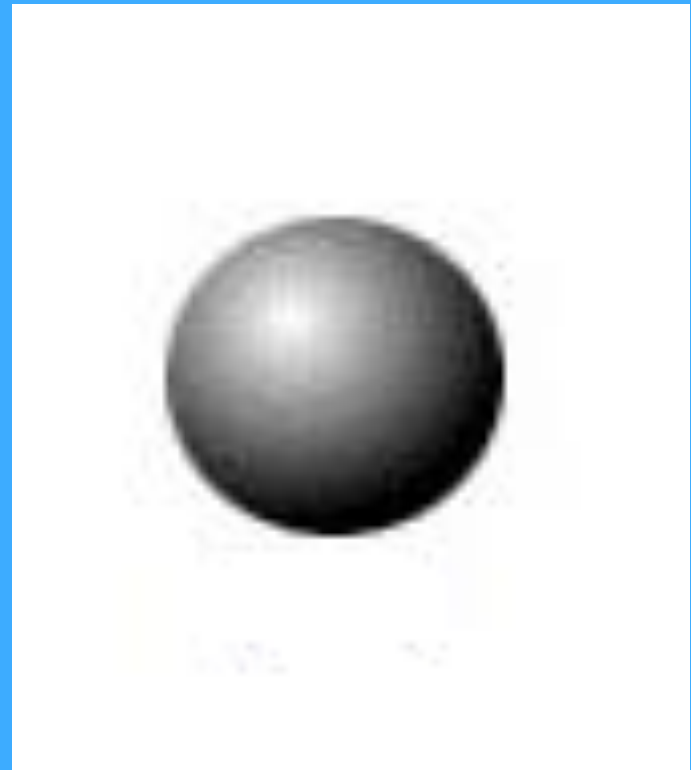
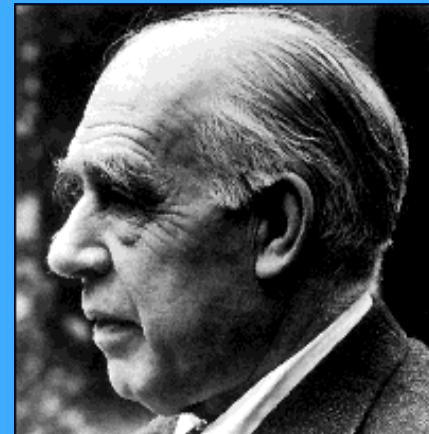
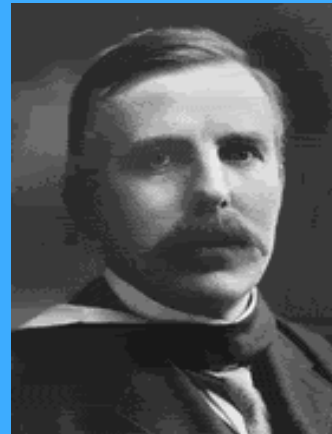
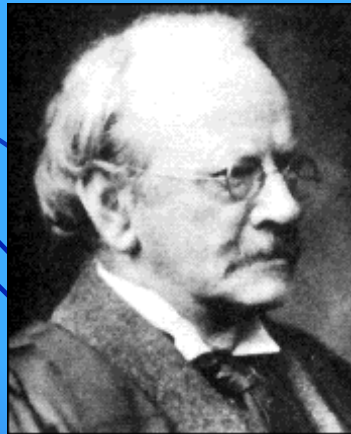
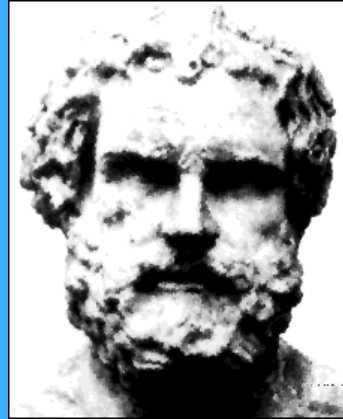


# Ch 4.1 – Early Theories of Matter: The Philosophers

- The atomic model has changed throughout the centuries, starting in 400 BC, when it looked like a billiard ball →



