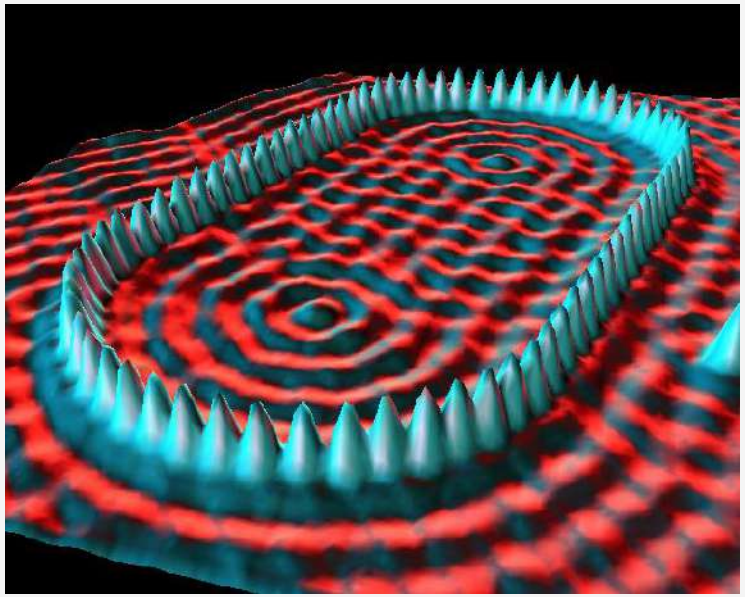
# Chapter 4 Atomic Structure

Jennie L. Borders

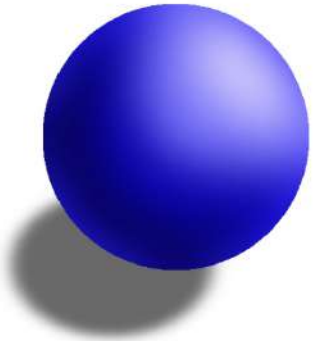


# Warm-Up Feb. 24

1. What did Rutherford discover?
2. What charge does a neutron have?
3. How many electrons can the first energy level hold?

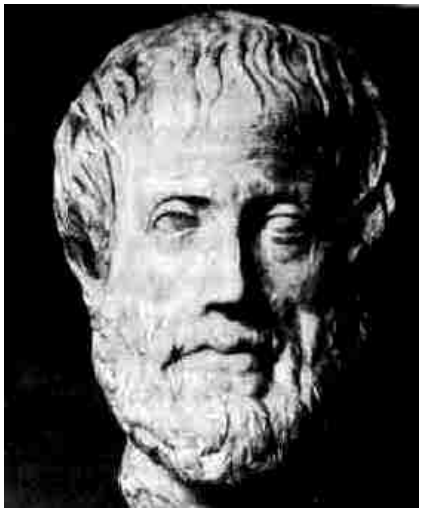
# Section 4.1 – Studying Atoms

- Democritus believed that all matter consisted of extremely small particles that could not be divided.
- He called these particles atoms from the Greek word "atomos", which meant indivisible.
- He thought that there were different types of atoms with specific sets of properties.



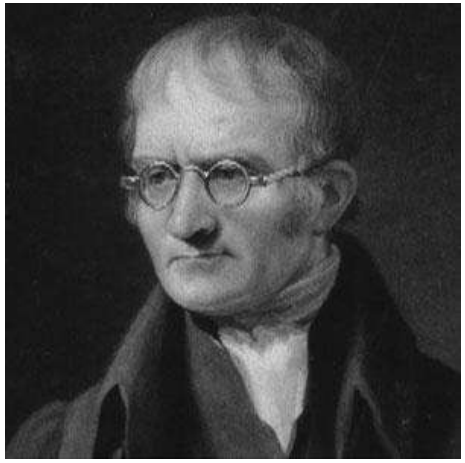
# Aristotle

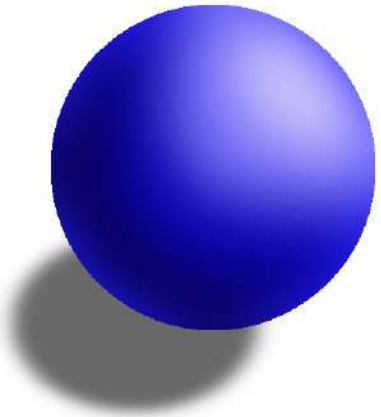
- Aristotle did not think there was a limit to the number of times matter could be divided.
- Aristotle thought that matter could be broken into fire, air, water, and earth.



