3 • The Periodic Table & Makeup of Atoms
The Subatomic Particles
(1 of 12)

Name	Symbol	Mass	Charge	Location
protons	p^+	1 u	1+	part of the nucleus
neutron	n°	1 u	0	part of the nucleus
electron	e^-	$\frac{1}{1837}$ u	1–	normally at large distances from the nucleus

J.J. Thompson is given credit for discovering **electrons** using a Crookes tube and testing many different gases. Cathode rays were found to be beams of electrons.

Chadwick is given credit for the discovery of the **neutron**.

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3 • The Periodic Table & Makeup of Atoms
Terms I-- Atomic Structure
(2 of 12)

atoms the smallest particle of an element . It consists of a central nucleus and electron clouds outside the nucleus.

nucleus the dense central portion of an atom.

subatomic smaller than an atom. The proton, neutron, and electron are subatomic.

net charge the difference in the positive charge due to protons and the negative charge due to electrons in an atom.

nucleons the particles that make up the nucleus.

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3 • The Periodic Table & Makeup of Atoms
Terms II-- Atomic Structure
(3 of 12)

atomic number the number of protons in an atom. This # determines the identity of an element.

mass number the number of protons + neutrons

isotopes atoms with the same number of protons, but different numbers of neutrons. Atoms with the same atomic number, but different mass numbers.

isotopic notation shorthand notation for a nucleus that shows the mass #, atomic # and the symbol. U-238 would be $^{238}_{92}U$

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3 • The Periodic Table & Makeup of Atoms
Calculating Atomic Mass
(4 of 12)

Any **real** sample of an element contains more than one naturally occuring **isotope**. For instance, **boron**

isotope		abundance	mass #	isotopic mass
boron-10	$^{10}_{5}B$	19.78%	10	mass = 10.013 u
boron-11	$^{11}_{5}B$	80.22%	11	mass = 11.009 u

The atomic mass is the weighted average of the isotopes.

$$\text{at. mass} = \frac{(19.78\%)(10.013u) + (80.22\%)(11.0009u)}{100} \text{ or}$$

$$\text{at. mass} = (0.1978)(10.013u) + (0.8022)(11.0009u)$$
$$= 10.81 \text{ u}$$

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3 • The Periodic Table & Makeup of Atoms Determining Numbers of Protons, Neutrons, and Electrons from the Isotopic Notation (5 of 12)

Consider the following symbol: $^{33}_{16}S^{2-}$

The 16 is the **atomic number** which is the number of **protons**.

The 33 is the **mass number** which is the mass of one of the isotopes. This mass is due to the **protons and neutrons**.

The number of **neutrons** is the **mass number - the atomic number**. 33 - 16 = 17 neutrons.

Since the charge is 2-, there are 2 **more electrons than protons.** In this case, there are 18 electrons.

3 • The Periodic Table & Makeup of Atoms Important People in the Development of the Atomic Theory (6 of 12)

Democritus [atomos]
philosopher who argued that matter was discontinuous
John Dalton [billiard-ball model]
experimented with gases… different substances are different combinations of atoms
J.J. Thomson [plum-pudding model]
experimented with gas-discharge tubes… atoms have + and – parts… the negative e^-'s are the same for any atom
Ernest Rutherford [nuclear model/solar system model]
most of the mass of the atom is concentrated in a tiny, positively-charged nucleus
Niels Bohr [quantized electron energy levels]
the electrons have only certain allowed energy levels

3 • The Periodic Table & Makeup of Atoms Metals, Nonmetals, and Metalloids (7 of 12)

The elements can be classified as **metals, nonmetals, and metalloids.** Memorize the elements classified as metalloids (also called semi-metals or semiconductors).

Properties of metals include:
ductility - the ability to pull a substance into a wire
sectility - the ability to cut with a knife
malleability - the ability to pound substance into a sheet
conductivity - the ability to carry an electrical current

Gold is the most malleable of all the metals.

3 • The Periodic Table & Makeup of Atoms Rutherford's Gold Foil Experiment (8 of 12)

Ernest Rutherford's classic gold foil experiment led to the **nuclear model** of the atom.

- **the nucleus is tiny** - because most of the alpha's missed the nucleus and went straight through the foil
- **the nucleus is positively charged** - because the (+) charged alpha was repelled by the (+) charged nucleus
- **the nucleus is incredibly dense** - because the nucleus was able to bounce back at a very large angle

3 • The Periodic Table & Makeup of Atoms
The First Periodic Table
(9 of 12)

Meyer and **Mendeleev** are given credit for developing the first version of the periodic table. Mendelleev's true claim to fame was that he actually predicted the existence of several element that had not been discovered. He found gaps in the table when he tried to organize the atoms and left spaces for those elements (ekasilicon = "like silicon", etc.)

He predicted Ga, Ge, and Sc.

He also arranged elements in order of atomic number rather than the previous idea of atomic mass. Several of the elements change order... (like Te and I).

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3 • The Periodic Table & Makeup of Atoms
Families of the Periodic Table
(10 of 12)

Horizontal rows of the table are called **periods**.
Vertical columns are called **groups** or **families**.

Memorize the names of some groups:
IA - the alkali metals
IIA - the alkaline earth metals
VIIA - the halogens
0 - the noble gases

Also know the transition metals, the inner transition metals (composed of the lanthanide series and the actinide series... the lanthanides are also called the rare earth metals)

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3 • The Periodic Table & Makeup of Atoms
Radioactivity Basics
(11 of 12)

Radioactivity was discovered by **Henri Becquerel** (but named by **Marie Curie**).

"Becquerel rays" were found to consist of 3 types or radiation:
alpha particles (α) a helium nucleus - 2 protons + 2 neutrons
…easily stopped by paper or skin

beta particles (β) a high energy electron
…stopped by Al foil (several thicknesses of foil)

gamma radiation (γ) a very high energy form of light (EMR)
…the most penetrating and dangerous of the rays.

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3 • The Periodic Table & Makeup of Atoms
JJ Thomson & cathode ray tubes
(12 of 12)

Know the design of a **cathode rays tubes.** Realize that cathode rays are really beams of electrons. The cathode rays are the same for any substance, but the **canal rays** (the positive ions left after ionizing the gases) are different for each gas.

Know how the bending of cathode rays can tell you the **charge-to-mass ratio (e/m)** (but not the mass or the charge of the electron).

Millikan's oil drop experiment gave evidence for the charge of the electron. Knowing this and the e/m ratio, you can calculate the mass of the electron.