# Who are these men?

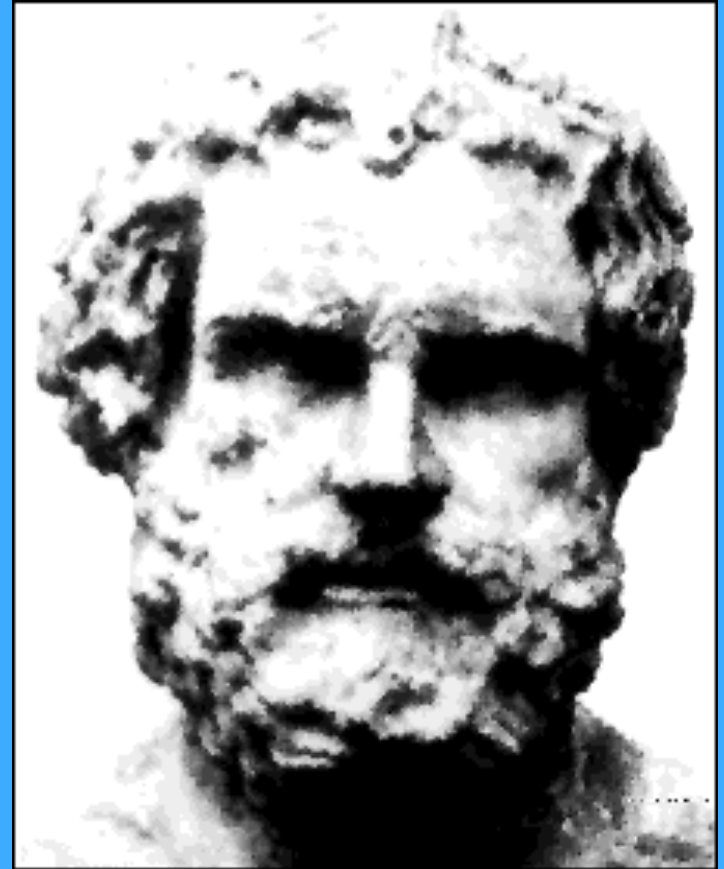




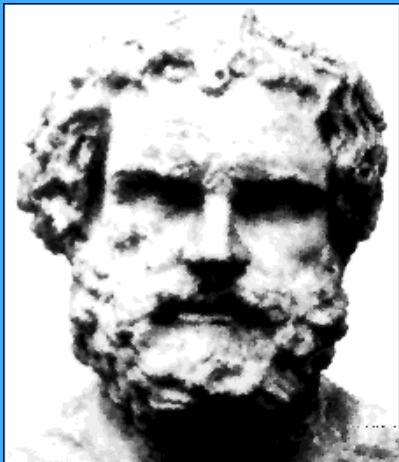
# Democritus

400 BC

- This is the Greek philosopher Democritus who began the search for a description of matter more than 2400 years ago.