# Dalton's Atomic Theory

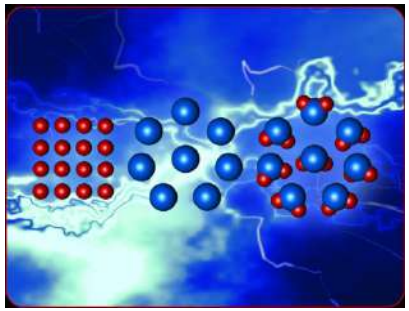
- Dalton developed a theory to explain why the elements in a compound always join the same way.
- Dalton proposed the theory that all matter is made up of individual particles called atoms, which cannot be divided.





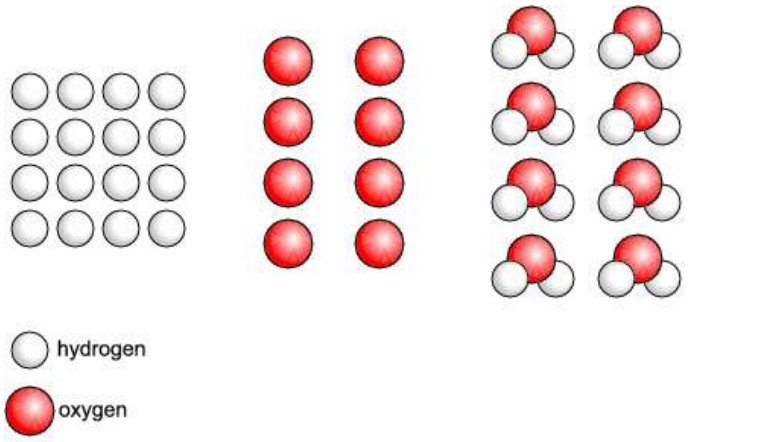
# Dalton's Atomic Theory

- The main point of Dalton's theory are:
  1. All elements are composed of atoms.
  2. All atoms of the same element have the same mass, and atoms of different elements have different masses.
  3. Compounds contain atoms of more than one element.
  4. In a particular compound, atoms of different elements always combine in the same way.



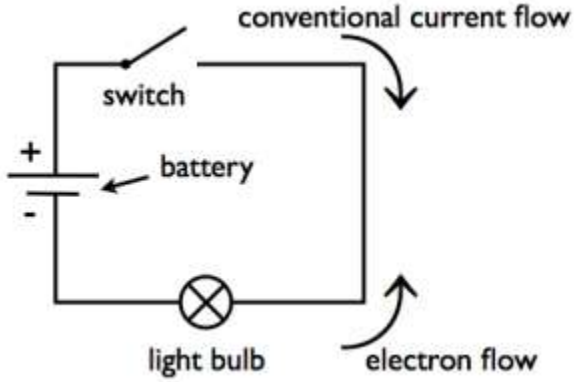
# Dalton's Atomic Theory

- Dalton believed that each type of atom is represented by a tiny, solid sphere with a different mass.



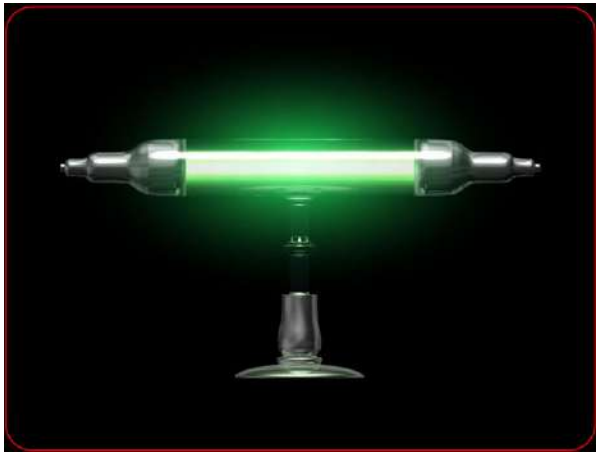

# Thomson's Atomic Theory

- When some materials are rubbed, they gain the ability to attract or repel other materials.
- Based on their behavior, such materials are said to have either a positive or negative electric charge.
- Some charged particles can flow from one location to another.
- A flow of charged particles is called an electric current.

