Unit 1

PART I. MATH TOOLS FOR CHEMISTRY Chapter 2

I. Scientific Notation-Review!

Scientific notation is used for expressing very large or very small numbers

153000000000000 → 1.53×10^{14}

note: *There should only be 1 number to the left of the decimal place!!*
not....15.3×10^{14}

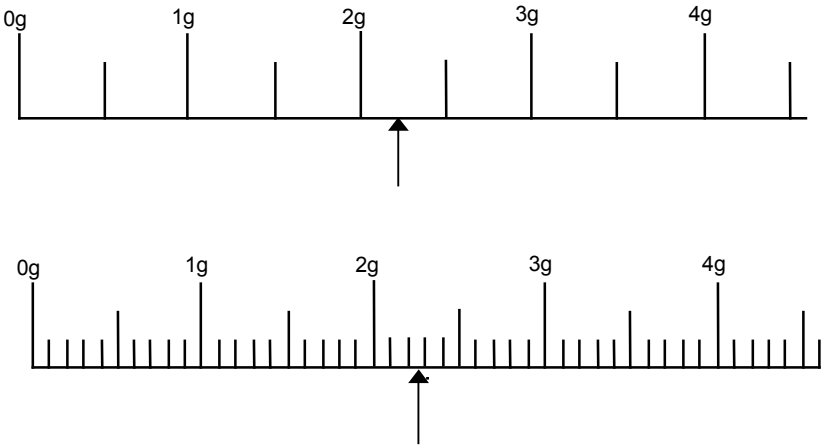
Examples: 453442 =
0.00034200024=

II. Significant Figures in Measurements (Sig. fig.)

Example $^{o}T = 25^{o}C$ or $^{o}T = 25.45\ ^{o}C$

A. Significant Figures in measurements

Record all **accurate** numbers plus **one estimate** number



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The number of Sig. Fig. in measured numbers will show the uncertainty of the measuring device.

B. Determining the Number of Significant Figures in a **Measured** value

1. All non-zero digits are significant

2. Zeros between non-zero digits are significant

3. Zeros on the left side of a non-zero digit are not significant

4. Zeros on the right side of non-zero digits.....

a. If the number has a <u>decimal</u> point, the zeros are significant

b. If the number does not have a decimal point, the zeros may/may not be significant →it is ambigious!!!

note: Always write these type of numbers in scientific notation!

How many significant figures do the following numbers contain?

5.07

0.0000876

998.9877000

0.0000009830000

<u>C Rounding - Off Numbers</u>

1. If the digit to be dropped is < 5 → eliminate the number [Round-down]

2. If the digit to be dropped is ≥ 5 → Round-up

D. Significant Figures in Calculations

1. Addition and Subtraction

Answer may not have any more **decimal places** than the least accurate number

2. Multiplication and division

Answer contains the same number of significant figures as the measurement with the **least number** of sig. fig.

3. [Multiplication or Division] and [Addition or Subtraction] are combined.

* *Key*: Do Sig. Fig. stepwise

Example (4.04 + 143.) x (3.550 + 5.4090)

E. Exact numbers

Exact numbers are not measured numbers and have an infinite number of significant figures

II. The Metric System

The metric system is the scientific system of units of measurement

METRIC BASE UNITS

	LENGTH	MASS	VOLUME	TIME
	meter	gram	liter	sec
Abbr.	mg	l	s	

Metric Prefixes

Metric prefixes are all related by a factor of ten

Know:	Prefix	Symbol	Exponential form	Standard form
	Mega-	M	10^6	1,000,000
	*Kilo-	K	10^3	1,000
	*Deca-	da	10^1	10
	*Deci-	d	10^{-1}	0.1
	*centi-	c	10^{-2}	0.01
	*milli-	m	10^{-3}	0.001
	*micro-	μ	10^{-6}	0.000001
	*nano-	n	10^{-9}	0.000000001

Metric Mechanics

III. DIMENSIONAL ANALYSIS

Dimensional Analysis is a method used to convert from one unit to another.

Problem: Convert 1.77 centimeters to meters

Metric conversion factors and sig. figs.

