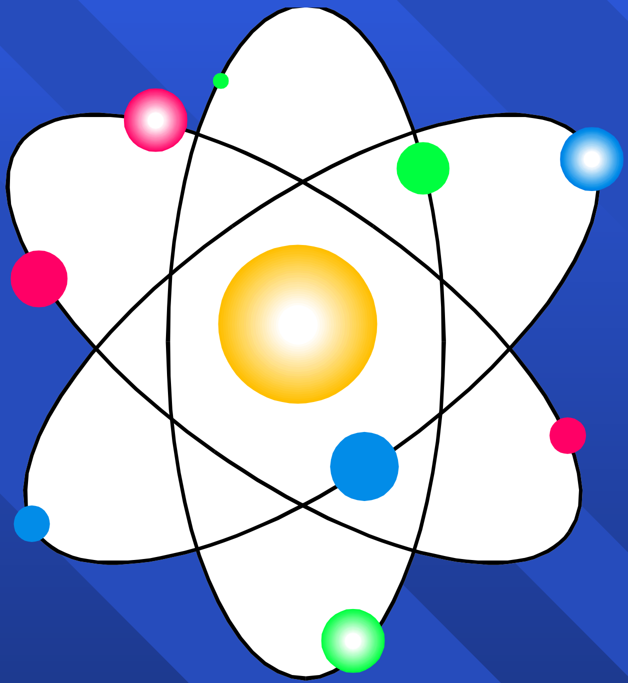
Chapter 4



Atoms and their structure

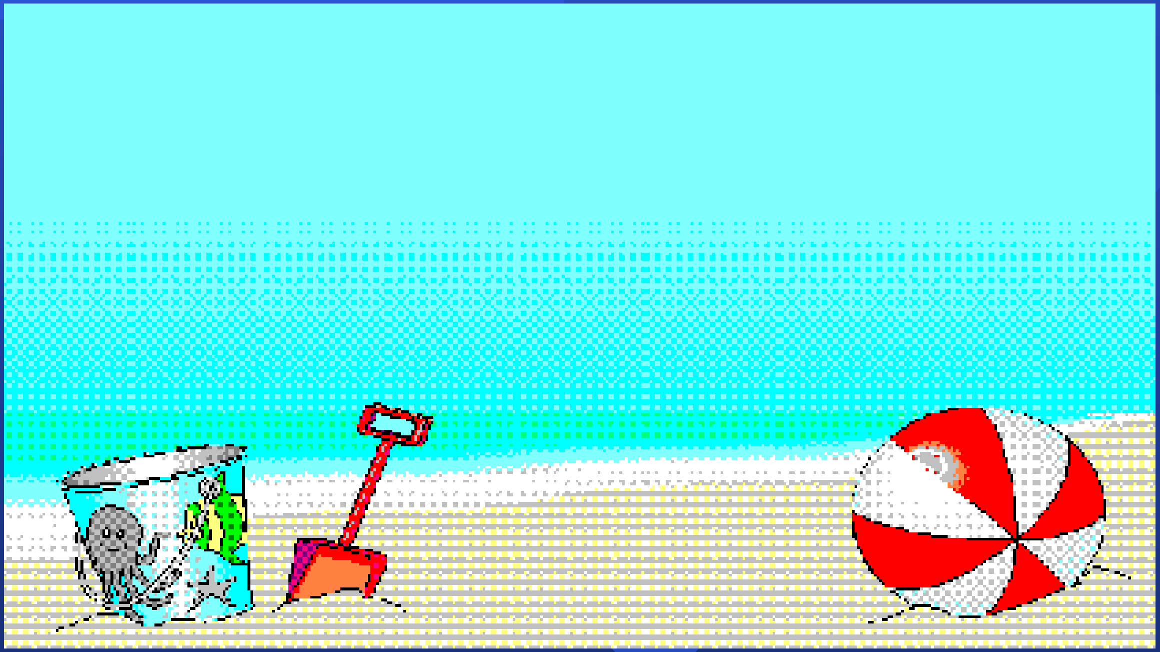
History of the atom

- Not the history of atom, but the idea of the atom.
- Original idea Ancient Greece (400 B.C.)
- Democritus and Leucippus- Greek philosophers.

History of Atom

- Looked at beach
- Made of sand
- Cut sand - smaller sand

- Smallest possible piece?
- Atomos - not to be cut



Another Greek

- Aristotle - Famous philosopher
- All substances are made of 4 elements
- Fire - Hot
- Air - light
- Earth - cool, heavy
- Water - wet
- Blend these in different proportions to get all substances

Who Was Right?

- Did not experiment.
- Greeks settled disagreements by argument.
- Aristotle was a better debater - He won.
- His ideas carried through middle ages.
- Alchemists tried to change lead to gold.

Who's Next?

- Late 1700's - John Dalton- England.
- Teacher- summarized results of his experiments and those of others.
- Elements substances that can't be broken down
- In Dalton's Atomic Theory
- Combined idea of elements with that of atoms.

