The Beginnings of Atomic Theory

- Who came up with the first theory of atoms?
- In the fourth century BCE, the Greek philosopher Democritus suggested that the universe was made of indivisible units called atoms.

Democritus did not have evidence for his atomic theory.

..\..\..\..\Videos\John Dalton's Atomic Theory.mp4

- **Dalton agreed with Democritus:**
  Elements are made up of atoms.
- Atoms cannot be divided, created, or destroyed.
- What did Dalton add to the atomic theory?
- **According to Dalton,**
- **1. All atoms of a given element were exactly alike,**
- **2. Atoms of different elements could join to form compounds. (This "joining" is called a chemical reaction.)**
- **3. The elements "join" in definite proportions or ratios**
  - **Example Water is always 2 parts hydrogen and 1 part oxygen , H_2O**

Thomson's Model of the Atom

- How did Thomson discover the electron?
- Thomson's cathode-ray tube experiment suggested that cathode rays were made of negatively charged particles that came from inside atoms.

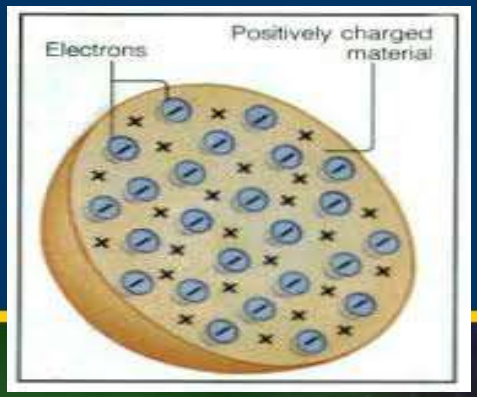
Thomson's Model of the Atom, *continued*

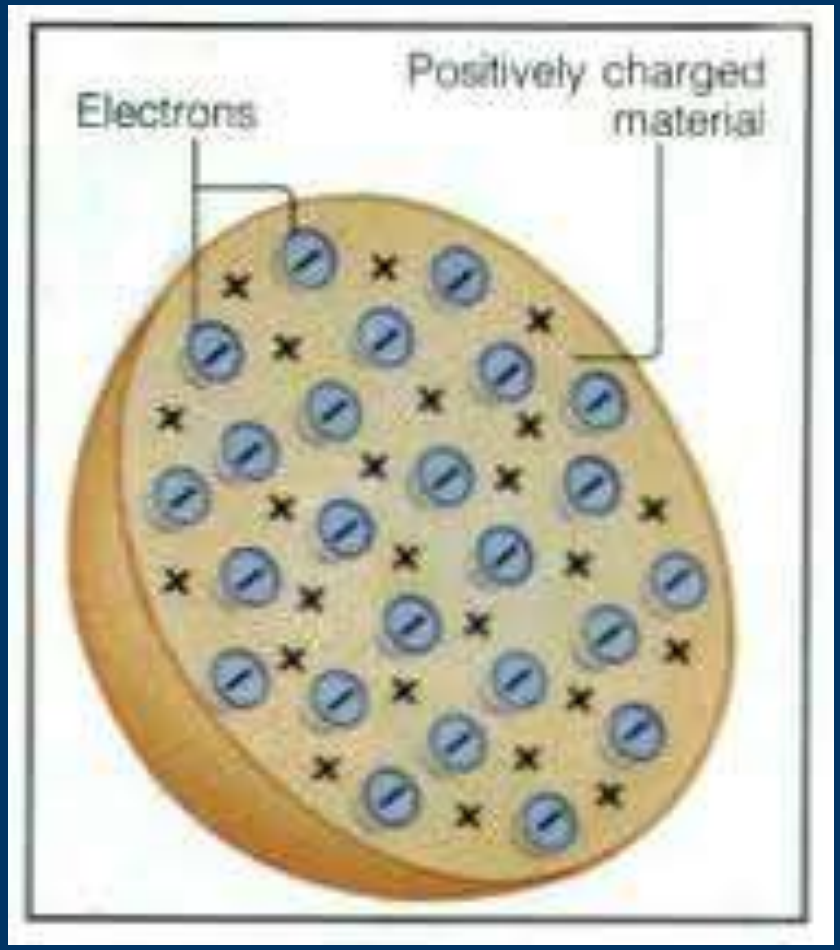
Thomson developed the plum-pudding model.

