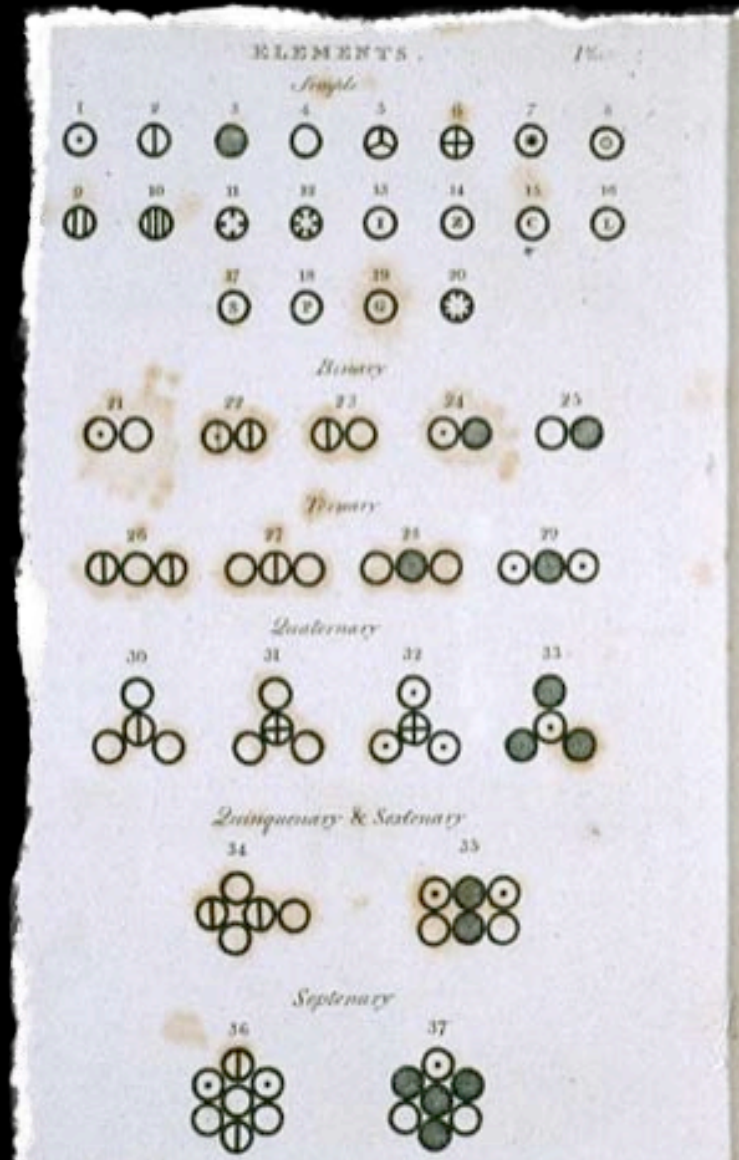
Billiard Ball Model

- Until 1808, a scientist called John Dalton proposed that an element was composed of identical, indivisible atoms characteristic of that element and no other.

The atom is describe as a small solid sphere, like a billiard ball. Hence it was known as the Billiard Ball Model.



- Dalton also proposed that:
- Each element was composed of the same kind of atoms.
- Compounds are composed of atoms in specific ratios.
- Chemical reactions are rearrangements of atoms (mass is conserved)



EXPLANATION OF THE PLATES. 319

PLATE IV. This plate contains the arbitrary marks or signs chosen to represent the several chemical elements or ultimate particles.

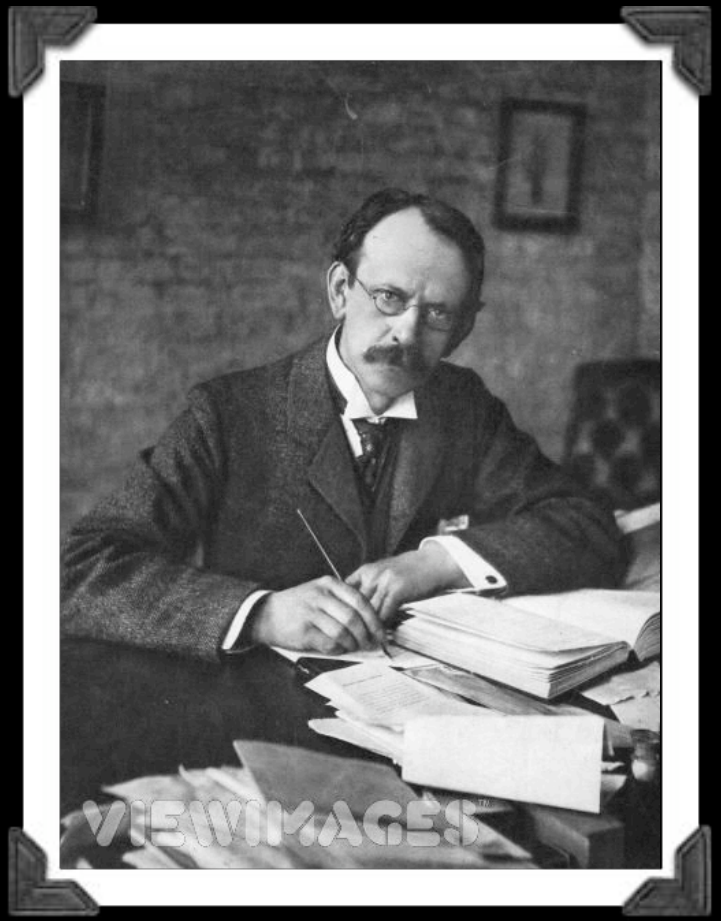
Fig.		Fig.	
1	Hydrog. its rel. weight 1	11	Strontites - - - - 46
2	Azote, - - - - - 5	12	Barytes - - - - - 68
3	Carbone or charcoal, - 5	13	Iron - - - - - - 38
4	Oxygen, - - - - - 7	14	Zinc - - - - - - 56
5	Phosphorus, - - - - 9	15	Copper - - - - - 56
6	Sulphur, - - - - - 13	16	Lead - - - - - - 95
7	Magnesia, - - - - - 20	17	Silver - - - - - - 100
8	Lime, - - - - - - 24	18	Platina - - - - - 100
9	Soda, - - - - - - 28	19	Gold - - - - - - 140
10	Potash, - - - - - 42	20	Mercury - - - - - 167

