Everything around us is made from atoms. The chair, the air, water, food, our skin, and the screen in front of us are built from atoms arranged in different ways. An atom is unbelievably small, but inside it are three important particles: protons, neutrons, and electrons. The easiest way to understand them is to remember that the protons give an atom its identity, the neutrons help build and stabilize its center, and the electrons control how it behaves around other atoms.

Begin with the center of the atom. This center is called the nucleus. Protons and neutrons are packed together inside it. Electrons occupy the space surrounding the nucleus. Although pictures make the nucleus look large, it is actually tiny compared with the entire atom. Most of an atom's size comes from the area occupied by its electrons.

A proton carries a positive electrical charge. The number of protons tells us exactly which element we have. An element is a basic type of matter, such as hydrogen, carbon, oxygen, iron, or gold. Every element has its own proton number, almost like an identification number that cannot be shared with another element.

Hydrogen has one proton. Helium has two. Carbon has six. Oxygen has eight. Gold has seventy-nine. Any atom with six protons must be carbon. It does not matter where we find it or what other atoms surround it. Six protons always means carbon.

This is why the proton can be remembered as the atom's identity. If the number of protons changes, the atom becomes a different element. Adding one proton to carbon would not create a larger piece of carbon. Carbon has six protons, but nitrogen has seven. Changing six protons to seven changes carbon into nitrogen.

The periodic table is organized according to proton numbers. The small whole number connected with each element is called its atomic number. Carbon's atomic number is six because carbon has six protons. Oxygen's atomic number is eight because oxygen has eight protons. Iron's atomic number is twenty-six because iron has twenty-six protons.

A neutron has no electrical charge. It is neutral, which is where its name comes from. Neutrons sit beside protons inside the nucleus and add mass. They also help the nucleus remain stable.

The positively charged protons naturally repel one another. Imagine trying to press the positive ends of several magnets together. They resist being packed into the same small space. A powerful force inside the nucleus holds the protons and neutrons together. Neutrons help build that nucleus without adding more positive electrical repulsion.

The neutron does not decide the identity of the atom. Carbon must have six protons, but it can have different numbers of neutrons and remain carbon. A carbon atom with six neutrons is called carbon-12. A carbon atom with eight neutrons is called carbon-14. Both are carbon because both have six protons.

Atoms of the same element that contain different numbers of neutrons are called isotopes. Think of them as different versions of the same element. They have the same identity because they have the same number of protons, but their masses are different because they contain different numbers of neutrons.

Some isotopes are stable, while others are unstable. An unstable nucleus may release particles or energy as it changes. This process is called radioactive decay. Carbon-14 slowly changes over time, which allows scientists to estimate how long ago certain plants, animals, or people lived.

Now we come to the electrons. An electron carries a negative electrical charge and is much lighter than a proton or neutron. Protons and neutrons contain nearly all the atom's mass, while electrons take up most of its surrounding space.

Electrons are not packed inside the nucleus. They occupy regions around it. They are often drawn as small balls circling the nucleus like planets around the Sun. That picture helps us begin, but electrons do not actually follow neat circular roads. They move according to rules that are much stranger than ordinary objects, so scientists describe the areas where an electron is likely to be found.

Positive and negative charges attract. The positive protons in the nucleus attract the negative electrons around them. This electrical attraction helps keep the electrons connected to the atom.

An atom usually has the same number of protons and electrons. Oxygen normally has eight protons and eight electrons. The eight positive charges and eight negative charges balance each other, leaving the whole atom with no overall charge.

The electrons control much of the atom's behavior. They determine how the atom connects with other atoms, whether it gains or loses charge, and whether it participates easily in chemical reactions. If the protons give an atom its identity, the electrons give it much of its personality.

Consider sodium and chlorine. Sodium has eleven protons and normally eleven electrons. Chlorine has seventeen protons and normally seventeen electrons. Sodium is more stable after giving away one of its outer electrons, while chlorine is more stable after receiving one.