In his cathode-ray tube experiment, Thomson had discovered electrons.

electron: a subatomic particle that has a negative charge

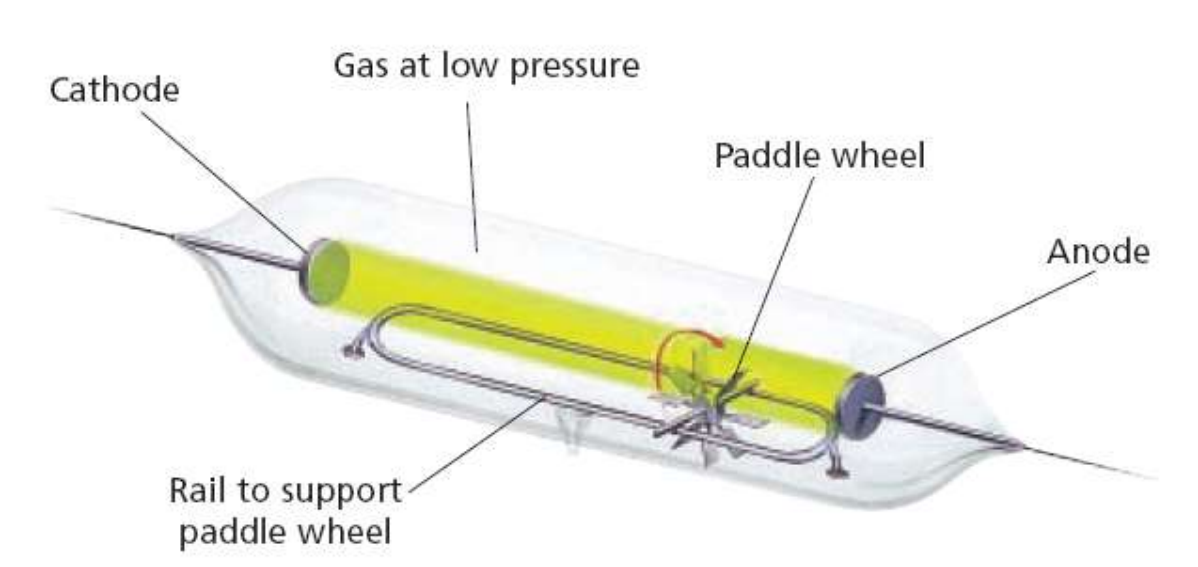
Thomson's *plum-pudding model:* electrons are spread throughout the atom, like blueberries in a muffin



