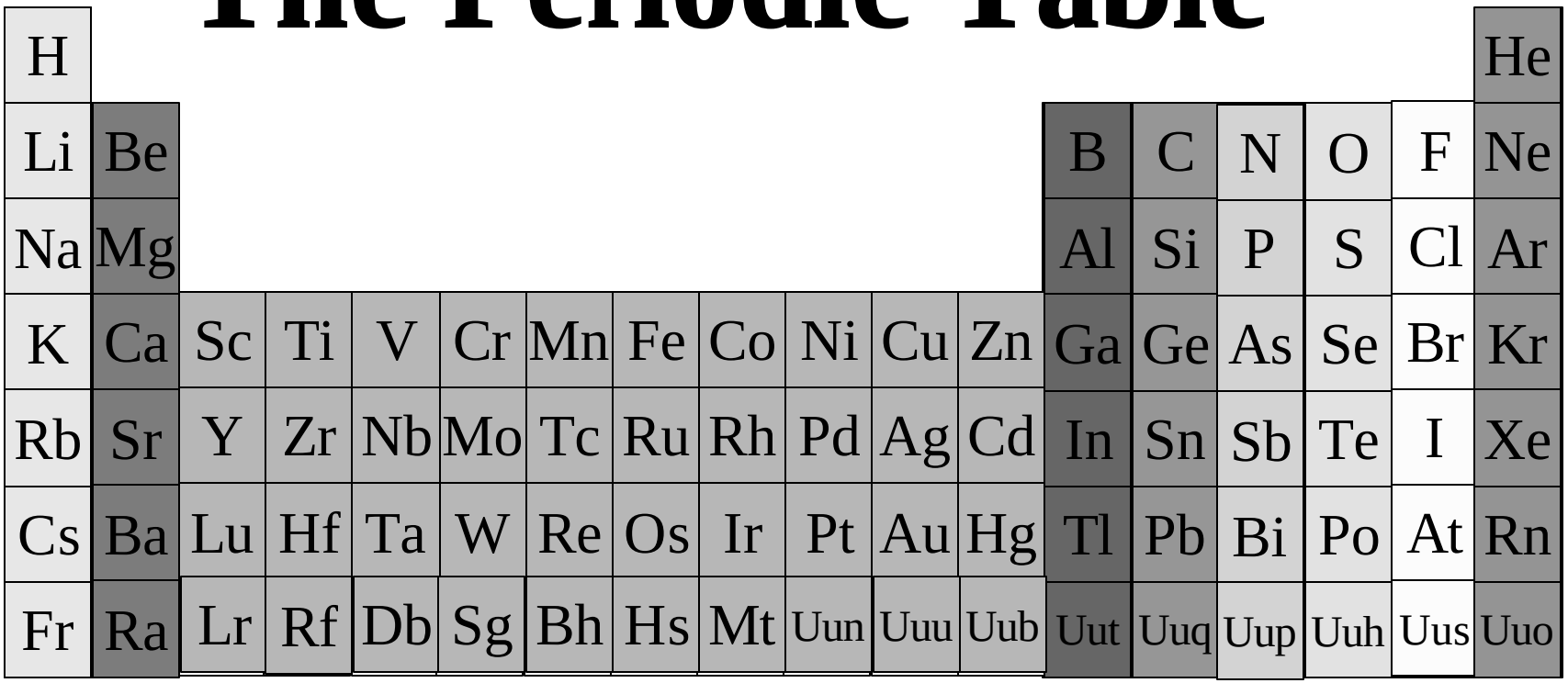
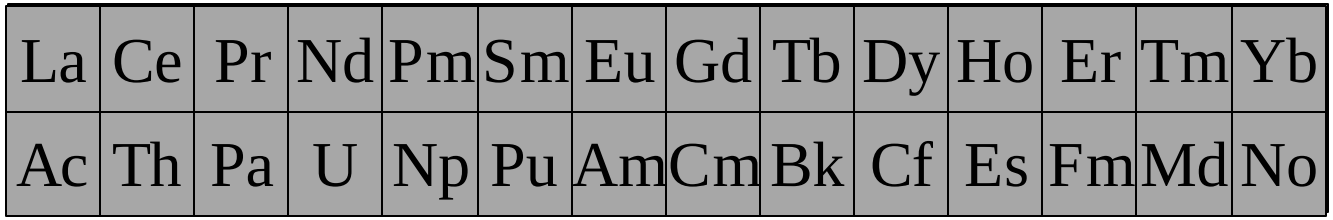
The Periodic Table





Atoms

- All matter is made of them
- Idea came from Greek philosopher Democritus
- 400 B.C
- Greek word “atomos” – not to be cut
- Did not use scientific method
- No experiments to support idea

John Dalton

- Late 1808 look at all the data from experiments- his and others
- Developed his own theory
- Was accepted because of all the evidence

Dalton's Atomic theory

1. All matter is made up of atoms- tiny particles of that can't be broken up
2. Atoms of the same element are identical
3. Atoms of different elements join to form molecules.

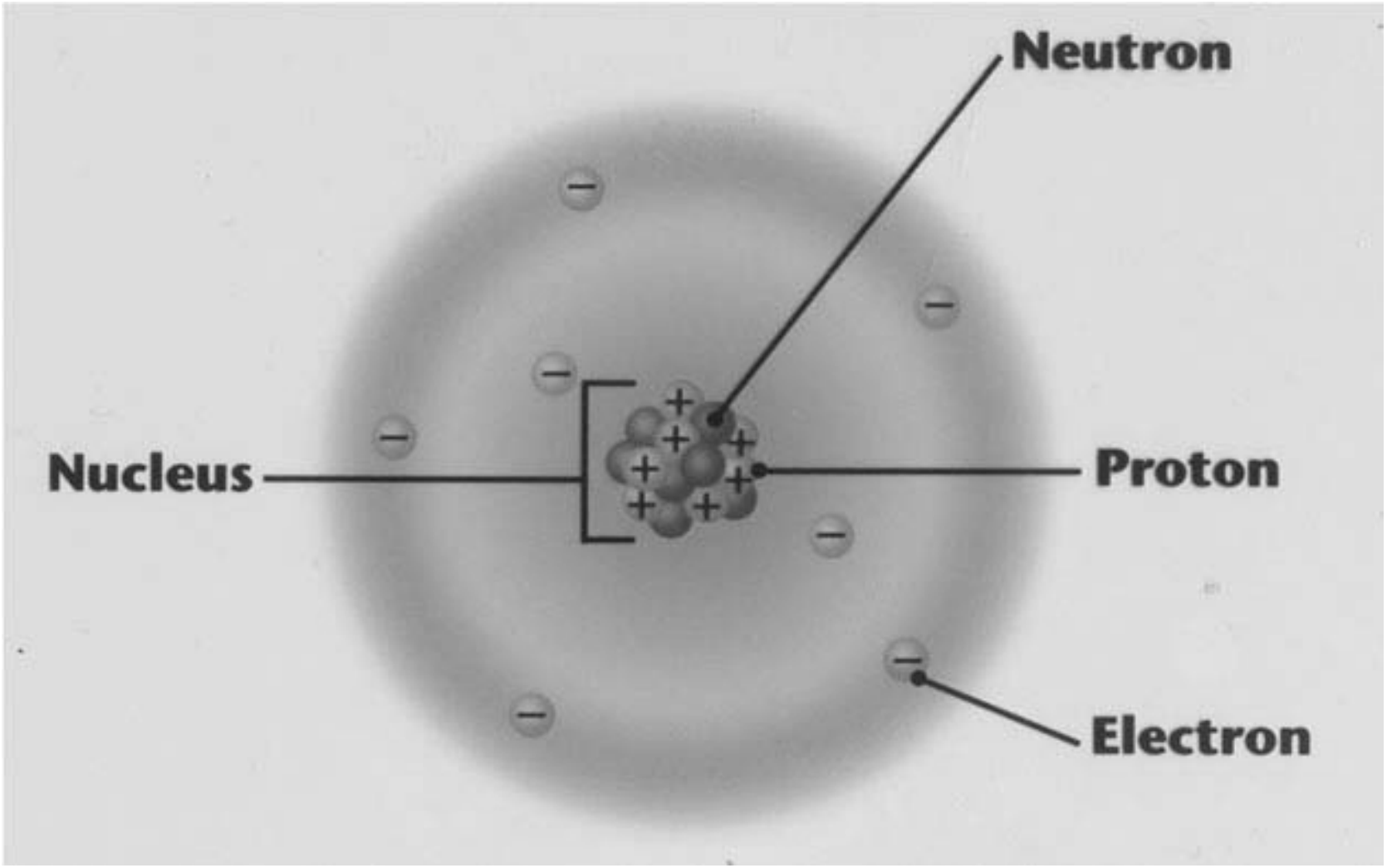
- The smallest part of an element with all the properties of that element.
- Join in certain ratios to form molecules