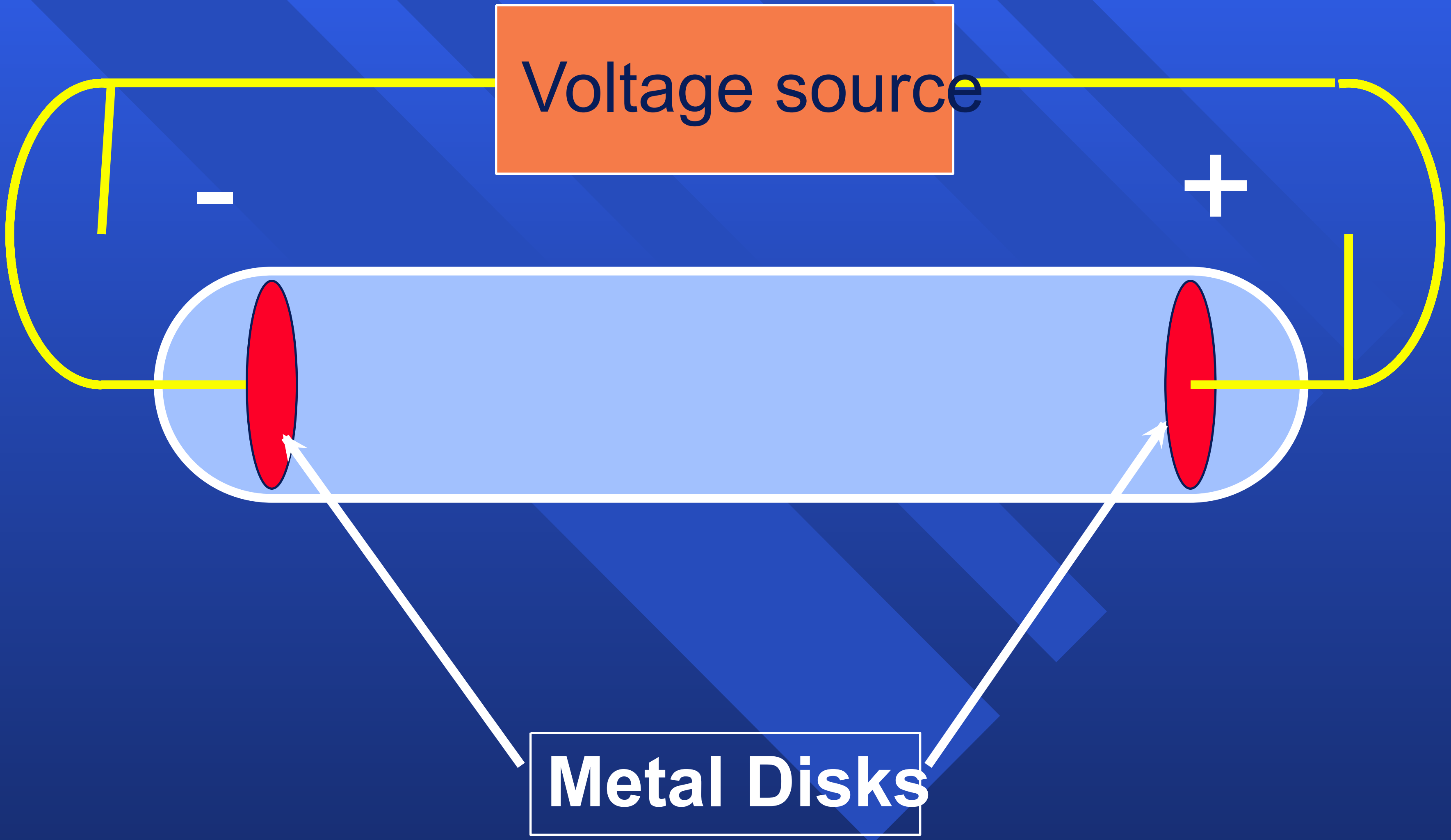
Dalton's Atomic Theory

1. All matter is made of tiny indivisible particles called atoms.
2. Atoms of the same element are identical, those of different atoms are different.
3. Atoms of different elements combine in whole number ratios to form compounds.
4. Chemical reactions involve the rearrangement of atoms. No new atoms are created or destroyed.

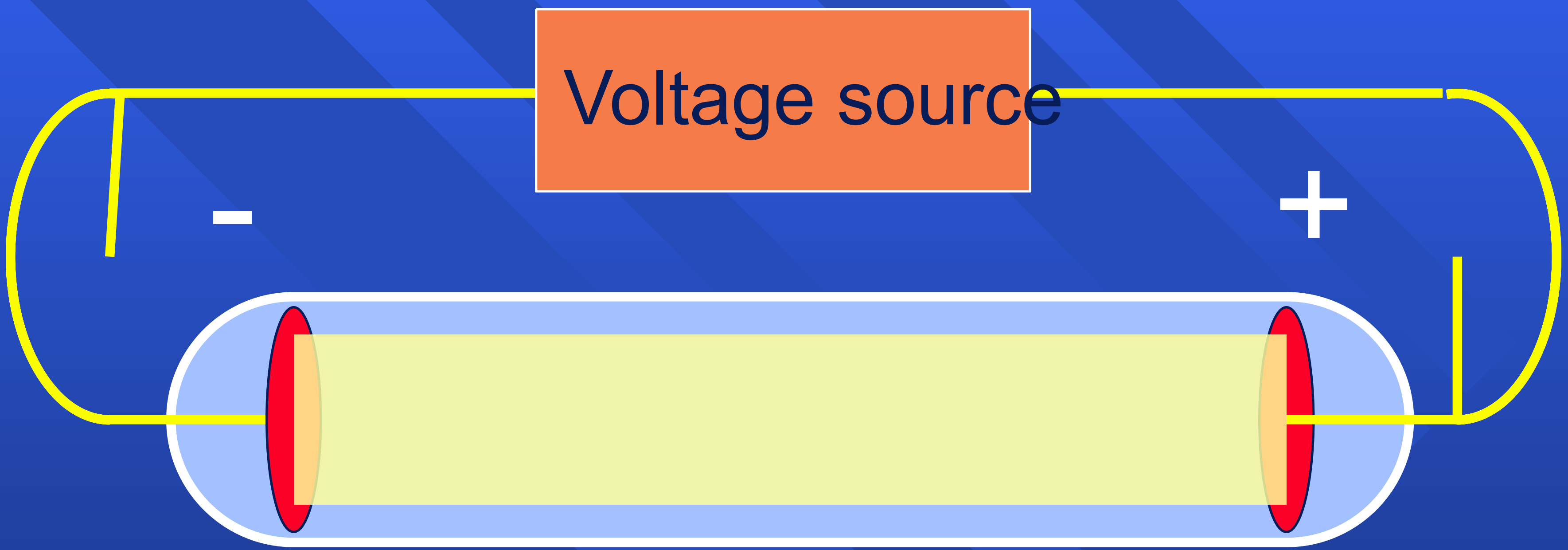
Parts of Atoms

- J. J. Thomson - English physicist. 1897
- Made a piece of equipment called a cathode ray tube.
- It is a vacuum tube - all the air has been pumped out.
- A limited amount of other gases are put in

