

The Atom

Background Essay

All matter—basically anything that has mass and takes up space—is made up of tiny particles called atoms. At one time, atoms were thought to be the fundamental unit of matter (the smallest particles from which all matter was made). In fact, the term "atom" originated from a Greek word meaning "indivisible." However, in the late 19th century, it was discovered that the atom was not the most basic particle of matter, and that atoms are composed of even smaller particles.

Atoms are microscopic—there are roughly one million atoms across the thickness of a single human hair—and cannot be seen without the aid of special technology. Each atom is composed of subatomic particles: protons, neutrons, and electrons. In a basic atomic model, electrons orbit a dense nucleus made of protons and neutrons. The random orbits of electrons are sometimes referred to as an electron cloud because the electrons are in constant motion, so the atom has no distinct outer edge.

The space occupied by the electrons is much larger than the space taken up by the nucleus. In a hydrogen atom, the orbits of the electrons are about 100,000 times the diameter of the nucleus. However, electrons are the least massive of the three types of particles and add almost no mass to an atom. Each proton and neutron contained in the nucleus is about 1,837 times more massive than an electron. Protons, neutrons, and electrons also vary in their electrical charges: protons have a positive charge, electrons have a negative charge, and neutrons have no charge.

Electrons are held in orbit around the nucleus by the electromagnetic force (the negatively charged electrons are attracted to the positively charged nucleus). However, electrons can be lost, gained, or shared to create bonds with other atoms in chemical reactions. The chemical properties of an element are determined by how its electrons are arranged.

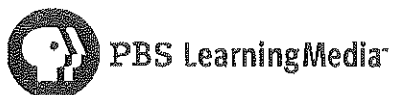
The number of protons within the nucleus defines the atomic number, which is unique to each chemical element; if a proton is added or removed from an element, it becomes a different element. Variations in the number of neutrons in the nucleus form isotopes of an element; while isotopes differ in mass from one another, their chemical properties are still similar. Protons and neutrons are bound together in the nucleus by the strong

nuclear force—a force much stronger than the electromagnetic force that holds electrons to the nucleus. The number of protons or neutrons in the nucleus can only be changed by radioactive transformations.

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Discussion Questions

- Just how small do you think an individual atom is?
- Why don't protons stick together?
- Why can't an atom lose or gain a proton?
- What is in the space between electrons?
- What do you suppose would cause an atom to lose an electron?

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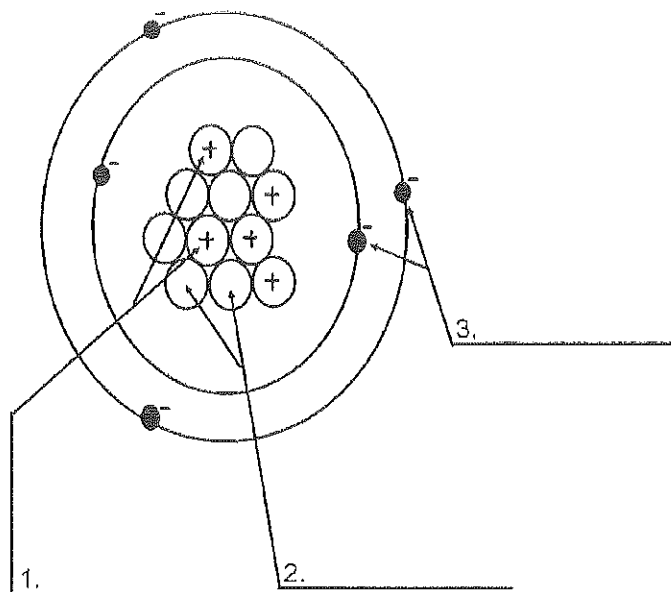
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Name _____

Period _____

Atomic Structure Worksheet

Label the parts of an atom on the diagram below.



4. What type of charge does a proton have?

5. What type of charge does a neutron have?

6. What type of charge does an electron have?

7. Which two subatomic particles are located in the nucleus of an atom?

8. If an atom has 35 protons in the nucleus, how many electrons will it have orbiting the nucleus?

9. What is the atomic number of the atom in the diagram above?

10. What is the atomic mass/mass number of the atom in the diagram above?

11. How many protons are in the nucleus of an atom with an atomic number of 15?

12. How many electrons are in the nucleus of an atom with an atomic number of 20?

13. How many neutrons are in the nucleus of an atom with an atomic number of 25?
(use Periodic Table for mass)

14. What is the mass number of an atom with 3 protons, 4 neutrons, and 3 electrons?

15. How many neutrons are in the nucleus of an atom that has an atomic mass of 36 and an atomic number of 25?