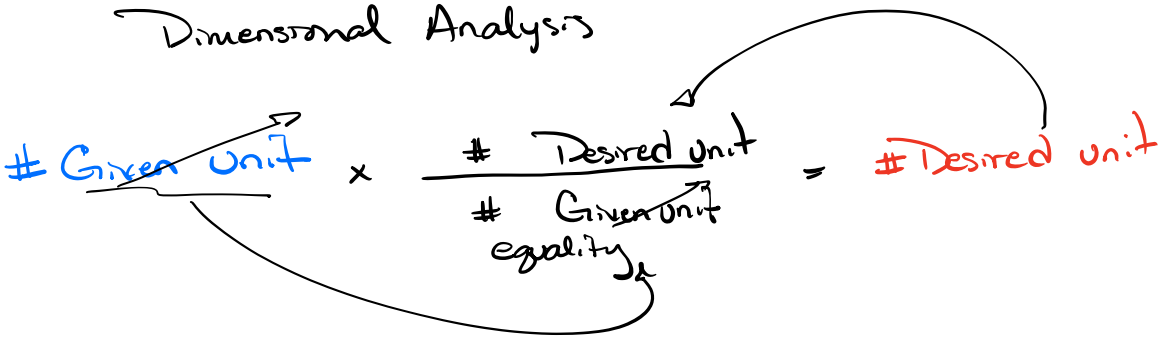
Dimensional Analysis Check-in

Problems have a given unit of measure and desired unit and a series of "equalities" (conversion factors)

Conversion factor = Ratio $\frac{12\text{ in}}{1\text{ ft}}$ or $\frac{1\text{ ft}}{12\text{ in}}$

Equality $12\text{ in} = 1\text{ ft}$ no numerator or denominator

Dimensional Analysis



Convert 13.76 in into feet $12\text{ in} = 1\text{ ft}$

4 SF

$$13.76\text{ in} \times \frac{1\text{ ft}}{12\text{ in}} = 1.147\text{ ft}$$

def

$13.76 \div 12 = 1.146\overline{66}\text{ ft}$

How many second are there in 51.6 years?

1 year = ? Seconds Hard

Road Map

years $\xrightarrow{365\text{ days} = 1\text{ year}}$ days $\xrightarrow{1\text{ day} = 24\text{ hrs}}$ hours $\xrightarrow{1\text{ hour} = 60\text{ min}}$ min $\xrightarrow{1\text{ min} = 60\text{ sec}}$ seconds

Given — Desired

$\longrightarrow$ Represents an equality

3

$$51.6\text{ yrs} \times \frac{365\text{ days}}{1\text{ yrs}} \times \frac{24\text{ hrs}}{1\text{ day}} \times \frac{60\text{ min}}{1\text{ hrs}} \times \frac{60\text{ sec}}{1\text{ min}} = \text{sec}$$

def def def def

$$51.6 \times 365 \times 24 \times 60 \times 60 = 1627\,257\,600\text{ sec}$$

$$= 1630\,000\,000\text{ sec}$$

$$= 1.63 \times 10^9\text{ sec}$$

Convert 3.72 miles into km.
(5280 ft = 1 mi)

Memorize these three
3 key Conversion factors

* length 1 in = 2.54 cm def
mass 1 lb = 453.6 g
Volume 1 gal = 3.785 L
} 4 SF

in addition to the
SI prefixes

Giga	G	10^9
mega	M	10^6
kilo	k	10^3
base		
centi	c	10^{-2}
milli	m	10^{-3}
Micro	μ	10^{-6}
nano	n	10^{-9}

Road Map

5280 ft = 1 mi
12 in = 1 ft
1 in = 2.54 cm
1 cm = 1×10^{-2} m
100 cm = 1 m
1 km = 1×10^{3} m
1000 m = 1 km

Miles → ft → in → cm → m → km

Miles: Eng length
in → cm: Eng SI Bridging equality
km: SI Length

(3)

$$3.72\ \text{mi} \times \frac{5280\ \text{ft}}{1\ \text{mi}} \times \frac{12\ \text{in}}{1\ \text{ft}} \times \frac{2.54\ \text{cm}}{1\ \text{in}} \times \frac{1 \times 10^{-2}\ \text{m}}{1\ \text{cm}} \times \frac{1\ \text{km}}{1 \times 10^{3}\ \text{m}}$$

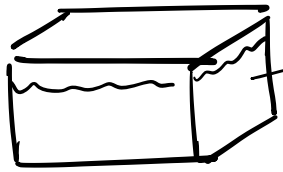
definition · def · def · def · def

$$3.72 \times 5280 \times 12 \times 2.54 \times 1\text{E}-2 \div 1\text{E}3 = 5.986\,75968\ \text{km}$$

EE (−) 10^x ± EE 10^x

$$= 5.99\ \text{km}$$

The density of salt water is 1.23 g/mL. If fish tank holds 75.6 gallons of H_2O, how many lbs would just the salt water weigh?



75.6 gallons = ? lbs

density = 1.23 g = 1 mL

1 gal = 3.785 L

1 mL = 1×10^{-3} L

density

1 lb = 453.6 g

gal → L → mL → g → lbs

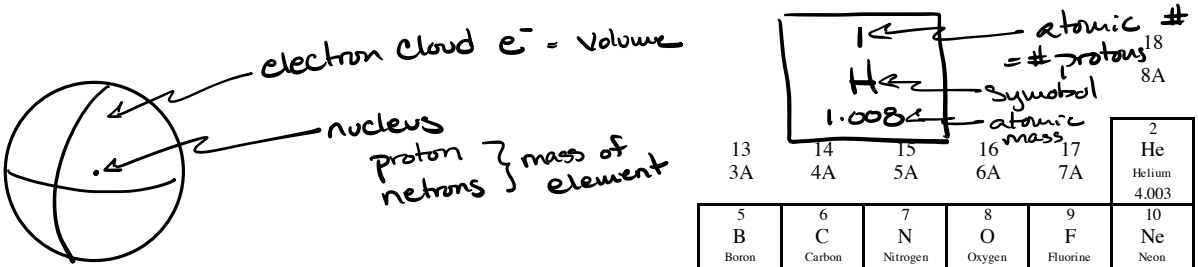
Vol Eng — Vol — mass — Mass Eng

3 — 4 — def — 3 — 4

$$75.6 \text{ gal} \times \frac{3.785 \text{ L}}{1 \text{ gal}} \times \frac{1 \text{ mL}}{1 \times 10^{-3} \text{ L}} \times \frac{1.23 \text{ g}}{1 \text{ mL}} \times \frac{1 \text{ lbs}}{453.6 \text{ g}} = \text{lbs}$$

$$75.6 \times 3.785 \div 1 \times 10^{-3} \times 1.23 \div 453.6 = 775.925 \text{ lbs}$$

= 776 lbs



1 1A												13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
1 H Hydrogen 1.008	2 2A																2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18
11 Na Sodium 22.99	12 Mg Magnesium 24.30	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.07	17 Cl Chlorine 35.45	18 Ar Argon 39.95
19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.87	23 V Vanadium 50.94	24 Cr Chromium 52.00	25 Mn Manganese 54.94	26 Fe Iron 55.84	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.39	31 Ga Gallium 69.72	32 Ge Germanium 72.61	33 As Arsenic 74.92	34 Se Selenium 78.96	35 Br Bromine 79.90	36 Kr Krypton 83.80
37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.95	43 Tc Technetium 97.91	44 Ru Ruthenium 101.1	45 Rh Rhodium 102.9	46 Pd Palladium 106.4	47 Ag Silver 107.9	48 Cd Cadmium 112.4	49 In Indium 114.8	50 Sn Tin 118.7	51 Sb Antimony 121.8	52 Te Tellurium 127.6	53 I Iodine 126.9	54 Xe Xenon 131.3
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Lanthanides	57 La Lanthanum 138.9	58 Ce Cerium 140.1	59 Pr Praseodymium 140.9	60 Nd Neodymium 144.2	61 Pm Promethium 145	62 Sm Samarium 150.4	63 Eu Europium 152.0	64 Gd Gadolinium 157.2	65 Tb Terbium 158.9	66 Dy Dysprosium 162.5	67 Ho Holmium 164.9	68 Er Erbium 167.3	69 Tm Thulium 168.9	70 Yb Ytterbium 173.0	71 Lu Lutetium 175.0
Actinides	89 Ac Actinium 227	90 Th Thorium 232.0	91 Pa Protactinium 231.0	92 U Uranium 238.0	93 Np Neptunium 237	94 Pu Plutonium 244	95 Am Americium 243	96 Cm Curium 247	97 Bk Berkelium 247	98 Cf Californium 251	99 Es Einsteinium 252	100 Fm Fermium 257	101 Md Mendelevium 258	102 No Nobelium 259	103 Lr Lawrencium 262

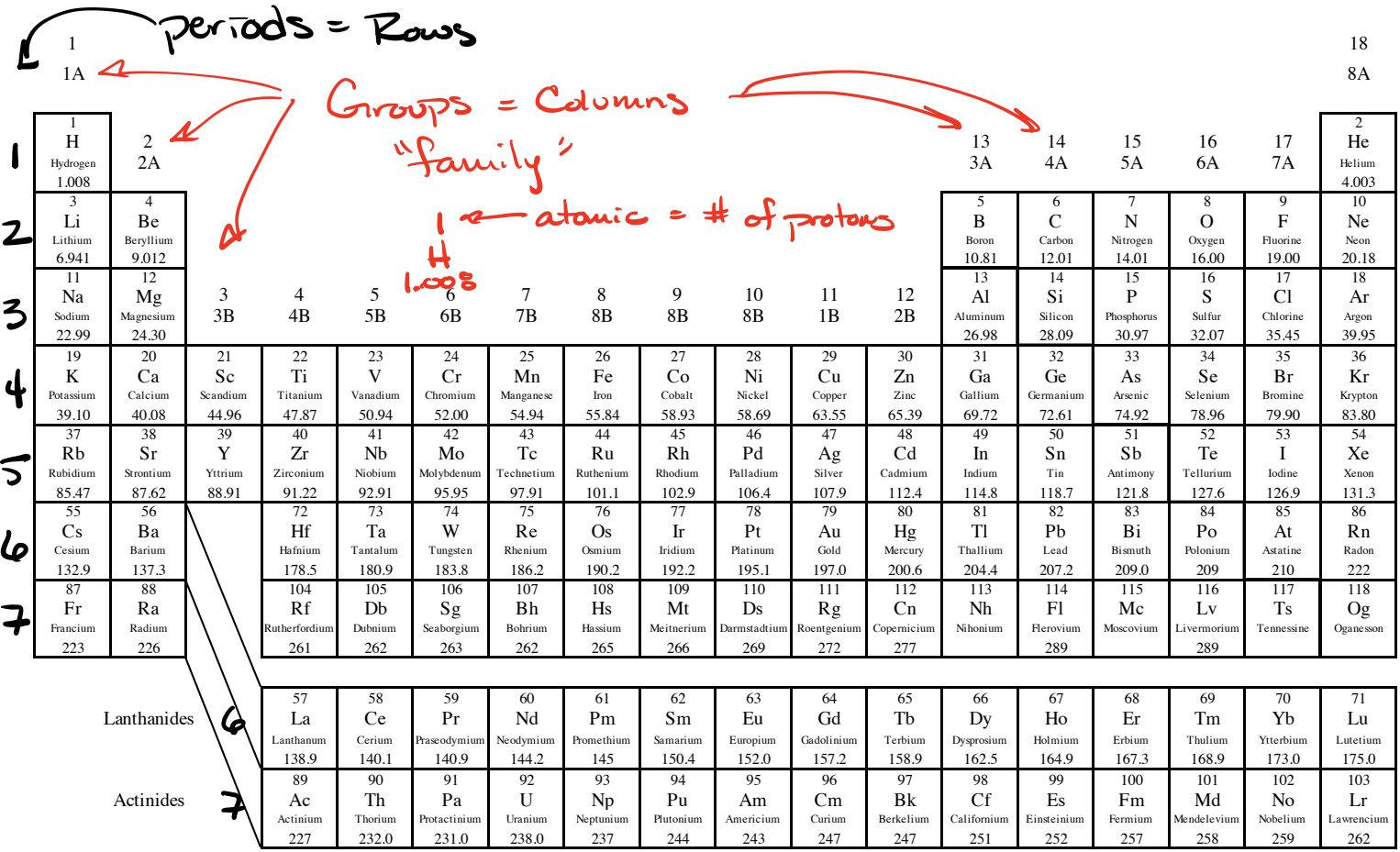
Periodic Table = Regular Repeating Pattern