Thomson's Experiment

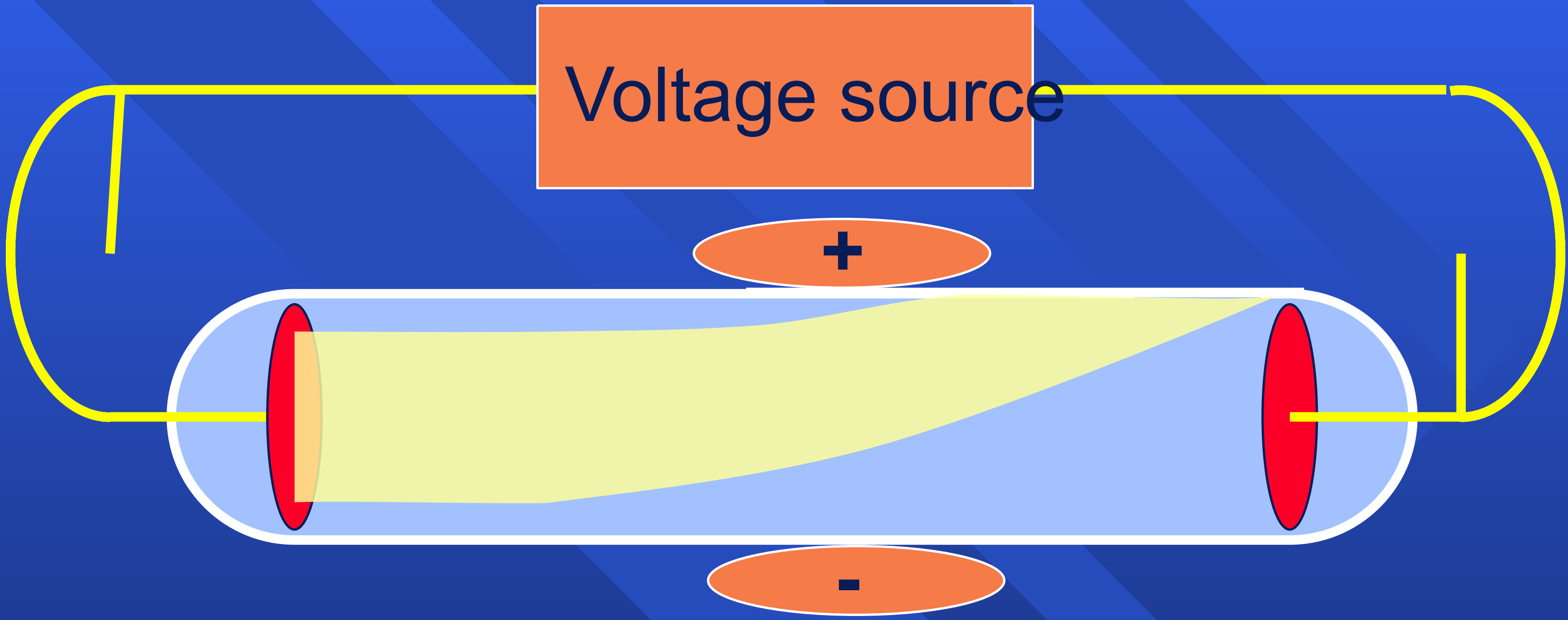


Thomson's Experiment



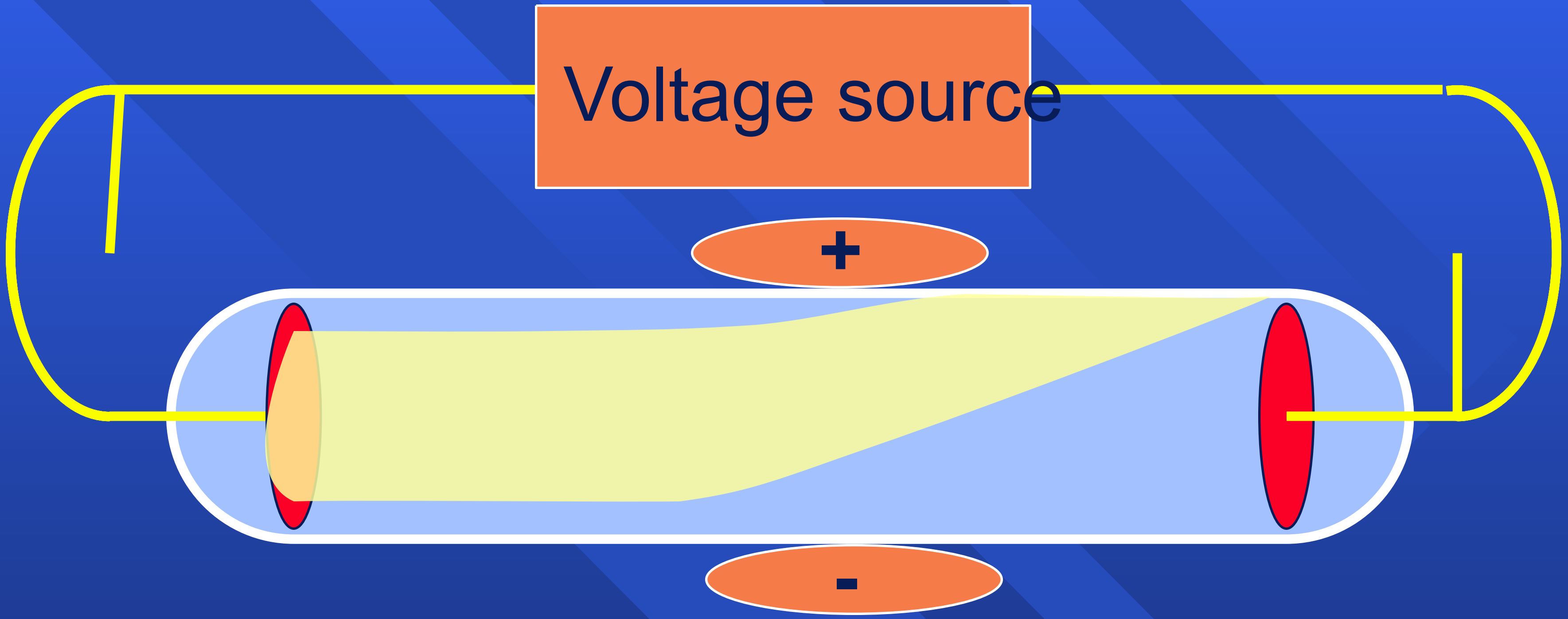
- Passing an electric current makes a beam appear to move from the negative to the positive end

Thomson's Experiment



- By adding an electric field

Thomson's Experiment



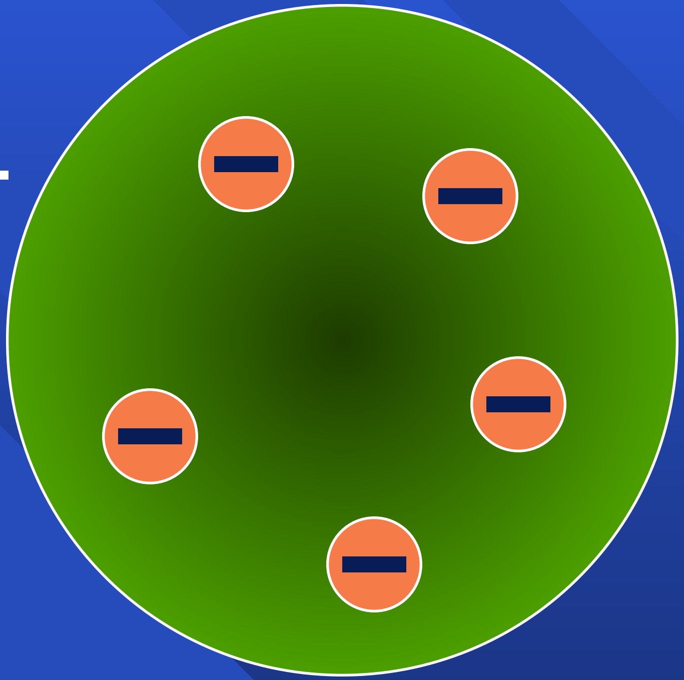
- By adding an electric field he found that the moving pieces were negative

Thomson's Experiment

- Used many different metals and gases
- Beam was always the same
- By the amount it bent he could find the ratio of charge to mass
- Was the same with every material
- Same type of piece in every kind of atom

Thomsom's Model

- Found the electron.
- Couldn't find positive (for a while).
- Said the atom was like plum pudding.
- A bunch of positive stuff, with the electrons able to be removed.