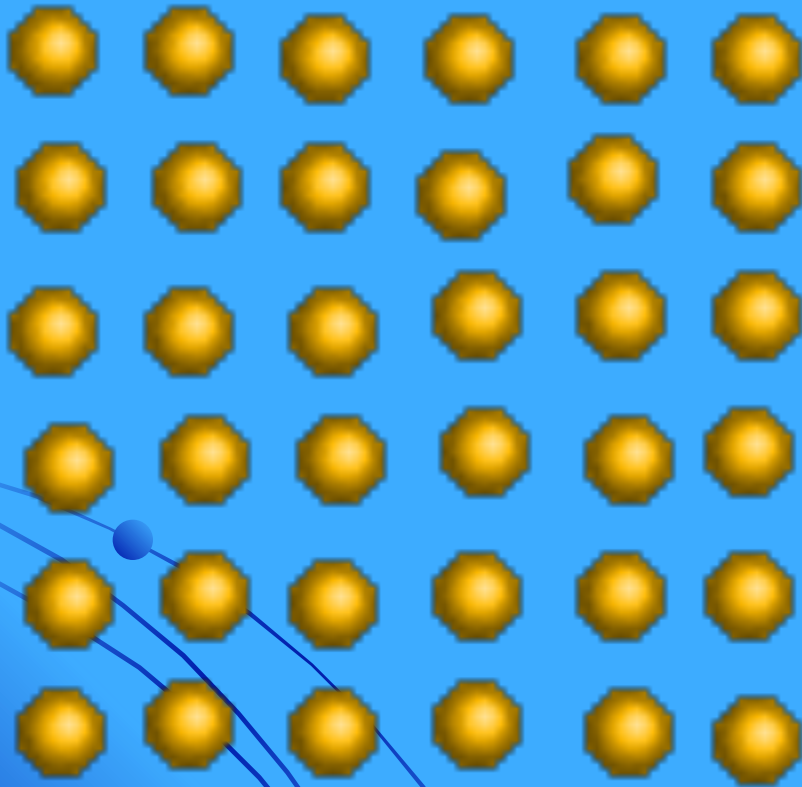


# Atomos



- His theory: Matter could not be divided into smaller and smaller pieces forever, eventually the smallest possible piece would be obtained.
- This piece would be indivisible.
- He named the smallest piece of matter “atomos,” meaning “not to be cut.”

# Atomos



- To Democritus, atoms were small, hard particles that were all made of the same material but were different shapes and sizes.
- Atoms were infinite in number, always moving and capable of joining together.

# Why?

- Most influential philosopher, Aristotle rejected Democritus' atom theory b/c different from his ideas
- Criticized Democritus' idea that atoms moved through empty space
- Aristotle was wrong in the end.



Aristotle favored the earth, fire, air and water approach to the nature of matter.

# Dalton's Model

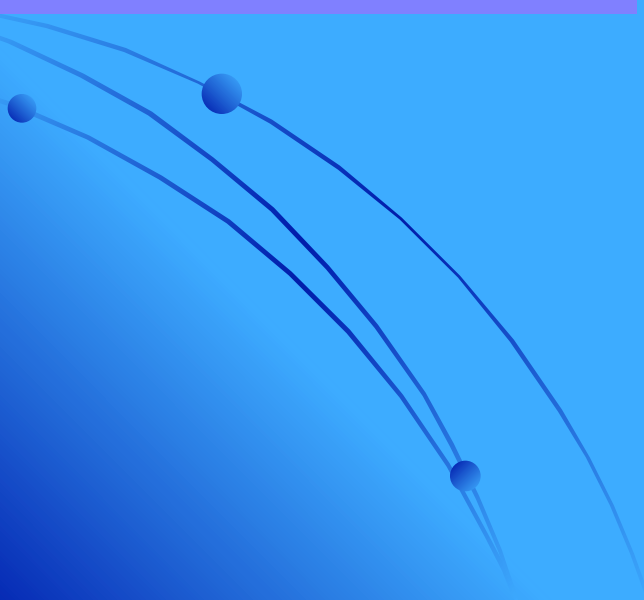
- John Dalton (1766-1844)
- performed a number of experiments
- led to the acceptance of the idea of atoms.



# Dalton's Atomic Theory (1803)



- All elements are composed of indivisible and indestructible particles called atoms.
- Atoms of the same element are exactly alike.
- Atoms of different elements are different.
- Compounds are formed by the joining of atoms of two or more elements.



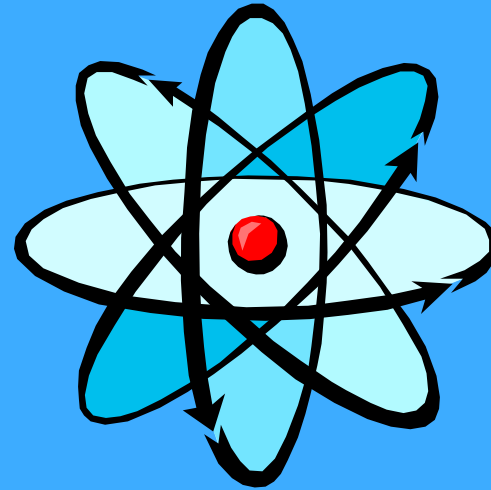


# John Dalton(cont.)

- Dalton's atomic theory (1803) was a breakthrough in our understanding of matter.
- Was all of Dalton's theory accurate?
  - No!!! Dalton was wrong about:
    - atoms being indivisible
    - all atoms of an element having identical properties.
  - Atoms are divisible into subatomic particles
  - Atoms of an element may have different masses.