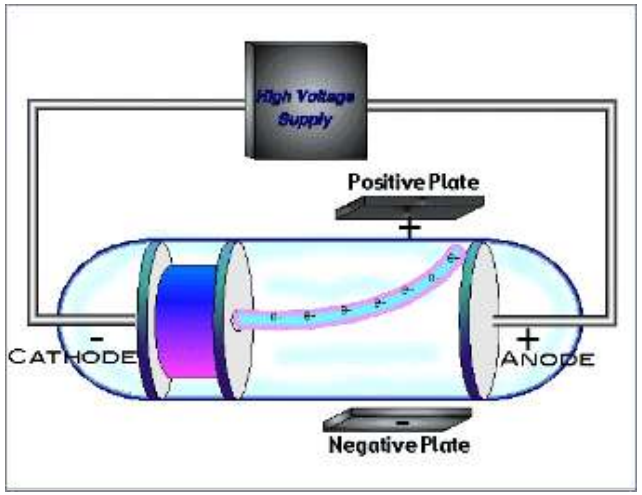
# Thomson's Atomic Theory

- Thomson used a cathode ray tube to study atoms.
- A cathode ray tube is a glass tube filled with a gas that is attached to a source of electric current.
- The beam created is the cathode ray.



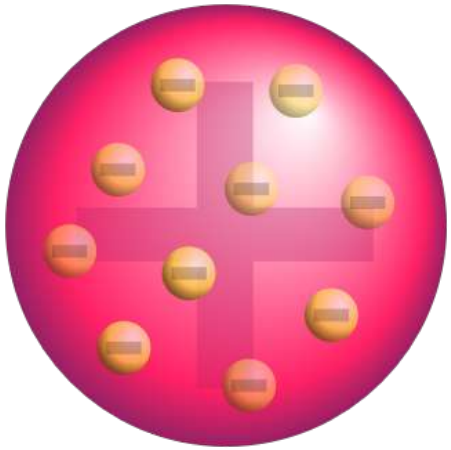
# Thomson's Atomic Model

- When charged plates are placed around the glass tube, the cathode ray bends toward the positively charged plate.
- Thomson concluded that the particles in the cathode ray have a negative charge, and he called them electrons.



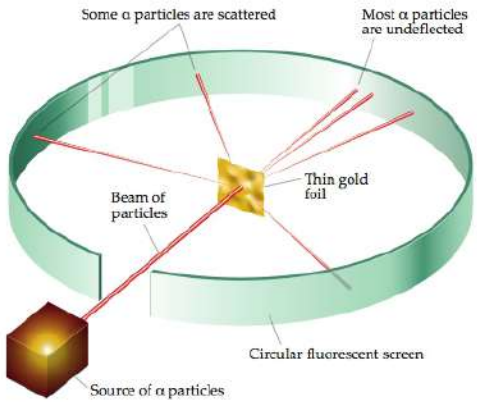
# Thomson's Atomic Model

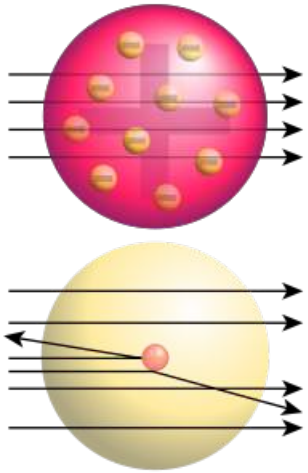
- Thomson's experiments provided the first evidence that atoms are made of even smaller particles.
- Since atoms are neutral, Thomson's model shows a positively charged area with electrons scattered throughout. This model is known as the plum pudding model.



# Rutherford's Experiment

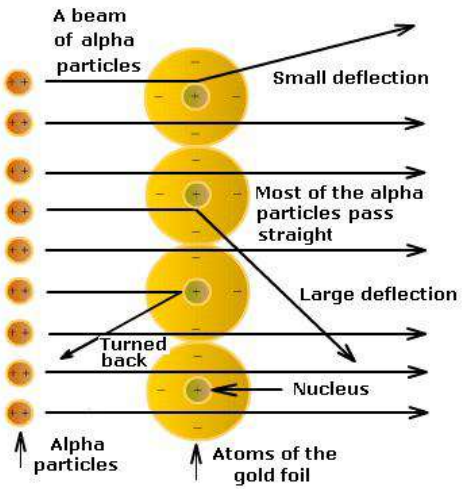
- Rutherford tested the Thomson's plum pudding model.
- Rutherford shot alpha particles at a gold foil.
- If the plum pudding model was correct, the alpha particles would pass through with a slight deflection.