21. An atom of water or steam, composed of 1 of oxygen and 1 of hydrogen, retained in physical contact by a strong affinity, and supposed to be surrounded by a common atmosphere of heat; its relative weight = - - - - - - 8
22. An atom of ammonia, composed of 1 of azote and 1 of hydrogen - - - - - - - - - - 6
23. An atom of nitrous gas, composed of 1 of azote and 1 of oxygen - - - - - - - - - - 12
24. An atom of olefiant gas, composed of 1 of carbone and 1 of hydrogen - - - - - - - - - - 6
25. An atom of carbonic oxide composed of 1 of carbone and 1 of oxygen - - - - - - - - - 12
26. An atom of nitrous oxide, 2 azote + 1 oxygen - 17
27. An atom of nitric acid, 1 azote + 2 oxygen - - 19
28. An atom of carbonic acid, 1 carbone + 2 oxygen 19
29. An atom of carburetted hydrogen, 1 carbone + 2 hydrogen - - - - - - - - - - - - - 7
30. An atom of oxynitric acid, 1 azote + 3 oxygen 26
31. An atom of sulphuric acid, 1 sulphur + 3 oxygen 34
32. An atom of sulphuretted hydrogen, 1 sulphur + 3 hydrogen - - - - - - - - - - - - - 16
33. An atom of alcohol, 3 carbone + 1 hydrogen - 16
34. An atom of nitrous acid, 1 nitric acid + 1 nitrous gas - - - - - - - - - - - - - - 31
35. An atom of acetous acid, 2 carbone + 2 water - 28
36. An atom of nitrate of ammonia, 1 nitric acid + 1 ammonia + 1 water - - - - - - - - - 33
37. An atom of sugar, 1 alcohol + 1 carbonic acid - 35

A page from Dalton's book
"A New System of Chemical Philosophy" (1808)

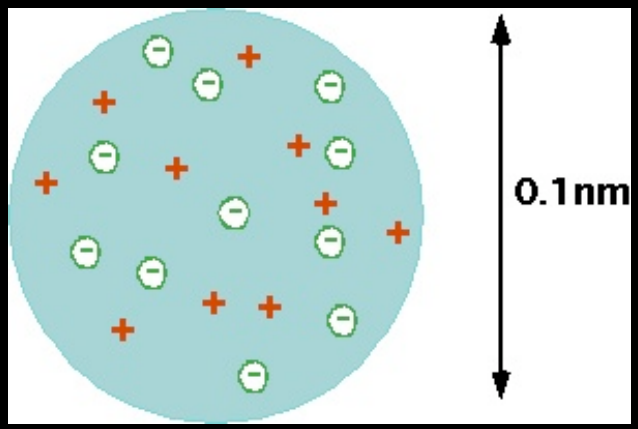
Development of the Atomic Theory :
Plum Pudding Model

- In 1898, Joseph John Thomson's identification of the electrons showed that atoms were not indivisible.



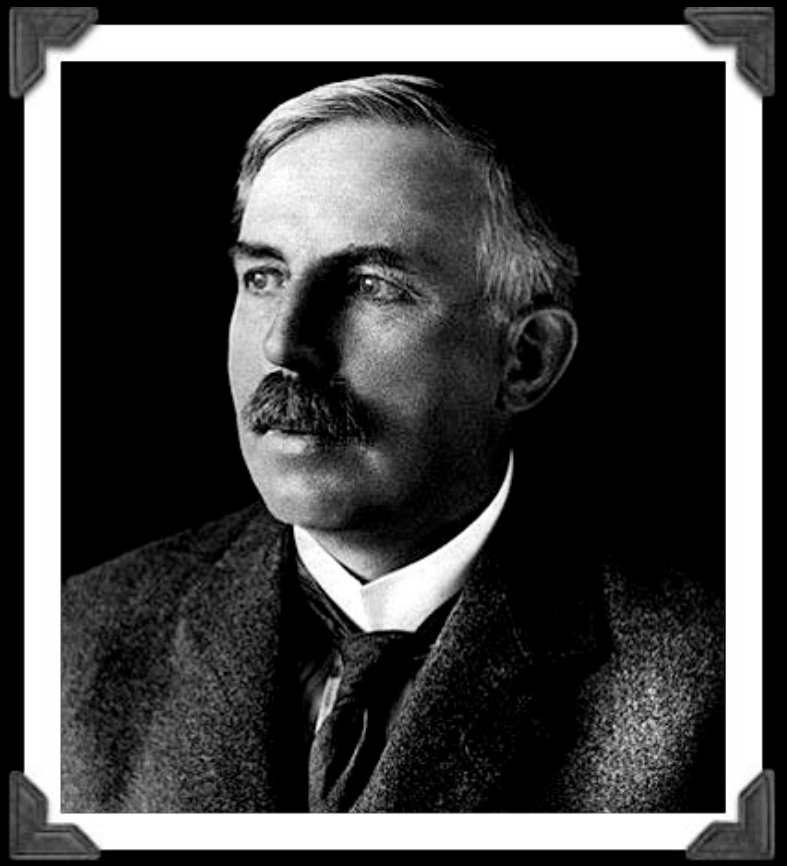
Development of the Atomic Theory :
Plum Pudding Model