Parts of Atoms

- Atoms can be broken.
- There are many different particles
- We will learn about the three most important to chemistry
- Proton – positively charged, big mass
- Electron – negatively charged, very small mass
- Neutron – no charge, about the same mass as a proton

Parts of Atoms

- Proton and neutron are about 2000 times heavier than the electron
- Protons and neutrons are located in the nucleus
- Electrons outside the nucleus
- An atom is mostly empty
- If the atom were the size of a baseball stadium, the nucleus would be the size of a marble


Neutron
Nucleus
Proton
Electron

Bohr's Model

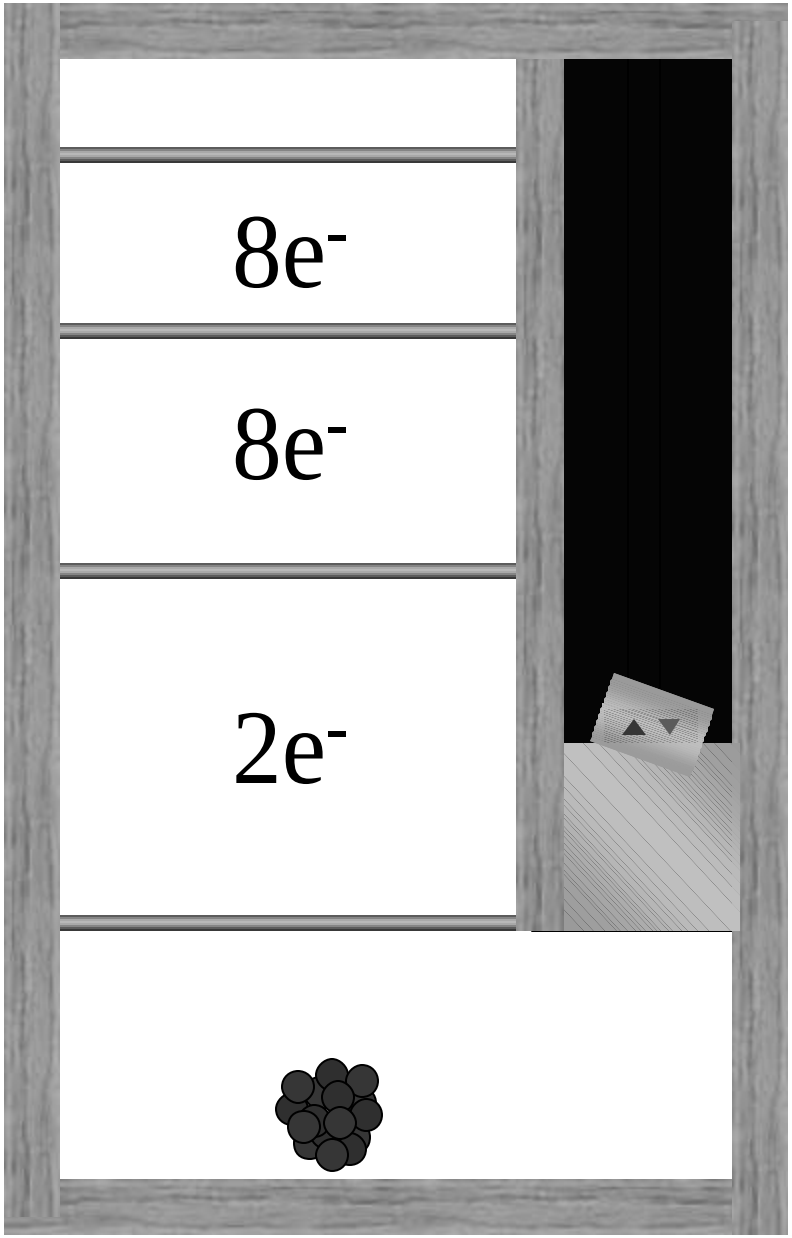
- Niels Bohr
- Why don't negative electrons fall into positive nucleus?
- They move like planets around the sun.
- Each electron in it's own energy level

Energy Level

- Describe the path the electron takes around the nucleus
- Farther from nucleus is more energy
- Gain energy they move away
- Lose energy they move toward
- Only certain energies are allowed in each atom

Energy Levels

- Like an elevator
- it can only be on certain floors
- Never in between
- Energy levels get closer together the higher you go
- Each has room for a certain number of electrons



Current Model

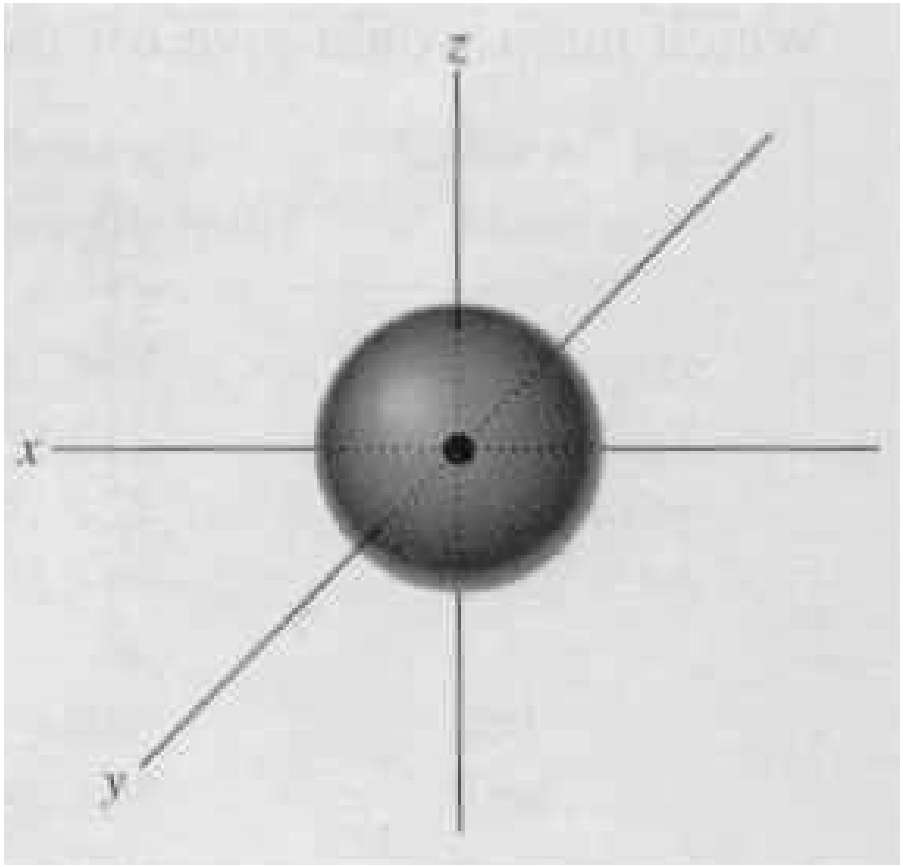
- Treats electrons as waves, not particles
- Talks only about the probability of finding an electron
- Region called the electron cloud
- Where are the blades in a fan?
- It is impossible to know the exact location and the speed and direction of an electron

Orbitals

- Regions where you have a chance of finding the electron
- There are different types of orbitals
  - s, p, d, f
- Each has its own shape or shapes
- Each shape has room for two electrons
- Each can be found in the energy levels