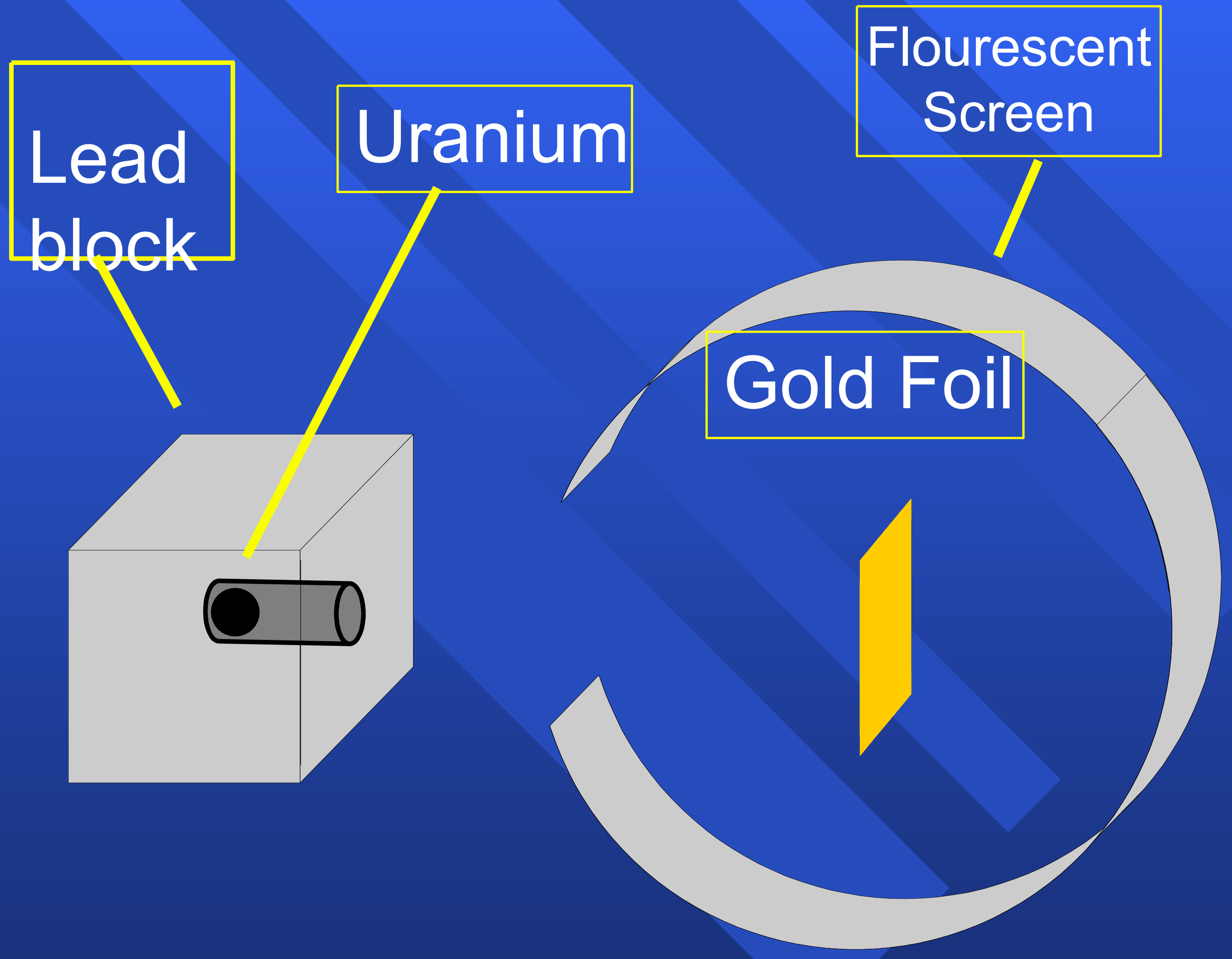


Rutherford's Experiment

- Ernest Rutherford English physicist. (1910)
- Believed the plum pudding model of the atom was correct.
- Wanted to see how big atoms are.
- Used radioactivity.
- Alpha particles - positively charged pieces given off by uranium.
- Shot them at gold foil which can be made a few atoms thick.

Rutherford’s experiment

- When the alpha particles hit a florescent screen, it glows.
- Here’s what it looked like (pg 104)