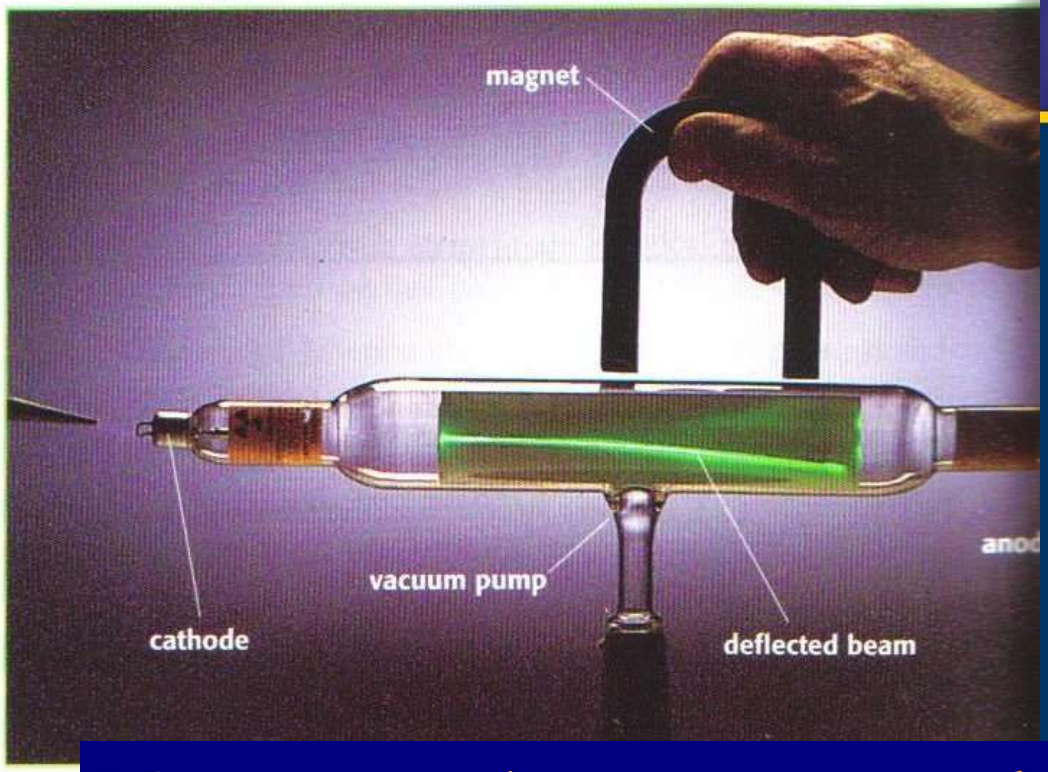

Electrons
Positively charged material

The Experiment and data

A paddle wheel placed in the path of the cathode ray moves away from the negatively charged cathode and toward the positively charged anode



Data/ Results



The green ray bent away from a negative charge and a negative magnetic field and towards positive fields.

No matter what gas was used the ray spun the paddle wheel and bent away from negative towards positive.

Furthermore, *experimental evidence showed atoms to be electrically neutral (they would not be deflected by negative or positive charges)*

Types of Elements

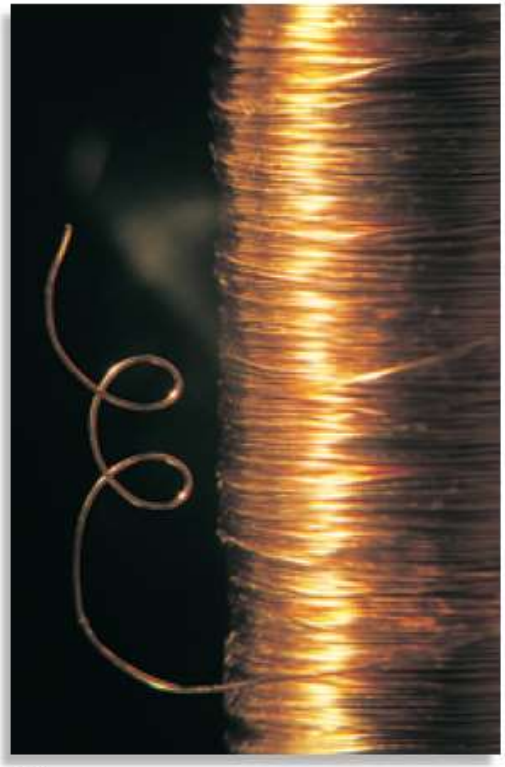
Metals

- A **metal** is an element that is a good electrical conductor of electrical charge and a good heat conductor.
    - most are solids at room temperature
    - malleable - they can be hammered or rolled into thin sheets
    - ductile - they can be drawn into a fine wire

Types of Elements

- Gold, copper, and aluminum are metals


(a)


(b)


(c)

Types of Elements

Nonmetals

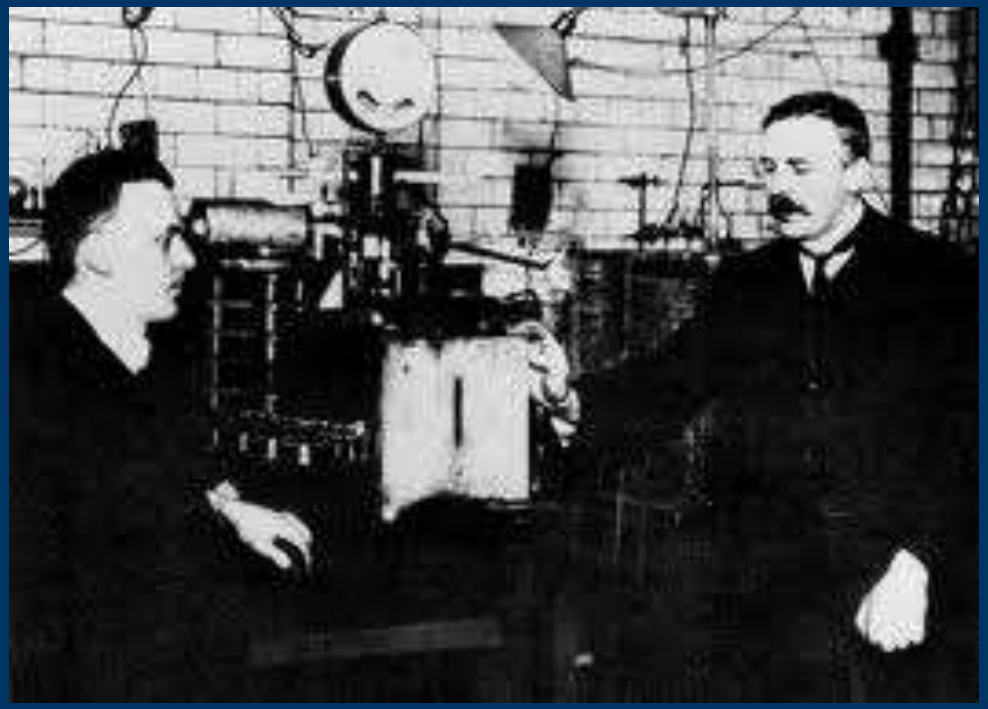
- A **nonmetal** is an element that is a poor conductor of electrical charge and a poor conductor of heat.
  - Properties of nonmetals
    - many are gases
    - solids are brittle
    -