- Thomson proposed that an atom consisted of a soft, positively charged jelly-like sphere into which negatively charged electrons were embedded, like plums in a pudding, thus known as the Plum Pudding Model.



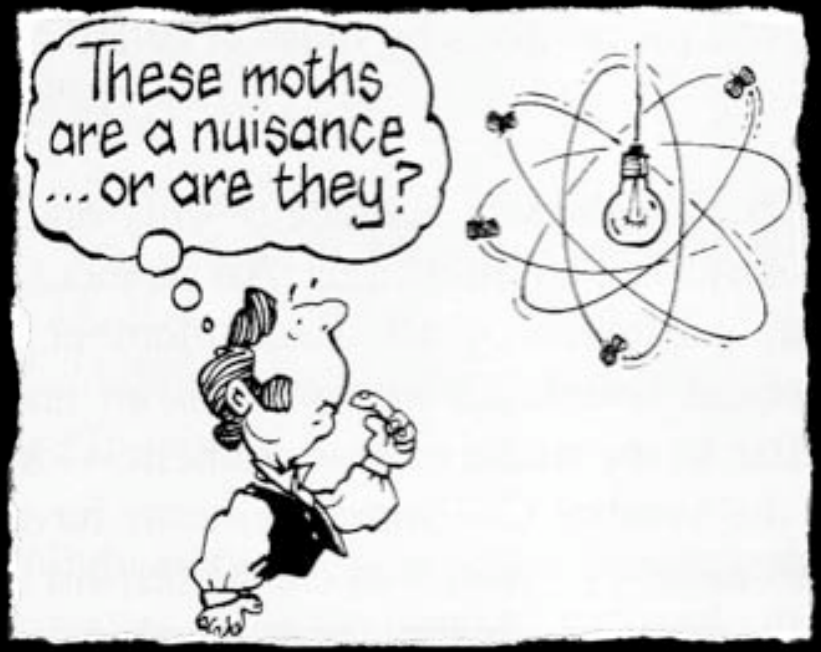
Development of the Atomic Theory :
The Nuclear Model

- Ernest Rutherford discovered that the atom is mostly empty space with a dense positively charged nucleus surrounded by negative electrons.