Conversion factors within the metric system are exact numbers and are not involved in the significant figure determination.

PROBLEMS:

Significant figures:

Metric ⇔ metric conversion factors are **exact numbers** and have an infinite number of significant figures

English ⇔ english conversion factors are **exact numbers** and have an infinite number of significant figures

English ⇔ metric conversion factors are **measured** numbers and have a finite number of significant figures

Note: *Know typical english ⇔ english conversion factors*

A. SINGLE-STEP PROBLEMS

1. How many millimeters are in 3.4 meters

2. How many liters in 55 μL?

B MULTISTEP

Key: Go thru the base unit.

1. Metric ↔ Metric conversions

a. How many Kilometers are in 3.46×10^{13} mm?

b. How many milliliters are in 1.2×10^{6} deciliters?

2. English ↔ Metric conversions

a. How many milligrams in 32 lbs?

b. How many Km is a 100.0 yd football field

3. Converting to or from an unusual unit

What is 2.00 drams in gallons if : 1 dram = $3.6967 \times 10^{-3} \mu l$

4. Rates

a. If gas is 66 cents per L, what is this in dollars per gallon?

b. If a faucet is dripping at 1.0 drop per sec, how many mls per week is this?
16 drops = 1.0 ml

5. Volume conversions

a. A piece of wood is 15 cm x 24 cm x 11 cm.

(1) What is the volume of this wood?

(2) What is the volume in cubic meters?

b. If a glass holds 4.600×10^{4} mm^3 of water, What is this in cubic inches?

IV. PROBLEM SOLVING:

a. The estimated amount of recoverable oil from the field at Prudhoe Bay in Alaska is 9.6×10^{9} barrels. What is the amount of oil in cubic meters?

[12 barrel = 42 gal (exact)] [1 qt = 9.46×10^{-4} m^3]

b. On the planet Aragonose (which is made mostly of the mineral aragonite, whose composition is calcium carbonate) has an atmosphere containing methane and carbon dioxide. Aragonose has an ocean and it's depth was measured to be 2425 fathoms. What is this depth in meters?
(1 fathom = 6.00 ft.)

V. Density

Density measures how closely the mass of a given substance is packed in a given volume

$$D = \frac{\text{Mass}}{\text{Volume}}$$

Problems: a. If 40.53 g gold = 2.10 cm^3, what is its density?

b. Calculate the mass of 251 mL of Al. (Density of Al = 2.7 g Al / cm^3 Al)

c. What is the volume of 2.5 lbs of Au?

Note: $1cm^3$ = 1 ml = 1cc (know)

STARRED PROBLEMS

1. A square piece of aluminum foil, 4.0 in on one side, is found to weigh 0.466 g.

   What is the thickness of the foil, in mm if the density of the foil is 269 cg/cm^3?

2. The metal chromium has a density of 7.18 g/cm3 and aluminum has a density

   of 2.70 g/cm^3

   a. What volume does 1000.0 g of Al occupy?

   .

   b. What would be the mass of the same volume of Cr?