When sodium gives one electron to chlorine, the sodium atom now has eleven positive protons but only ten negative electrons. Positive charge wins by one, so sodium becomes positively charged. Chlorine now has seventeen positive protons and eighteen negative electrons. Negative charge wins by one, so chlorine becomes negatively charged.

Opposite charges attract, so the positive sodium and negative chlorine pull toward each other. Together, they form sodium chloride, which is ordinary table salt. Two elements that are dangerous or highly reactive by themselves can form a substance we regularly place on food because their atoms have connected in a new way.

An atom that gains or loses electrons is called an ion. Losing electrons creates a positive ion because some negative charge has been removed. Gaining electrons creates a negative ion because extra negative charge has been added.

This can feel backward at first. People may think losing something should make the atom negative. Remember that the atom is losing negative electrons. If we remove negative charge, the positive protons have the advantage.

Electrons can change without changing the element. Sodium remains sodium after losing an electron because it still has eleven protons. The electron number changed its charge, not its identity.

Chemical reactions mostly involve electrons. When wood burns, food is digested, iron rusts, or ingredients are cooked, atoms rearrange their connections by sharing or transferring electrons. The nuclei generally remain unchanged.

This is completely different from a nuclear reaction. A nuclear reaction changes something inside the nucleus. If the proton number changes, one element can become another. Nuclear reactions can release enormous amounts of energy because they involve the tightly held center of the atom.

The Sun produces energy through nuclear fusion. Deep inside it, hydrogen nuclei are forced together by tremendous heat and pressure. They eventually combine and help create helium. A small amount of mass is converted into energy, which travels outward as light and heat. The sunlight warming our skin began with changes inside atomic nuclei.

Electrons also make electricity possible. In materials such as metal, some electrons can move between atoms. A battery supplies an electrical push that causes charge to move through a complete circuit. That moving charge is electric current.

When a light is switched on, electrons do not begin their journey at the power plant and individually race all the way to the bulb. Electrons are already present throughout the wires. The electrical influence moves through the circuit and causes those electrons to begin moving, somewhat like pushing one end of a tube already filled with marbles.

Static electricity also comes from electrons changing locations. When a balloon is rubbed against hair, electrons may transfer from one material to the other. The balloon gains extra negative charge, while the hair loses some negative charge. The difference in charge causes attraction, making the hair move toward the balloon.

Protons normally remain locked inside the atomic nucleus. Electrons are the particles that commonly move during electricity and chemical reactions. Neutrons remain inside the nucleus as well, helping provide mass and stability.

Almost all the atom’s mass is concentrated inside the nucleus because electrons are extremely light. A proton or neutron has roughly eighteen hundred times the mass of an electron. The electron matters greatly, but not because it is heavy. It matters because of where it is and how it interacts.

Atoms contain a surprising amount of open space. If an atom were enlarged until it was the size of a large stadium, its nucleus would be extremely small near the center. The electrons would occupy regions far away, and nearly everything between them would be open space.

If atoms contain so much open space, why can we not walk through a wall? The answer is that electrons in our body interact with electrons in the wall. Their electrical forces resist being pushed together, and the particles follow rules that prevent them from simply occupying the same arrangement. What we experience as the wall’s solid surface is largely the force between atoms pushing back.

We can now build one complete atom. Take carbon. Carbon must contain six protons because six is its identity number. A common carbon atom contains six neutrons, adding mass and helping form the nucleus. It also has six electrons around the nucleus, balancing the six positive proton charges.

If we change the neutrons, we get another carbon isotope. If we change the electrons, we get a charged carbon ion. If we change the protons, we no longer have carbon.

That gives us the cleanest way to remember everything. Protons answer, “Which element is this?” Neutrons answer, “Which version of the element is this, and how stable is its nucleus?” Electrons answer, “How will this atom behave, connect, and react?”

The entire material world grows from those relationships. Protons create the identities listed on the periodic table. Neutrons help construct atomic nuclei and create different isotopes. Electrons allow atoms to connect and form molecules. Those molecules become water, air, stone, blood, plants, animals, planets, and stars. Three tiny particles, arranged in different amounts, build nearly everything we know.