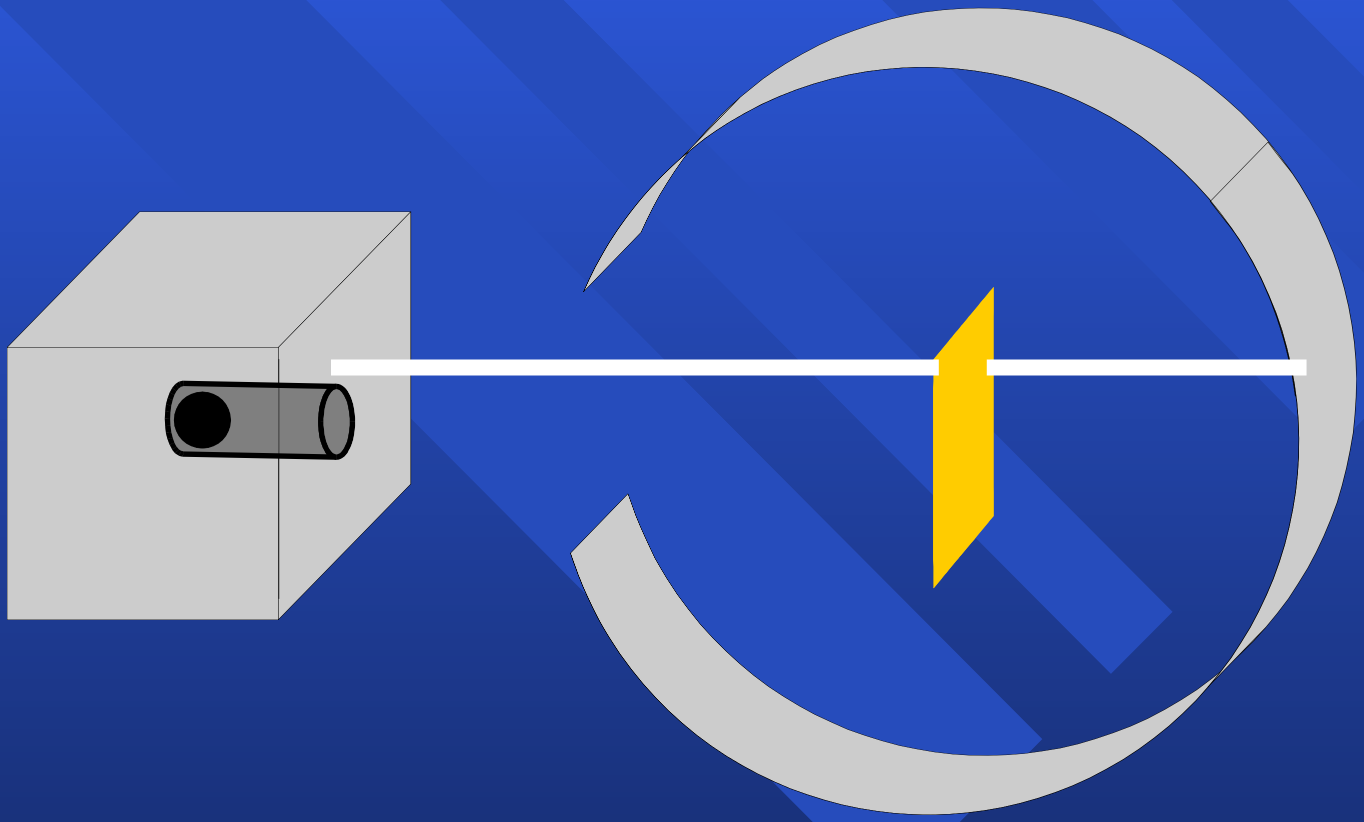


Lead block
Uranium
Flourescent Screen
Gold Foil

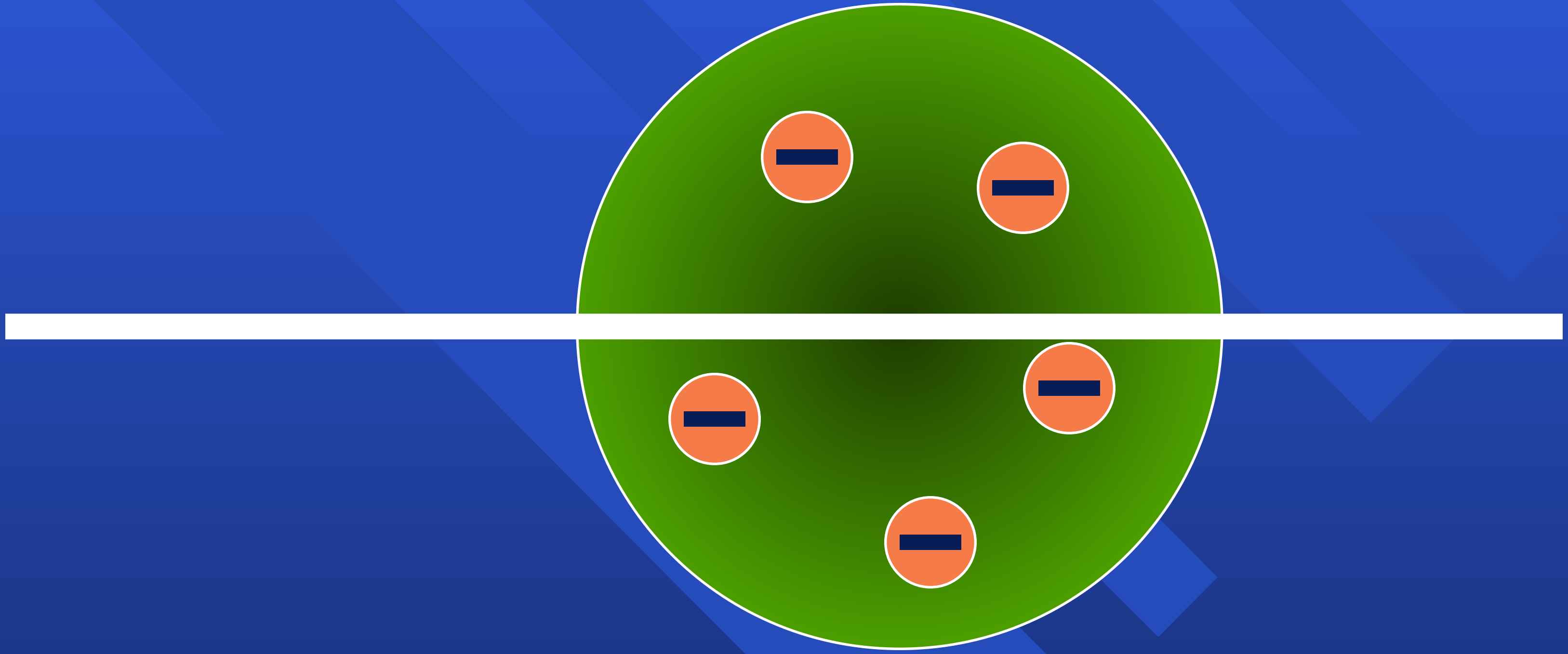
He Expected

- The alpha particles to pass through without changing direction very much.
- Because…
- The positive charges were spread out evenly. Alone they were not enough to stop the alpha particles.