Part II BASIC CHEMISTRY

Chapter 3-Matter and Energy

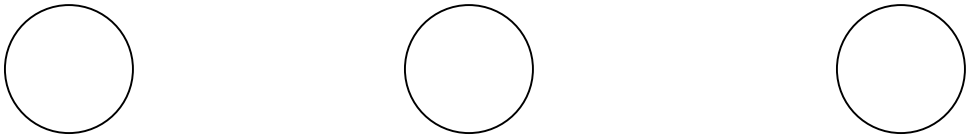
I. Matter

Matter is anything that occupiers space and has mass

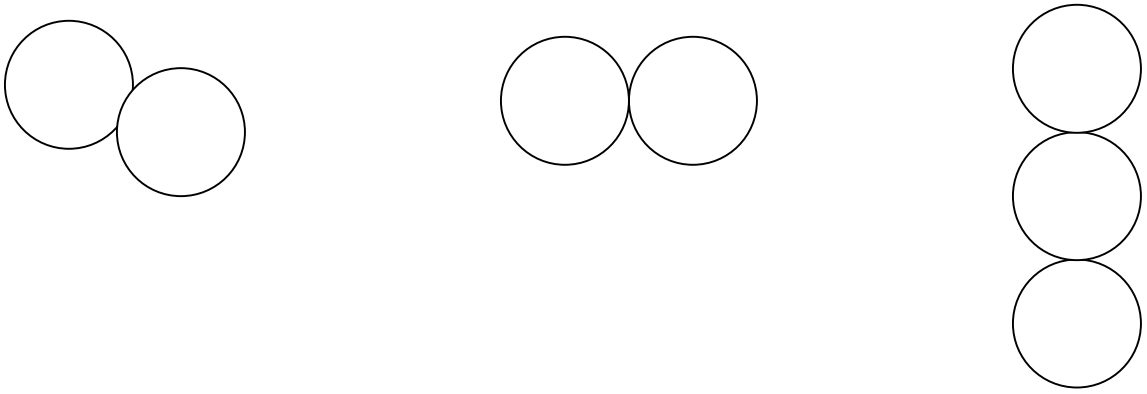
Ultimately matter is composed of atoms. In many cases atoms bond together to form molecules or large arrays of ions represented by "formula units"

II. Types of Particles

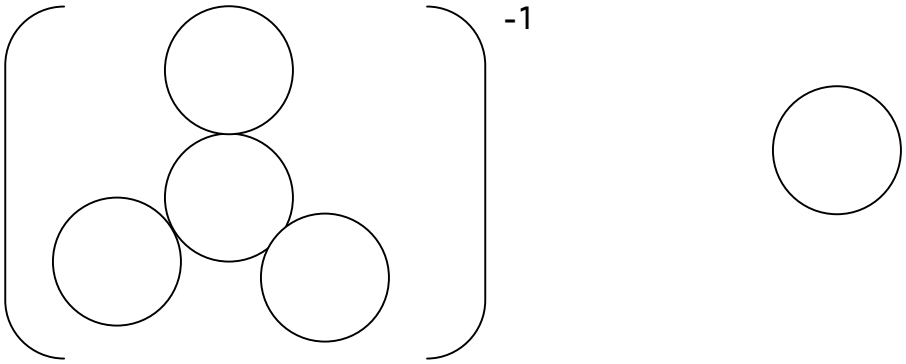
A. Atoms are the smallest units/particles that can exist that will have the characteristics of the element.



B. Molecules are the smallest unit of two or more atoms covalently bonded together. (more later)



C. An ion is a positively or negatively charged atom or group of atoms



A. PHYSICAL STATES OF MATTER

	SPACING	SHAPE	VOLUME	COMPRESSIBILITY
SOLID				
LIQUID				
GAS				

III. Types of Matter

A. Pure Substances Matter with a definite composition

a. Element - an element cannot be broken down by simple chemical means.

Symbols of Elements:

b. Compound - a compound can be broken down into two or more elements. Two or more elements chemically bonded together.

(1) Ionic compounds - (+) and (-) charged ions bonded together by the force of their positive and negative charges

Formulas of Compounds:

(2) Molecular compounds - Two or more atoms covalently bonded together (more later)
Formulas of Compounds:

B. Mixture – Physical mixture of two or more substances.

a. Homogeneous mixture is uniform in appearance and properties throughout.
-could consist of 2 or more substances.
Examples:

b. Heterogeneous mixture has 2 or more physically distinct phases.
Examples:

B. PHYSICAL PROPERTIES

Each substance has a unique set of properties. *Physical properties* can be seen or measured with out changing the chemical composition.

C. PHYSICAL CHANGES

A physical change alters the physical properties of a substance without altering its chemical composition.

Usually when:

1. Changing a sample of matter from one physical state to another
2. Changing the size or shape of the substance
3. Mixing or dissolving two or more substances

D. CHEMICAL PROPERTIES

Chemical properties are observed or measure only when it is undergoing a chemical reaction.