Types of Elements

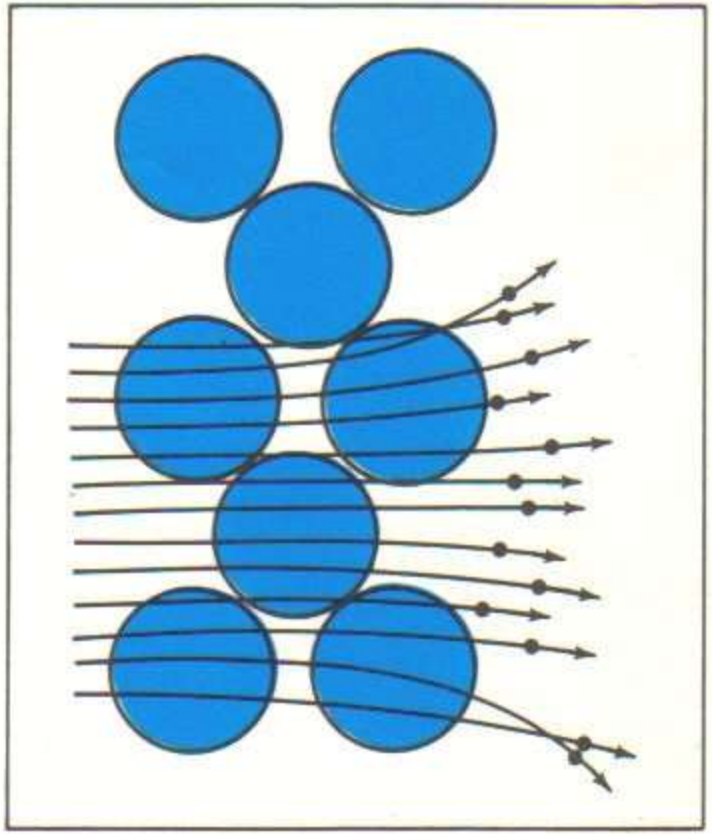
- **Various nonmetal elements**

(a) carbon, (b) sulfur, (c) phosphorus, and (d) iodine

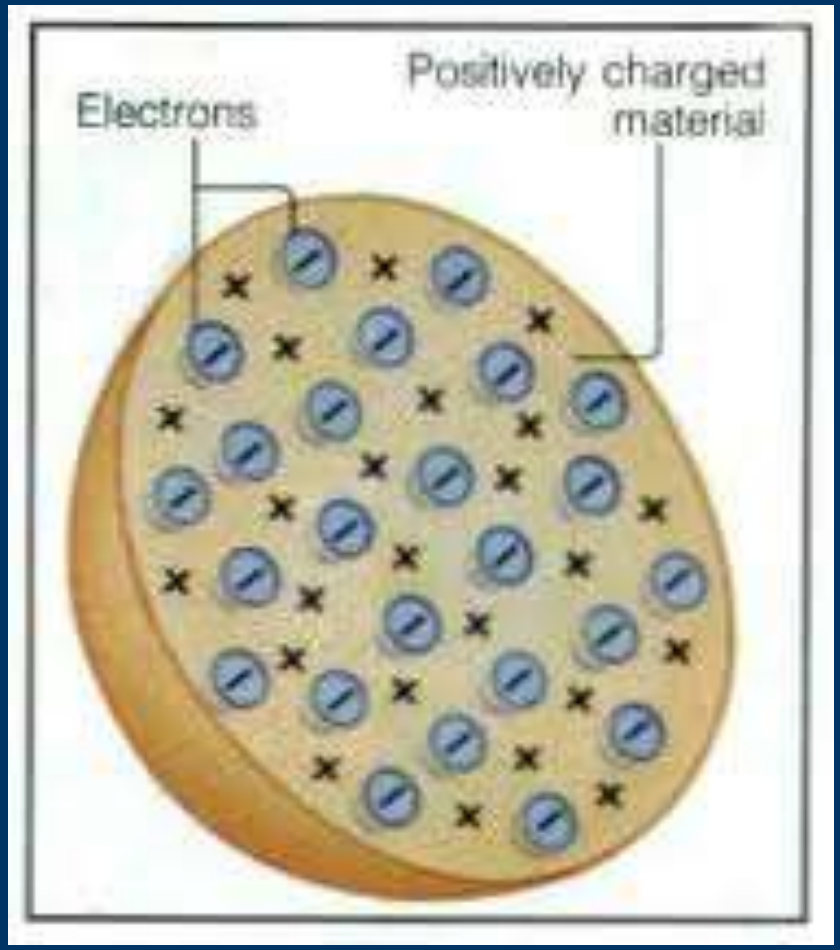
Ernest Rutherford



Rutherford's 1st hypothesis: the positively charged alpha