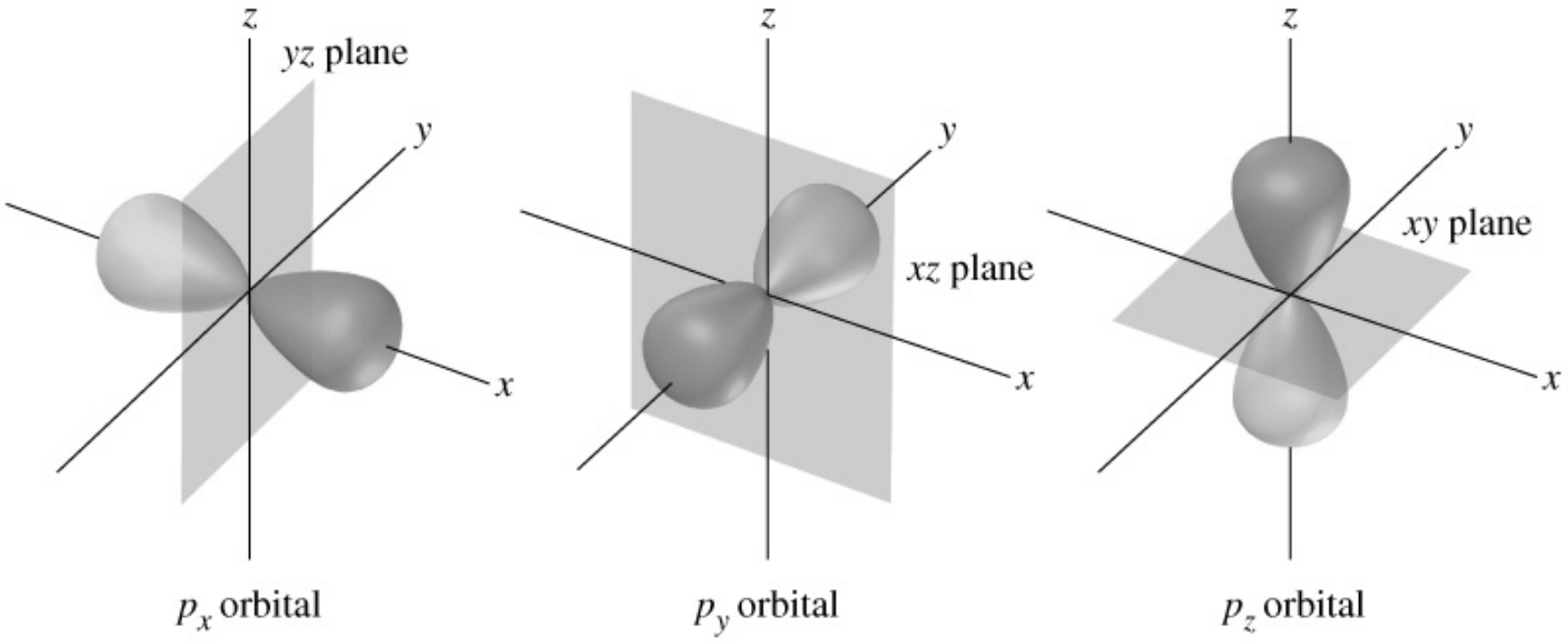
S orbital

- Shaped like a sphere
- Room for 2 electrons



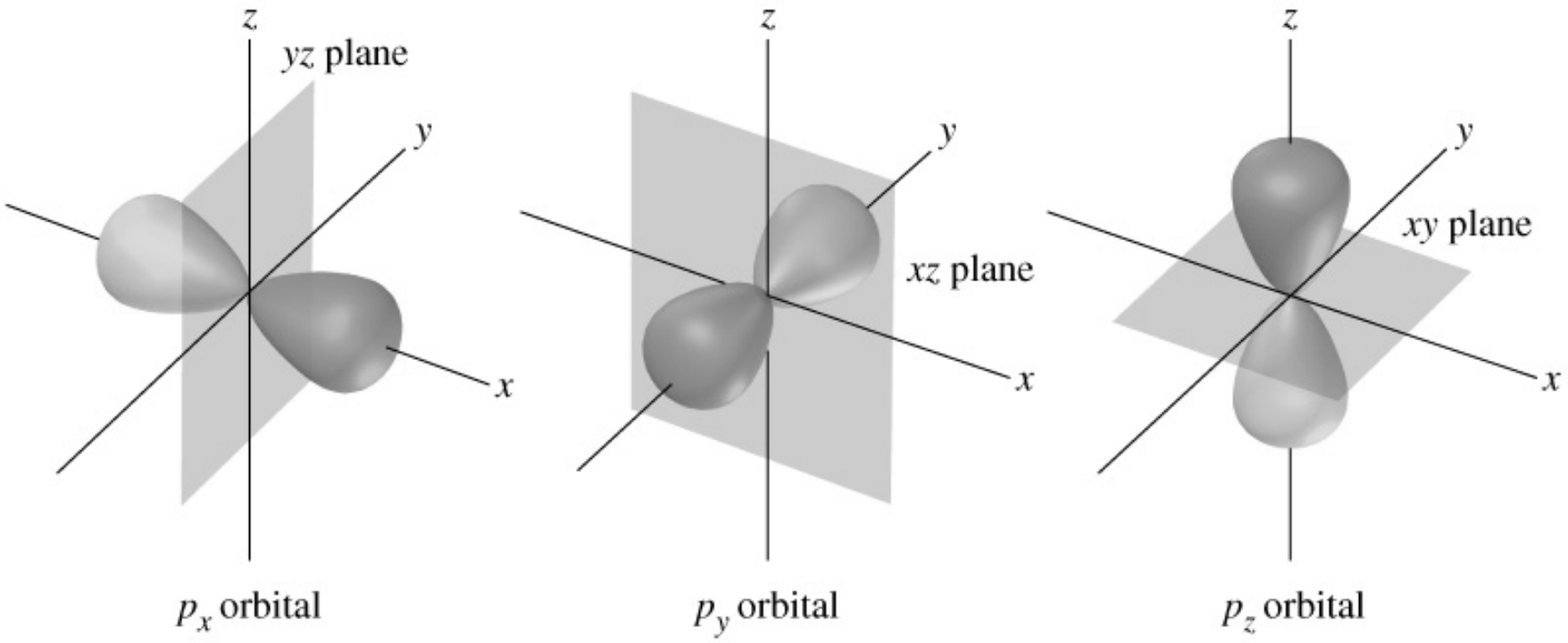
P orbitals

- 3 dumbbell-shaped regions
- One on each axes of a 3-D graph



P orbitals

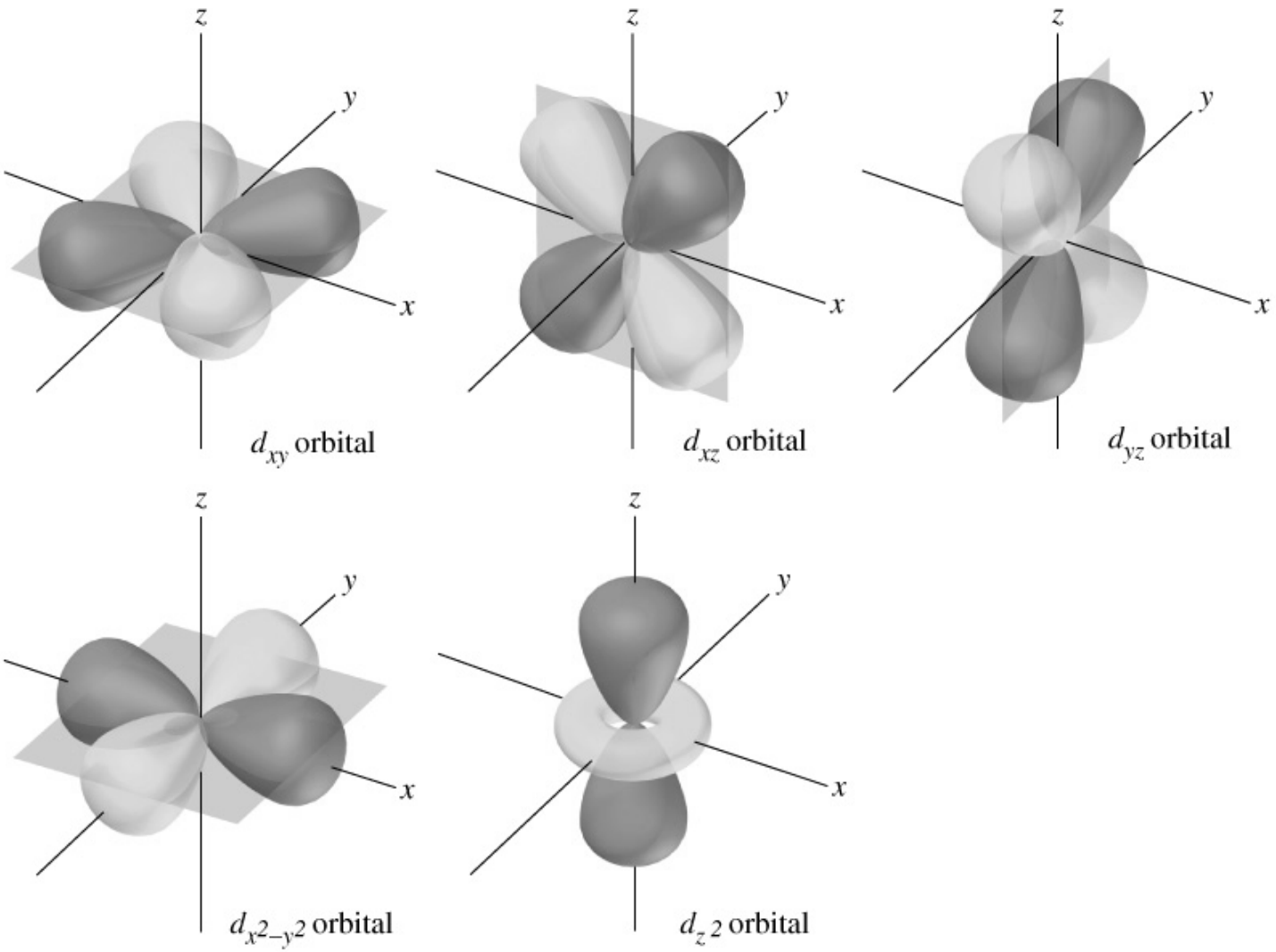
- Each shape can hold two electrons
- Total of 6



d orbitals

- Five different shapes
- More complex
- Each can hold 2 electrons
- Total of 10 electrons

