



14.1 Structure of the Atom

READ

Atoms are made of three tiny subatomic particles: protons, neutrons, and electrons. The protons and neutrons are grouped together in the nucleus, which is at the center of the atom. The chart below compares electrons, protons, and neutrons in terms of charge and mass.

	Occurrence	Charge	Mass (g)
 Electron	found outside of nucleus	-1	9.109×10^{-28}
 Proton	found in all nuclei	+1	1.673×10^{-24}
 Neutron	found in almost all nuclei (exception: most H nuclei)	0	1.675×10^{-24}

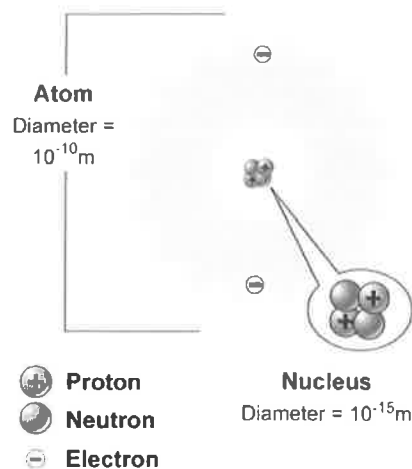
The **atomic number** of an element is the number of protons in the nucleus of every atom of that element.

Isotopes are atoms of the same element that have different numbers of neutrons. The number of protons in isotopes of an element is the same.

The **mass number** of an isotope tells you the number of protons plus the number of neutrons.

Mass number = number of protons + number of neutrons

Size and Structure of the Atom



EXAMPLE

- Carbon has three isotopes: carbon-12, carbon-13, and carbon-14. The atomic number of carbon is 6.
 - How many protons are in the nucleus of a carbon atom?
Solution:
 6 protons
 The atomic number indicates how many protons are in the nucleus of an atom. All atoms of carbon have 6 protons, no matter which isotope they are.
 - How many neutrons are in the nucleus of a carbon-12 atom?
Solution:
 the mass number - the atomic number = the number of neutrons.
 $12 - 6 = 6$
 6 neutrons
 - How many electrons are in a neutral atom of carbon-13?
Solution:
 6 electrons. All neutral carbon atoms have 6 protons and 6 electrons.
 - How many neutrons are in the nucleus of a carbon-14 atom?
Solution:
 the mass number - the atomic number = the number of neutrons
 $14 - 6 = 8$
 8 neutrons


PRACTICE

Use a periodic table of the elements to answer these questions.

1. The following graphics represent the nuclei of atoms. Using a periodic table of elements, fill in the table.

What the nucleus looks like	What is this element?	How many electrons does the neutral atom have?	What is the mass number?

2. How many protons and neutrons are in the nucleus of each isotope?
- hydrogen-2 (atomic number = 1)
 - scandium-45 (atomic number = 21)
 - aluminum-27 (atomic number = 13)
 - uranium-235 (atomic number = 92)
 - carbon-12 (atomic number = 6)
3. Although electrons have mass, they are not considered in determining the mass number of an atom. Why?
4. A hydrogen atom has one proton, two neutrons, and no electrons. Is this atom an ion? Explain your answer.
5. An atom of sodium-23 (atomic number = 11) has a positive charge of +1. Given this information, how many electrons does it have? How many protons and neutrons does this atom have?

Name: _____

Date: _____

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The atomic number of an element is the number of protons in the nucleus of every atom of that element.

Isotopes are atoms of the same element that have different numbers of neutrons. The number of protons in isotopes of an element is the same.

The mass number of an isotope tells you the number of protons plus the number of neutrons.

Mass number = number of protons + number of neutrons

EXAMPLE

Carbon has three isotopes: carbon-12, carbon-13, and carbon-14. The atomic number of carbon is 6.

a. How many protons are in the nucleus of a carbon atom?

Solution:

6 protons

The atomic number indicates how many protons are in the nucleus of an atom. All atoms of carbon have 6 protons, no matter which isotope they are.

b. How many neutrons are in the nucleus of a carbon-12 atom?

Solution:

the mass number - the atomic number = the number of neutrons.

$12 - 6 = 6$

6 neutrons

c. How many electrons are in a neutral atom of carbon-13?

Solution:

6 electrons. All neutral carbon atoms have 6 protons and 6 electrons.

d. How many neutrons are in the nucleus of a carbon-14 atom?

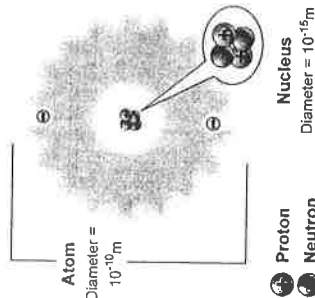
Solution:

the mass number - the atomic number = the number of neutrons

$14 - 6 = 8$

8 neutrons

Size and Structure of the Atom



PRACTICE

Use a periodic table of the elements to answer these questions.

1. The following graphics represent the nuclei of atoms. Using a periodic table of elements, fill in the table.

What the nucleus looks like	What is this element?	How many electrons does the neutral atom have?	What is the mass number?
	Lithium Li	3	7
	Carbon C	6	12
	Hydrogen	1	1
	Hydrogen	1	3
	Beryllium Be	4	9

2. How many protons and neutrons are in the nucleus of each isotope?

- hydrogen-2 (atomic number = 1) $P = 1, N = 1, Z = 2$
- scandium-45 (atomic number = 21) $P = 21, N = 24, Z = 45$
- aluminum-27 (atomic number = 13) $P = 13, N = 14, Z = 27$
- uranium-235 (atomic number = 92) $P = 92, N = 143, Z = 235$
- carbon-12 (atomic number = 6) $P = 6, N = 6, Z = 12$

3. Although electrons have mass, they are not considered in determining the mass number of an atom.

Why? electrons are much lighter compared to protons and neutrons