particles will scatter per the figure because the Thompson theory states the atom is net neutral at any given point

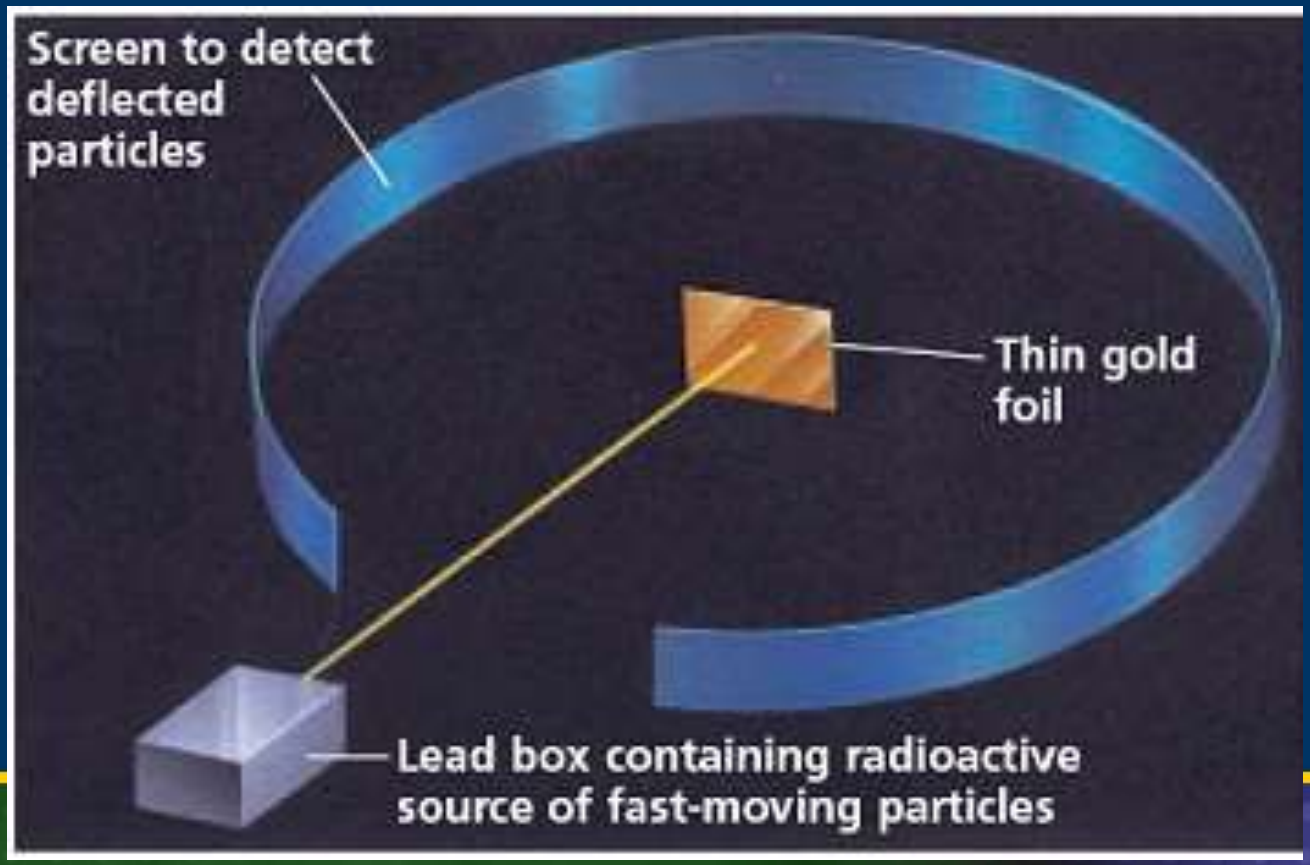


The figure shows how the alpha particle scattering would look like if the Thompson theory was correct.