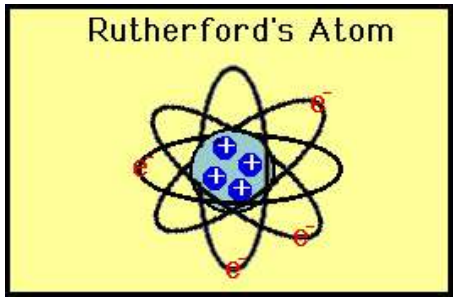
# Rutherford's Experiment

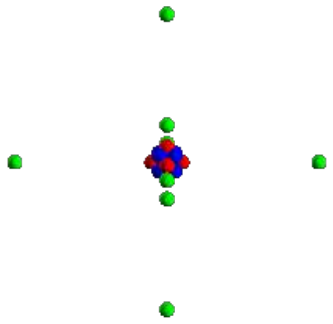
- Most of the alpha particles actually passed straight through and some actually bounced back.
- This led Rutherford to the conclusion that there was a dense positive charge in the center of the atom and that most of the atom is empty space.



# Rutherford's Experiment

- Rutherford called the center of the atom the nucleus.
- The nucleus is the dense, positively charged mass located in the center of the atom.
- According to Rutherford's model, all of an atom's positive charge is concentrated in its nucleus.



# Section 4.1 Assessment

1. What theory did Dalton propose about the structure of an atom?
2. What evidence did J.J. Thomson provide about the structure of an atom?
3. What did Rutherford discover about the structure of an atom?
4. What evidence did Thomson have that his glowing beam contained negative particles?

# Section 4.1 Assessment

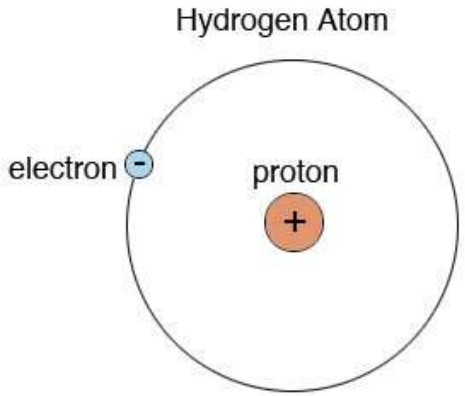
5. Why was Dalton's model of the atom changed after Thomson's experiment?
6. If you observed a beam of particles being bent toward a negatively charged plate, what might you conclude?
7. In the Rutherford experiment, why weren't all the alpha particles deflected?

# Warm-Up Feb. 26

1. What part of the atom did Thomson discover?
2. What did Rutherford shoot at the gold foil?
3. List the 4 elements that Aristotle believed existed.

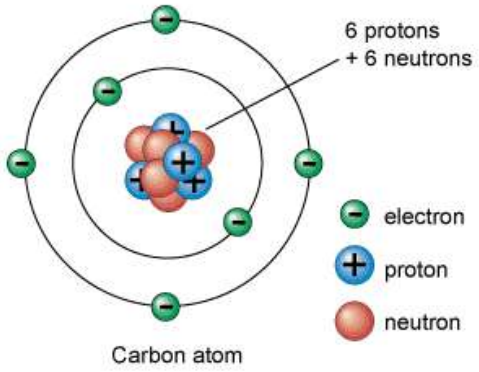
# Section 4.2 – Structure of an Atom

- Protons, electrons, and neutrons are subatomic particles.
- A proton is a positively charged particle subatomic particle that is found in the nucleus of an atom. A proton has a +1 charge.



# Subatomic Particles

- An electron is a negatively charged subatomic particle that is found in the space outside the nucleus. An electron has a -1 charge.
- A neutron is a neutral subatomic particle that is found in the nucleus of an atom. It has about the same mass as a proton.