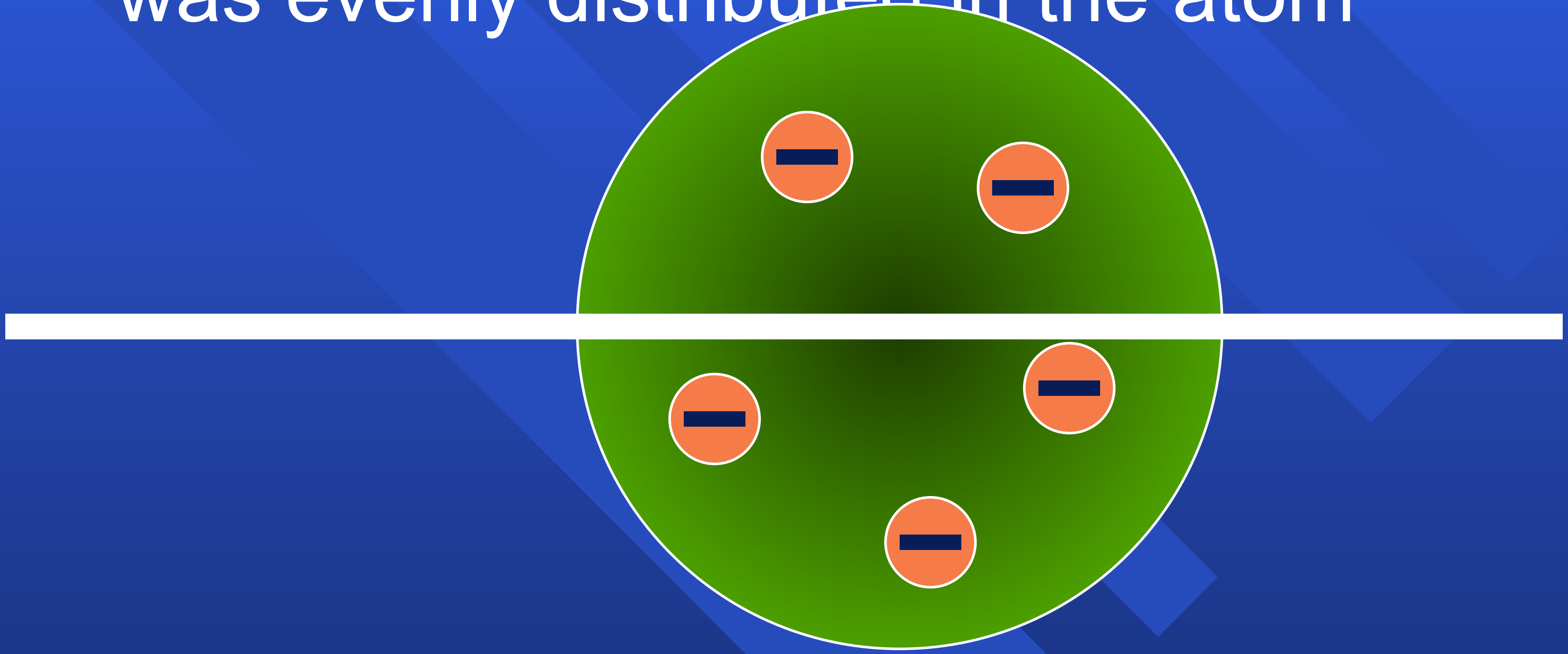
What he expected



Because



Because, he thought the mass was evenly distributed in the atom



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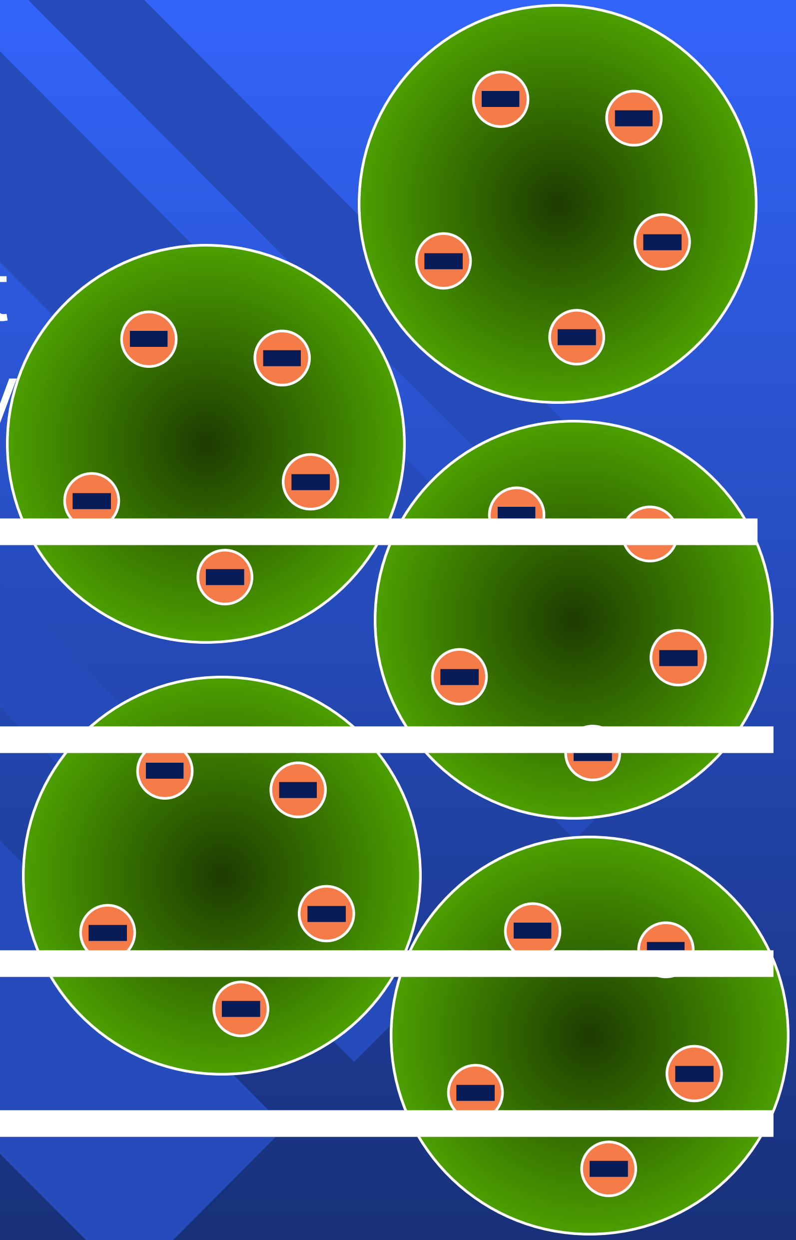
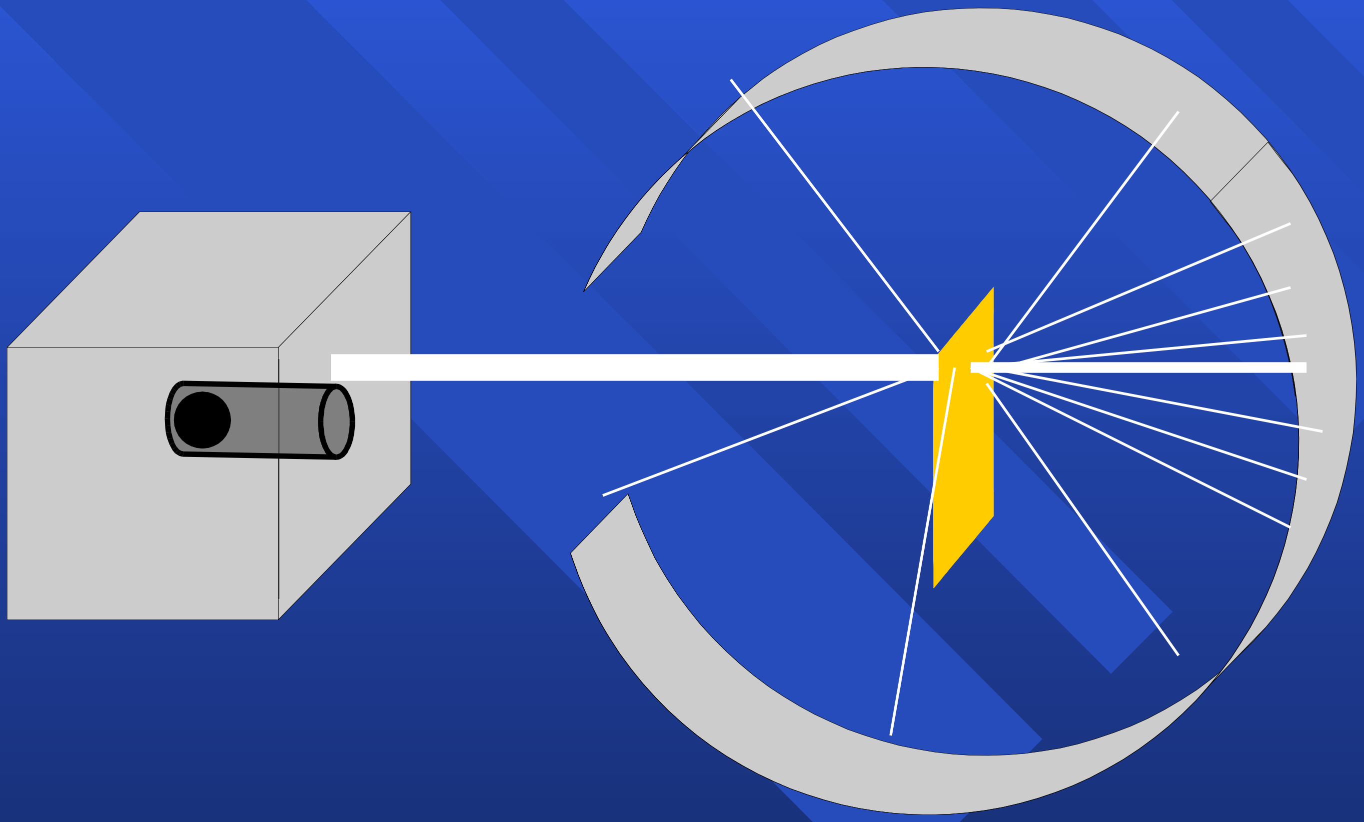
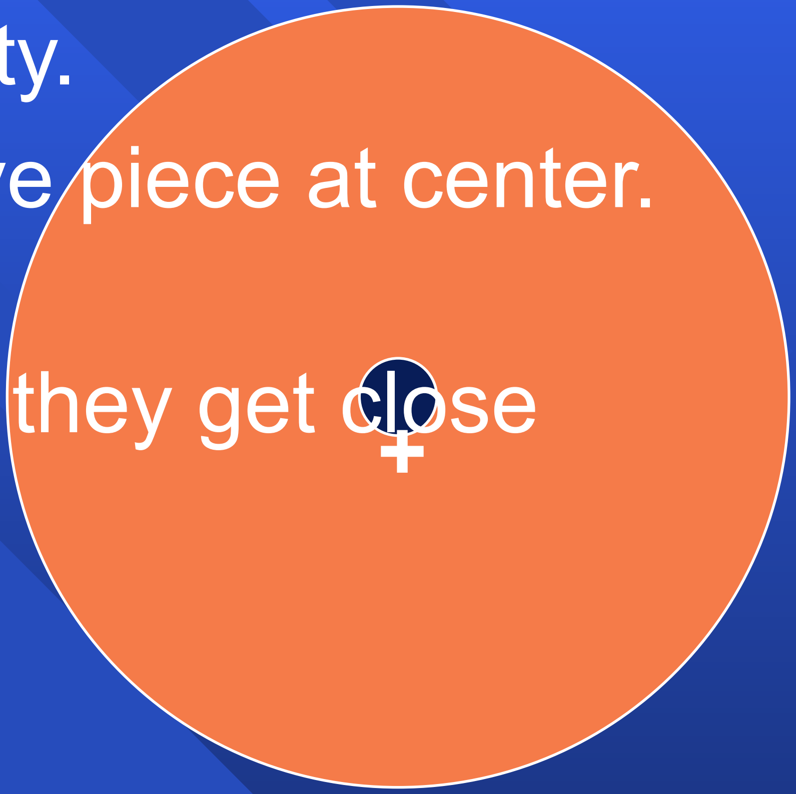