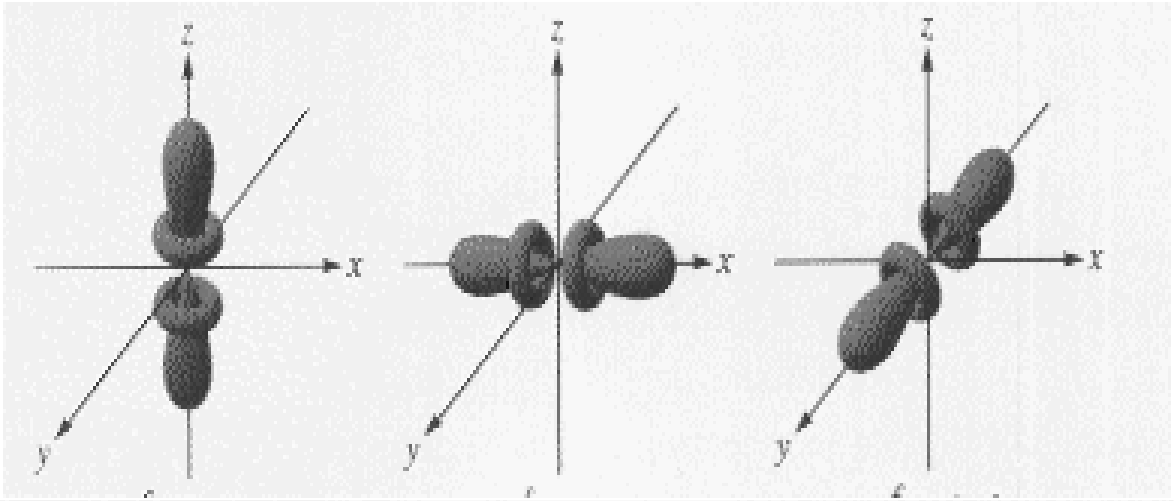
d orbitals

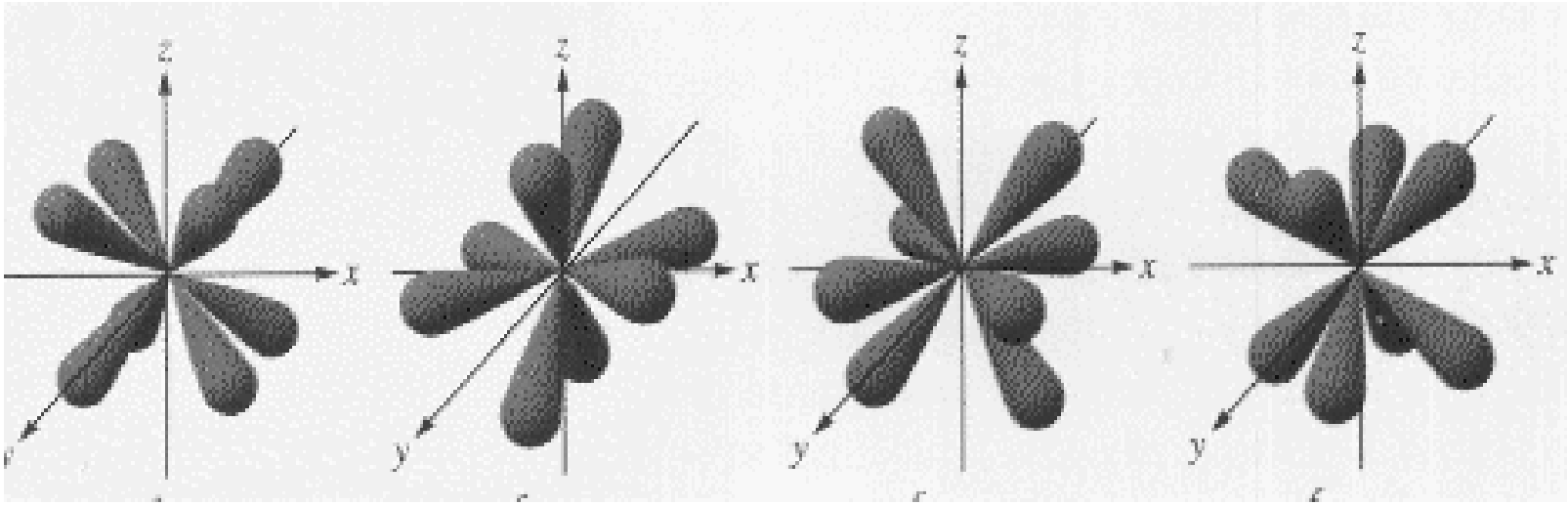

z
y
x
d_{xy} orbital
d_{xz} orbital
d_{yz} orbital
$d_{x^2-y^2}$ orbital
d_{z^2} orbital

f orbitals

- seven different shapes
- Much more complex
- Each can hold 2 electrons
- Total of 14 electrons

f orbitals





Valence electrons

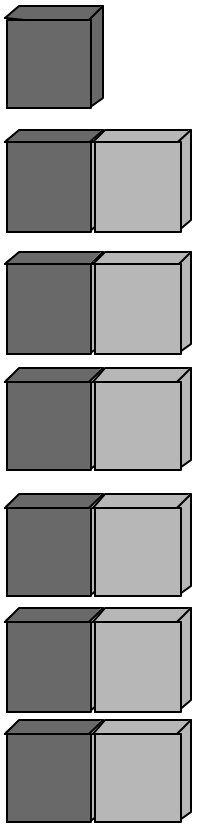
- The electrons in the outermost energy level
- Responsible for most of the chemical properties
- When two atoms interact, the outside electrons are the ones affected

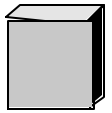
The Periodic Table

- Listed in order of increasing number of protons
- When you do this the properties of the elements repeat.
- Periodic Law- when the elements are arranged in order of increasing number of protons, the properties tend to repeat in a pattern

The Periodic Table

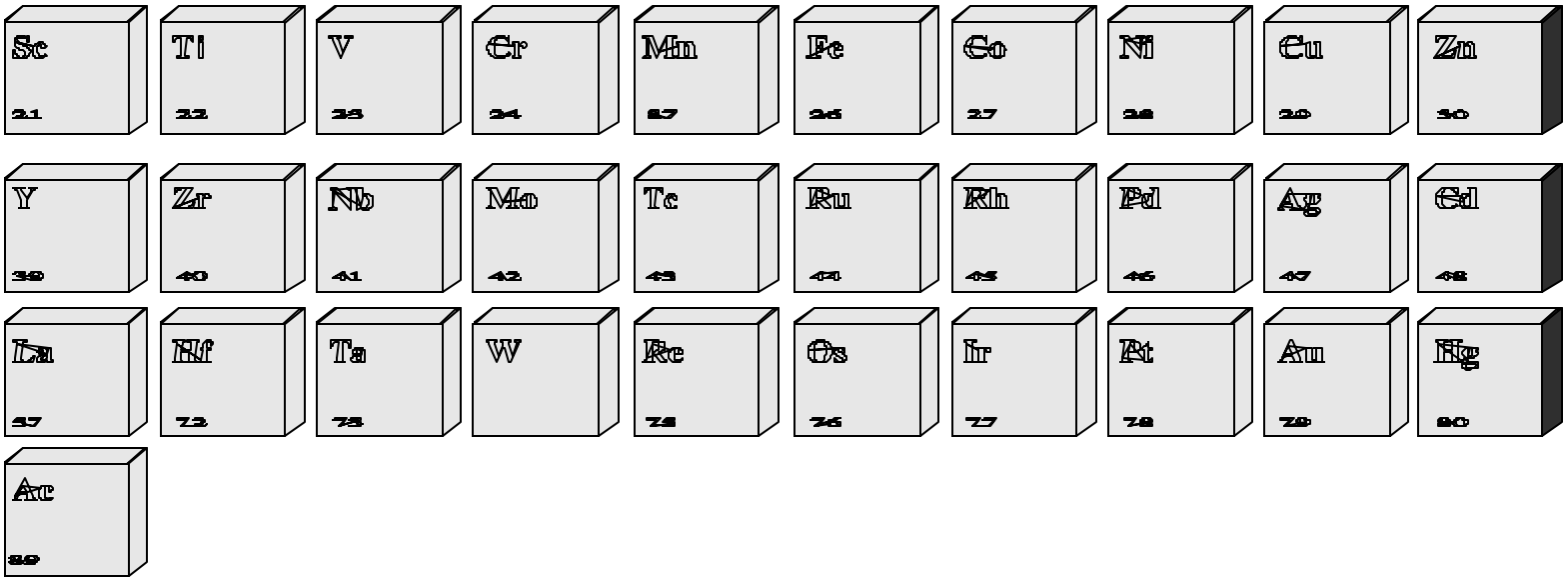
- Atoms in the same column have similar properties
- Columns are called groups or families
- They have similar properties because they have the same number of valence electrons
- Rows are called periods



