Notes #1 Unit 1: Foundations

Ch. Chemical Foundations

I. Significant Figures

-are digits in a number that have been measured.

Rule:

Every digit is significant, except:

-leading zeros in small numbers.

-trailing zeros in numbers without a decimal point.

In 0.0023 only the 2 & 3 count, in 5000 only the 5 counts, in 5000**.** all digits count.

Ex. 1) State the number of significant figures.

4.23	**3**	
5.20	**3**	(has a decimal)
0.000059	**2**	(leading zeros)
5.09	**3**	
20.090	**5**	
320.00	**5**	
10200	**3**	(trailing zeros, no decimal point)

II. Exponential Notation

-is a way of writing numbers using only significant figures.

#.## X 10^{power} (1 digit, then decimal, then rest of number)

Ex. 1) 256 = 2.56 X 100 = **2.56 X10^{2}**

43.9 = **4.39 X10^{1}**

0.02 = **2. X10^{-2}** Big #, positive power!

0.000490 = **4.90 X10^{-4}** Small #, negative power!

10200 = **1.02 X10^{4}** *non significant figures are not included

Ex. 2) Round 124973 to 3 significant figures = **1.25 X10^{5}**

to 2 significant figures = **1.2 X10^{5}**

#2 Notes: III. Rules for Rounding with Significant Figures

a) Addition/Subtraction

The answer is rounded to the decimal place of the least accurate digit in the problem.

Ex. 1) 429.3 tenths *tenths is least accurate (fewest decimal places)
37.45 hundredths
+ 1.93 hundredths
468.68 round it to tenths
468.7 = **4.687 X10^2**

Ex. 2) 0.049 thousandths
1.20 hundredths *hundredths is least accurate
+3.02 hundredths
4.269 round to hundredths
4.27 = **4.27 X10^0**

Ex. 3) 1.956 X10^2 – 2.3 X10^1

195.6 tenths
-23. ones *ones is least accurate
172.6 round to ones
173 = **1.73 X10^2**

**Take numbers out of exponential notation.

b) Multiplication/Division

The answer should have the same number of significant figures as the term with the least number of significant figures in the problem.

Ex. 1) 4.2 X10^4 X 2.43 X10^2= (4.2 X10^4) X (2.43 X10^2)= 10206000 = 1.0206 X10^7
1st number has 2 sig fig, 2nd number has 3 sig fig, 2 is least = **1.0 X10^7**

Ex. 2) 4.9 X10^{-2} X 3.11 X10^2 / 3.97 X10^3 = (4.9 X10^{-2})(3.11 X10^2) / (3.97 X10^3) =
0.003838539 = 3.838539 X10^{-3} = **3.8 X10^{-3}**
1st number has 2 sig fig, 2nd number has 3 sig fig, 3rd number has 3 sig fig, 2 is least

X10^n (-)
On calculator: 4.9 **EXP or EE** **+/-** 2 **X** 3.11 **EXP or EE** 2 ÷
3.97 **EXP or EE** 3 =

Some new calculators have a **X10^n button, instead of **EXP** or **EE** . (Do not confuse this with the **10^x** button, which is for inverse log! Never type in **X** **1** **0** separately!)

Some new calculators have a **(-) or a $+ \overrightarrow{\leftarrow}$ **-** button, instead of a **+/-** button.

On the calculator, these buttons are usually on top of the 7 or 8 or by the equals (=) sign.

Ex. 3) 3.729×10^2 X 2.36×10^2 / 4.56×10^2 = $(3.729 \times 10^2)(2.36 \times 10^2) / (4.56 \times 10^2)$=
192.9921053 = **1.93×10^2**
1st number has 4 sig fig, 2nd number has 3 sig fig, 3rd number has 3 sig fig, 3 is least

Exact Numbers
-have an infinite number of significant figures.

4 eggs = 4.00000000
Averaging 3 numbers $\frac{\# + \# + \#}{3}$ the 3 is exact, 3.00000000
Exact numbers will not limit you, look at the other numbers in the problem for rounding.

Notes #3 IV. Combined Operations

Steps:
1) Work out the problem on the calculator.
2) Then go back and find what the numbers should be rounded to.
3) Round off the original answer.