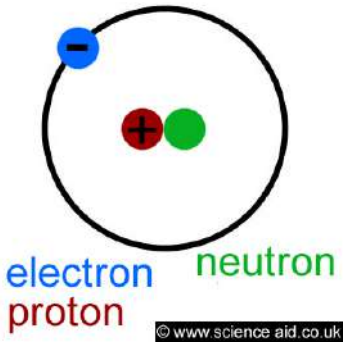
# Subatomic Particles

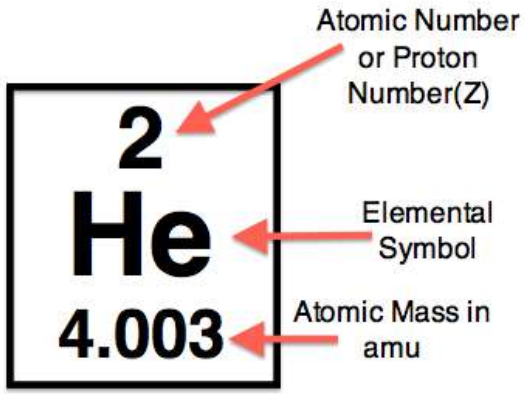
- Protons, electrons, and neutrons can be distinguished by mass, charge, and location in an atom.

| Subatomic Particle | Charge | Relative Mass | Location |
|---|---|---|---|
| proton | +1 | 1 | nucleus |
| neutron | 0 | 1 | nucleus |
| electron | -1 | 1/1840 | electron cloud |

# Atomic Number

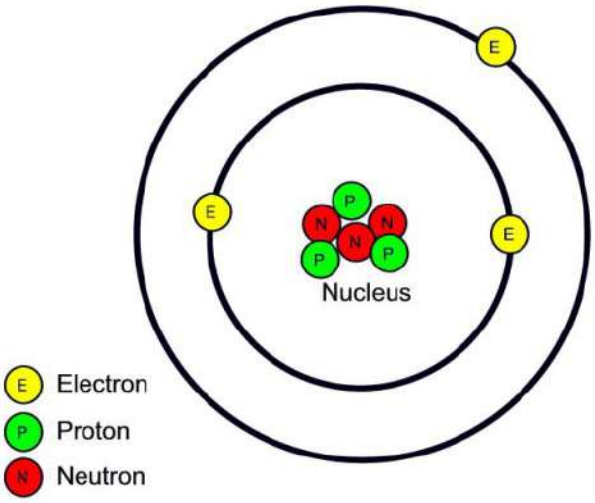
- The atoms of any given element always have the same number of protons.
- The atomic number of an element equals the number of protons in an atom of that element.
- Atoms of different elements have different numbers of protons.



# Atomic Number

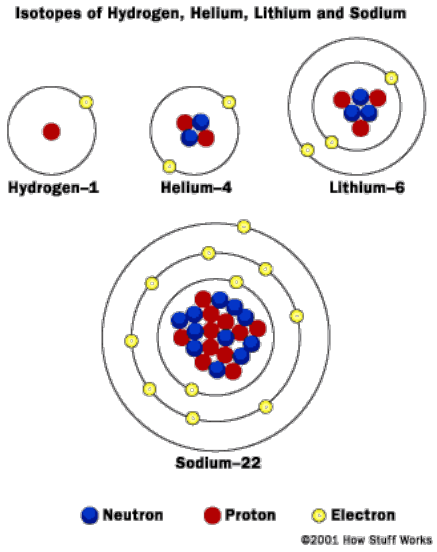
- Each positive charge in an atom is balanced by a negative charge because atoms are neutral.
- So the atomic number of an element also equals the number of electrons in an atom.

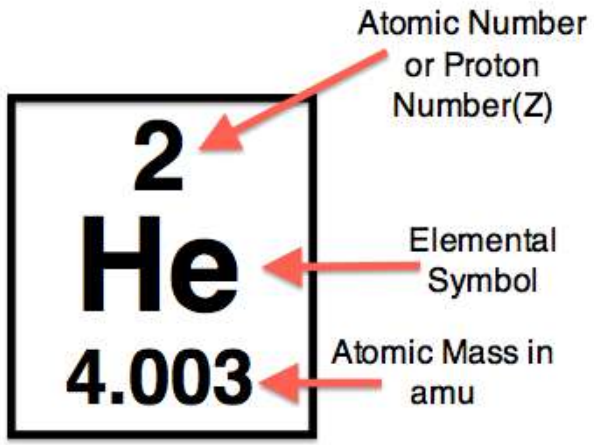


# Mass Number

- The mass number of an atom is the sum of the protons and neutrons in the nucleus of that atom.