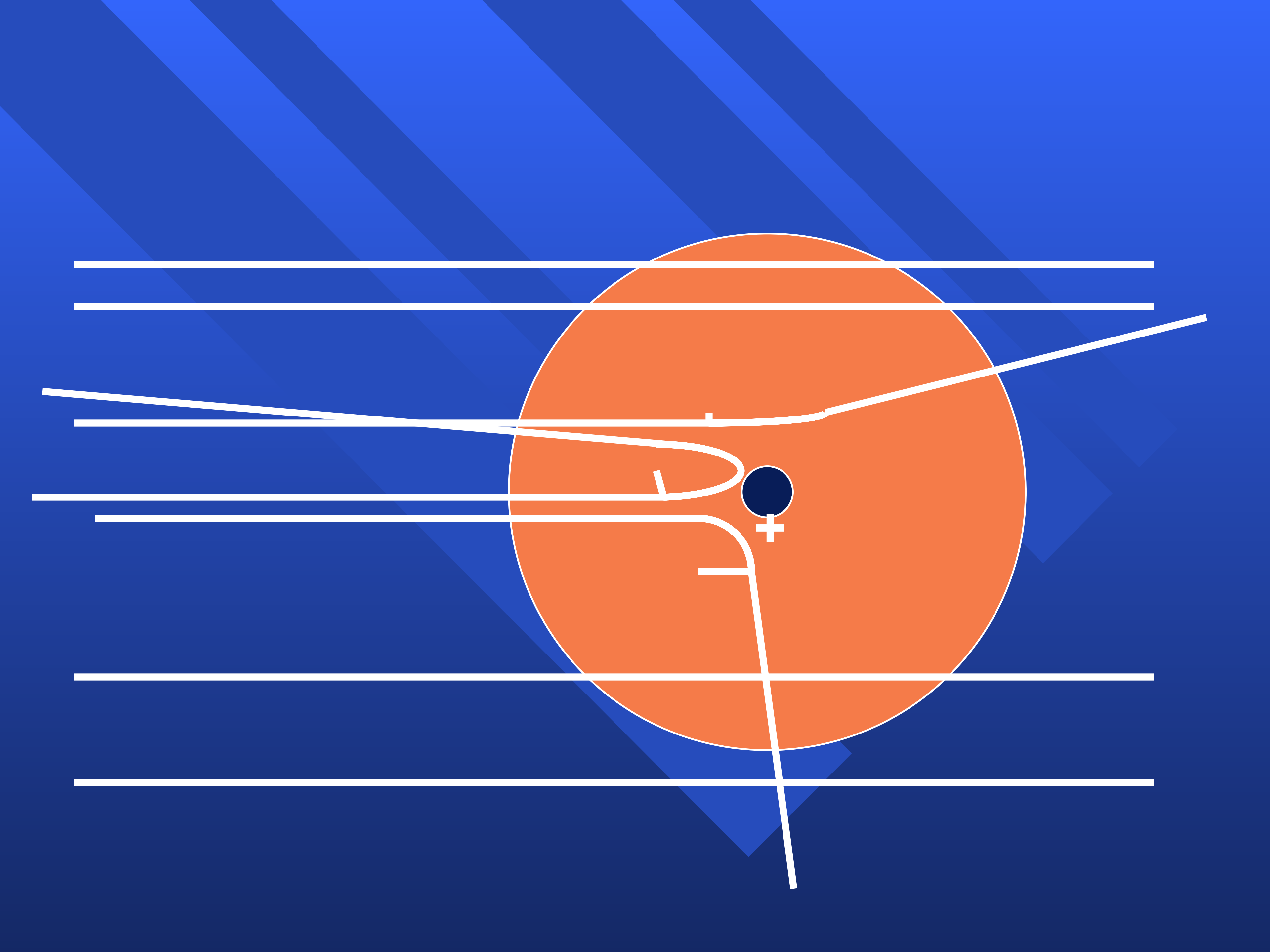
What he got



How he explained it

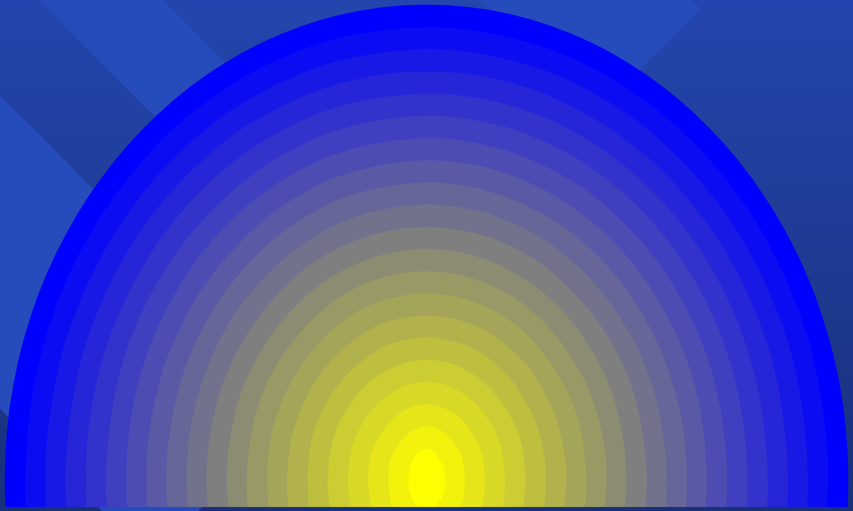
- Atom is mostly empty.
- Small dense, positive piece at center.
- Alpha particles are deflected by it if they get close enough.