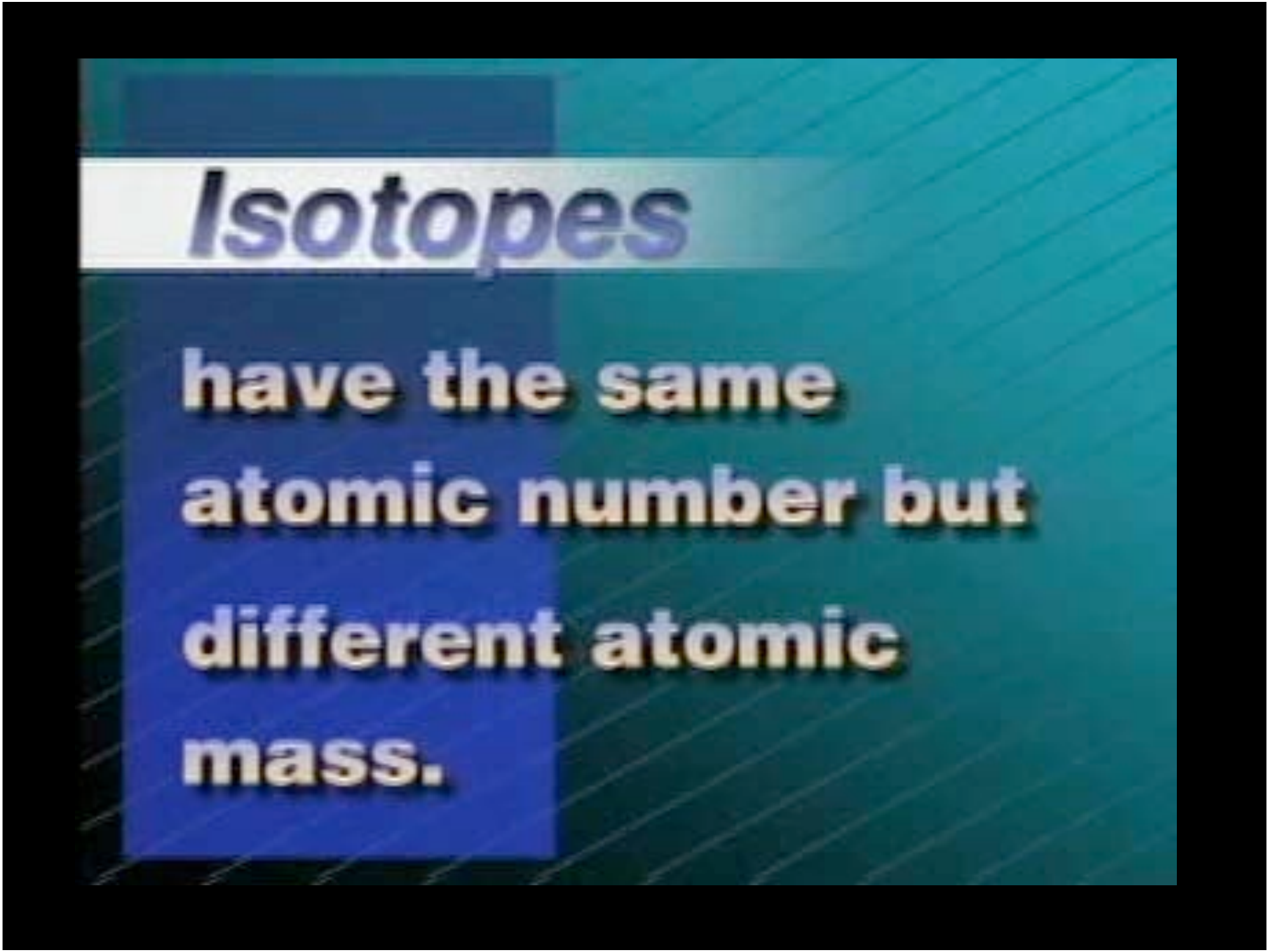


Development of the Atomic Theory :
The Nuclear Model

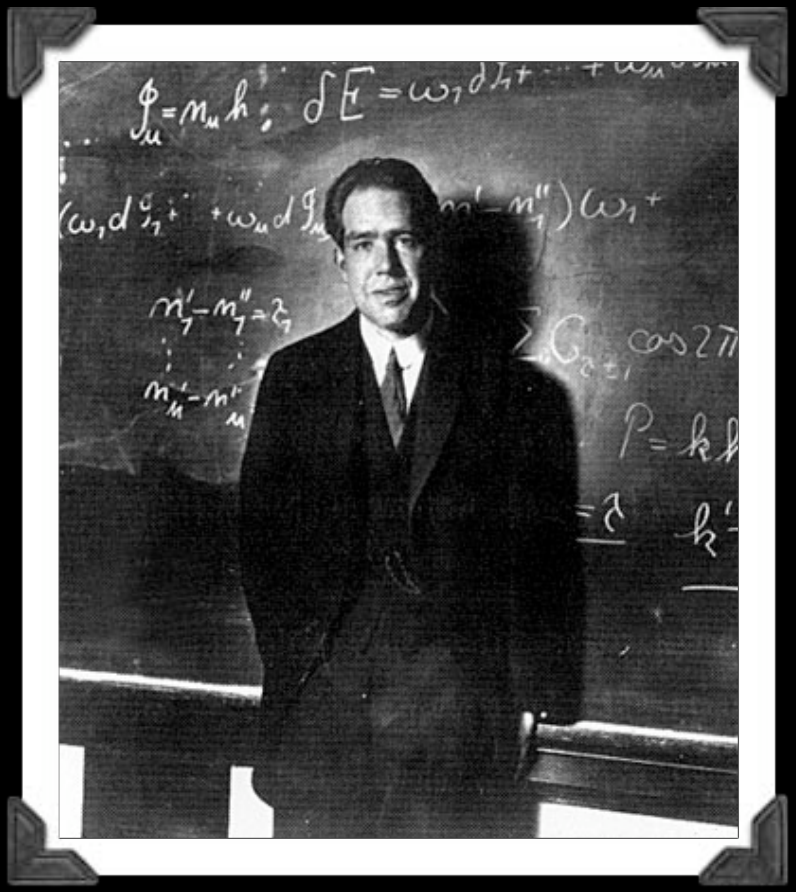
- Rutherford ‘discovered’ this nuclear model through the an experiment using a very thin gold foil.
- [refer swf and applet]



Since atom is mostly empty space, then all matter (solid, liquid and gas) is mostly empty space?


Isotopes
have the same atomic number but different atomic mass.

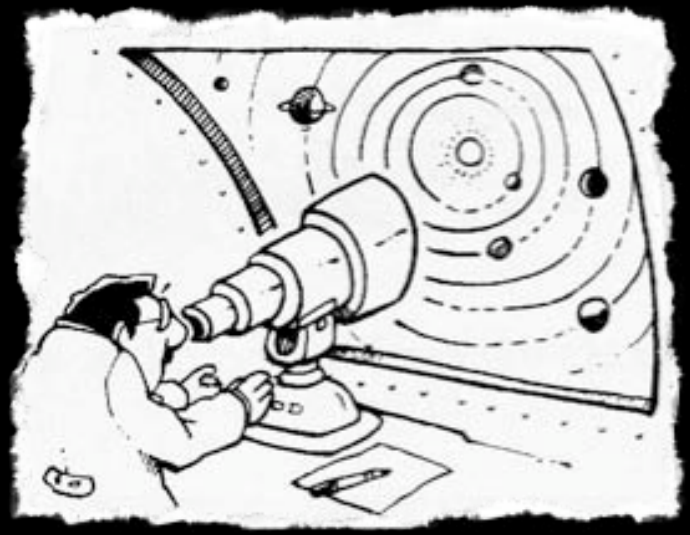
Development of the Atomic Theory :
Solar System Model

