4.3

# Distinguishing Among Atoms

## Connecting to Your World

# Atomic Number

## What makes one element different from another?

**Elements are different from one another because they contain different numbers of protons.**

**Atomic Number=** The number of protons an element has. (It is the small whole number in the periodic table.)

## Understanding Atomic Number

The element nitrogen (N), shown here in liquid form, has an atomic number of 7. How many protons and electrons are in a neutral nitrogen atom?

**15.** Complete the table.

| Element | Atomic number | Protons | Electrons |
|---|---|---|---|
| K | 19 | (a) | 19 |
| (b) | (c) | (d) | 5 |
| S | 16 | (e) | (f) |
| V | (g) | 23 | (h) |

# Mass Number

## How do you find the number of neutrons in an atom?

The total number of protons and neutrons in an atom is called the **mass number.**

**The number of neutrons in an atom is the difference between the mass number and atomic number.**

$$\text{Number of neutrons} = \text{mass number} - \text{atomic number}$$

Au is the chemical symbol for gold.

# SAMPLE PROBLEM 4.1

## Determining the Composition of an Atom

How many protons, electrons, and neutrons are in each atom?

| | Atomic number | Mass number |
|---|---|---|
| **a.** Beryllium (Be) | 4 | 9 |
| **b.** Neon (Ne) | 10 | 20 |
| **c.** Sodium (Na) | 11 | 23 |

**17.** How many neutrons are in each atom?

**a.** $^{16}_{8}O$ **b.** $^{32}_{16}S$ **c.** $^{108}_{47}Ag$

**d.** $^{80}_{35}Br$ **e.** $^{207}_{82}Pb$

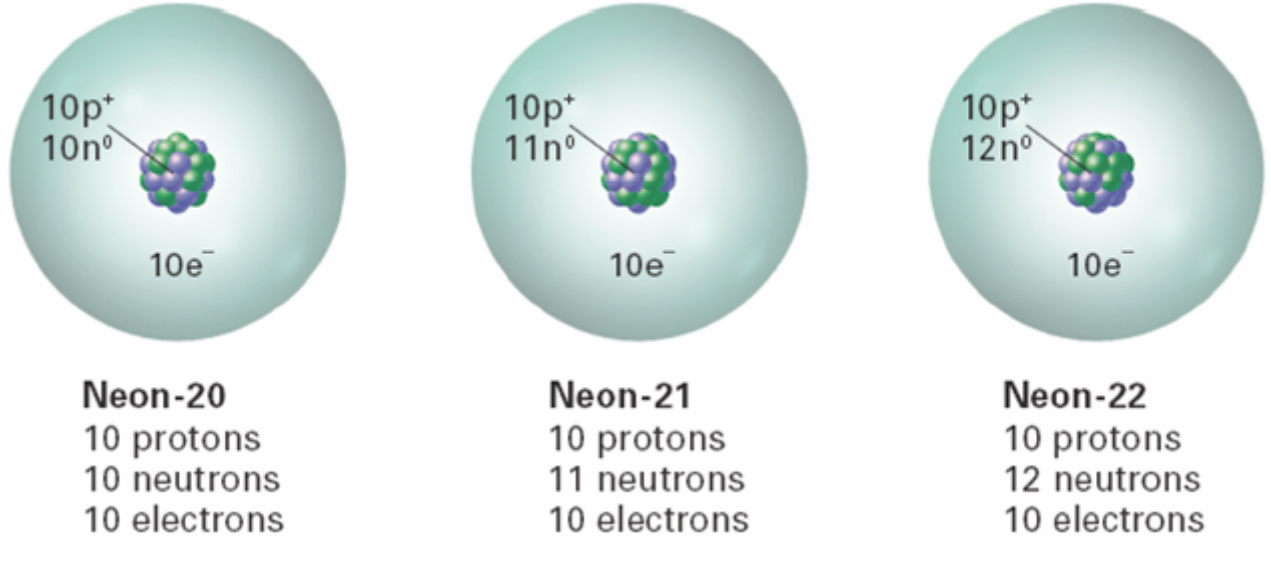
# Isotopes

## How do isotopes of an element differ?

**Isotopes** are atoms that have the same number of protons but different numbers of neutrons.

**Because isotopes of an element have different numbers of neutrons, they also have different mass numbers.**

Isotopes: Chemically alike because have same number of protons and electrons. Only the number of neutrons is different.




**Neon-20**
10 protons
10 neutrons
10 electrons

**Neon-21**
10 protons
11 neutrons
10 electrons

**Neon-22**
10 protons
12 neutrons
10 electrons

# Writing chemical symbols of isotopes:

Carbon-12 or $^{12}C$ : both mean the carbon isotope with a mass number of 12.

**20.** Three isotopes of chromium are chromium-50, chromium-52, and chromium-53. How many neutrons are in each isotope, given that chromium has an atomic number of 24?