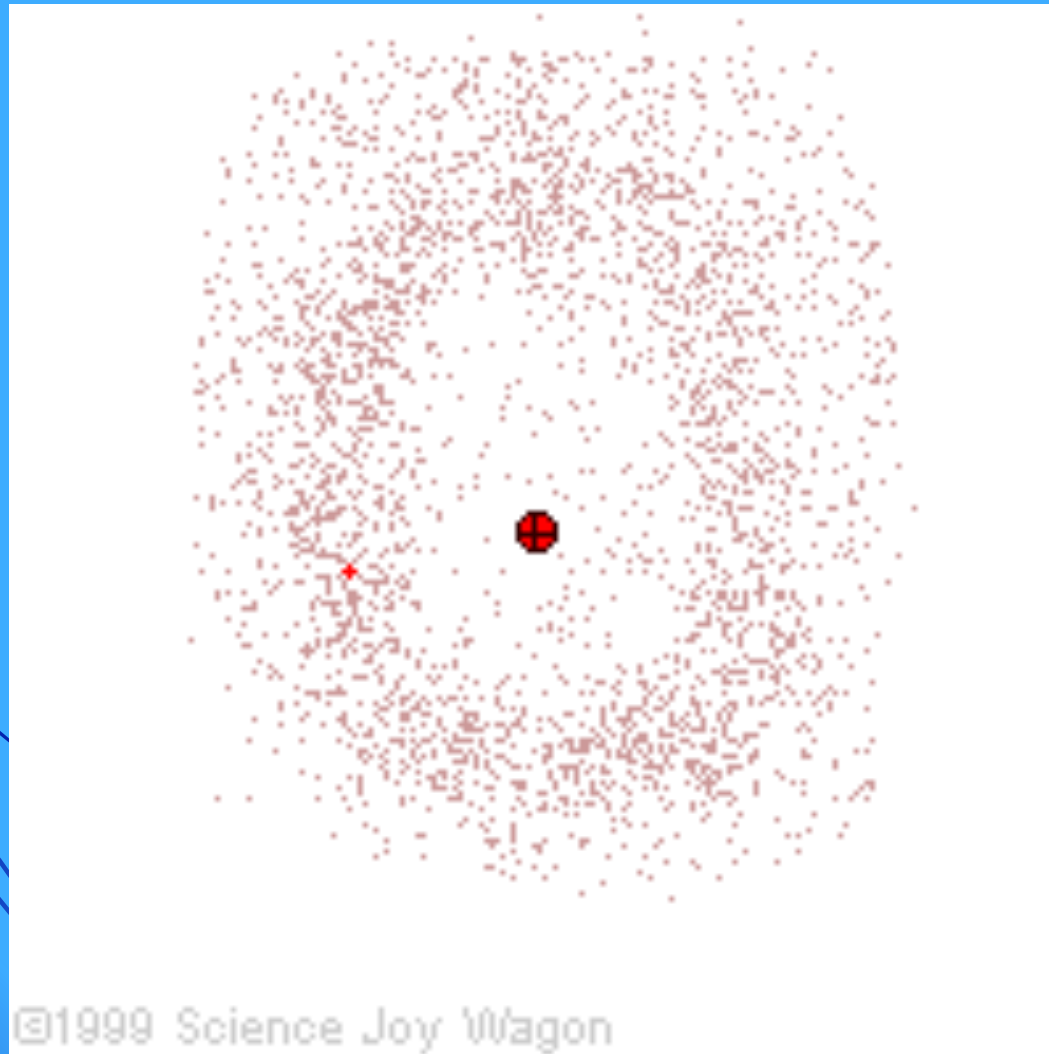
- The atom is made up of three subatomic particles.