E. CHEMICAL CHANGES

A chemical change is a process that changes the chemical composition of a substance

1. Examples of chemical reactions

2. Evidence of a chemical reaction occurring

3. Chemical equations

F. EXAMPLES OF PHYSICAL VS CHEMICAL CHANGES

1. Paper burns to produce CO_2 and H_2O

2. Gasoline evaporates

3. The statue of liberty turns green

4. Tearing paper

5. A tree stump rots

6. Dissolving a package of jello in water

IV. Scientific Law and Theory

1. Scientific Law

2. Scientific Theory

V. Conservation of Mass

In a chemical change matter cannot be created nor destroyed.
Example:

VI. Energy – Chemical, electrical, heat or light

Conservation of Energy

Types:

a. Kinetic energy - Energy due to the motion of the object

b. Potential energy - due to the position or chemical composition of the object

Examples:

c. Thermal energy

(1) Endothermic Reaction - Heat is absorbed in a reaction

(2) Exothermic reaction - Heat is released in a reaction

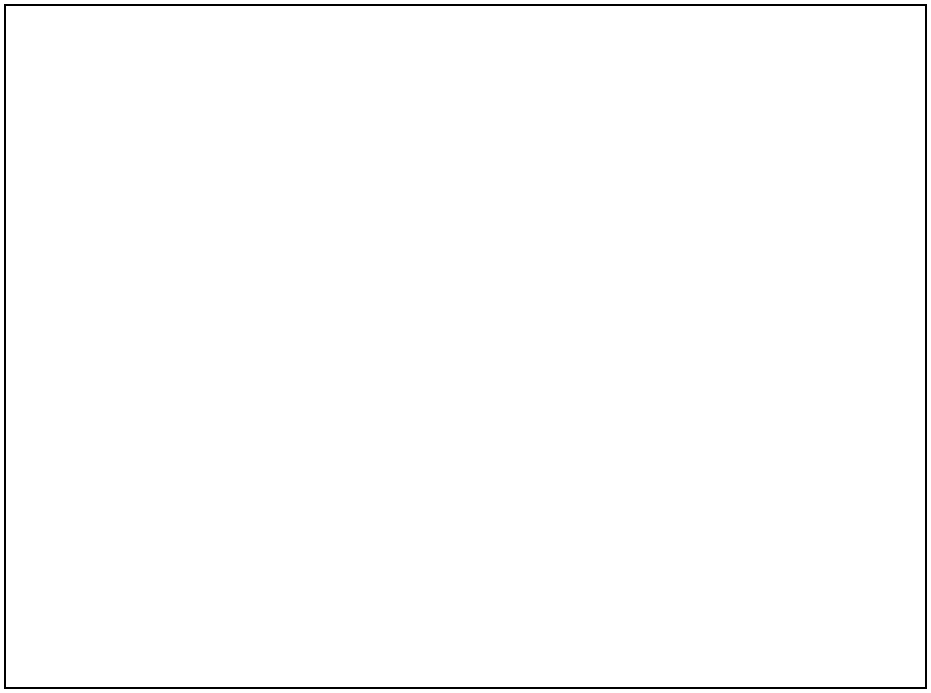
VII. Temperature

Temperature ,T°, is a measurement of kinetic energy in a substance – what we call "hotness or coldness."

A. Celsius & Kelvin

B. °F

C. Thermometers



D. Temperature conversions:

1.

2.

Chapter 4-Atoms and Elements

I. The Atom - history:

A. Democritus (approx. 400 BC) - Mental concept of the atom: A repeated dividing of matter would eventually result in indivisible, invisible, minute particles called *atomos*

B. Dalton (approx. 1800 AD)- Experimentally based: Atoms are the building blocks of matter

C. Thompson (1897) Discovered the electron

D. Rutherford (1911) Developed the structure of the atom

E. Schrodenger (1923) Developed the orbital model of the atom/ electrons move in a wave motion

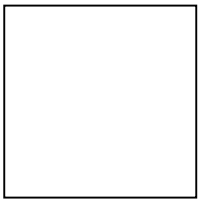
F. Chadwick (1932) Discovered the neutron

II. Subatomic Particles: -

III ELEMENTS: Defined by their numbers of Proton
Protons are "The atomic DNA"

IV. THE PERIODIC TABLE

A. ELEMENTAL SYMBOLS→ Memorize selected elements. Correct spelling is essential!!!



B.