**Problem Solving 4.20**
Solve Problem 20 with the help of an interactive guided tutorial.

# Atomic Mass

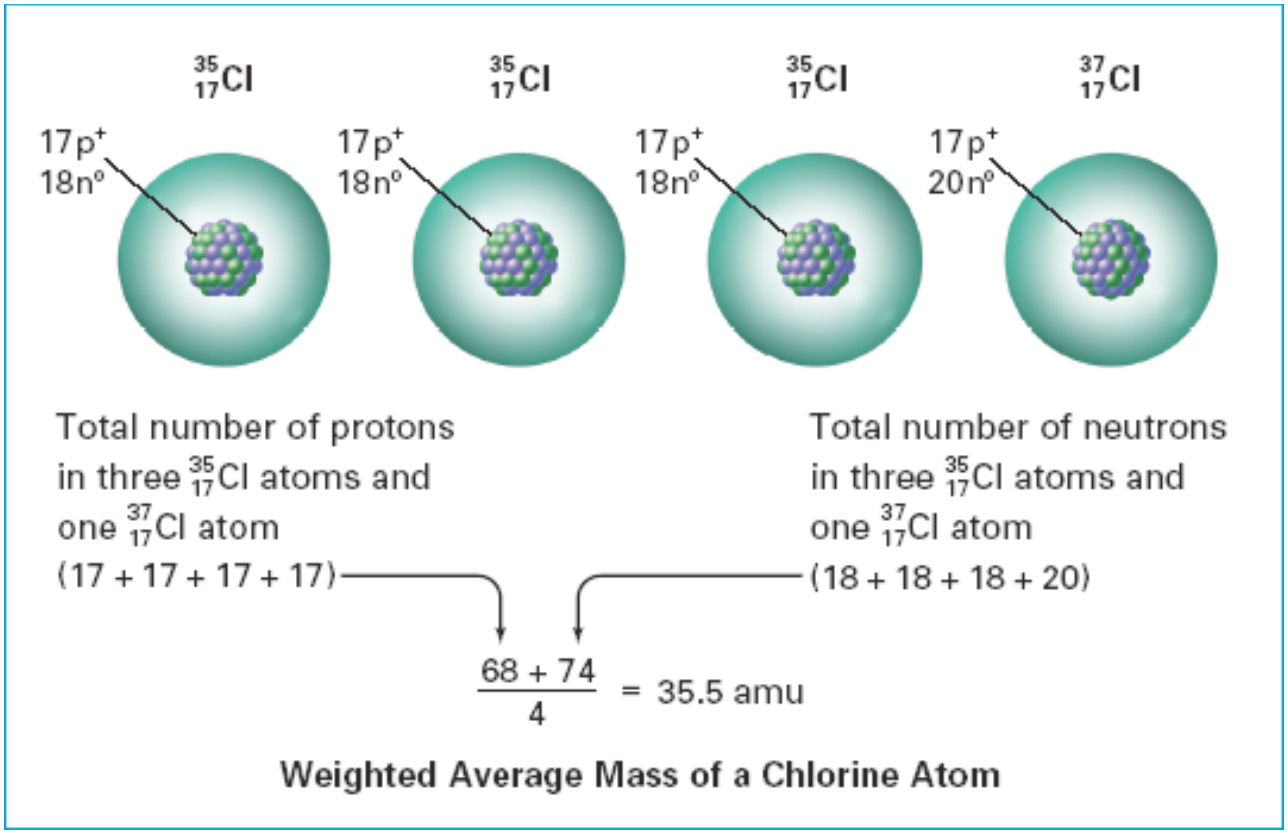
## How do you calculate the atomic mass of an element?

An **atomic mass unit (amu)** is defined as one twelfth of the mass of a carbon-12 atom.
It is the unit used for atomic mass.

The **atomic mass** of an element is a weighted average mass of the atoms in a naturally occurring sample of the element.

A weighted average mass reflects both the mass and the relative abundance of the isotopes as they occur in nature.

# Weighted Average Mass of a Chlorine Atom



# Using Atomic Mass to Determine the Relative Abundance of Isotopes

The atomic mass of copper is 63.546 amu. Which of copper's two isotopes is more abundant: copper-63 or copper-65?

# 4.3 Section Quiz

1. Isotopes of an element have

   a. the same mass number.

   b. different atomic numbers.

   c. the same number of protons but different numbers of neutrons.

   d. the same number of protons but different numbers of electrons.

# 4.3 Section Quiz

2. How many neutrons are in sulfur-33?

a. 16 neutrons

b. 33 neutrons

c. 17 neutrons

d. 32.06 neutrons

# 4.3 Section Quiz

3. If sulfur contained 90.0% sulfur-32 and 10.0% sulfur-34, its atomic mass would be

a. 32.2 amu.

b. 32.4 amu.

c. 33.0 amu.

d. 35.4 amu.