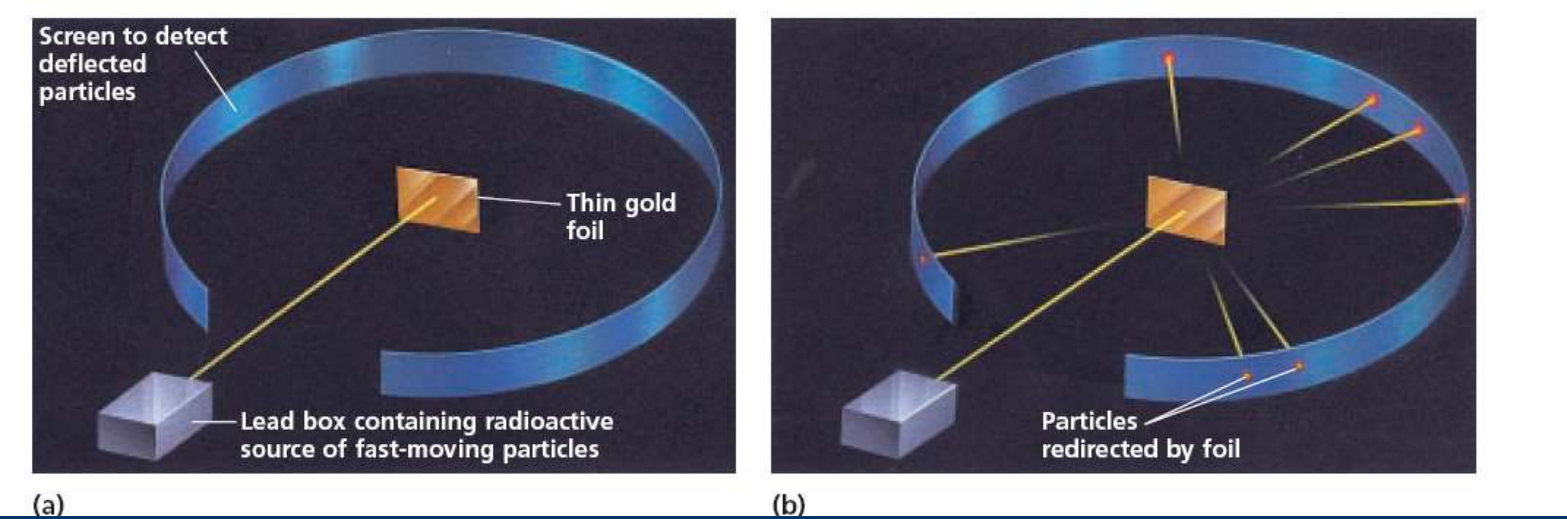

Electrons
Positively charged material

In 1911 Ernest Rutherford decided to test Thompson's theory that states the atom is net neutral at any given point

He did this by shooting positively charged particles, called alpha particles, at atoms.



Rutherford's 1st hypothesis: the positively charged alpha particles will scatter per figure 8-13 because the Thompson theory states the atom is net neutral at any given point.



Rutherford's experiment gave a result that hypothesis could not explain.

Figure 8-13 show how the alpha particle scattering would look like if the Thompson theory was correct.

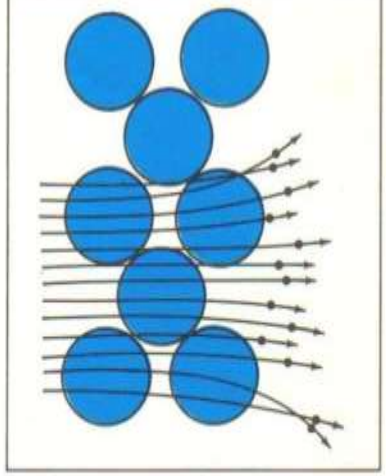


FIGURE 8-13

The scattering of alpha particles by a metallic crystal made up of Thomson atoms. Rutherford's results are *not* explained.

