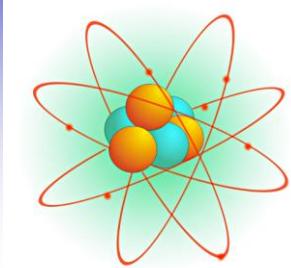


Atomic Structure



Subatomic particles

Name	Symbol	Charge	Relative mass
Electron	e^-	-1	~0
Proton	p^+	+1	1
Neutron	n^0	0	1

• Electrons and protons have equal but opposite charges

• Electrons are so tiny we say their mass is "negligible" and ignore it when doing calculations. This means that the mass of an atom comes from the protons and neutrons.

Structure of the Atom

There are two regions

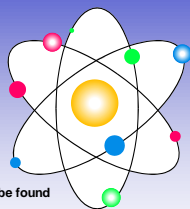
The nucleus

» With protons and neutrons

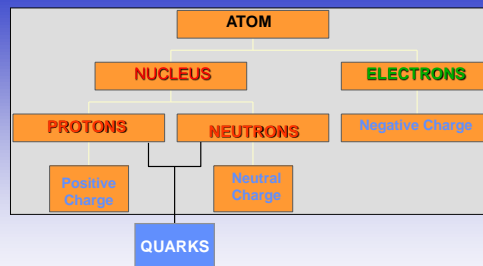
- Positive charge
- Almost all the mass
- Very dense

Electron cloud

- Most of the volume of an atom
- The region where the electron can be found



Subatomic Particles



-The mass of an atom comes from the protons and neutrons.

-There will be an equal number of protons and electrons in a neutral atom.

-The atomic number is equal to the number of protons and identifies the element.

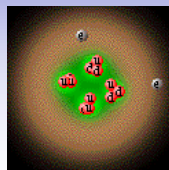
Subatomic Particles

• Quarks

-component of protons & neutrons

-6 types

-3 quarks = 1 proton or 1 neutron



He

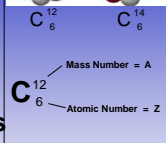
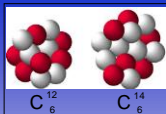
Size of an atom



- Atoms are incredibly tiny.
- Measured in a unit called picometers.
- Nucleus is tiny and dense.
- IF the atom was the size of a stadium, the nucleus would be the size of a marble.



Counting the Pieces



Atomic Number = number of protons
 # of protons determines kind of atom

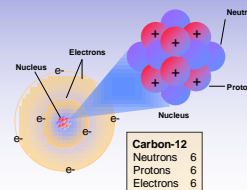
Atomic Number = number of electrons in a neutral (uncharged) atom



California WEB

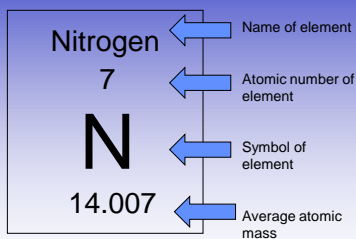
Mass Number

- mass Number = protons + neutrons
- always a whole number
- NOT on the Periodic Table!

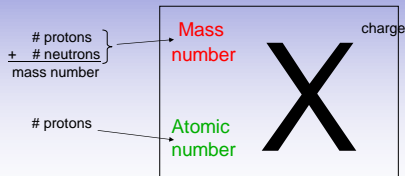


(Periodic table has average masses, which are usually shown as decimal numbers. When you need to use the mass off the periodic table to find the number of protons or neutrons, you have to round it to the nearest whole number.)

What does your periodic table tell you... how do you read it?



Isotope Notation



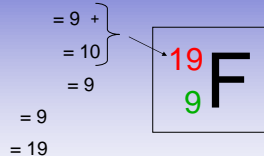
If there is a charge on the atom it will be written in the upper right hand corner- if there is nothing there assume that this is a neutral atom and the charge is zero.

Symbols



Find the

- number of protons
- number of neutrons
- number of electrons
- Atomic number
- Mass number



Symbols



Find the

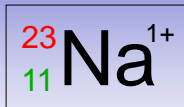
- number of protons = 35
- number of neutrons = 45
- number of electrons = 35
- Atomic number = 35
- Mass number = 80



Symbols

Find the

- number of protons = 11
- number of neutrons = 12
- number of electrons = 10
- Atomic number = 11
- Mass number = 23



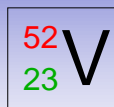
Sodium ion

Symbols



If an element has an atomic number of 23 and a mass number of 52 what is the

- number of protons = 23
- number of neutrons = 29
- number of electrons = 23
- Complete symbol



*Notice that on the periodic table vanadium has a mass of 51. This is because of isotopes. (Much more about that later!) Use the mass number they give you in a problem, or if you need to calculate mass number add protons and neutrons together- you can't just look at the average mass on the periodic table and assume it is the mass number.

Symbols



If an element has 60 protons and 84 neutrons what is the

- Atomic number = 60
- Mass number = 144
- number of electrons = 60
- Complete symbol



Symbols



If a neutral atom of an element has 78 electrons and 117 neutrons what is the

- Atomic number = 78
- Mass number = 195
- number of protons = 78
- Complete symbol



Ions and Isotopes

Not all atoms are the same!

Remember: The number of protons always identifies the element!

IONS

- **IONS** are atoms or groups of atoms which have lost or gained electrons to become positively or negatively charged

=> Have unequal numbers of protons and electrons

IONS

- **Losing** an electron from an atom gives a **CATION** with a **positive charge**
- **Adding** an electron to an atom gives an **ANION** with a **negative charge**.
- To tell the difference between an atom and an ion, look to see if there is a charge in the superscript!