- 1. electron
- 2. proton
- 3. neutron



**Atom** - The smallest particle of an element that retains the properties of the element.

# Review Notes 4.2



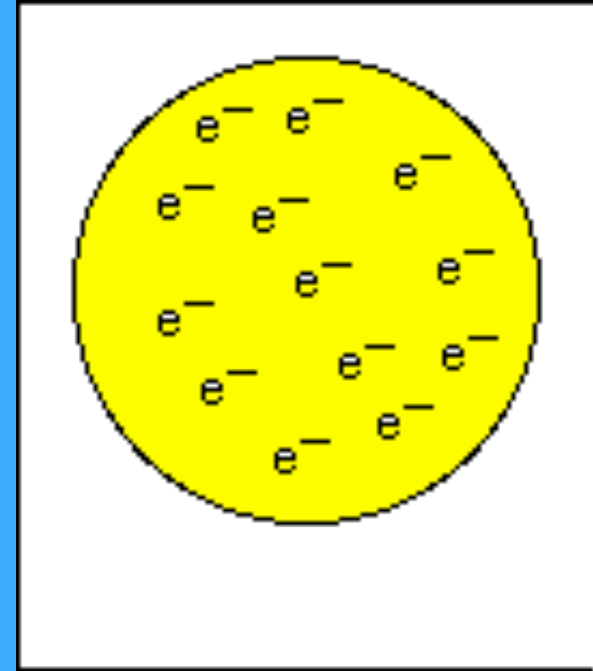
# Thomson's Plum Pudding Model




- 1897
- English scientist **J.J. Thomson**
- atom is made of smaller particles.

# Thomson Model

- “Plum Pudding” model.
  - Atoms were made from a positively charged substance.
  - Atoms contained negatively charged electrons scattered.
  - *Like raisins in a pudding.*

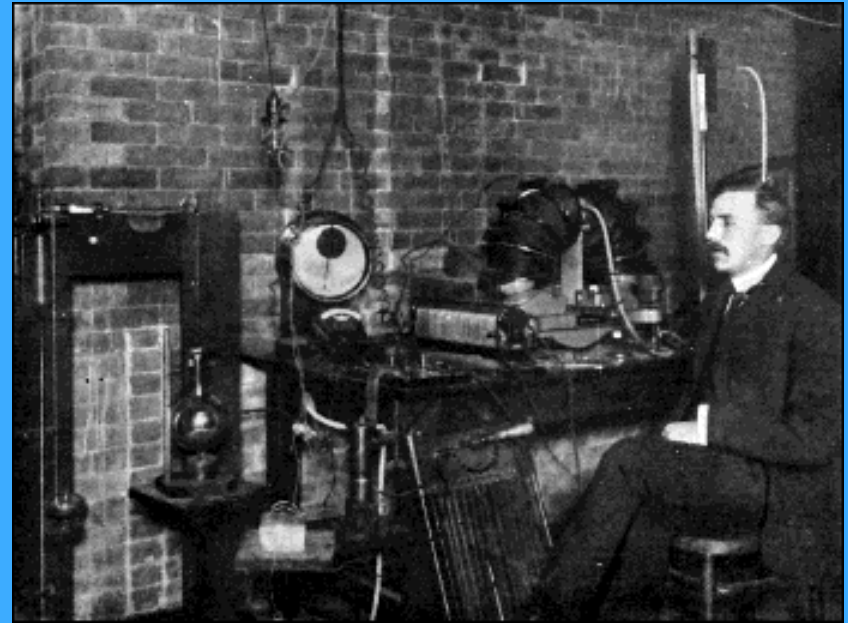


# Discovering the electron

- Robert Millikan (1909)
    - Found the charge of an electron
    - Electron carries the charge of 1-
    - He calculated the mass of an electron:
      - Mass of electron =  $9.1 \times 10^{-28}$  g
      - 1/1840 mass of proton
- 