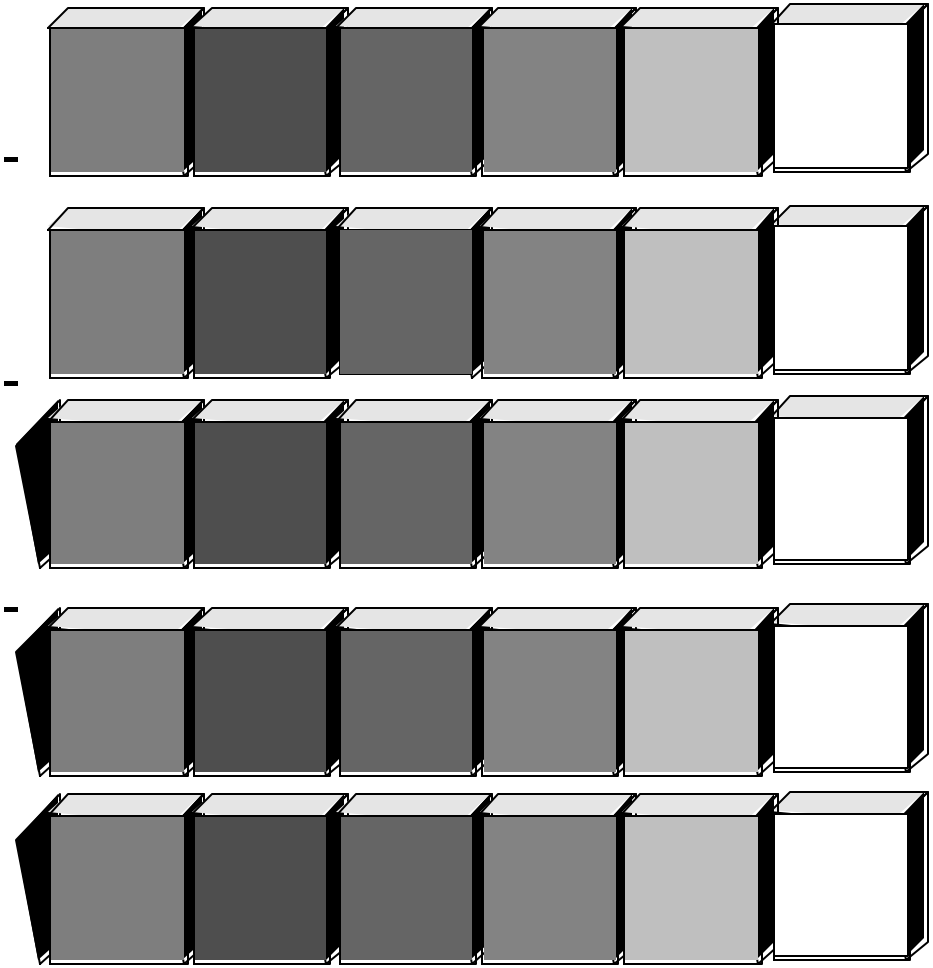


- Group 1 all have one electron in their outside s orbital
- Group 2 all have two electrons in their outside s orbital

- The middle of the table is 10 elements wide
- This is where the d orbitals are filling



- On the right hand side Group 13 -18 the s orbitals are full, and the p orbitals are filling
- Group 13 s has 2 e^- p has 1 e^-
- Group 14 s has 2 e^- p has 2 e^-
- Group 18 s has 2 e^- p has 6 e^-
- p and s both full



Ions

- Atoms with a charge
- Different number of protons and electrons
- Form by changing the number of electrons
- Ionization- adding or removing electrons from an atom or group of atoms
- Two types

Cations

- Ions with a positive charge
- More protons than electrons
- Formed by losing electrons
- Happens to atoms with few valence electrons
- Lose electrons to get down to full outside energy level
- Written as a superscript Na^{+} Ca^{2+}

Anions

- Negative ions
- More electrons than protons
- Form by gaining electrons
- Happens to atoms with many valence electrons
- Fill up outer energy level
- Written as a superscript F^- O^{2-}

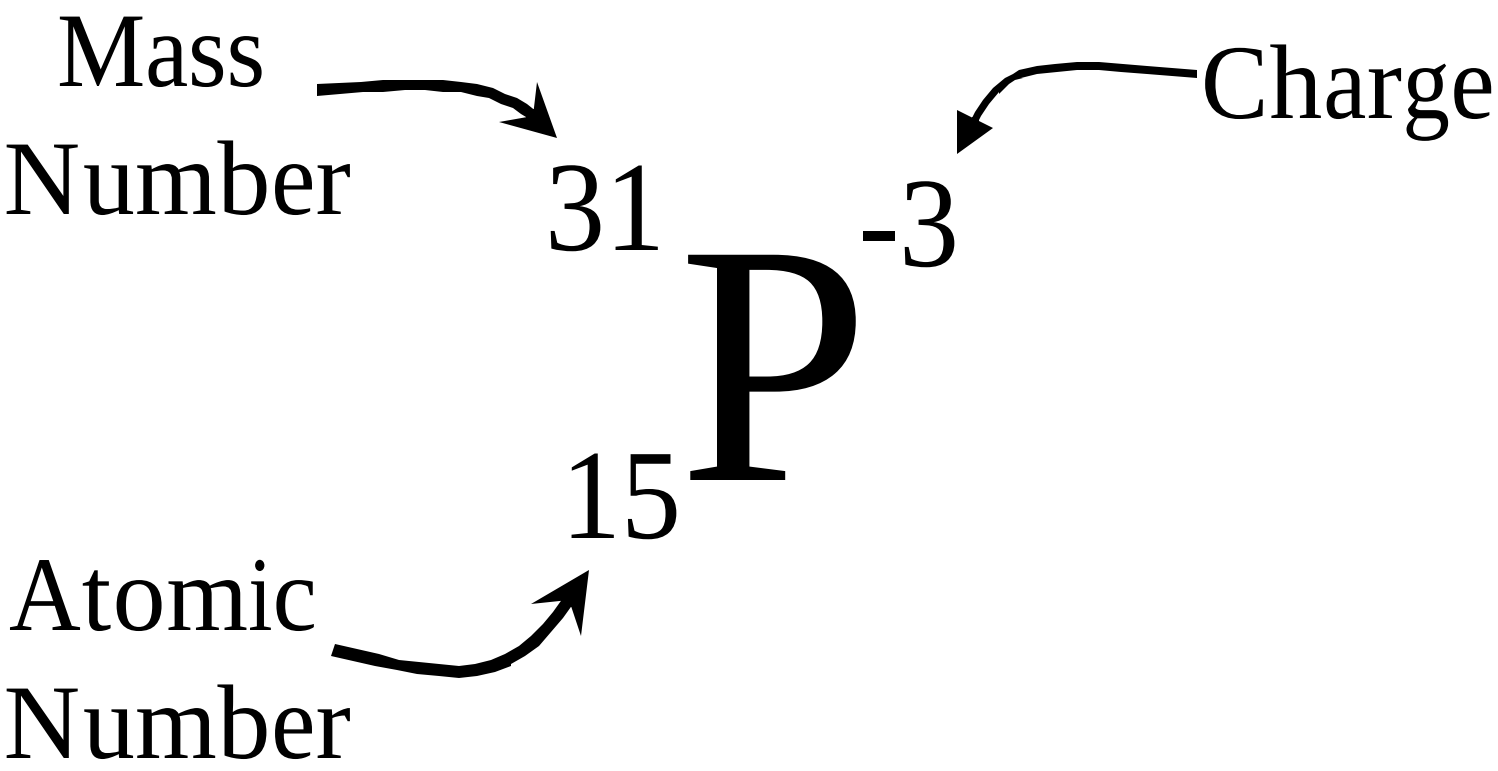
Counting the pieces

- Atomic Number- the number of protons
- Determines the type of atom and element
- Mass number- number of protons and neutrons
- All the heavy pieces
- Electrons are the same as protons if neutral.
- If an ion, it gained or lost electrons

Isotopes

- Atoms of the same type can have different numbers of neutrons
- These are isotopes
- They behave identically
- They just weigh different amounts
- Mass number is written after the name
- Hydrogen – 1
- Hydrogen – 2

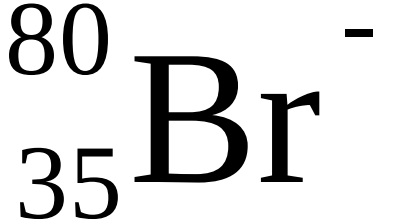
In the symbol



- Find the
  - number of protons
  - number of neutrons
  - number of electrons
  - Atomic number
  - Mass Number
  - Name

$$^{19}_{9}\mathrm{F}$$

- Find the
  - number of protons
  - number of neutrons
  - number of electrons
  - Atomic number
  - Mass Number
  - Name



- if an element has an atomic number of 34 and a mass number of 78 what is the
  - number of protons
  - number of neutrons
  - number of electrons
  - Complete symbol
  - Name

The Mass of Atoms

- Very, very small
- Can’t use grams
- Use the Atomic Mass Unit (amu)
- One twelfth the mass of a carbon-12 atom
- Since carbon-12 has 6 protons and 6 neutrons makes the mass of a proton or neutron 1.0 amu

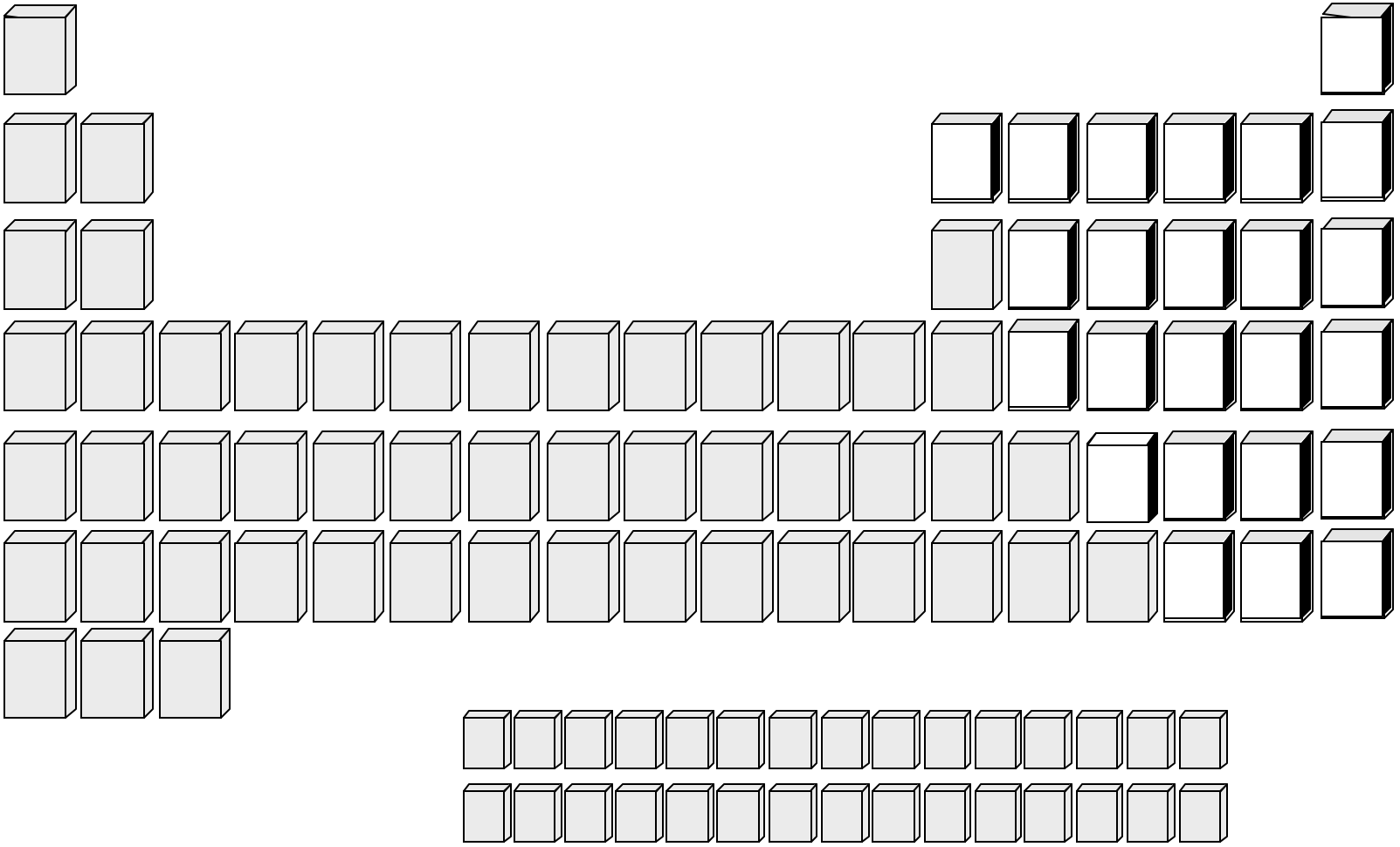
Atomic Mass

- Mass of the average atom
- Since there are isotopes of atoms two things affect the average
  - The mass of the isotopes
  - How much of each isotope there is
- These are the decimal numbers on the periodic table

Atomic Mass

- Two isotopes of copper
  - 72% copper-63
  - 28% copper-65
- Makes the average 63.56 amu

Metals

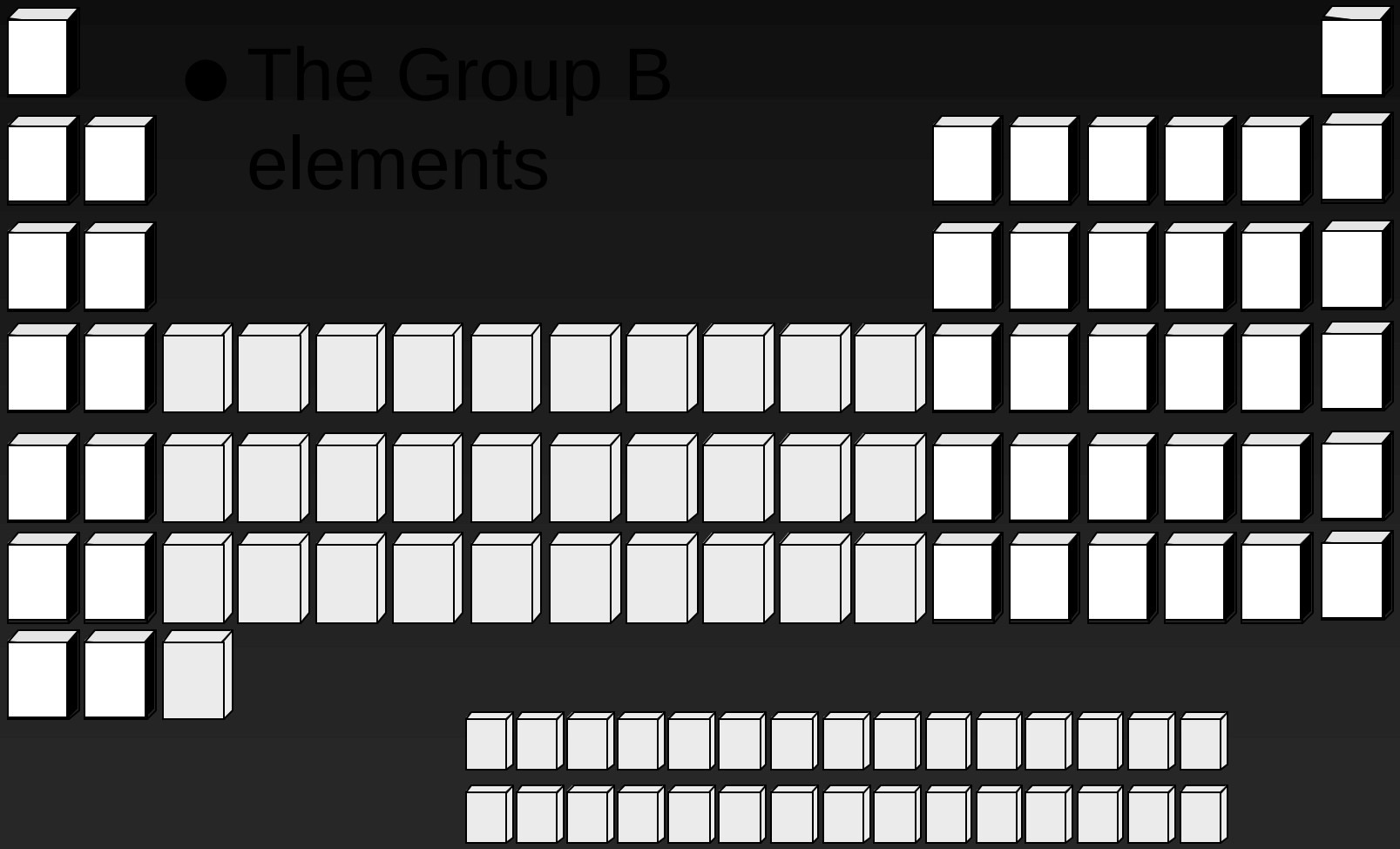


Metals

- Luster – shiny.
- Ductile – drawn into wires.
- Malleable – hammered into sheets.
- Conductors of heat and electricity.

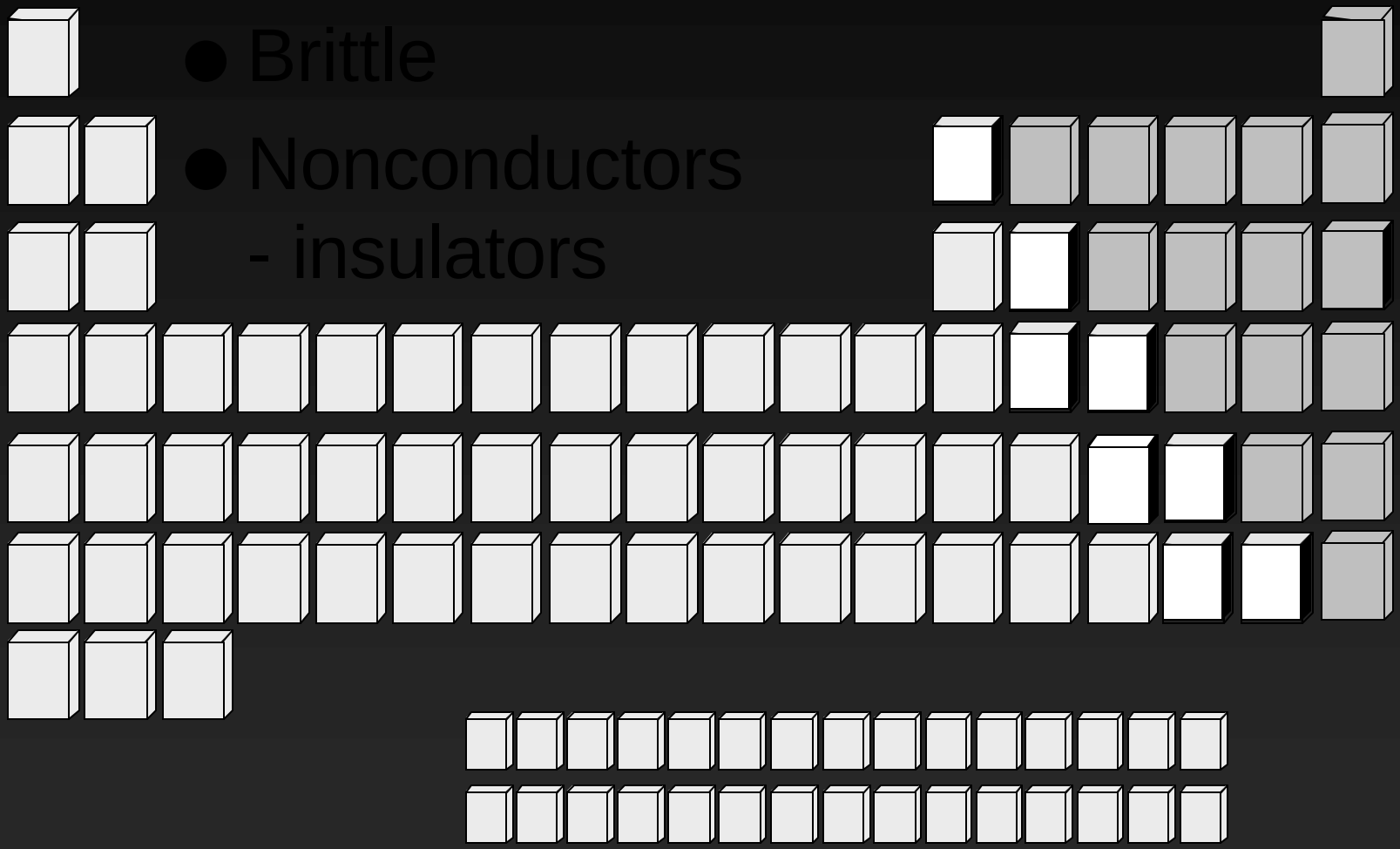
Transition metals

- The Group B elements



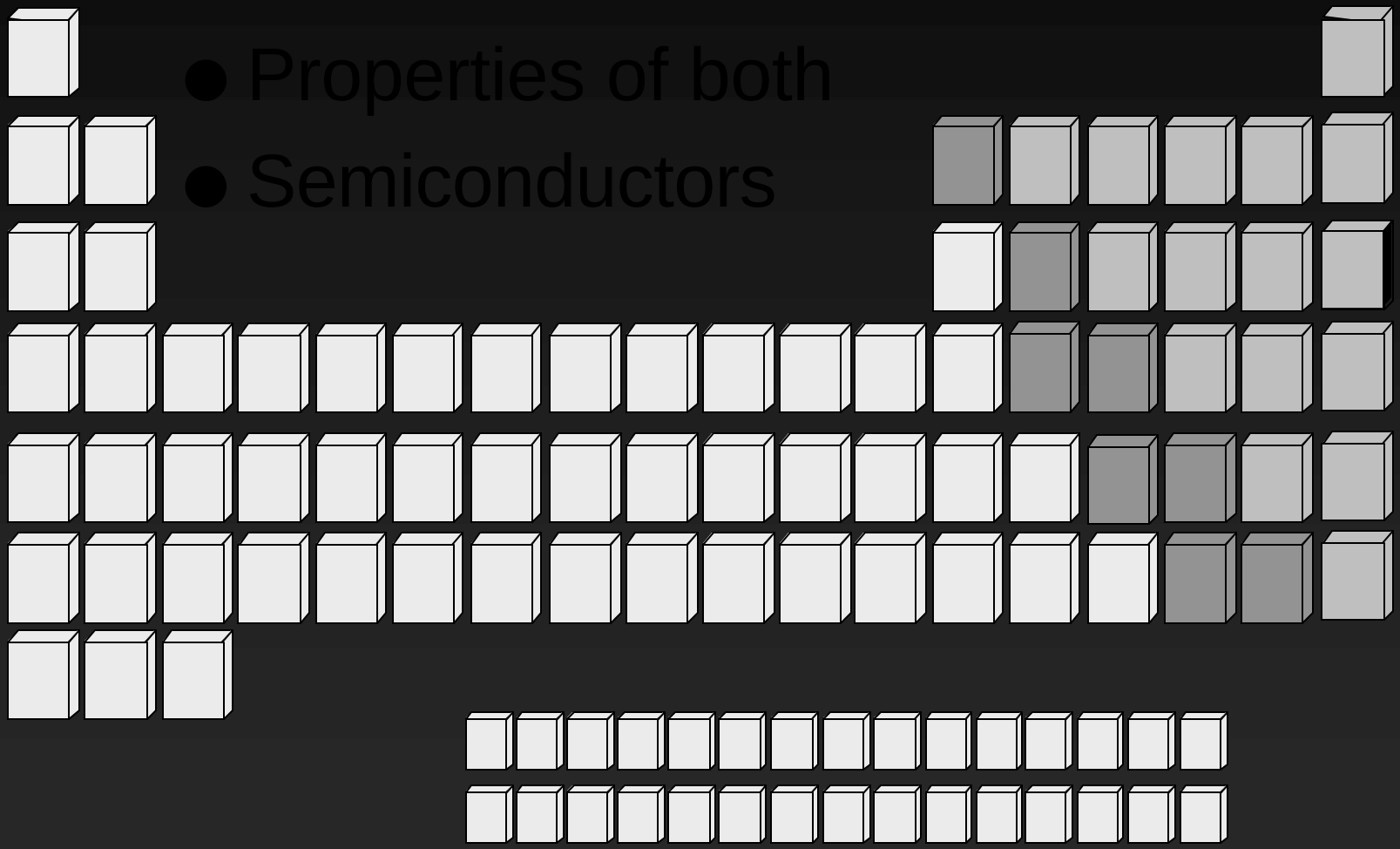
Non-metals

- Dull
- Brittle
- Nonconductors - insulators

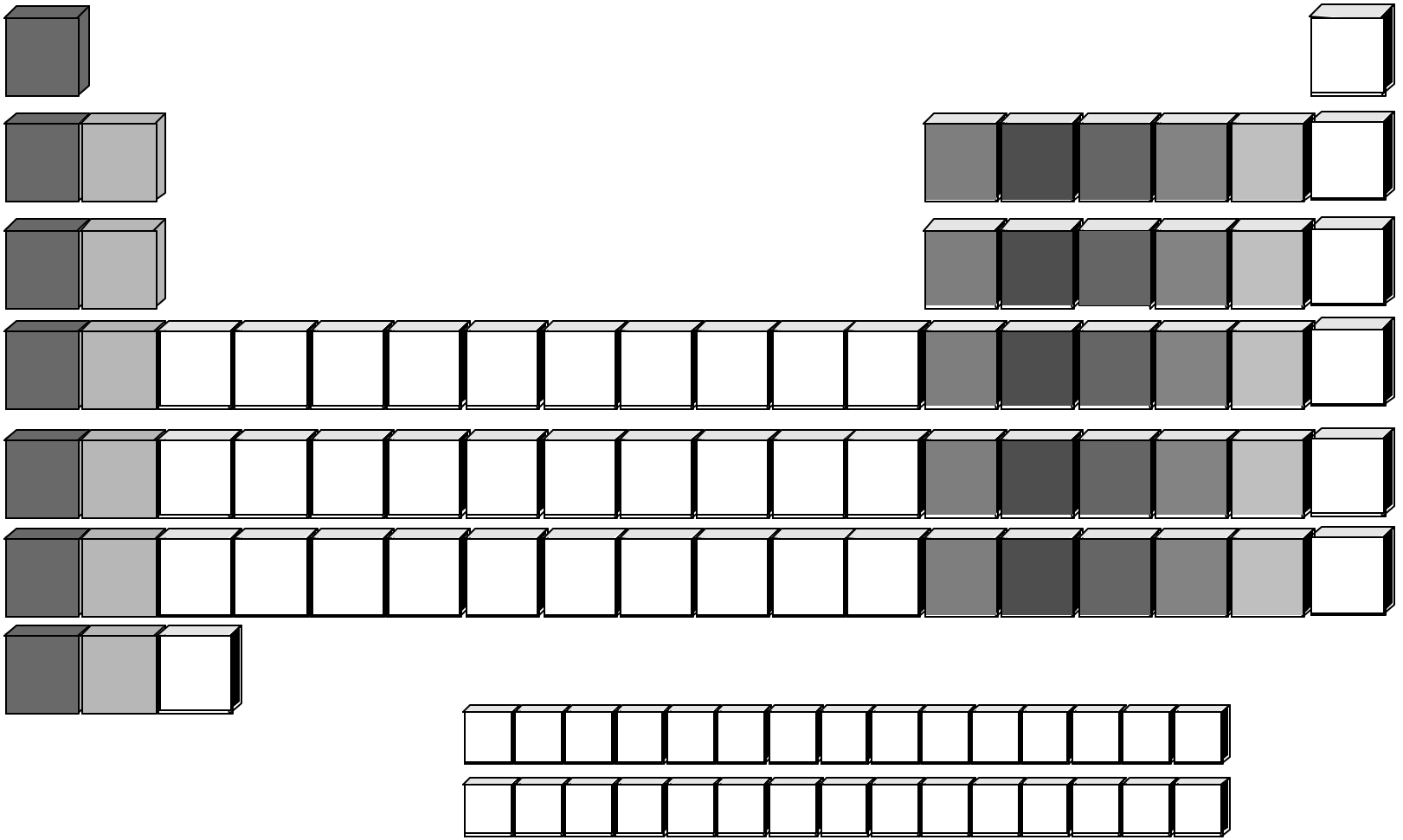


Metalloids or Semimetals

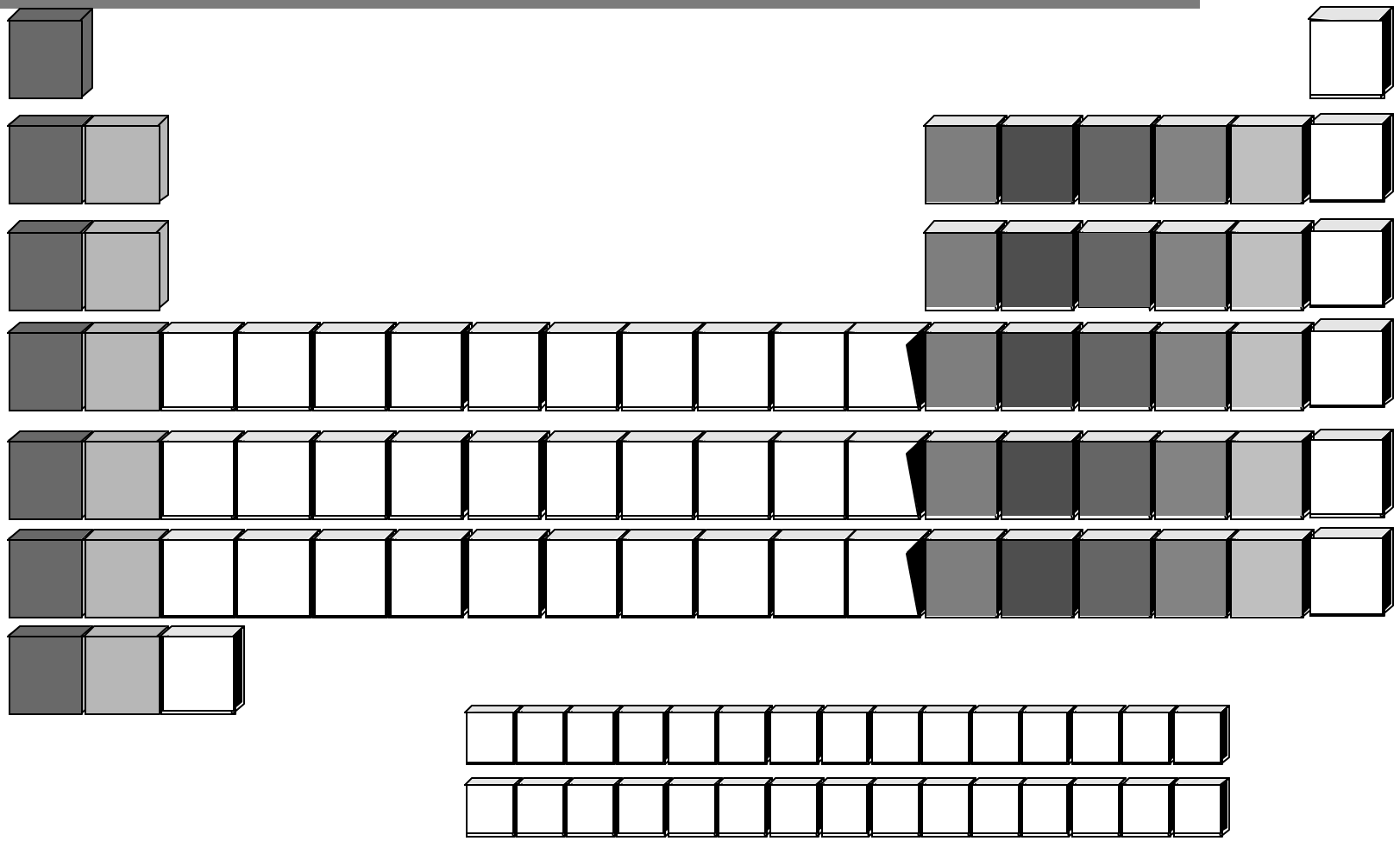
- Properties of both
- Semiconductors



- Group 1 are the alkali metals
- Group 2 are the alkaline earth metals



- Group 17 is called the Halogens
- Group 18 are the noble gases



Alkali Metals

- Very reactive
- Not found alone in nature
- Have one valence electron
- Easily lose it to form a 1+ ion

Alkaline Earth Metals

- Les reactive
- Have two valence electrons
- Lose them to form a 2+ ion

Transition Metals

- Less reactive
- Often found alone in nature
- Form many different ions

Halogens

- Very reactive
- Have many valence electrons
- Gain one electron to form a 1- ion

Noble Gases

- Do not react
- Will not form compounds

Counting the Particles

- Atoms are too small to be counted one at a time
- We count them in groups called the mole
- One dozen is twelve
- One gross is 144
- One mole is 602,213,670,000,000,000,000,000
- 6.022×10^{23}

The mole

- 6.022×10^{23} is called Avogadro's number
- Abbreviated mol
- The mass of 1 mole is the molar mass
- For an element it is the same as the atomic mass
- The decimal number on the periodic table

Conversion Factors

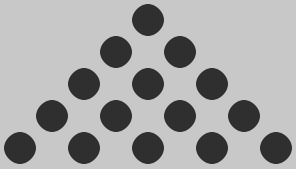
- A fraction with even top and bottom
- But with different units
- 1 m is 100 cm
- Can make two conversion factors
- $\frac{1\text{ m}}{100\text{ cm}}$ and $\frac{100\text{ cm}}{1\text{ m}}$
- Multiply by conversion factors to change units

Conversion Factors

- Choose the conversion factor with the unit you want in the numerator and the unit you don't want in the denominator
- 56 cm is how many meters?
- $56 \text{ cm} \times \frac{1 \text{ m}}{100 \text{ cm}} = 0.56 \text{ m}$

Conversion Factors

$$\times \frac{\text{molar mass of element}}{\text{1 mol of element}}$$



Amount (mol)

Mass (g)

$$\times \frac{\text{1 mol of element}}{\text{molar mass of element}}$$