

ChemQuest 8

Structure of the Atom

Name: _____

Date: _____

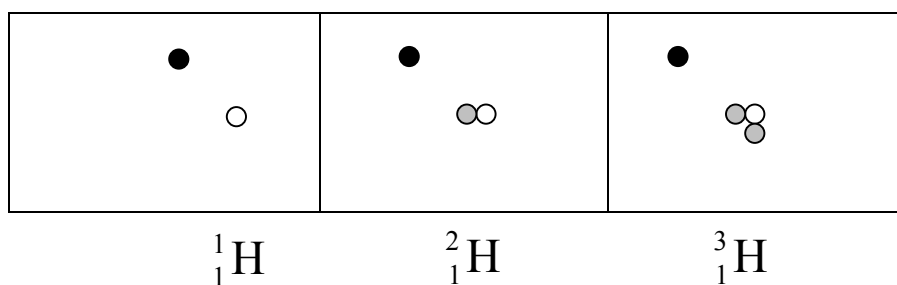
Hour: _____

Information: Structure of the Atom

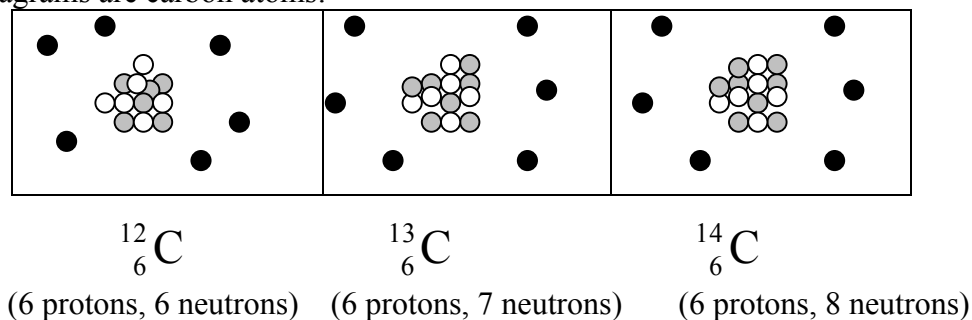
Note the following symbols: (they are not to scale)

- = proton (positive charge)
- = electron (negative charge)
- ◐ = neutron (no charge)

The following three diagrams are hydrogen atoms:



The following three diagrams are carbon atoms:



Notice the type of notation used for atoms:



X = chemical symbol of the element

Z = "atomic number"

A = "mass number"

${}^{12}_6\text{C}$, ${}^{13}_6\text{C}$, and ${}^{14}_6\text{C}$ are notations that represent **isotopes** of carbon.

${}^1_1\text{H}$, ${}^2_1\text{H}$ and ${}^3_1\text{H}$ are notations that represent **isotopes** of hydrogen.

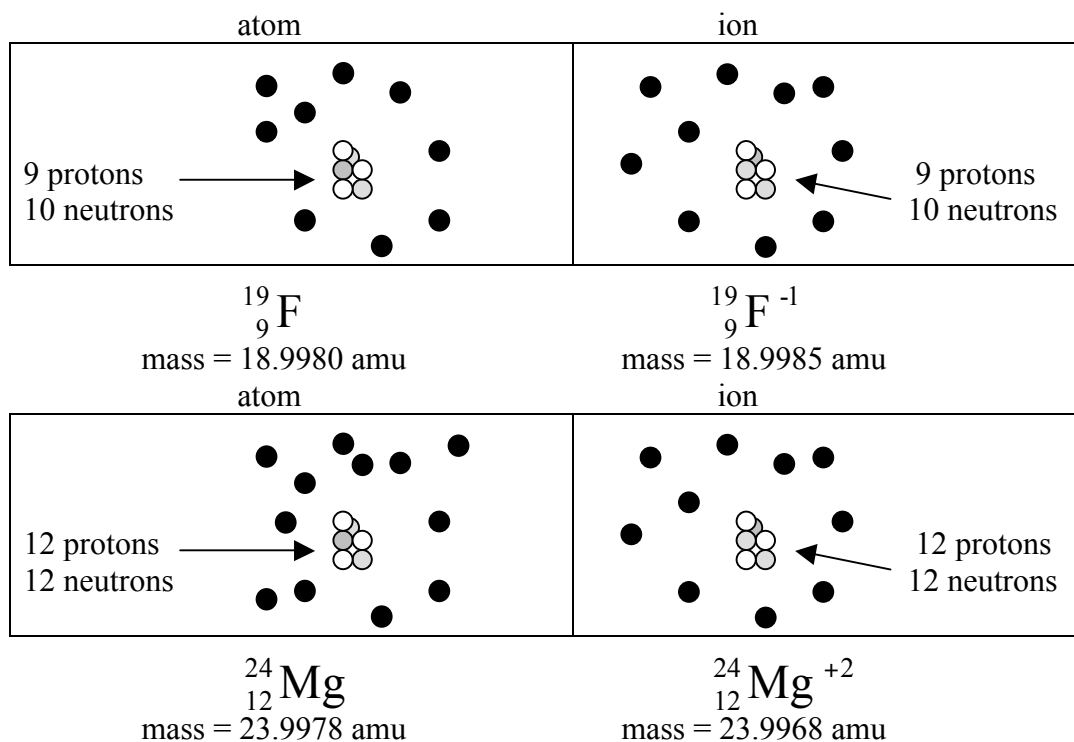
The part of the atom where the protons and neutrons are is called the **nucleus**.