# Rutherford's Gold Foil Experiment

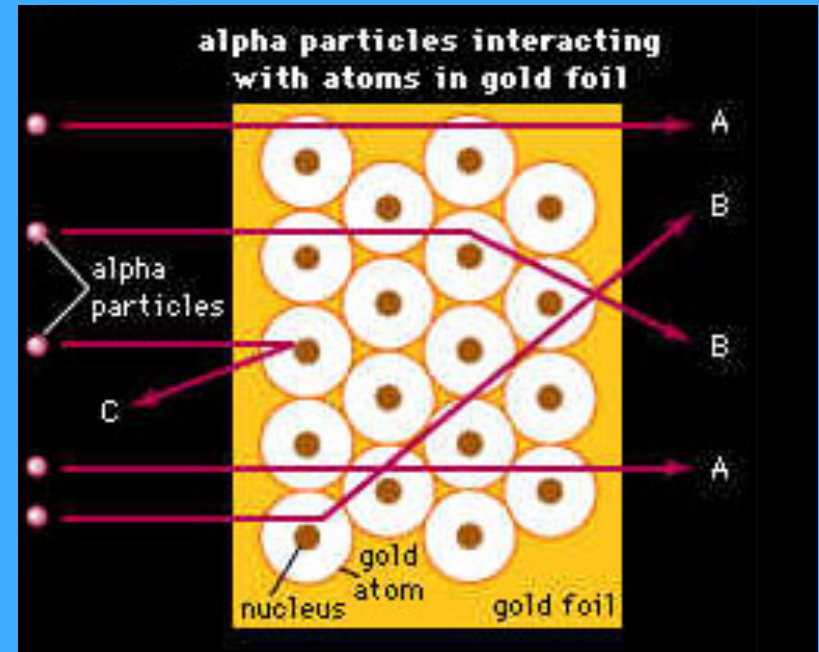
- 1908
- Ernest Rutherford
- Researching atomic structure.



Fired tiny positively charged particles at a thin sheet of gold foil (2000 atoms thick).

# Rutherford's experiment

- Most of the positive particles passed right through the gold foil.
- Some of the positively charged particles bounced away from the gold sheet as if they had hit something solid.
- He knew that positive charges repel positive charges.

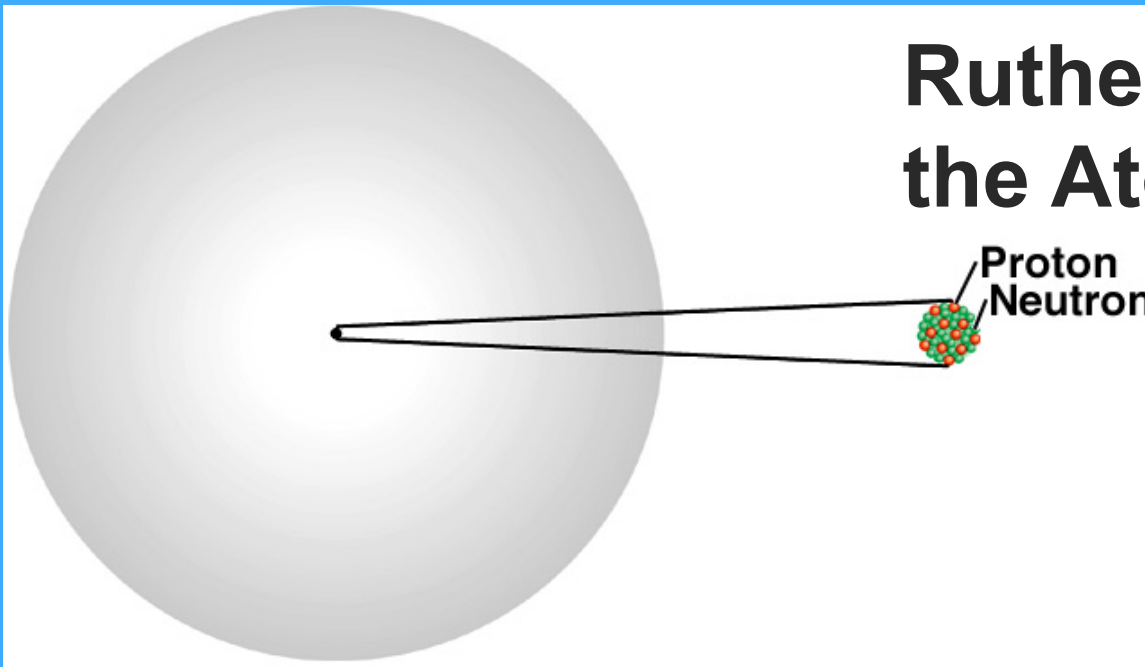




# Rutherford's Gold Foil Experiment

- Rutherford concluded
  - Atoms consist of mostly empty space through which electrons move. (not a pudding model)
  - Atoms have a tiny, dense, positively charged center called **nucleus**
- The nucleus (protons and neutrons) is 99.97% of an atom's mass.
- The electron cloud = majority of volume
  - Table 4.1 – p. 97