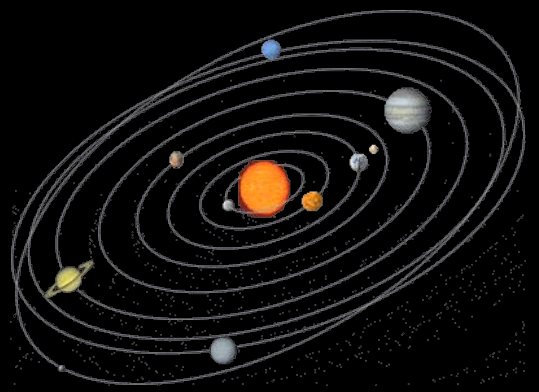


- In 1913, Neils Bohr added on to Rutherford's model of an atom and proposed that the electrons in an atom travel in circular orbits.

Development of the Atomic Theory :
Solar System Model

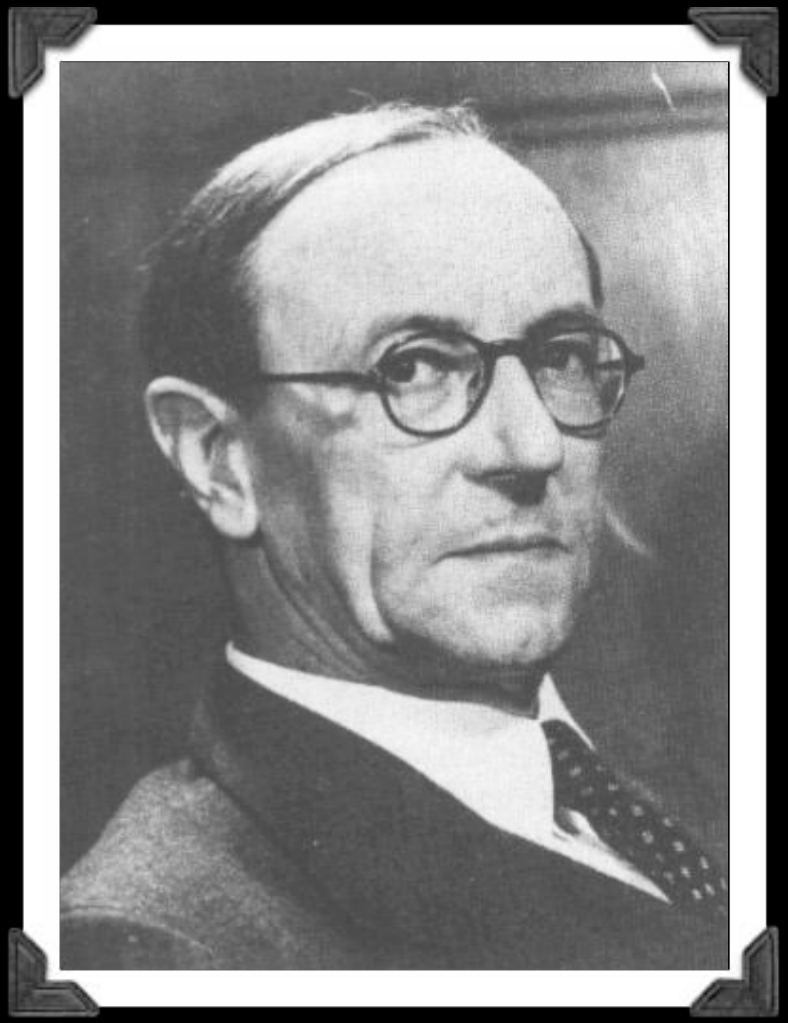
- According to Bohr's proposal, the electrons could be compared to a solar system with its planets (electrons) in definite orbits around the sun (nucleus).



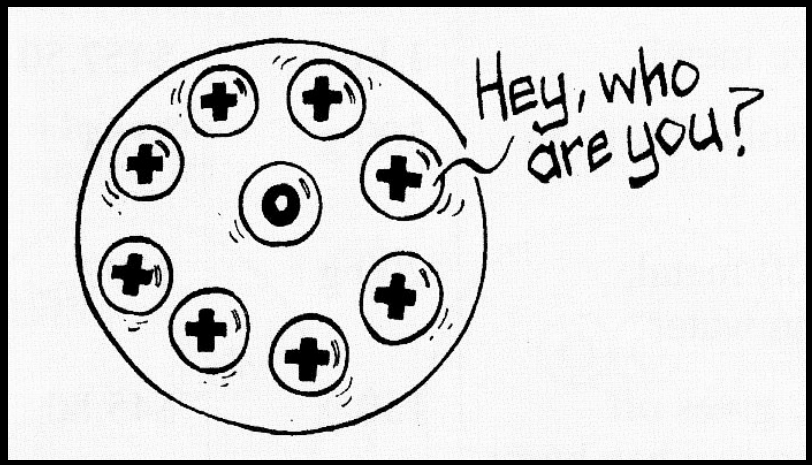


Development of the Atomic Theory :