Ex. 1) (4.23 + 5.6) (3.13 + 4.937) = (9.83) (8.067) = 79.2986

4.23		3.13	←hundredths least accurate
+5.6	←tenths least accurate	+4.937	
9.8	rounded to tenths	8.07	rounded to hundredths

(9.8) (8.07) = 79 = 7.9 X10^{1} rounded to 2 sig fig

↑

2 sig fig is the least amount

Ex. 2) $\dfrac{(1.53 + 2.961 + 37.0)}{(42.3 – 29.345 – 8.21)} = \dfrac{41.491}{4.745} = 8.7441517$

1.53		42.3	←tenths least accurate
+2.961		-29.345	
+37.0	←tenths least accurate	-8.21	
41.5	rounded to tenths	4.7	rounded to tenths

(41.5) / (4.7) = **8.7 = 8.7 X10**^{0} rounded to 2 sig fig

↑

2 sig fig is the least amount

Ex. 3) $\dfrac{(79.12 – 16.007 + 0.1)}{(49.30 + 24.970)} = \dfrac{63.213}{74.270} = 0.8511242$

79.12		49.30	←hundredths least accurate
-16.007		+24.970	
+0.1	←tenths least accurate	74.27	rounded to hundredths
63.2	rounded to tenths		

(63.2) / (74.27) = **0.851 = 8.51 X10**$^{-1}$ rounded to 3 sig fig

↑

3 sig fig is the least amount

V. SI Units

Mass = grams (really kilograms)
Length = meters
Time = seconds
Volume = liters

Multipliers	Example with meters: **(**Same for grams, seconds & liters!)**
Mega (M)	1 Mm = 1 $X10^{6}$ m
**kilo (k)	1 km = 1 $X10^{3}$ m
**deci (d)	1dm = 1 $X10^{-1}$ m
**centi (c)	1cm = 1 $X10^{-2}$ m
**milli (m)	1 mm = 1 $X10^{-3}$ m
micro (μ)	1 μm = 1 $X10^{-6}$ m
nano (n)	1 nm = 1 $X10^{-9}$ m
pico (p)	1 pm = 1 $X10^{-12}$ m

length
1 m = 39.37 in
2.54 cm = 1 in
1 km = 0.621 mile
1 mile = 5280 ft
Mass
1kg = 2.205 lb
1 lb = 16 oz

Volume
1 L = 1.06 qt ** 1 L = 1dm^3 and 1 ml = 1cm^3
1 gal = 3.773 L
1 gal = 4 qt

#4 Notes VI. Conversions

Ex. 1) Convert 2.00 hr to min

$$\frac{2.00\ \text{hr}}{} \Big| \frac{60\ \text{min}}{1\ \text{hr}} = 120\ \text{min} = \mathbf{1.20 \times 10^{2}\ min}$$

1 hr = 60 min

Ex. 2) Convert 5.0 m to km

$$\frac{5.0\ \text{m}}{} \Big| \frac{1\ \text{km}}{1 \times 10^{3}\ \text{m}} = 0.005 = \mathbf{5.0 \times 10^{-3}\ km}$$

1 km = 1 $X10^{3}$ m

Ex. 3) Convert 2.5 g to mg

$$\frac{2.5\ \text{g}}{} \Big| \frac{1\ \text{mg}}{1 \times 10^{-3}\ \text{g}} = \mathbf{2.5 \times 10^{3}\ mg}$$

1 mg = 1 $X10^{-3}$ g

Ex. 4) Convert 49.3 cl to l

$$\frac{49.3\ \text{cl}}{} \Big| \frac{1 \times 10^{-2}\ \text{l}}{1\ \text{cl}} = \mathbf{4.93 \times 10^{-1}\ l}$$