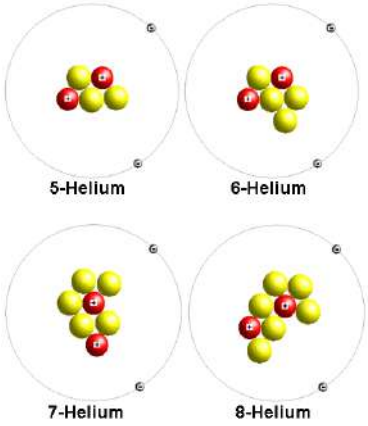
Number of neutrons = mass # – atomic #

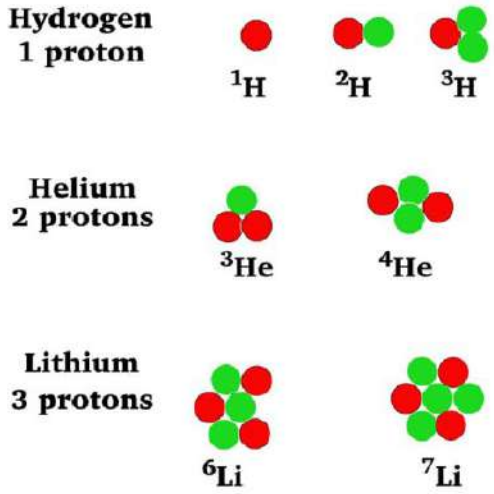


# Isotopes

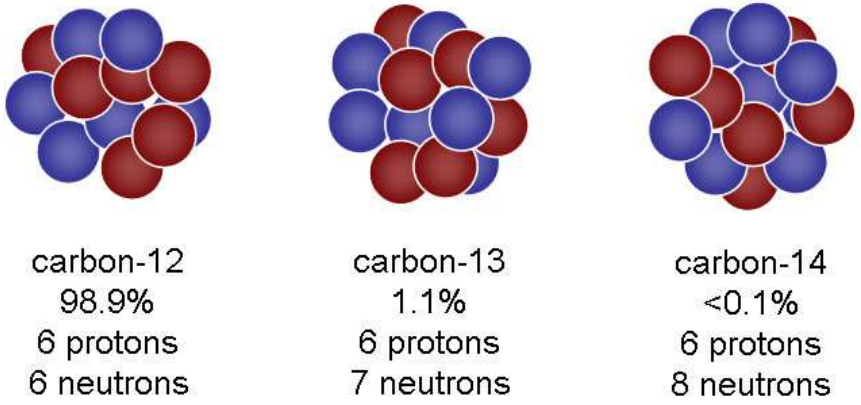
- Isotopes are atoms of the same element that have different numbers of neutrons and different mass numbers.
- Isotopes of an element have the same atomic number but different mass numbers because they have different numbers of neutrons.



# Isotopes

- Isotopes are referred to in the following way: carbon – 12, carbon – 13, and carbon – 14.
- With most elements, it is hard to notice any differences in the physical or chemical properties of their isotopes.



carbon-12
98.9%
6 protons
6 neutrons

carbon-13
1.1%
6 protons
7 neutrons

carbon-14
<0.1%
6 protons
8 neutrons

# Section 4.2 Assessment

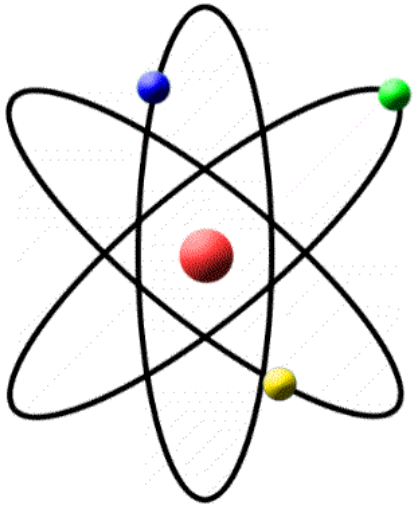
1. Name three subatomic particles.
2. Name three properties you could use to distinguish a proton from an electron.
3. Which characteristic of an atom always varies among atoms of different elements?
4. How are the isotopes of an element different from one another?
5. What do neutrons and protons have in common? How are they different?

# Section 4.2 Assessment

6. How can atoms be neutral if they contain charged particles?
7. What is the difference between atoms of oxygen – 16 and oxygen – 17?
8. What property do protons can electrons have that neutrons do not?
9. Explain why it isn't possible for an atom to have a mass number of 10 and an atomic number of 12.