118 Elements
most are metals
most solids
few liquids
few gas
} at standart temperature & pressure
25°C 1 atm

Li_2O
Na_2O
K_2O
} Li & Na & K must be related

Family X_2O	XO
Li	Be
Na	Mg
K	Ca
[Sr] ⟸ missing	
Ba	

Lighter ↓ More mass



	1 1A												13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
1	1 H Hydrogen 1.008	2 2A																2 He Helium 4.003
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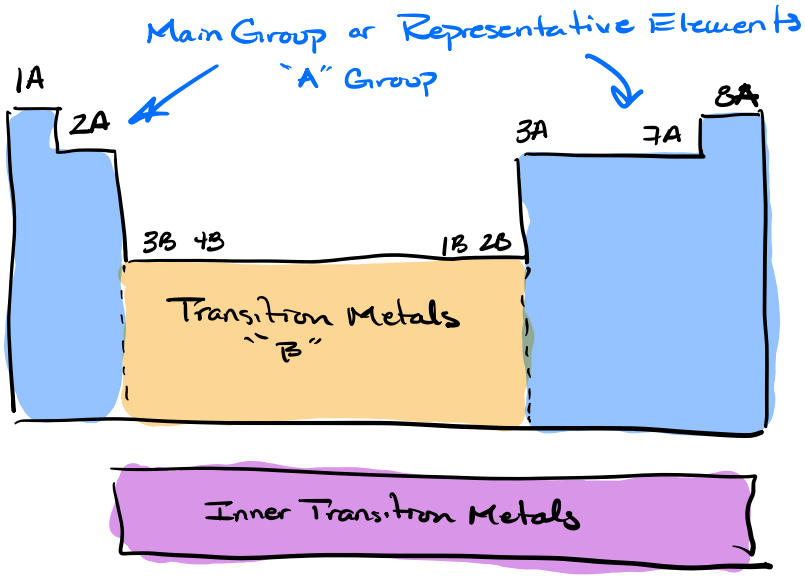
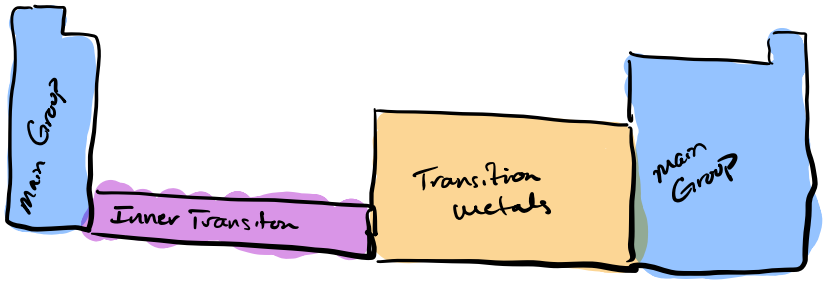
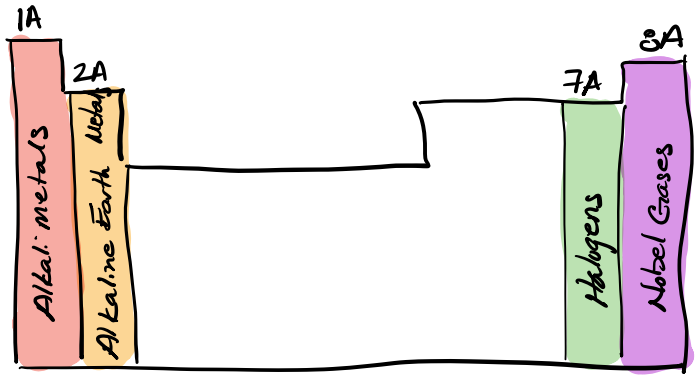
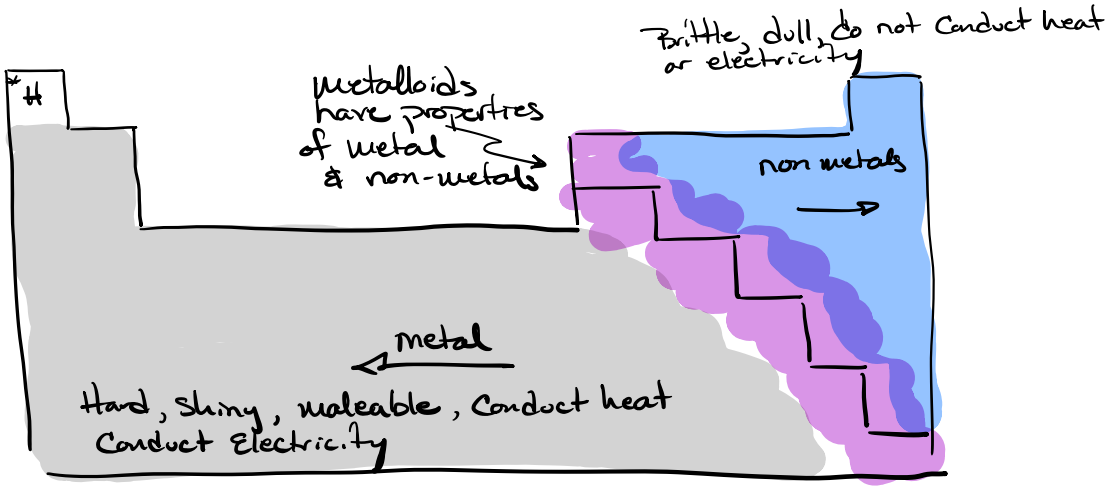