# Rutherford's Model of the Atom

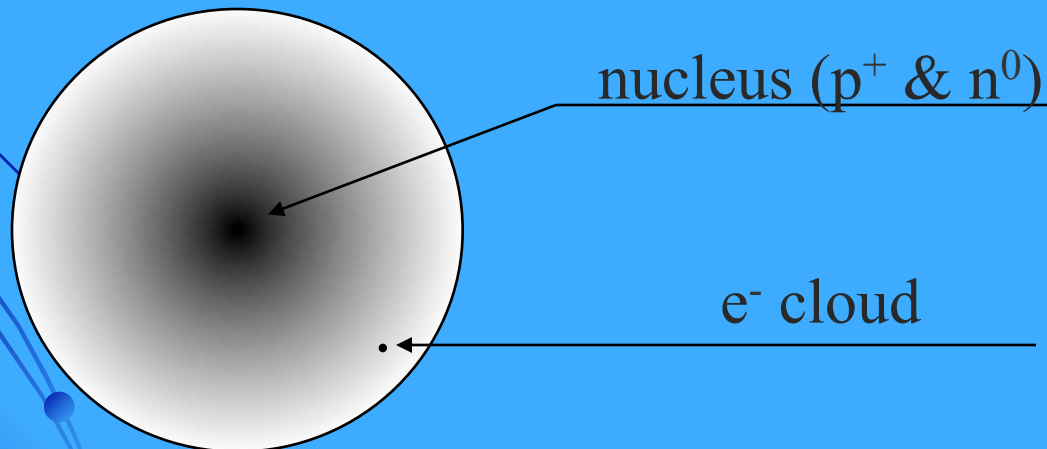


If the atom is the  
Houston Astrodome  
Then the nucleus is a marble  
on the 50 yard line!!