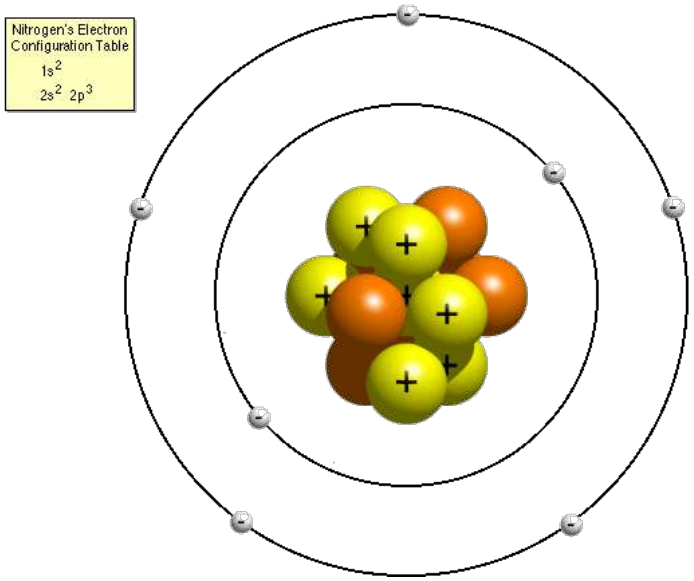
# Section 4.3 – Modern Atomic Theory

- In Bohr's model, the electrons move with constant speed in fixed orbitals around the nucleus.
- Each electron in an atom has a specific amount of energy.



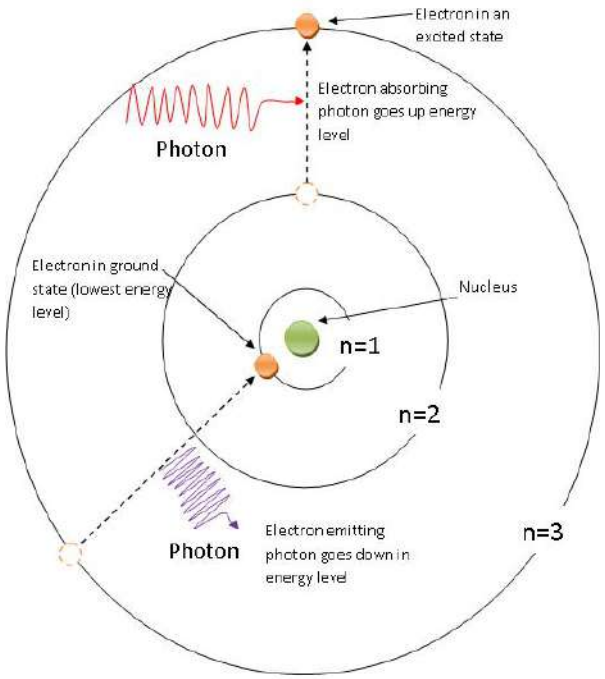
# Bohr's Model

- If an atom gains or loses energy, the energy level of an electron can change.
- The possible energies that electrons in an atom can have are called energy levels.



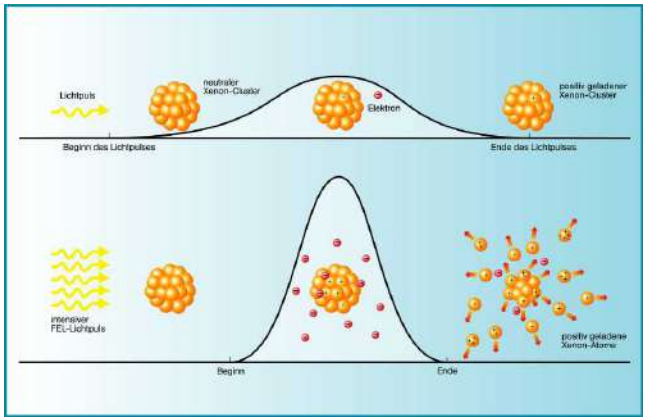
# Bohr's Model

- An electron in an atom can move from one energy level to another when the atom gains or loses energy.