Figure 8-14 show the actual results of the alpha particle scattering experiment.

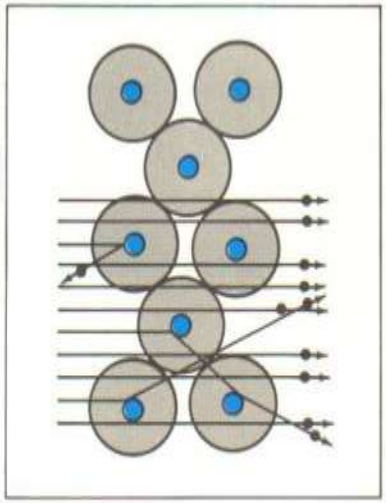


FIGURE 8-14

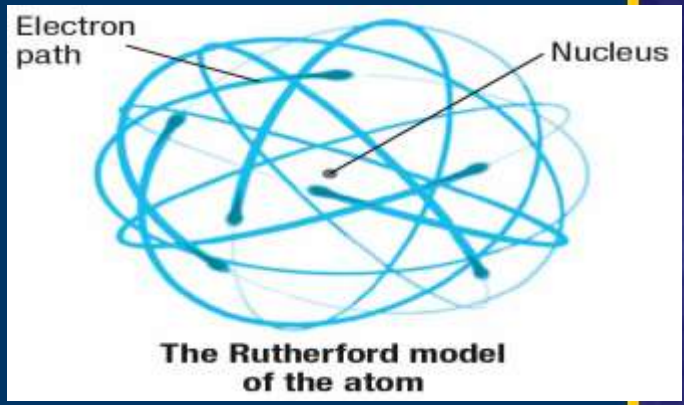
The scattering of alpha particles by a metallic crystal made up of Rutherford atoms. Rutherford's results *are* explained.

Rutherford's 2nd hypothesis: An atom has a very small positively charged nucleus which is surrounded by electrons.

Rutherford's Model of the Atom, *continued*

Rutherford conducted the gold-foil experiment.

Rutherford discovered the nucleus.

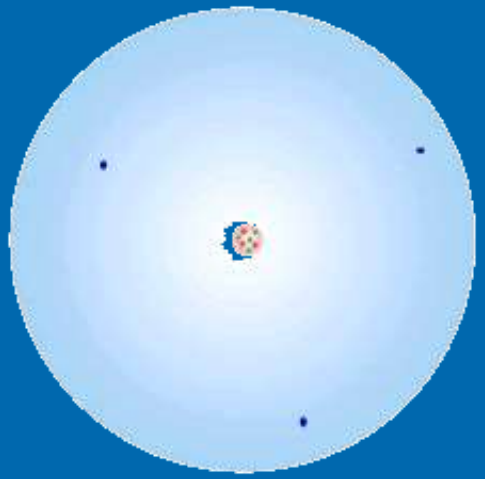


The Rutherford model of the atom

nucleus: an atom's central region, which is made up of protons and neutrons

Rutherford's Conclusions

- All of an atom's positive charge is concentrated in a *very small core* at the atom's center, which Rutherford called the **nucleus**.



- The negatively charged *electrons move around the nucleus*.

Rutherford's Conclusions

Also noted that if the entire atom is the size of a football stadium, the nucleus would be about the size of a marble sitting on the 50-yd line.

Hundred times smaller than shown

Properties of Subatomic Particles

Particle	Symbols	Relative electric charge	Mass
Electron	e^-,	–1	0
Proton	p^+,	+1	1
Neutron	n°,	0	1

