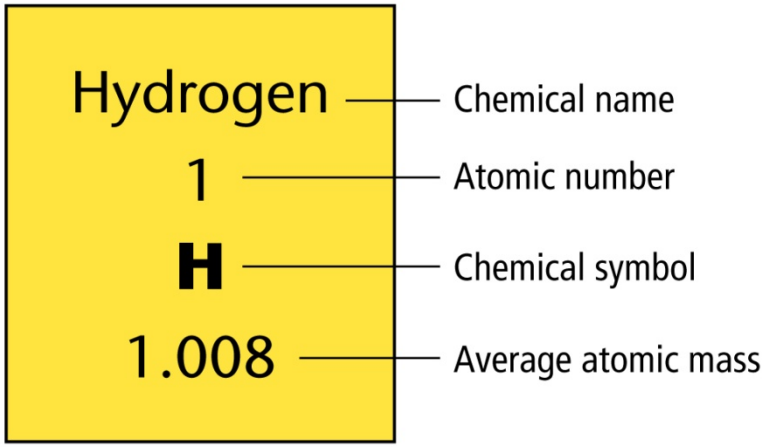
# Chapter 4 : The Structure of the Atom

Section 3 & 4 Notes

Atomic Number

# Section 4-3

- Each element contains a unique positive charge in their nucleus.
- The number of protons in the nucleus of an atom identifies the element and is known as the element's **atomic number**.



Isotopes and Mass Number

# Section 4-3

- All atoms of a particular element have the same number of protons and electrons but the number of neutrons in the nucleus can differ.

- Atoms with the same number of protons but different numbers of neutrons are called **isotopes**.

# Section 4-3

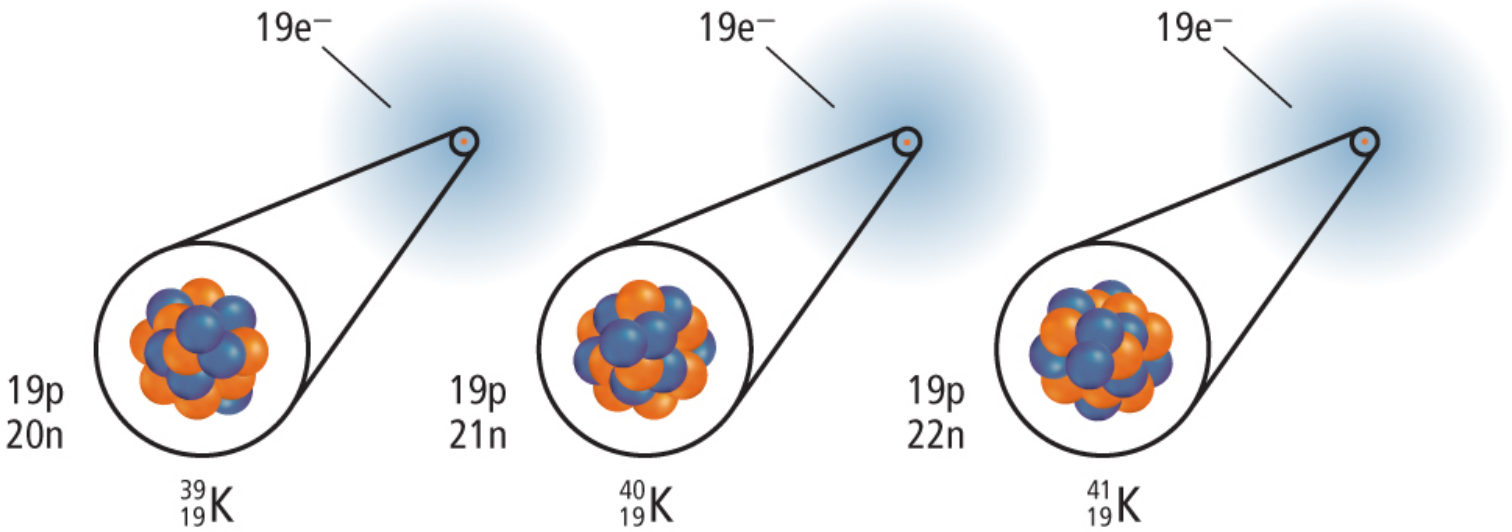
- The relative abundance of each isotope is usually constant.

- Isotopes containing more neutrons have a greater mass.
- Isotopes have the same chemical behavior.
- The **mass number** is the sum of the protons and neutrons in the nucleus.