Examples: Na^+ Ca^{+2} I^- O^{-2} charged ions
 Na Ca I O uncharged atoms

Forming Cations & Anions

A **CATION** forms when an atom loses one or more electrons.



Mg 12 protons, 12 electrons



An **ANION** forms when an atom gains one or more electrons.



F 9 protons, 9 electrons



PREDICTING ION CHARGES

In general

- **metals** lose electrons \rightarrow **cations**
- **nonmetals** gain electrons \rightarrow **anions**

Learning Check – Counting

State the number of protons, neutrons, and electrons in each of these ions.



#p⁺ _____

#n^o _____

#e⁻ _____

Learning Check – Answers

State the number of protons, neutrons, and electrons in each of these ions.



#p⁺ 19 8 20

#n^o 20 8 21

#e⁻ 18 10 18

Learning Check

Write the nuclear symbol form for the following atoms or ions:

A. 8 p⁺, 8 n, 8 e⁻ _____

B. 17p⁺, 20n, 17e⁻ _____

C. 47p⁺, 60 n, 46 e⁻ _____

Learning Check- Answers

Write the nuclear symbol form for the following atoms or ions:

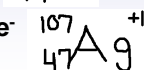
A. 8 p⁺, 8 n, 8 e⁻



B. 17p⁺, 20n, 19e⁻



C. 47p⁺, 60 n, 46 e⁻

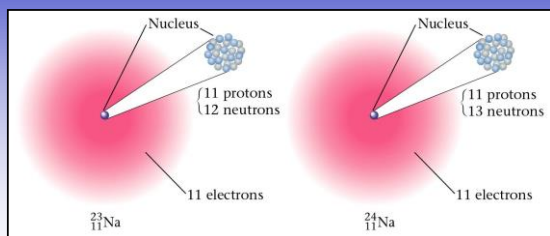


Isotopes

- Atoms of the same element (same # of protons) but different mass number
- Caused by atoms having different numbers of neutrons
- Boron-10 (¹⁰B) has 5 p and 5 n
- Boron-11 (¹¹B) has 5 p and 6 n



Example: Two isotopes of sodium.



Na-23

Na-24

Atomic Symbols

- Hyphen notation- Show the name of the element, a hyphen, and the mass number in hyphen notation

sodium-23

- Isotope notation- Show the mass number and atomic number in nuclear symbol form



Learning Check – Counting

¹²C
6

¹³C
6

¹⁴C
6

#p⁺ _____

#n⁰ _____

#e⁻ _____

Answers

¹²C
6

¹³C
6

¹⁴C
6

#p⁺ 6

6

6

#n⁰ 6

7

8

#e⁻ 6

6

6

Learning Check

Which of the following represent isotopes of the same element?
Which element?



Learning Check

Which of the following represent isotopes of the same element?
Which element?



Learning Check

An atom has 14 protons and 20 neutrons.

- A. Its atomic number is
1) 14 2) 16 3) 34
- B. Its mass number is
1) 14 2) 16 3) 34
- C. The element is
1) Si 2) Ca 3) Se
- D. Another isotope of this element is
1) ${}^{34}_{16}\text{X}$ 2) ${}^{34}_{14}\text{X}$ 3) ${}^{36}_{14}\text{X}$

Learning Check- Answers

An atom has 14 protons and 20 neutrons.

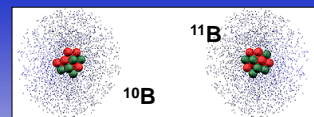
- A. Its atomic number is
1) 14
- B. Its mass number is
3) 34
- C. The element is
1) Si
- D. Another isotope of this element is
2) ${}^{34}_{14}\text{X}$ 3) ${}^{36}_{14}\text{X}$

AVERAGE ATOMIC MASS

- Because of the existence of isotopes, the mass of a collection of atoms has an average value.

$$\text{AAM} = (\text{mass A}) (\% \text{abundance A}) + (\text{Mass B}) (\% \text{abundance B}) + \dots$$

AVERAGE ATOMIC MASS



- Boron is 20% ${}^{10}\text{B}$ and 80% ${}^{11}\text{B}$. That is, ${}^{11}\text{B}$ is 80 percent abundant on earth.
- For boron atomic weight
= 0.20 (10 amu) + 0.80 (11 amu) = 10.8 amu

(Check this with what's on the periodic table)

Learning Check

- ${}^6\text{Li}$ = 7.5% abundant and ${}^7\text{Li}$ = 92.5%
–Avg. Atomic mass of Li = _____
- ${}^{28}\text{Si}$ = 92.23%, ${}^{29}\text{Si}$ = 4.67%, ${}^{30}\text{Si}$ = 3.10%
–Avg. Atomic mass of Si = _____

Learning Check- Answers

- ${}^6\text{Li}$ = 7.5% abundant and ${}^7\text{Li}$ = 92.5%
–Avg. Atomic mass of Li = **6.935**
- ${}^{28}\text{Si}$ = 92.23%, ${}^{29}\text{Si}$ = 4.67%, ${}^{30}\text{Si}$ = 3.10%
–Avg. Atomic mass of Si = **28.1087**

Atomic Mass

Calculate the atomic mass of each element described below. Then use the periodic table to identify each element.

Isotope	Mass (amu)	Percent Abundance
${}^{63}\text{X}$	62.930	69.17
${}^{65}\text{X}$	64.928	30.83

Isotope	Mass (amu)	Percent Abundance
${}^{35}\text{X}$	34.969	75.77
${}^{37}\text{X}$	36.966	24.23

Atomic Mass Answers

- ${}^{63}\text{X}$ has an atomic mass of **63.55** and is an atom of **Copper**.
- ${}^{35}\text{X}$ has an atomic mass of **35.45** and is an atom of **Chlorine**.