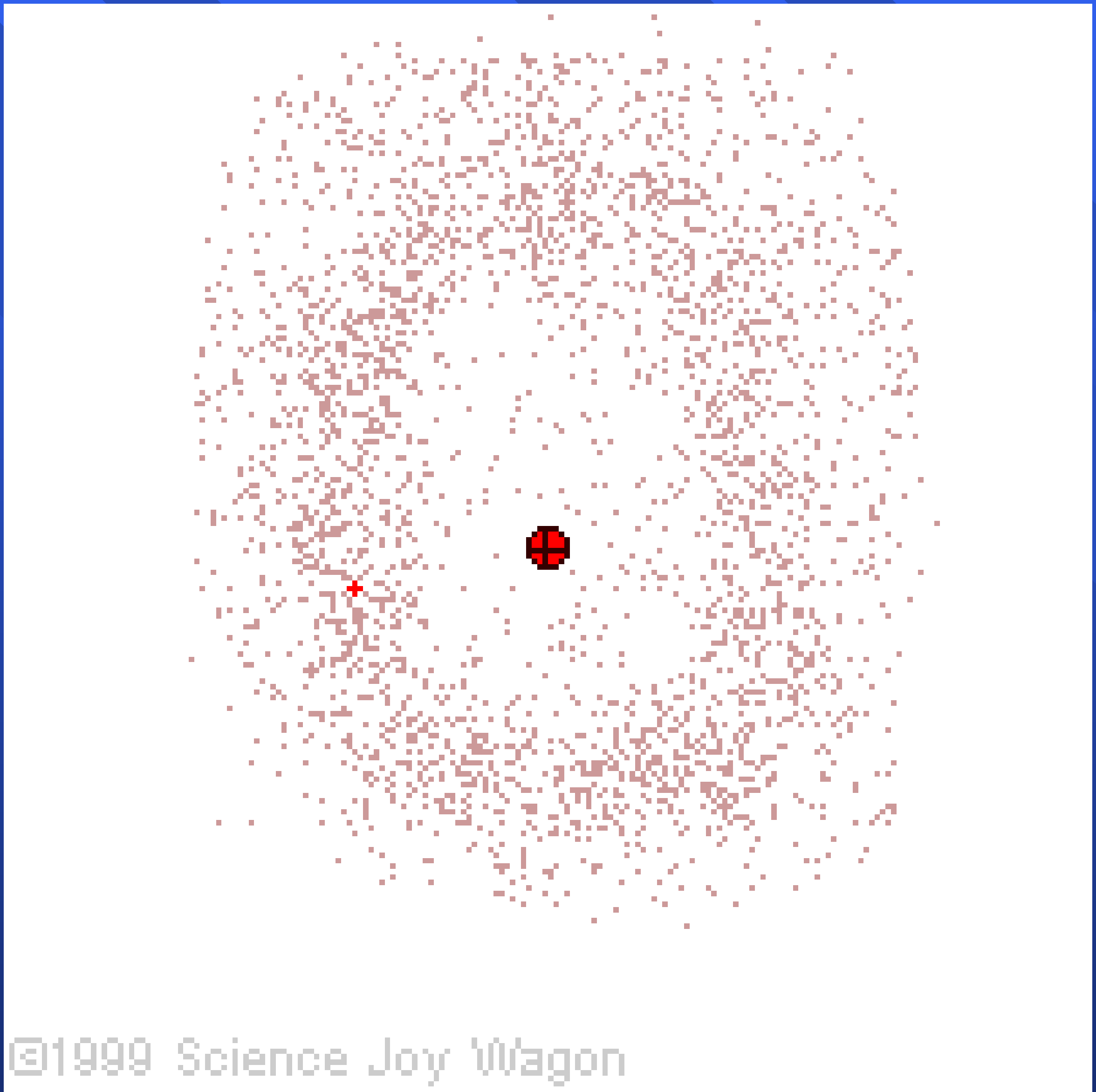




Modern View

- The atom is mostly empty space.
- Two regions.
- Nucleus- protons and neutrons.
- Electron cloud- region where you might find an electron.

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Density and the Atom

- Since most of the particles went through, it was mostly empty.
- Because the pieces turned so much, the positive pieces were heavy.
- Small volume, big mass, big density.
- This small dense positive area is the nucleus.

Schrodinger-1926

- developed the wave model
- His work leads to the electron cloud model.

CHADWICK - 1932

- Confirms the existence of neutrons which have no charge and are found in the nucleus with protons that have a positive charge.

Other pieces

- Proton - positively charged pieces 1840 times heavier than the electron.
- Neutron - no charge but the same mass as a proton.
- Where are the pieces?

Subatomic particles

Name	Symbol	Charge	Relative mass	Actual mass (g)
Electron	e^-	-1	1/1840 (Almost 0)	9.11×10^{-28}
Proton	p^+	+1	1	1.67×10^{-24}
Neutron	n^0	0	1	1.67×10^{-24}

Structure of the Atom

- There are two regions.

  The NUCLEUS almost all the mass
- With protons and neutrons.
- Positive charge and neutral charge.

  ELECTRON CLOUD- most of the volume of an atom.
- The region where the electron can be found.
- Negative Charge

Size of an atom

- Atoms are small.
- Measured in picometers, 10^{-12} meters.
- Hydrogen atom, 32 pm radius.
- Nucleus tiny compared to atom.
- IF the atom was the size of a stadium, the nucleus would be the size of a marble.
- Radius of the nucleus is near 10^{-15}m.
- Density near 10^{14} g/cm^3.

Counting the Pieces

- Atomic Number = number of protons
- # of protons determines kind of atom.
- the same as the number of electrons in the neutral atom.
- Mass Number = the number of protons + neutrons.
- All the things with mass.

Isotopes

- Atoms of the same element can have different numbers of neutrons.
- different mass numbers.
- called isotopes.

Symbols

- Contain the symbol of the element, the mass number and the atomic number.

Symbols

- Contain the symbol of the element, the mass number and the atomic number.

Mass number

X

Atomic number

Naming Isotopes

- Put the mass number after the name of the element.
- carbon- 12
- carbon -14
- uranium-235

Symbols

- Find the
  1. number of protons
  2. number of neutrons
  3. number of electrons
  4. Atomic number
  5. Mass Number
  6. Name
  7. Valence Electrons

$^{23}_{11}Na$

Symbols

- Find the
  - number of protons
  - number of neutrons
  - number of electrons
  - Atomic number
  - Mass Number
  - Name

$^{80}_{35}Br$

Symbols

- if an element has an atomic number of 34 and a mass number of 78 what is the
  - number of protons
  - number of neutrons
  - number of electrons
  - Complete symbol
  - Name

Symbols

- if an element has 91 protons and 140 neutrons what is the
  - Atomic number
  - Mass number
  - number of electrons
  - Complete symbol
  - Name

Symbols

- if an element has 78 electrons and 117 neutrons what is the
  - Atomic number
  - Mass number
  - number of protons
  - Complete symbol
  - Name

Atomic Mass

- How heavy is an atom of oxygen?
- There are different kinds of oxygen atoms.
- More concerned with average atomic mass.
- Based on abundance of each element in nature.
- Don’t use grams because the numbers would be too small.

Measuring Atomic Mass

- Unit is the Atomic Mass Unit (amu)
- One twelfth the mass of a carbon-12 atom.
- 6 p^+ and 6 n^0
- Each isotope has its own atomic mass
- we get the average using percent abundance.

Calculating averages

- You have five rocks, four with a mass of 50 g, and one with a mass of 60 g. What is the average mass of the rocks?
- Total mass = 4 x 50 + 1 x 60 = 260 g
- Average mass = 4 x 50 + 1 x 60 = 260 g 5 5
- Average mass = 4 x 50 + 1 x 60 = 260 g 55 5

Calculating averages

- Average mass = $\frac{4}{5} \times 50 + \frac{1}{5} \times 60 = \frac{260\text{ g}}{5}$
- Average mass = .8 x 50 + .2 x 60
- 80% of the rocks were 50 grams
- 20% of the rocks were 60 grams
- Average = % as decimal x mass + % as decimal x mass + % as decimal x mass +

Atomic Mass

- Calculate the atomic mass of copper if copper has two isotopes. 69.1% has a mass of 62.93 amu and the rest has a mass of 64.93 amu.

Atomic Mass

- Magnesium has three isotopes. 78.99% magnesium 24 with a mass of 23.9850 amu, 10.00% magnesium 25 with a mass of 24.9858 amu, and the rest magnesium 26 with a mass of 25.9826 amu. What is the atomic mass of magnesium?
- If not told otherwise, the mass of the isotope is the mass number in amu

Atomic Mass

- Is not a whole number because it is an average.
- are the decimal numbers on the periodic table.

Neon has 3 different isotope 90.51% have a mass of 19.99 Amu. 0.27% have a mass of 20.994 amu, 9.22% have a mass of 21.991 amu. What is the average mass of neon

Chlorine-35 is one isotope of chlorine . (35 is the mass #)
Chlorine-37 is another isotope of chlorine. How many protons and how many neutrons are in each isotope?

Of all chlorine atoms, 75.771 % are chlorine 35. Chlorine -35 atoms have a mass of 34.96885 amu. All other chlorine atoms are chlorine -37 and these have a mass of 36.96590. What is the average mass

Do your average atomic mass answers for Neon and Chlorine agree with the average atomic masses on the periodic table?

EXIT SLIP

Write a paragraph explaining how to determine average atomic mass for elements that are isotopes.