Periods are horizontal rows on the periodic table

Groups are vertical columns on the periodic table

Group	Name
IA	Alkali Metals
IIA	Alkaline Earth Metals
VIIA	Halogens
VIIIA	Noble Gases

Families are groups (essentially). These elements have similar properities.

Diatomic Elementsare those elements that exists as two atoms bonded together

Representative elementsare "A" group elements

Metals are those elements which have the characteristic properities of: high luster, good conductors of heat and electricity, and are malleable

Nonmetals are those elements, unlike metals do not have a high luster and generally are not good conductors of heat and electricity

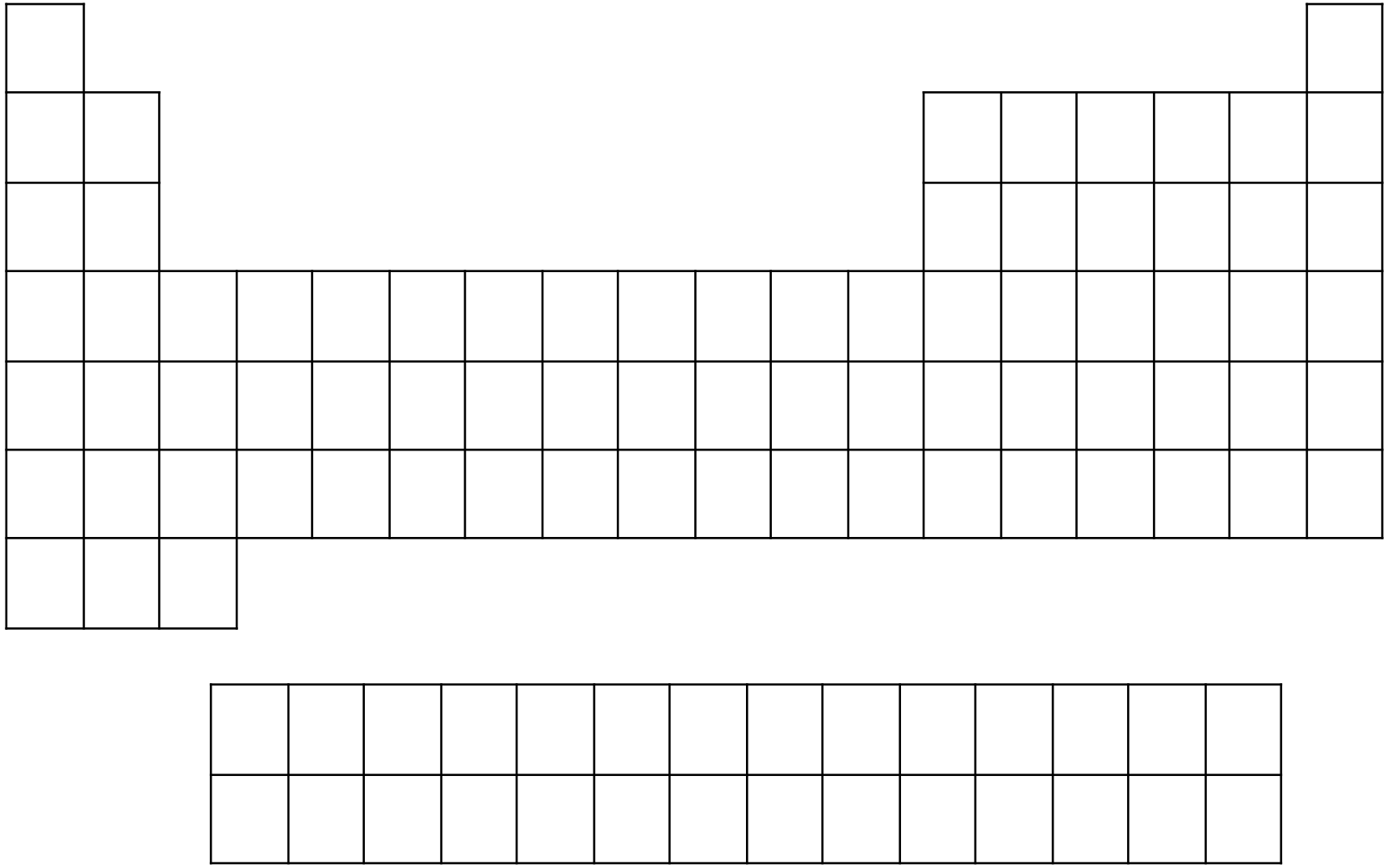
Transition elements (metals) are the "B" group elements