4 Named Families




Brittle, dull, do not Conduct heat or electricity
H
metalloids have properties of metal & non-metals
non metals
metal
Hard, Shiny, malleable, Conduct heat
Conduct Electricity

Gas Liquids Solid

1 1A	2 2A	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
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Element Symbols & Names

H Hydrogen

C Carbon

Ca (uppercase / Lowercase) Calcium

Co Cobalt

CO Carbon monoxide (not an element)

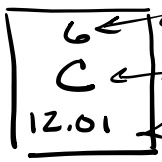
Na Sodium "Natrium" Latin for salt

W Tungsten "Wolfram"

~~Ag~~

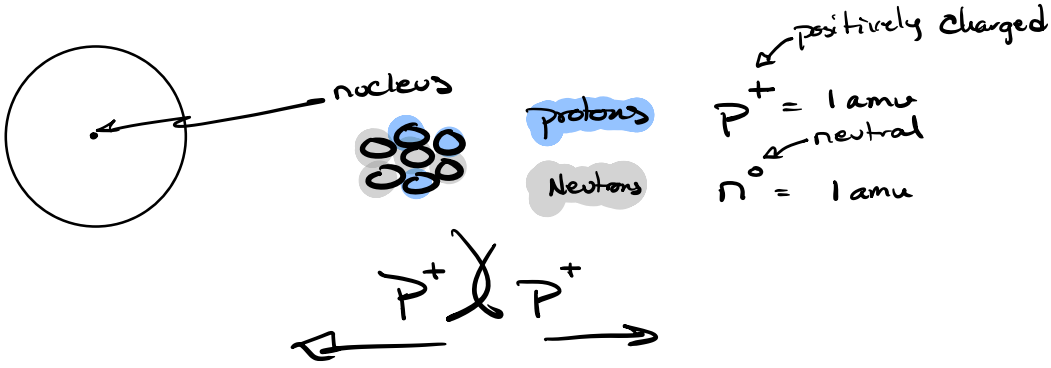
Au gold "Aurum" Shining Dawn

Periodic Table Symbol



- 6 ← atomic # = # of protons
- C ← element Symbol
- 12.01 ← Atomic mass
  - ↳ Average mass of all isotopes