Solar System Model

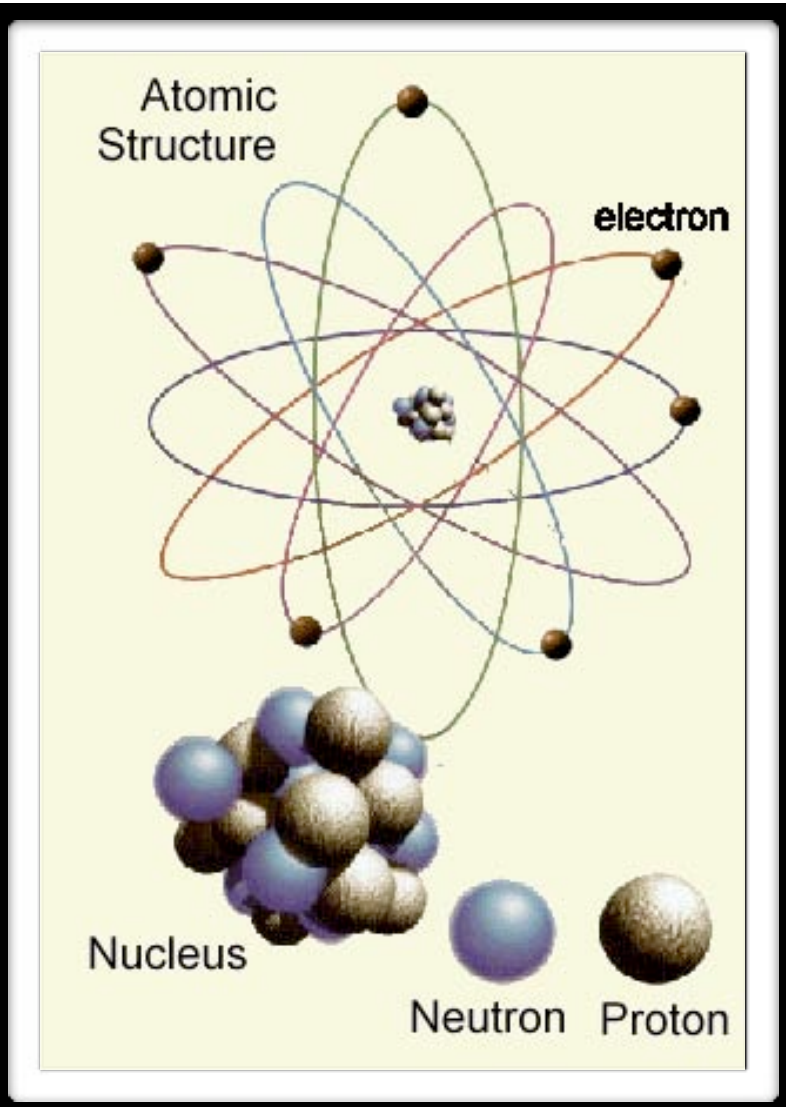


- In 1932, James Chadwick identify a particle in the nucleus that has the same mass as an proton but no charge.

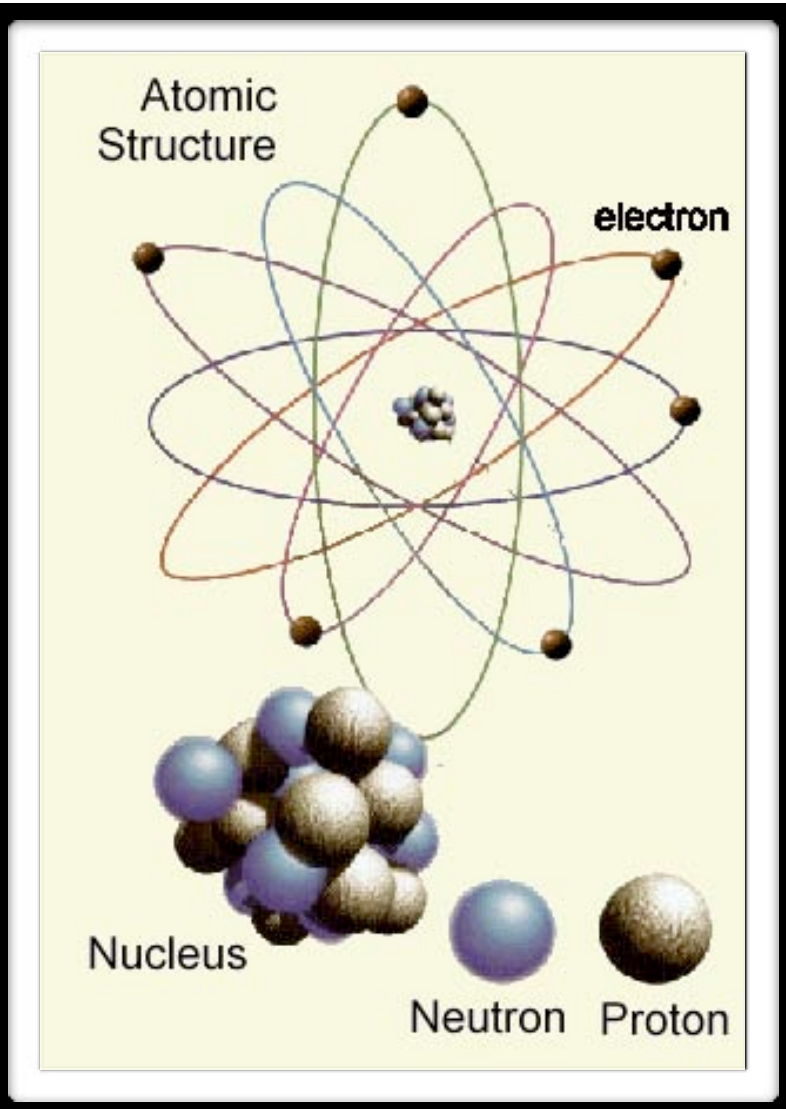


QUANTUM MECHANICS (modern theory)