1 cl = 1 $X10^{-2}$ l

Ex. 5) Convert 49.6 in to miles

12 in = 1 ft   1 mile = 5280 ft
in → ft   ft→ mi

1 m = 39.37 in   1 km = 1 $X10^3$ m   1 km = 0.621 mile
in → m   m→ km   km→ mi

2.54 cm = 1 in   1 cm = 1 $X10^{-2}$ m   1 km = 1 $X10^3$ m   1 km = 0.621 mile
in → cm   cm→ m   m→ km   km→ mi

in → ft → mi**
or in → m → km → mi
or in → cm → m → km → mi

$$\frac{49.6 \text{ in}}{} \left| \frac{1 \text{ ft}}{12 \text{ in}} \right| \frac{1 \text{ mi}}{5280 \text{ ft}} = \mathbf{7.83\ X10^{-4}\ mi}$$

in → ft → mi
1 ft = 12 in, 1 mi = 5280 ft

Ex. 6) Convert 6.2 hr to sec

hr → min → sec

$$\frac{6.2 \text{ hr}}{} \left| \frac{60 \text{ min}}{1 \text{ hr}} \right| \frac{60 \text{ sec}}{1 \text{ min}} = 22320 = \mathbf{2.2\ X10^{4}\ sec}$$

hr → min → sec
1 hr = 60 min, 1 min = 60 sec

Ex. 7) Convert 49.6 in to km

in → ft → mi → km
or in → m → km **
or in → cm → m → km

$$\frac{49.6 \text{ in}}{} \left| \frac{1\text{m}}{39.37 \text{ in}} \right| \frac{1\text{km}}{1 \times 10^{3} \text{ m}} = \mathbf{1.26 \times 10^{-3} \text{ km}}$$

in → m → km

1 m = 39.37 in, 1km = 1 X10^{3} m

#5 Notes VII. Conversions with cubes and denominators.

Ex.1) Convert 4.3 dm^3 to cm^3

$$\begin{array}{l|l|l|l} 4.3\ dm^3 & 1\ L & 1\ ml & 1\ cm^3 \\ \hline & 1dm^3 & 1\ X10^{-3}\ l & 1\ ml \end{array} = \mathbf{4.3\ X10^{3}\ cm^{3}}$$

$1\ dm^3 = 1$ L, $\quad 1\ ml = 1\ X10^{-3}\ l$, $\quad 1\ cm^3 = 1\ ml$

OR

$$\begin{array}{l|l|l} 4.3\ dm^3 & 1\ X10^{-3}\ m^3 & 1cm^3 \\ \hline & 1\ dm^3 & 1\ X10^{-6}\ m^3 \end{array} = \mathbf{4.3\ X10^{3}\ cm^{3}}$$

$(1\ dm)^3 = (1\ X10^{-1}\ m)^3 \qquad (1cm)^3 = (1\ X10^{-2}\ m)^3$

$1\ dm^3 = 1\ X10^{-3}\ m^3 \qquad 1cm^3 = 1\ X10^{-6}\ m^3$

Ex. 2) Convert 9.0 m/sec to km/hr

$$\begin{array}{l|l|l|l} 9.0\ m & 1\ km & 60\ sec & 60\ min \\ \hline sec & 1\ X10^3\ m & 1\ min & 1\ hr \end{array} = \mathbf{3.2\ X10^{1}\ km/hr}$$

$1\ km = 1\ X10^3\ m$, $\quad 1\ min = 60\ sec$, $\quad 1\ hr = 60min$

Ex. 3) Convert 15.6 kg/m^3 to g/cm^3

$$\begin{array}{l|l|l} 15.6\ kg & 1\ X10^3\ g & 1\ X10^{-6}\ m^3 \\ \hline m^3 & 1\ kg & 1cm^3 \end{array} = \mathbf{1.56\ X10^{-2}\ g/cm^{3}}$$

$1\ kg = 1\ X10^3\ g$, $\quad (1cm)^3 = (1\ X10^{-2}\ m)^3$

$1cm^3 = 1\ X10^{-6}\ m^3$

Ex. 4) Convert $1.34\ X10^6$ cm/sec to mi/day

$$\begin{array}{l|l|l|l|l|l|l} 1.34\ X10^6\ cm & 1\ X10^{-2}\ m & 1km & 0.621\ mi & 60\ sec & 60\ min & 24\ hr \\ \hline sec & 1cm & 1\ X10^3\ m & 1\ km & 1\ min & 1hr & 1\ day \end{array} = \mathbf{7.19\ X10^{5}\ mi/day}$$

VIII. Temperature & Density

A) Temperature Conversions

$^{o}C = 5/9\,(^{o}F – 32)$ $K = {}^{o}C + 273$

^{o}C = Celsius ^{o}F = Fahrenheit K = Kelvin (0 K = Absolute Zero)
-lowest possible temperature,
all motion stops, no Kinetic Energy

Ex. 1) What is 154 K in ^{o}F?