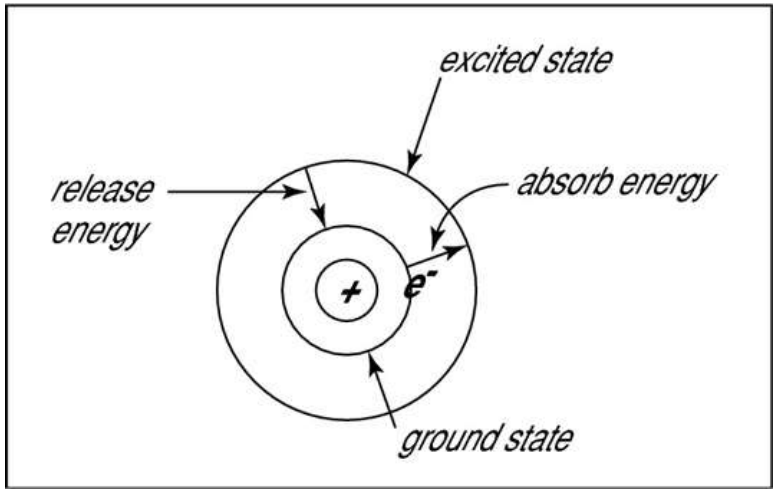
# Energy Levels

- The movement of electrons between energy levels explains the light you see when fireworks explode. Light is a form of energy.
- Because no two elements have the same set of energy levels, different elements emit different colors of light.



# Energy Levels

- When all the electrons in an atom have the lowest energy possible, the atom is said to be in its ground state.
- If one or more electrons have jumped to higher energy levels, the atom is said to be in its excited state.



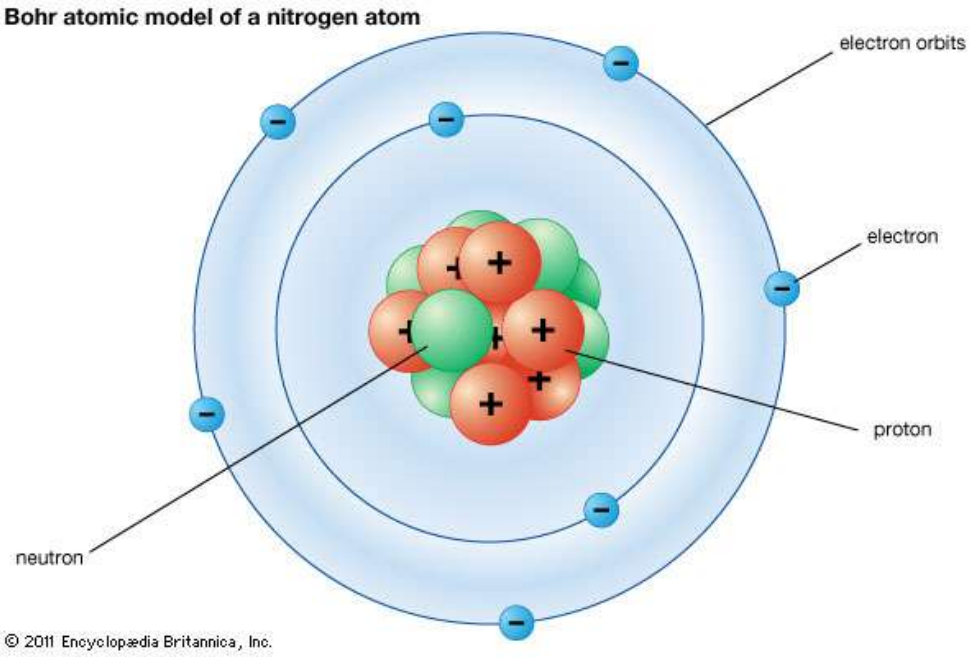
# Energy Levels

- Each energy level can hold a maximum number of electrons.

| Energy Level | Max Number of Electrons |
|---|---|
| 1 | 2 |
| 2 | 8 |
| 3 | 18 |
| 4 | 32 |

# Electron Dot Diagram

An electron dot diagram shows the placement of electrons in the energy levels.



# Sections 4.3 Assessment

1. When is an electron in an atom likely to move from one energy level to another?
2. What model do scientists use to describe how electrons move around the nucleus?
3. Describe the most stable configuration of the electrons in an atom.
4. What did Bohr contribute to modern atomic theory?

# Section 4.3 Assessment

5. What does an electron cloud represent?
6. A boron atom has two electrons in the first energy level and three in the second energy level. Compare the relative energies of the electrons in these two energy levels.