Critical Thinking Questions

- How many protons are found in each of the following: ${}^1_1\text{H}$? in ${}^2_1\text{H}$? in ${}^3_1\text{H}$?
Each has one proton, given by the atomic number of one.
- How many neutrons are found in each of the following: ${}^1_1\text{H}$? in ${}^2_1\text{H}$? in ${}^3_1\text{H}$?
 ${}^1_1\text{H}$ has zero neutrons ${}^2_1\text{H}$ has one neutron ${}^3_1\text{H}$ has two neutrons
Calculate the number of neutrons by taking the mass number and subtracting the atomic number.
- How many electrons are found in each of the following: ${}^1_1\text{H}$? in ${}^2_1\text{H}$? in ${}^3_1\text{H}$?
Each has one electron. Every atom has the same number of electrons as protons.
- What structural characteristics do all hydrogen atoms have in common?
Each hydrogen atom has the same number of protons (1) and the same number of electrons (1).
- What structural characteristics do all carbon atoms have in common?
Each carbon atom has the same number of protons (6) and the same number of electrons (6).
- What does the mass number tell you? Can you find the mass number of an element on the periodic table? It tells you the total number of protons plus neutrons. The mass number is **not** found on the periodic table.
- What does the atomic number tell you? Can you find the atomic number of an element on the periodic table? It tells you the number of protons that an atom has. The atomic number is found on the periodic table.
- Define the term **isotope**. The term “isotope” refers to an atom that has the same number of protons as another atom, but a different number of neutrons.
- How does one isotope of carbon differ from another isotope of carbon?
The isotopes have different numbers of neutrons (but the same number of protons).

Information: Atoms, Ions, Masses of Subatomic Particles

The atomic mass unit (amu) is a special unit for measuring the mass of very small particles such as atoms. The relationship between amu and grams is the following: $1.00 \text{ amu} = 1.66 \times 10^{-24} \text{ g}$
 Note the following diagrams of a fluorine atom and a fluorine ion.



Critical Thinking Questions

10. What is structurally different between an atom and an ion? Note: This is the ONLY structural difference between an atom and an ion.

An ion has a different number of electrons than protons. An atom always has the same number of protons as electrons. For example, the fluoride ion has one more electron than protons and the magnesium ion has two fewer electrons than protons.

11. In atomic mass units (amu), what is the mass of an electron? Since the fluoride ion has one extra electron than the fluorine atom, you can subtract their masses to find the mass of one electron.

$$18.9985 - 18.9980 = 0.0005 \text{ amu}$$

12. Is most of the mass of an atom located in the nucleus or outside the nucleus? How do you know?

Most of the mass is inside the nucleus. The electrons only have a mass of 0.0005 amu each. All of the rest of the mass is in the nucleus, where the protons and neutrons are located.

13. If protons and neutrons have the same mass, what is the approximate mass of a proton and neutron in atomic mass units (amu)? **Almost all of the nearly 19 amu of a fluorine atom is located in the nucleus, where there are a total of 19 protons and neutrons. The 19 protons and neutrons add up to a mass of approximately 19 amu and thus each proton and each neutron has a mass of about 1 amu.**
14. The mass of carbon-14 (mass number = 14) is about 14 amu. Does this agree with what you determined in questions 11 and 13?
Yes, since each proton and each neutron has a mass of about 1 amu (question #13) and the electrons have almost no mass (question #11) the mass of an atom that has 14 protons and neutrons should be about 14 amu.
15. The charge (in the upper right hand corner of the element symbol) is -1 for a fluorine ion. Why isn't it $+1$ or some other number?
The fluoride ion has one more electron (negative charge) than protons (positive charge).
16. What is the charge on every atom? Why is this the charge?
Every atom has a charge of zero (neutral) because of equal numbers of protons and electrons.
17. How do you determine the charge on an ion?
Compare the number of protons and electrons. Take the number of protons and subtract the number of electrons.
18. An oxygen ion has a -2 charge. (Use your periodic table if necessary)
- How many protons does the oxygen ion have? **From the periodic table we see that oxygen is atomic number 8 and therefore it has 8 protons.**
 - How many electrons does the oxygen ion have? **10 electrons because it must have two more electrons than protons.**