$K = {}^{o}C + 273$
$154\ K = {}^{o}C + 273$
$-119 = {}^{o}C$

$^{o}C = 5/9\,(^{o}F – 32)$
$-119\ {}^{o}C = 5/9\,(^{o}F – 32)$
$9/5\,(-119\ {}^{o}C) = {}^{o}F – 32$
$-214.2 = {}^{o}F – 32$
$-182 = {}^{o}F$

Ex.2) What is 72 ^{o}F in Kelvin?

$^{o}C = 5/9\,(^{o}F – 32)$
$^{o}C = 5/9\,(72\ {}^{o}F – 32)$
$^{o}C = 22$

$K = {}^{o}C + 273$
$K = 22\ {}^{o}C + 273$
$K = 295$

#6 Notes IX. Density

Density = $\frac{\text{mass}}{\text{volume}}$ $\frac{\text{(grams)}}{(\text{cm}^3)}$

mass is constant, weight changes (weight = mass X gravity)

Density of water = 1 g/cm^3
O_2 = 1.33 X 10^{-3} g/cm^3
Au = 19.32 g/cm^3 L. aurum
Al = 2.70 g/cm^3
Ag = 10.5 g/cm^3 L. argentums

Ex. 1) Bismuth has a density of 9.80 g/cm^3. What is the mass of 4.32 ml of Bi?

$$\frac{4.32\text{ ml}}{} \left| \frac{1\text{cm}^3}{1\text{ ml}} \right. = 4.32\text{ cm}^3$$

D = m/v $\quad 9.80\text{ g/cm}^3 = \frac{m}{4.32\text{ cm}^3}$

4.23 X 10^1 g = m

Ex. 2) Iron has a density of 7.87 g/cm^3. What volume would 2.46 X10^{-2} kg of Fe occupy?

$$\frac{2.46\text{ X}10^{-2}\text{ kg}}{} \left| \frac{1\text{ X}10^3\text{ g}}{1\text{ kg}} \right. = 24.6\text{ g}$$

D = m/v $\quad 7.87\text{ g/cm}^3 = \frac{24.6\text{ g}}{V}$

7.87 (V) = 24.6 **When in doubt, cross multiply!

V = 24.6 / 7.87

v = 3.13 X10^0 cm^3

#7 Notes X. States of Matter**

Matter is anything that occupies space and has mass.

1) **Solid:** particles arranged in a rigid pattern, definite shape & volume.
2) **Liquid**: particles close together in no pattern, takes the shape of its container, definite volume.
3) **Gas**: no definite shape or volume (shape and volume of container)
4) **Plasma**: hot gas-like mixture over 5000 ^{o}C, collisions cause some electrons to be knocked off, creating (+) ions. This charged mixture that conducts electricity is plasma.

XI. Mixtures

physical

[Heterogeneous Mixtures] ↔ **[Homogeneous Mixture = Solutions]**

Parts are visible *methods* parts are indistinguishable

↕ *physical methods*

Pure Substances (Homo)

↓ ↓

Elements (Homo) ↔ **Compounds (Homo)**

(One type of atom) (2 or more types of atoms)

chemical methods

Ex. 1) Heterogeneous or Homogeneous?

a) salt poured into water **Hetero**
b) salt is stirred/mixed into water **Homo**
c) soda **Hetero**
d) flat soda **Homo**
e) unmixed Kool Aid in water **Hetero**
f) apple **Hetero**

Ex. 2) Element or Compound? (=Pure Substance = Homo)

a) salt **compound**
b) isopropyl alcohol **compound** *look up formula in textbook/internet
c) gold **element**
d) oxygen **element**
e) sugar **compound**

XII. Physical/Chemical Characteristics/Changes**

Physical: melting, freezing, boiling, solubility, changing shape, malleability, conductivity.

Chemical: burning, exploding, reacting with acid, toxicity.

End of Notes (Assignments #8-9 are Review Assignments. There are no notes for these assignments.)