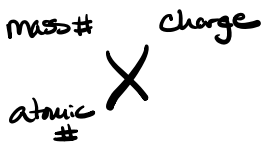
Isotope → A relationship of elements with different numbers of Neutrons



Isotopes of Hydrogen

	^1H	^2H	^3H	Hydrogen has 3 isotopes
#p	1	1	1	← All have 1 proton
#n	0	1	2	← different

Nuclide Symbol



atomic # = # of protons

mass # = $p^+ + n^\circ$

Charge = $\#p^+ - \#e^-$

$p^+ + n^\circ \Rightarrow$ $^{1}_{1}H^{\circ}$ ← $\#p^+ - \#e^-$ $\quad$ $^{2}_{1}H^{\circ}$ $\quad$ $^{3}_{1}H^{\circ}$

$\#p$ $\Rightarrow$ 1

$\#p^+$	1	1	1
$\#n^\circ$	1 − 1 = 0	2 − 1 = 1	3 − 1 = 2
$\#e^-$	1	1	1

Activity 3 - Atoms and Elements

Goals

- Write the correct symbols or names of some elements.
- Describe some physical properties of the elements you observe.
- Classify an element as a metal or nonmetal from its physical properties or location on the periodic table.
- Write the complete symbol of a nuclide including its mass number and atomic number.
- Use the complete symbol of a nuclide to determine mass number, atomic number, and the number of protons, neutrons and electrons.

Pre-lab Questions *(answer these on a separate sheet using complete sentences)*

1. What is the periodic table?
2. Where are the alkali metals located on the periodic table? Halogens? Noble gases?
3. Describe the three subatomic particles.
4. How are isotopes alike? Different?

Concepts to Review

Names and symbols of the elements
Properties of metals and nonmetals
Periodic table
Atoms
Subatomic particles
Isotopes

Introduction

Primary substances, called elements, build all the materials about you. There are 117 elements currently known (see http://www.webelements.com/). Some look very different from each other, while others look similar. In this experiment, you will describe the physical properties of some elements in a laboratory display. Then you will show the location of the elements on a blank periodic table.

Metals are elements that are usually shiny, or have a metallic luster. They are usually good conductors of heat and electricity, ductile (can be drawn into a wire), and malleable (can be beaten into sheets). Some of the metals such as sodium or calcium may have a white coating of oxide formed by reacting with oxygen in the air; if the metal were cut, you could see the fresh shiny surface underneath. In contrast, nonmetals are not good conductors of heat and electricity, are brittle (not ductile or malleable), and appear dull, not shiny.

Atoms

Atoms are made up of smaller bits of matter called **subatomic particles**. Of these, we will consider the protons, neutrons, and electrons. **Protons** are positively charged particles, **electrons** are negatively charged, and **neutrons** are neutral (have no charge). In an atom, the protons and neutrons are tightly packed in a tiny central body called the **nucleus**. Most of the atom is empty space, which contains fast-moving electrons. Electrons are so small that their mass is nearly negligible compared to the mass of the proton or neutron.

Every atom is identified by its atomic number and mass number. The **atomic number** is equal to the number of protons in the nucleus, which is the same as the nuclear charge. The **mass number** of an atom is the sum of the number of protons and neutrons, and is usually not equal to the exact measured mass of the atom.

atomic number = number of protons (p^+)
mass number = sum of the number of protons and neutrons ($p^+ + n^0$)

In a **neutral atom** (as opposed to an **ion**), the number of electrons is equal to the number of protons. Protons attract electrons because they have opposite charges.

number of protons (#p^+) = number of electrons (#e^-)

Isotopes

There are different versions of atoms for each of the elements. **Isotopes** are types of atoms of the same element that differ in the number of neutrons they contain. This means that isotopes of an element have the same number of protons, but different mass numbers. The following example represents the symbol of a sulfur nuclide that has 16 protons and 18 neutrons.

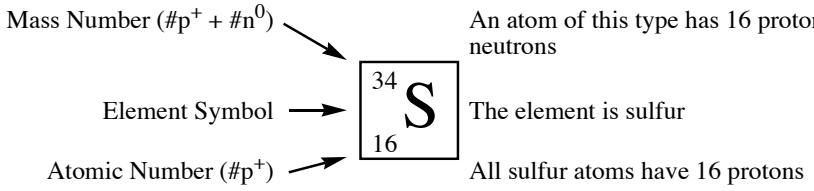


Figure 1. Complete symbol of a nuclide and the meaning of each component.

Periodic Table

The periodic table shown in Figure 1 on the next page contains information about each of the elements. The horizontal rows of the table are called **periods**, and the vertical columns are called **groups**. Each group contains elements that have similar physical and chemical properties. The groups are numbered across the top of the chart. Elements in Group 1A are the **alkali metals**, elements in Group 2A are the **alkaline earths,** and Group 7A contains the **halogens**. Group 8A contains the **noble gases**, which are elements that are generally unreactive with other elements. A double zigzag line that looks like a staircase separates the metals on the left side from the nonmetals on the right side.

1 1A																	18 8A
1 H	2 2A											13 3A	14 4A	15 5A	16 6A	17 7A	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe

Figure 2. The atomic numbers and symbols of some elements on the periodic table.

Materials

A display of samples of elements (metals and nonmetals), colored pencils.

Experimental Procedure

A. Physical Properties of Elements

Observe the elements in the laboratory display. In the worksheet provided, write the symbol and atomic number for each element listed. Describe a selection of physical properties such as color and luster. From your observations, identify each element as a metal, nonmetal, or metalloid.

B. Metals and Nonmetals on the Periodic Table

On the incomplete periodic table in Figure 3, write the symbols of the missing elements. Use your text or a periodic table in the laboratory as a reference. Write the group number at the top of each column of the representative (main group) elements. Using different colors, indicate the alkali metals, alkaline earth metals, halogens and noble gases. Write the period numbers for the horizontal rows shown. Outline and label the areas occupied by the metals, nonmetals, and metalloids.

Activity 3 - Atoms and Elements Worksheet

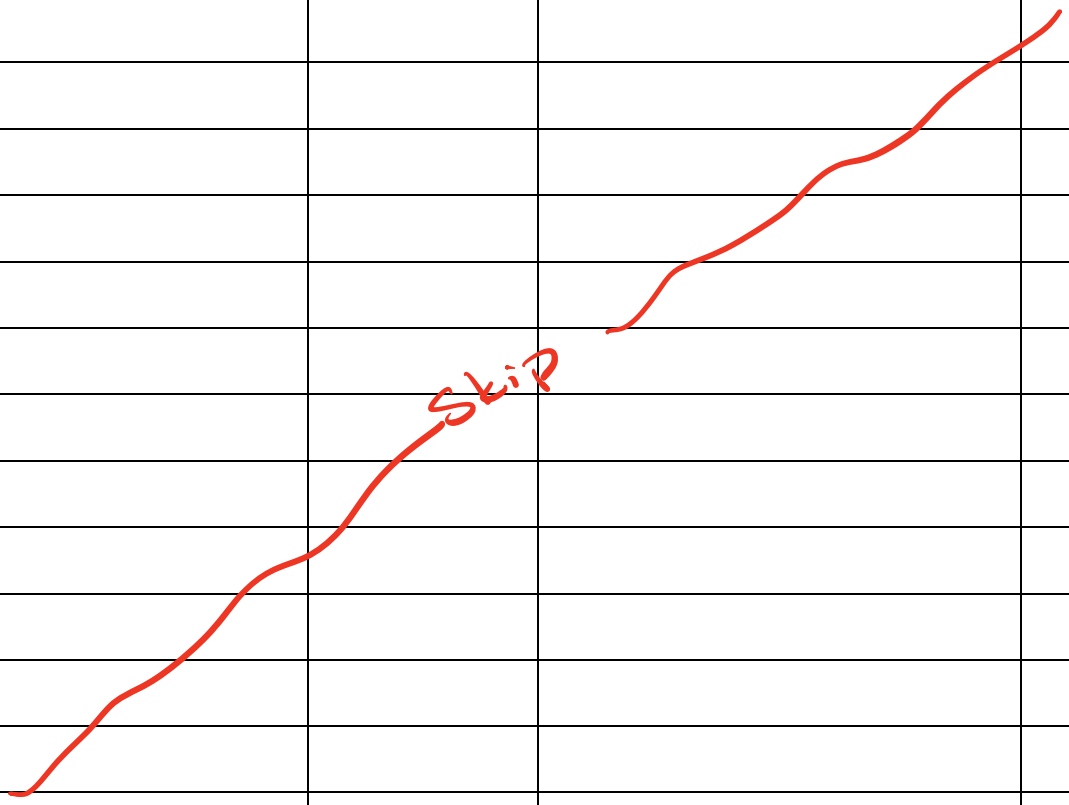
Name_____

Section_____ **Date**_____

Exercise A.

Complete the following table using the elements available in the lab:

Element Name (Atomic #)	Elemental Symbol	Physical Properties	Type of Element



After referring to a periodic table, review your answers regarding the "Type of Element" column. Are there any answers you would change based on their position in the periodic table?

Exercise B.

Complete the following periodic table as stated in the instructions to part B.

1																	2
3	4											5	6	7	8	9	10
11	12											13	14	15	16	17	18
19	20	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26	27	28	29	30	31 Ga	32 Ge	33 As	34 Se	35	36
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50	51 Sb	52 Te	53	54 Xe
55 Cs	56	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79	80	81 Tl	82	83 Bi	84 Po	85 At	86 Rn

Figure 3. Metals, Nonmetals, and Metalloids on the periodic table.

Questions and Problems

1. Complete the following table. All atoms are to be considered neutral (not ions).

Element	Atomic Number	Mass Number	Protons	Neutrons	Electrons
Fluorine	9	19	9	19-9 = 10	9
Iron				30	
		27			13
Potassium	19	19+20 = 39	19	20	19
Bromine		80			
Gold		197			
			53	74	

2. Complete the following table:

Isotope symbol	Protons	Neutrons	Electrons
$^{40}_{20}Ca$	20	40-20 = 20	20
$^{42}_{20}Ca$	20	22	20
$^{40}_{19}K$			
	20	24	20
$^{46}_{20}Ca$			

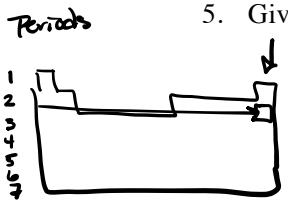
3. Complete the list of names of elements and symbols:

Name of Element	Symbol	Name of Element	Symbol
Potassium	K		Na
Sulfur			P
Nitrogen			Fe
Magnesium			Cl
Copper			Ag

4. On the following list of elements, circle the symbols of the transition metals and underline the symbols of the halogens:

Mg Cu Br Ag Ni Cl Fe F Br B Na

Mg Cu Br Ag Ni Cl Fe F Br B Na



5. Give the name of each of the following elements:

   a. Noble gas in Period 2 _____

   b. Halogen in Period 2 _____

   c. Alkali metal in Period 3 _____

   d. Halogen in Period 3 _____

   e. Alkali metal in Period 4 _____

6. From their positions on the periodic table, indicate by circling "M" or "NM" whether the following elements are metals or nonmetals:

Na	M	NM	S	M	NM	Cu	M NM
F	M	NM	Fe	M	NM	C	M NM
Ca	M	NM	O	M	NM	Zn	M NM

7. Consider the element chlorine:

   a. Explain how you would determine the number of neutrons in a chlorine atom that has a mass number of 37.

mass # given → 37 Cl
atomic # Look up PT → 17

   b. Another atom of chlorine has a mass number of 35. How does it compare to the above atom of chlorine?

35
17 Cl

   c. Naturally occurring chlorine is a mixture of the above isotopes, with 75.77% ^{35}Cl and 24.23% ^{37}Cl. The atomic masses of these isotopes are 34.9689 and 36.9659, respectively. Calculate the average atomic mass of chlorine from the above data.

- SKIP -

8. A neutral atom has a mass number of 80 and 45 neutrons. Write its complete isotope symbol.

9. An atom has eleven more protons and fifteen more neutrons than the atom in Question 8. Write the isotope symbol that describes this atom.