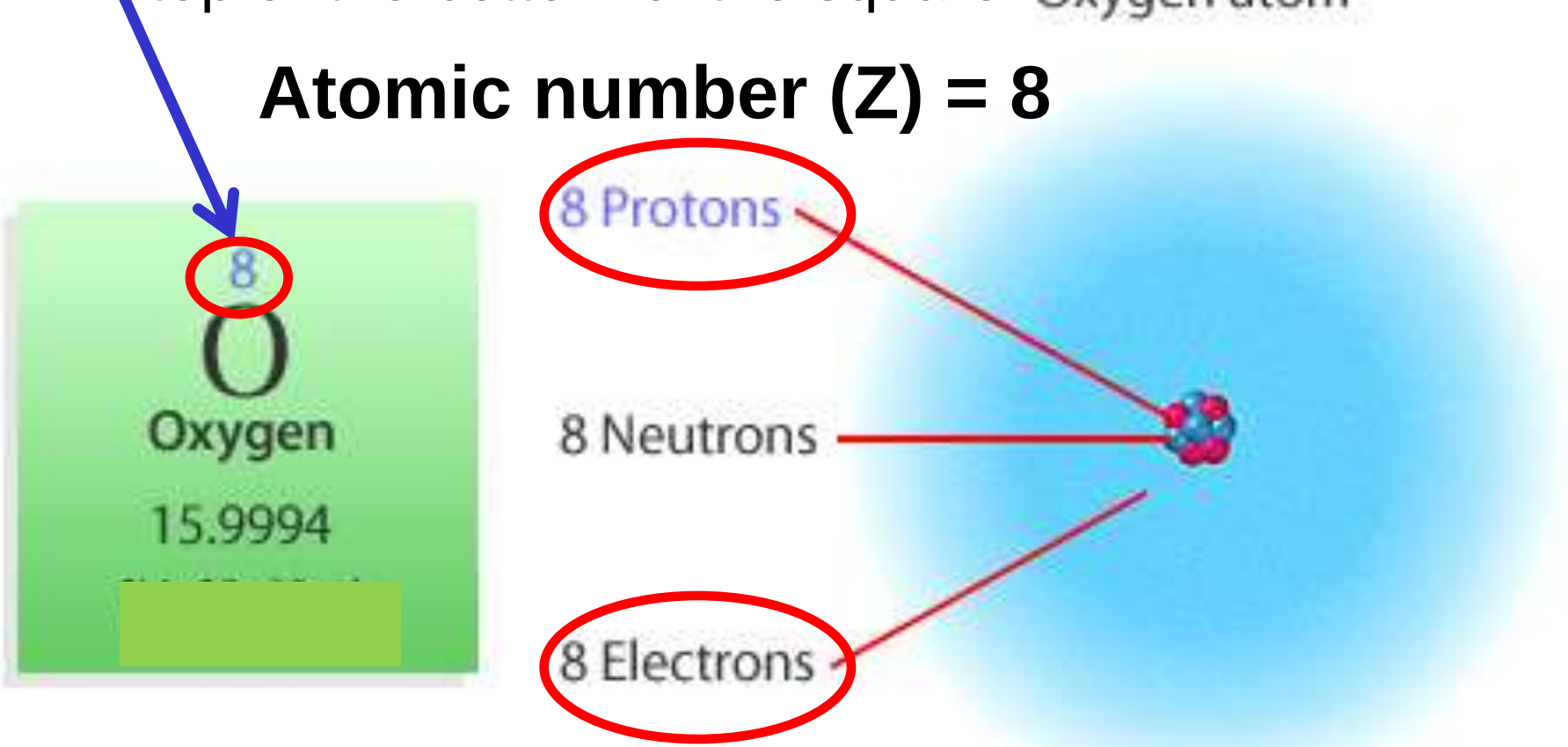
Atomic Number

- What do atoms of an element have in common with other atoms of the same element?
- Atoms of each element have the same number of protons, but they can have different numbers of neutrons.
- **The number of protons determines each element's identity.**

atomic number: the number of protons in the nucleus of an atom

The atomic number is the smaller whole number.

The atomic number can be written on the top or the bottom of the square.



How many electrons does oxygen have? 8

How many protons? 8

Note that atoms have equal numbers of protons and

What Is in an Atom?, *continued*

Each element has a unique number of protons.

Unreacted atoms have no overall charge.

- Because there is an equal number of protons and electrons, the charges cancel out.

The electric force holds the atom together.

- Positive protons are attracted to negative electrons by the *electric force.*
- This force holds the atom together.

Ions

An **ion** is an atom or group atoms that has a positive or negative charge.

A positive ion is known as a **cation**.

A cation has more positive charge than negitive charge

Thus it has a positive charge.

A negative ion is known as an **anion**.

An anion has more negative charge than positive charge

Thus it has a negative charge.

Ions

An **ion** is an atom or group atoms that has a positive or negative charge.

A positive ion is known as a **cation**.

If an atom loses an electron it has more protons than electrons.

Thus it has a positive charge

A negative ion is known as an **anion**.

If an atom gains an electron it has more electrons than protons.

Thus it has a negative charge.

Charge = (p^+) + $(-e^-)$

p+ = number of protons as a positive number

$-e^-$ = number of electrons as a negative number