Mettaloids are elements with properities that are intermediate between those of metal and nonmetals

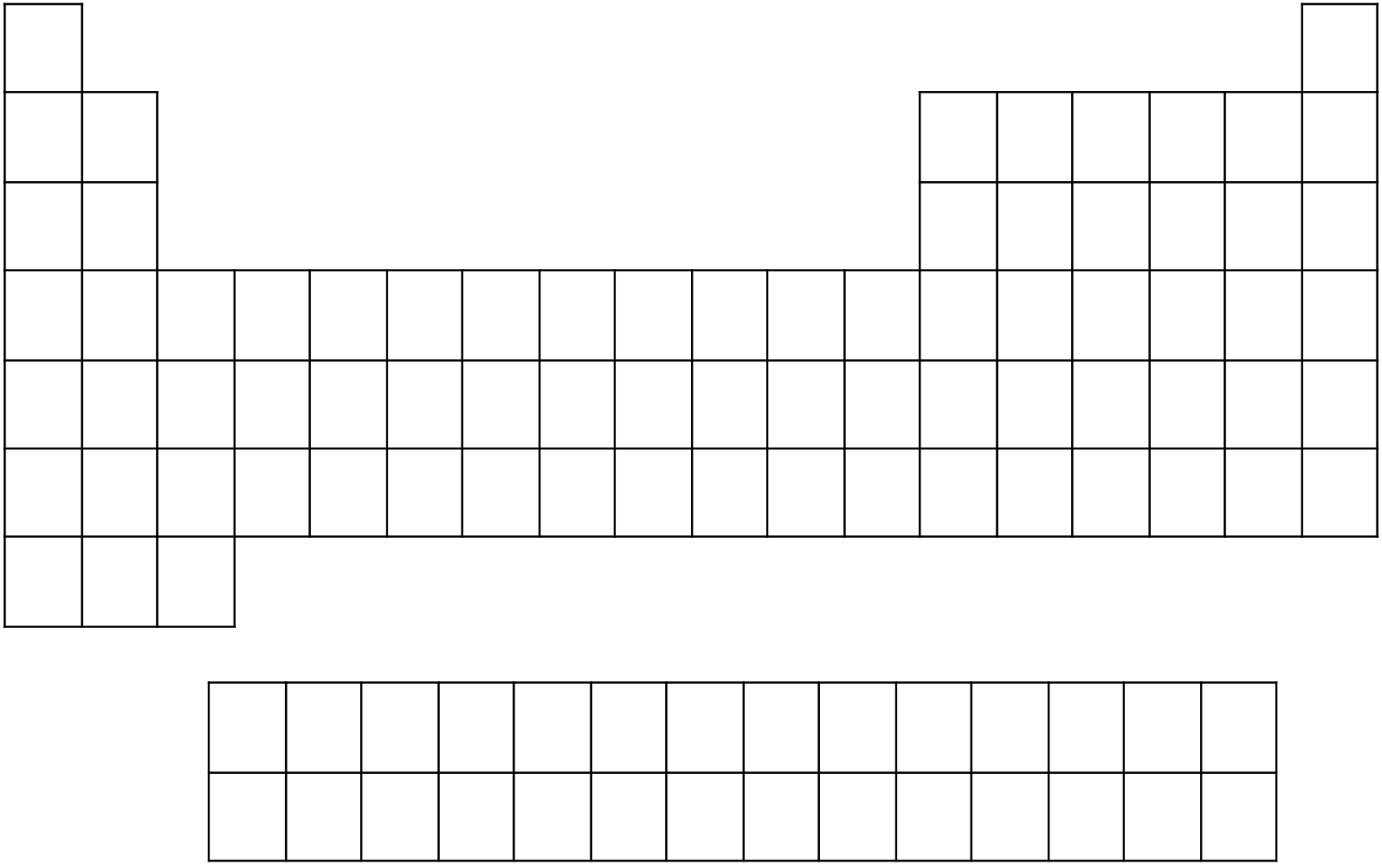
Physical States of elements- Elements exists as either a gas (g), liquid (l) or solid (s).