Ideas about atomic structure continue to be modified. The three basic particles (protons, neutrons, electrons) may be further subdivided into over fifty other unstable particles, including quarks, leptons, antiparticles, gluons, and photons. However, the Rutherford–Bohr model of an atom adequately explains much of the behaviour of matter.



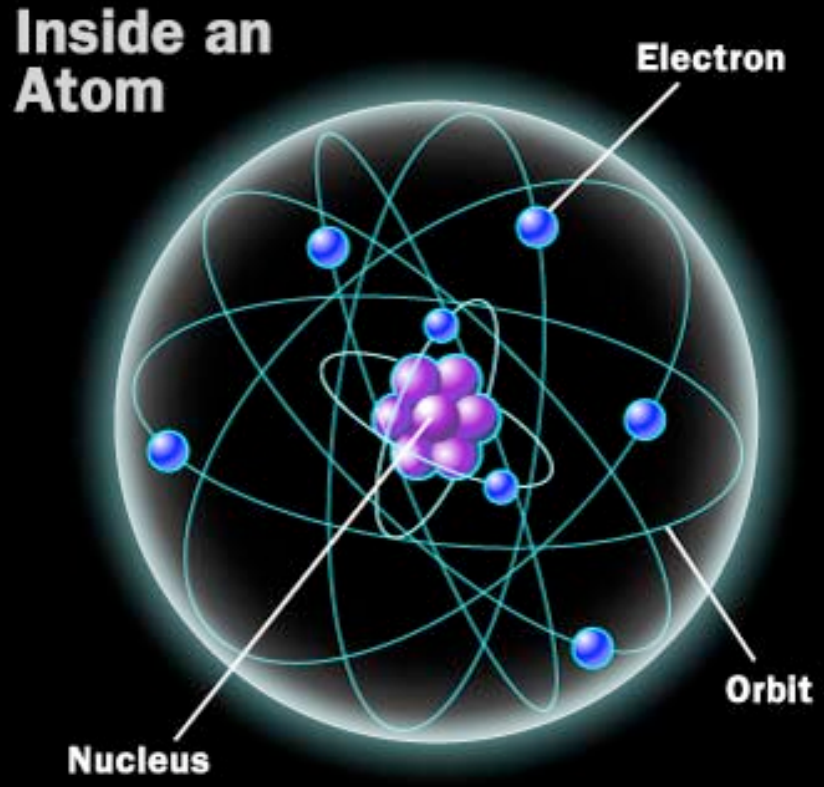
- This most common *layman* representation of an atom is derived from Rutherford & Bohr's model.



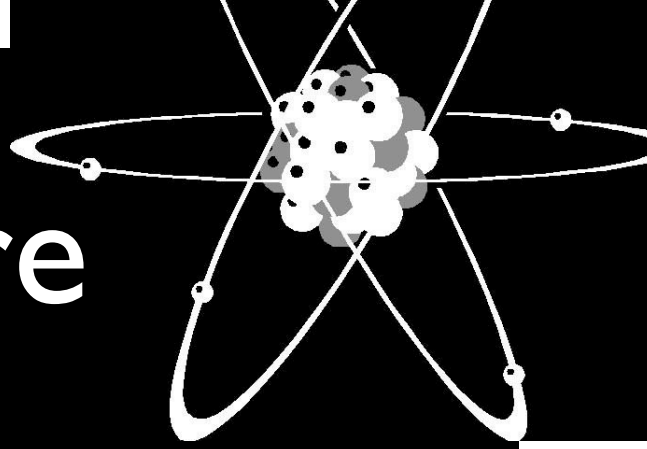
- HOWEVER, this model was eventually proven to be inaccurate later by Erwin Schrodinger and Werner Heisenburg who proposed the Electron Clouds Model. [To be covered later in IB years]

There you have it!

The ATOM.



We ‘found out’ about it...without even actually seeing it!