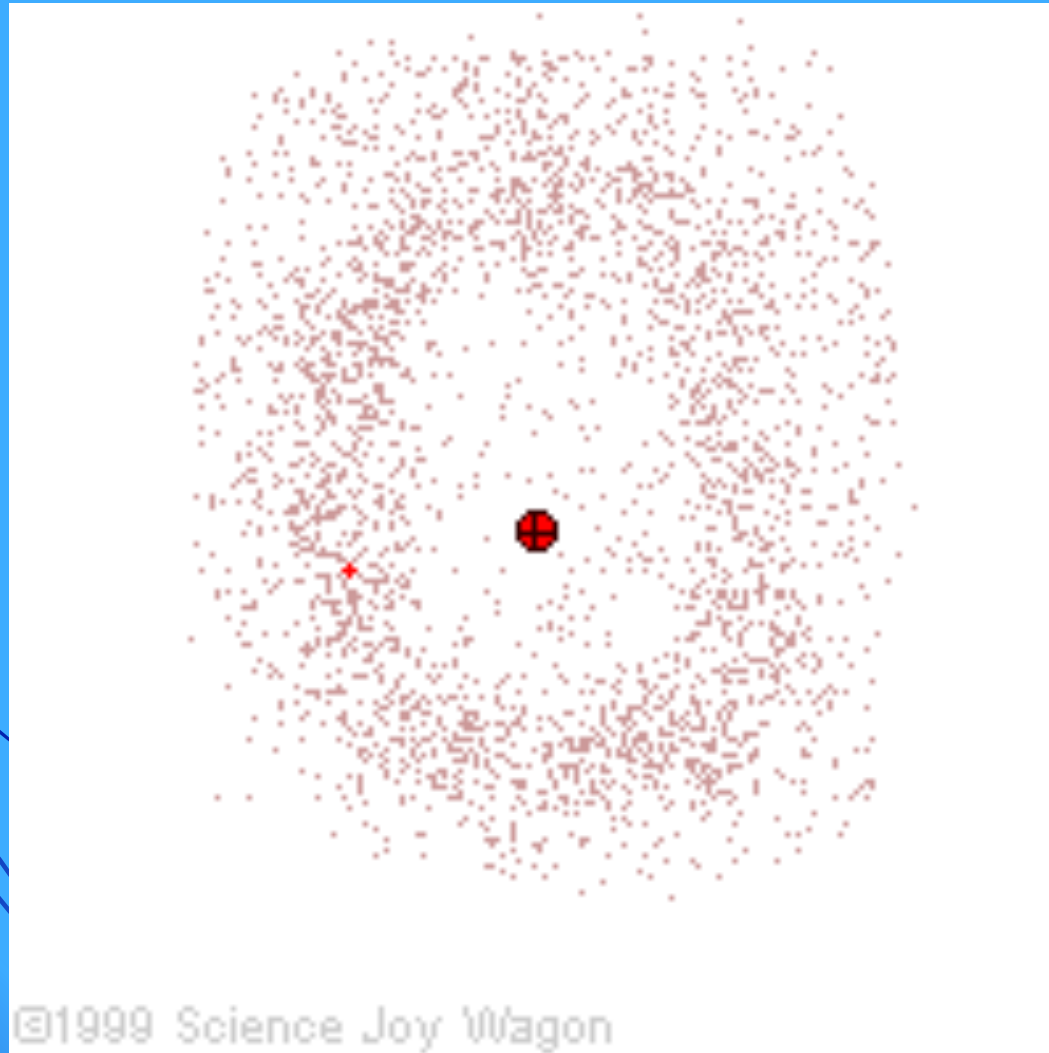


# Nuclear Atomic Structure

- Rutherford reasoned:
  - All of an atom's positively charged particles were contained in the nucleus.
  - The negatively charged particles were scattered outside the nucleus around the atom's edge.

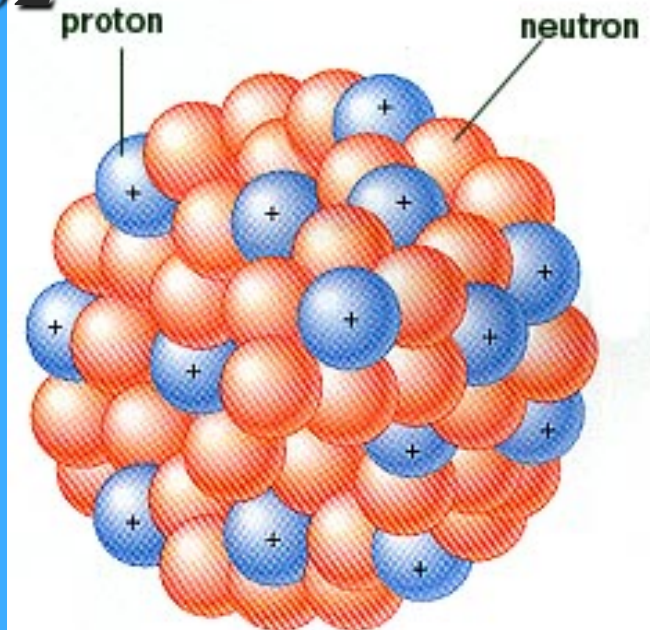


# Review Notes 4.2 (pt.2)



# Discovering Proton and Neutron

- Proton was discovered in 1886
  - by E. Goldstein.
- Neutron was discovered in 1932
  - by James Chadwick.
- **Neutron mass = Proton mass**
  - See table p. 97



## Rutherford's Conclusions about the Nucleus

- (1) Most of the atom is more or less empty space.
- (2) The nucleus is very tiny.
- (3) The nucleus is very dense.
- (4) The nucleus is positively charged.

- Rutherford's model:
  - Explained why the atom is neutral
  - The positive balances out the negative
- So, why do electrons stay surrounded around the nucleus?

**“Opposites attract”**

## Timeline of Atomic Theory

**Greek Model**  
400 BC  
**Democritus**

(Aristotle's 4 Elements)

**Crooke**  
1890's

**Rutherford Model**  
1911

**Chadwick**  
1932

**Wave Model**  
Modern

**Goldstein**  
1886

**Millikan**  
1909

**Dalton Model**  
1803

**Bohr Model**  
1922

**Thomson Model**  
1897