## Isotopes and Mass Number (cont.)

# Section 4-3

| | Potassium-39 | Potassium-40 | Potassium-41 |
|---|---|---|---|
| Protons | 19 | 19 | 19 |
| Neutrons | 20 | 21 | 22 |
| Electrons | 19 | 19 | 19 |



# Section 4-3

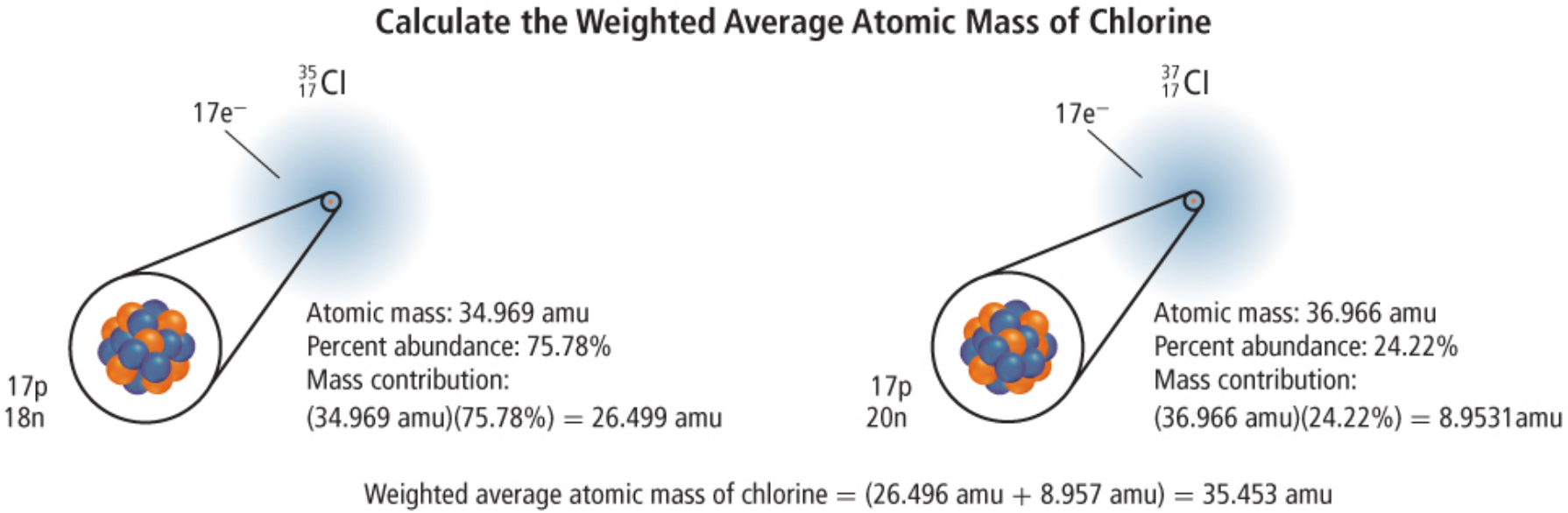
- One **atomic mass unit** (amu) is defined as 1/12$^{th}$ the mass of a carbon-12 atom.
- One amu is nearly, but not exactly, equal to one proton and one neutron.

**Table 4.4 Masses of Subatomic Particles**

| Particle | Mass (amu) |
|---|---|
| Electron | 0.000549 |
| Proton | 1.007276 |
| Neutron | 1.008665 |

# Section 4-3

- The **atomic mass** of an element is the weighted average mass of the isotopes of that element.



# Section 4-4

- Nuclear reactions can change one element into another element.
- In the late 1890s, scientists noticed some substances spontaneously emitted radiation, a process they called **radioactivity**.
- The rays and particles emitted are called **radiation**.
- A reaction that involves a change in an atom's nucleus is called a **nuclear reaction**.

# Section 4-4

- Unstable nuclei lose energy by emitting radiation in a spontaneous process called **radioactive decay**.

- Unstable radioactive elements undergo radioactive decay thus forming stable nonradioactive elements.

# Section 4-4

- **Alpha radiation** is made up of positively charged particles called **alpha particles**.
- Each alpha particle contains two protons and two neutrons and has a $2^+$ charge.

# Section 4-4

- The figure shown below is a **nuclear equation** showing the radioactive decay of radium-226 to radon-222.

$$^{226}_{88}\text{Ra} \rightarrow {}^{222}_{86}\text{Rn} + \alpha$$

radium-226 radon-222 alpha particle

- The mass is conserved in nuclear equations.

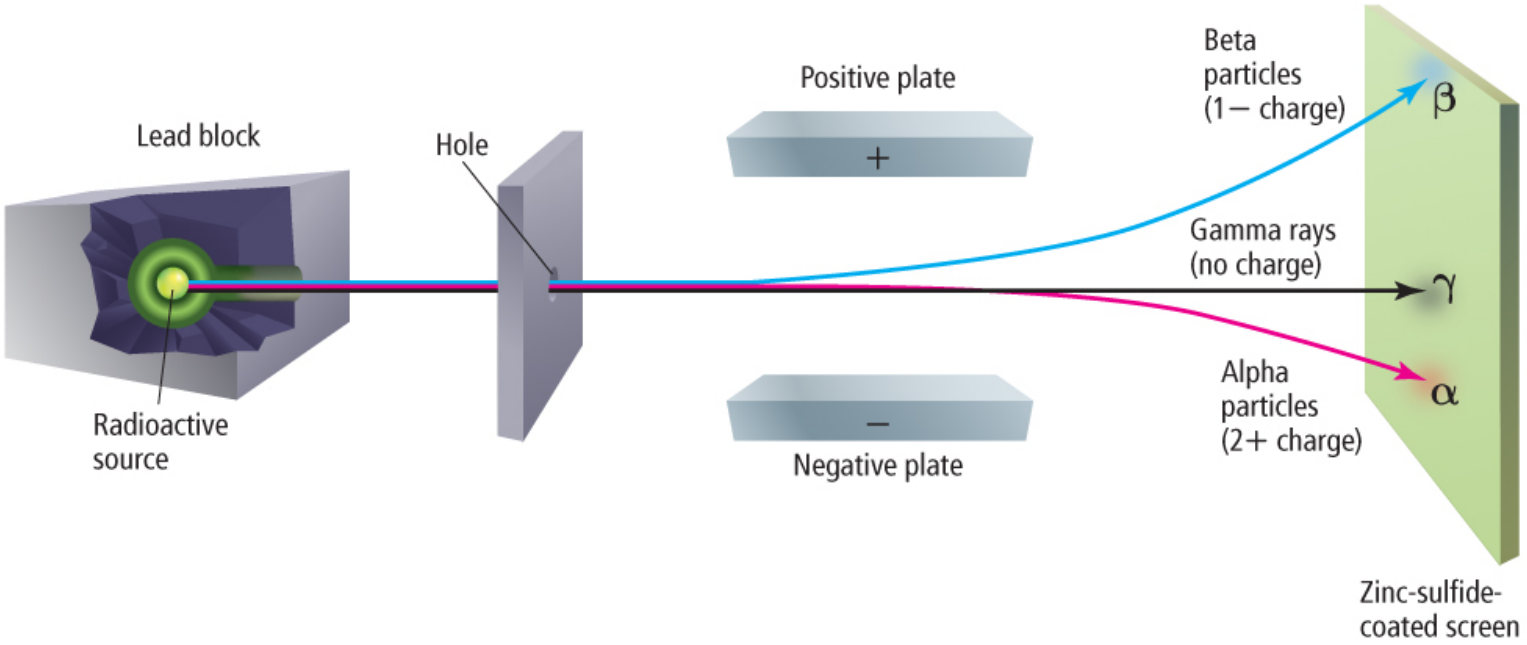
# Section 4-4

- **Beta radiation** is radiation that has a negative charge and emits beta particles.
- Each **beta particle** is an electron with a 1– charge.

$$^{14}_{6}C \rightarrow {}^{14}_{7}N + \beta$$

carbon-14 nitrogen-14 beta particle

# Section 4-4




Concepts In Motion
Click here to view an animated version of this graphic.

# Section 4-4

- **Gamma rays** are high-energy radiation with no mass and are neutral.
- Gamma rays account for most of the energy lost during radioactive decay.

**Table 4.5 Characteristics of Radiation**

| | Alpha | Beta | Gamma |
|---|---|---|---|
| Symbol | ${}_2^4\mathrm{He}$ or $\alpha$ | $e^-$ or $\beta$ | $\gamma$ |
| Mass (amu) | 4 | $\frac{1}{1840}$ | 0 |
| Mass (kg) | $6.65 \times 10^{-27}$ | $9.11 \times 10^{-31}$ | 0 |
| Charge | 2+ | 1− | 0 |

# Section 4-4

- Atoms that contain too many or two few neutrons are unstable and lose energy through radioactive decay to form a stable nucleus.

- Few exist in nature—most have already decayed to stable forms.