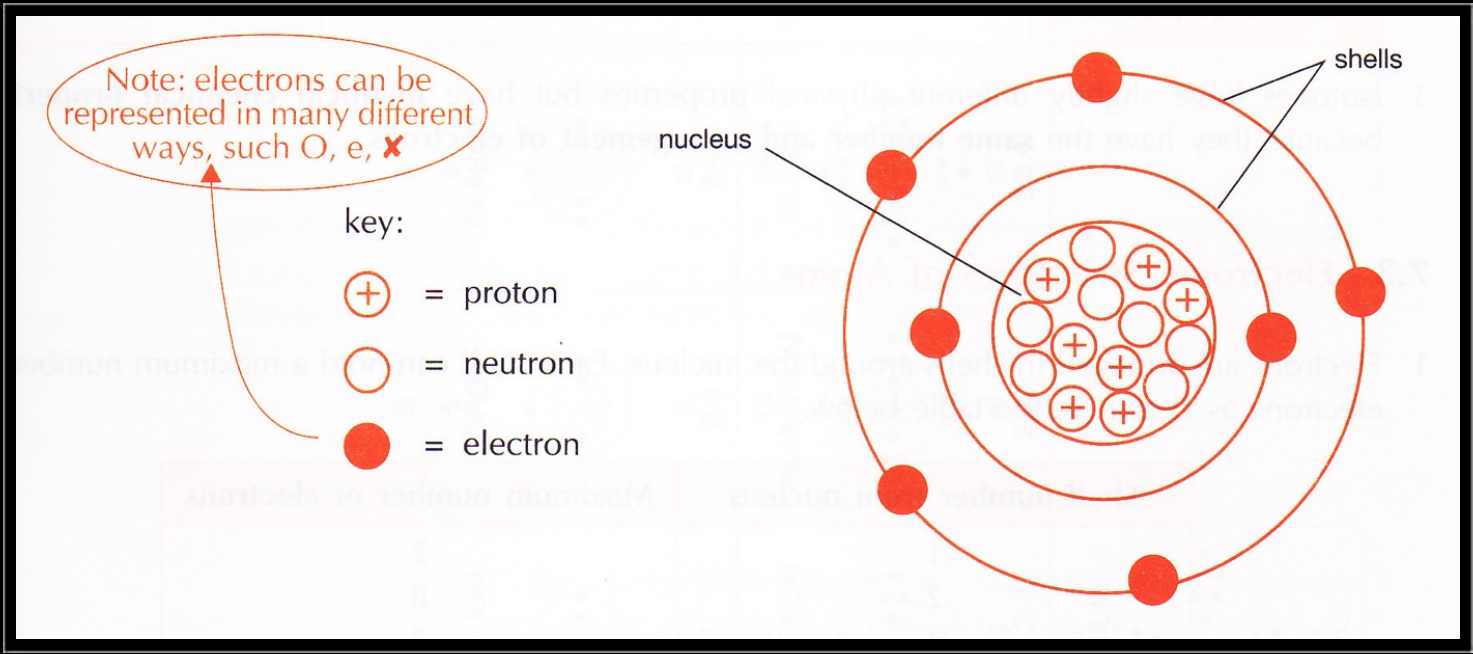
Atomic Structure

- In summary, atoms are currently believed to consist of three type of particles:

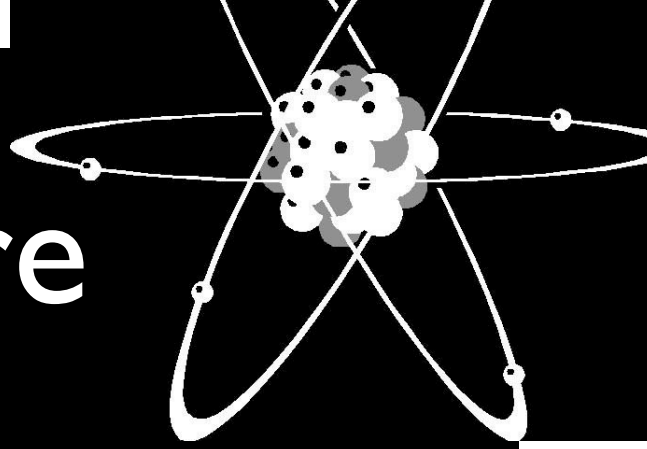
Name of particle	Relative mass	Relative charge
proton	1	+
neutron	1	-
electron	1/1836 of proton or neutron	0

Atomic Structure

- An atom consists of a nucleus surrounded by electrons in shells.
- The nucleus in turn contains protons and neutrons.

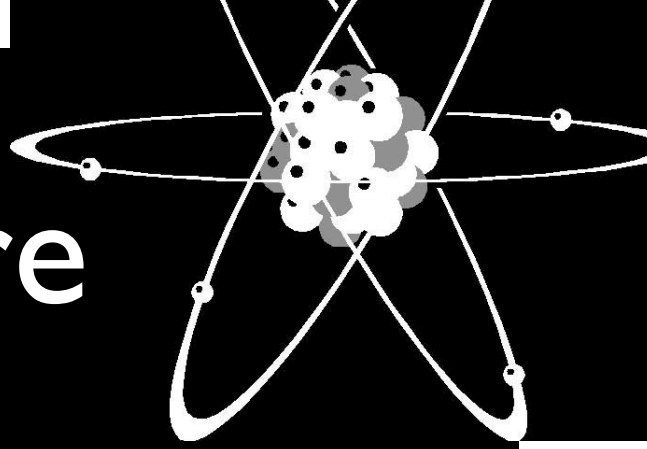


Atomic Structure



- The number of protons in an atom is called the proton numbers.
- Each element has a specific proton number.
- For any *neutral* atom, the number of electrons = the number of protons.
- The number of protons and neutrons in the nucleus of an atom gives the nucleon number or mass number.

Atomic Structure



- Elements are arranged in the Periodic Table according to the proton numbers and how the electrons are arranged.
- The diagram below shows some of the electron arrangement of some elements from the Periodic Table.
  Suggest how electrons are being arranged in atoms.

- Suggest how electrons are being arranged in atoms.