Gases: H_2, N_2, O_2, F_2, Cl_2, He, Ne, Ar, Kr, Xe, Rn

Liquids: Cs, Fr, Hg, Ga, Br_2



PERIODIC TABLE IA



PERIODIC TABLE IA

PRACTICE

SHOW ALL YOUR WORK. YOUR ANSWERS MUST HAVE THE CORRECT NUMBER OF SIGNIFICANT FIGURES AND UNITS.

CONVERSION FACTORS

note: you may or may not need all the following conversion factors.

Length

1 in = 2.540 cm 1 m = 39.37 in. 1 km = 0.6214 mi.

Mass

1kg = 2.205 lb 1 oz = 28.34 g 1 lb = 453.6g

Volume

1 qt = 0.9463 L 1 L = 2.113 pt. 1 fl oz = 29.57 mL

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1. Round to 3 significant figures then, express the answer in scientific notation.

	3 Sig. Fig.	Scientific notation
678.50×10^{12}	_____	_____
0.007850×10^{-2}	_____	_____

2. a. Place a S= solid g = gas l = liquid next to the elements indicating its physical state at room temperature.

Plus :

b. Place a D next to the diatomic elements

N _____	C _____	O _____
Ca _____	Ar _____	Hg _____
Br _____	Co _____	F _____

3. Solve the following: (Rem: Sig. Figs. !)

a. $\dfrac{(14.500 \times 10^{2})\,(0.003144 \times 10^{-50})}{(21.4 - 15.)} =$

b. $\dfrac{27.66\ g - 27.77\ g}{27.77g} =$

4. A certain diamond ring has 6 diamonds mounted in gold. Each diamond weighs 3.000×10^{-5} kg. If diamonds cost $1,213. per carat (1 carat = 200.0 mg) and the ring's gold costs a total of $397.44, how much does the diamond ring cost?

:

5. A solution of Sulfuric Acid, H_2SO_4, had a specific gravity of 1.14. What is the mass of solution which contains 54.7 nl of H_2SO_4.

(10) **6.** The density of gold is 19.3 g/cm^3 and that of platinum is 21.4 g/cm^3. Which of the following weighs more: A rectangle of gold measuring 2.00 cm x 1.00 cm x 4.00 cm
or a rectangle of platinum measuring 0.045 ft x 0.095 ft x 0.065 ft.

:

7. Normally our bodies can endure a temperature of 105.0 ^oF. What is this in.....

a. Kelvin
Calc:

b. $^o C$
Calc.:

(8) **8.** Convert: 1.00 $\frac{yds}{sec^2}$ to $\frac{nm}{hr^2}$

9. a. *Which of the following are homogeneous or heterogeneous mixtures?*

Brass _____

Cherry kool-aid _____

Oil and vinegar dressing _____

b. *Indicate which of the following is kinetic or potential energy:*

A rock at the top of a mountain _____

an arrow being shot _____

the space shuttle lifting off _____

c. *Indicate which of the following is a chemical or physical change*

Burning of a log _____

Rusting of a nail _____

melting of ice _____

The odor of a skunk _____

d. *Give examples of:*

Three metaloids _____

Three alkali metals _____

3 Halogens _____

3 transition elements in period #4 _____

e. *Give the definition of a compound*

(8) 10. What is 4.22×10^{58} grains in μg , if 1 pound = 5,760.0 grains.

Calculations: