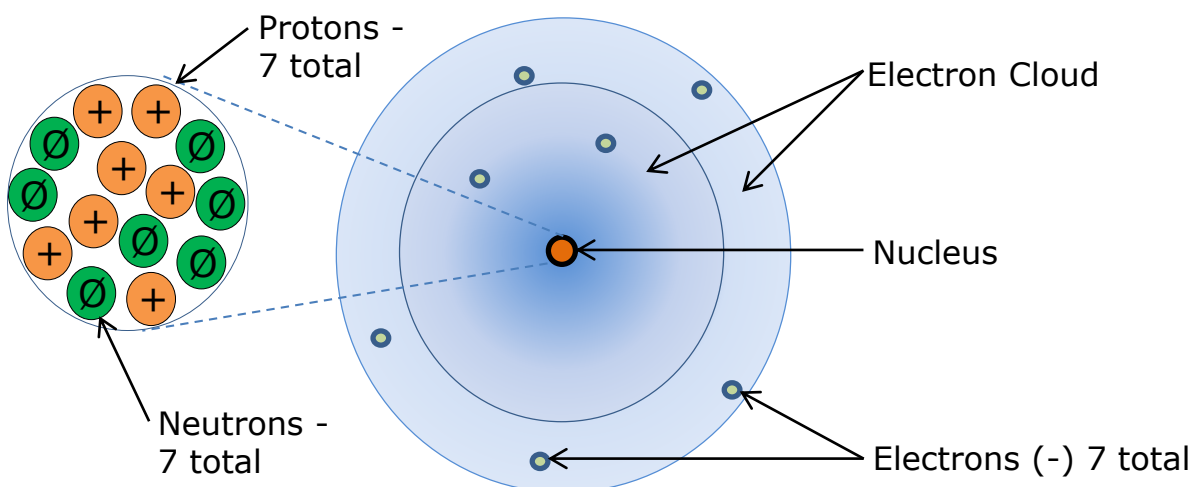


STAAR Science Tutorial 09 **TEK 8.5A: Atomic Structure**

TEK 8.5A: Describe the structure of atoms, including the masses, electrical charges, and locations, of protons and neutrons in the nucleus and electrons in the electron cloud.

Atomic Structure

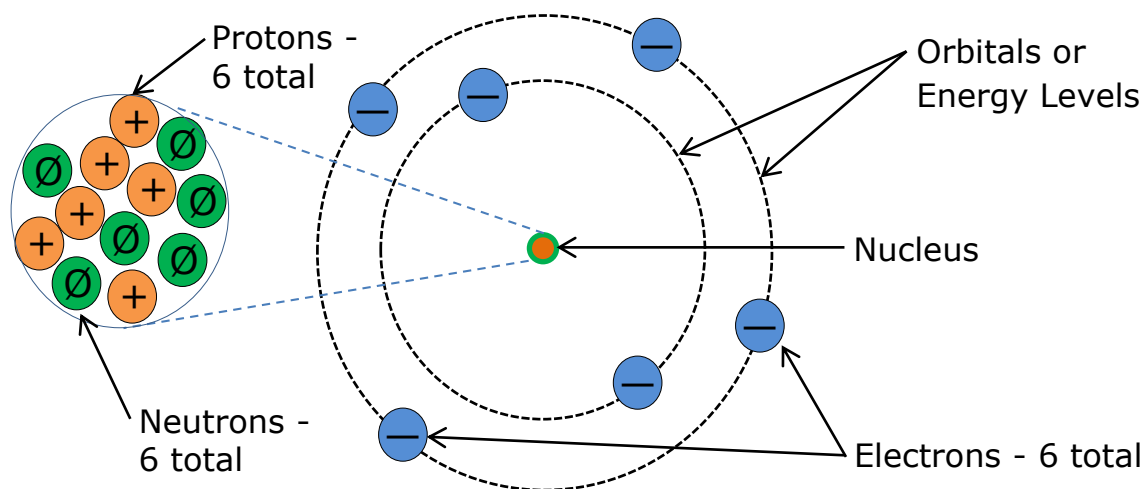
- **Atoms** are the smallest particle of an element. Each element is made of only one kind of atom. For example, gold is only made of gold atoms and neon is only made of neon atoms. The overall shape of all atoms is spherical (like a basketball), but they vary in size.
- Each atom has a **nucleus** located at its center, surrounded by an **electron cloud**, which is mostly empty space outside of the nucleus. The nucleus is very small, compared with the overall size of the atom. In the **Electron Cloud Model** of the atom shown below, both the nucleus and the sub-atomic particles are shown much larger than they really are—they otherwise would be invisible at this scale.



Electron Cloud Model of a Nitrogen Atom

- Atoms are made of three different kinds of **sub-atomic particles**: protons, neutrons, and electrons.
- All of an atom's protons and neutrons are tightly packed together in the atom's nucleus. The nucleus is held together by the strong nuclear force, which is stronger than the electromagnetic force that otherwise would cause like-charged protons to repel one another.
- **Protons** have a positive (+) charge, and each has a mass of one "**atomic mass unit**" (amu).

- **Neutrons** have no charge (sometimes stated as a neutral or zero (\emptyset) charge), and each also has a mass of 1 amu.
- **Electrons** have a negative (-) charge, and a very tiny mass of 0.005 amu. The mass of electrons are so small that they are usually ignored when adding up the mass of the entire atom to state the atom's atomic mass.
- All of the atom's electrons are located somewhere in the electron cloud. It is not possible to know exactly where the electrons of an atom are located. It is useful to think of electrons orbiting the nucleus much as planets orbit the Sun (as shown in the Bohr Model below), though electrons don't really have separate defined orbits.
- Atoms of a particular element have a set number of protons. For example, every atom of hydrogen has one proton, and every atom of gold has 79 protons. The number of protons is called the element's **atomic number**.
- Atoms that are electrically neutral will have the same number of protons and electrons. (If an atom has an electrical charge, it is because it has more or less electrons than its' fixed number of protons. In this case, the atom is called an **ion**.)
- Not all atoms of the same element will have the same number of neutrons. Atoms of an element with different number of neutrons are called **isotopes** of that element. Atoms of a particular element can thus have different atomic masses.
- The total number of protons and neutrons in an atom's nucleus is called the **atomic mass** of that atom.
- The most accurate model of the atom is the electron cloud model, shown above. Scientists also use the **Bohr Model** of the atom shown below, which shows the electrons in different orbits (also called orbitals, electron shells or energy levels). These are really different electron energy levels, not orbits, but this model is very useful to understand interactions between atoms. The electrons in the outer orbital are called the **valence electrons**.



Bohr Model of a Carbon Atom

- In summary, each subatomic particle in an atom has the following characteristics:

Subatomic Particle	Approximate Atomic Mass (amu)	Charge	Location in Atom
Proton	1	Positive (+)	Nucleus
Neutron	1	None (\emptyset) neutral	Nucleus
Electron	0	Negative (-)	Electron Cloud

Practice Problems

1. Where are protons found in an atom, and what electrical charge and mass do they have? _____

2. Where are neutrons found in an atom, and what electrical charge and mass do they have? _____

3. Where are electrons found in an atom, and what electrical charge and mass do they have? _____

4. What is the "atomic number" of an atom? What does it identify? _____

5. What is the "atomic mass" of an atom? _____

6. Can the atomic number of a particular element ever change? Why or why not? _____

7. Can the atomic mass of an atom of a particular element ever change? Why or why not? _____

8. Which model of the atom is the most accurate? _____

9. Which model of the atom do scientists often use to show the different energy levels of electrons? _____

10. What is the outermost energy level (also called orbital or shell) of electrons called? _____
