Name: Key Date: _____

TITLE: Metric Measurement

MEASUREMENTS

- Science is based on measurements
- All measurements have
  - Magnitude
  - Uncertainty
  - Units

NUMBERS

- Math is based on numbers
- Exact numbers are obtained by
  - Counting
  - Definitions

Also known as the SI System

- "SI" stands for *"Le Syste'me International d'Unites"*
- Law in France since 1790.
- It is based on the number **10**
- Always used in science

Base SI Units

- *Le Systéme Internationale* (SI) units are standard in science

Quantity	*Base Unit*	*Symbol*
length	meter	m
mass	kilogram	kg
time	second	s
temperature	kelvin	K

Other Base Units:

QUANTITY	BASE UNIT	SYMBOL
Volume	liter	L
Count/Quantity	mole	mol
Temperature*	Celsius	°C

**temp can be °C or* K*, depending on what you are doing....*

Temperature Conversion you need to know -

K = °C + 273

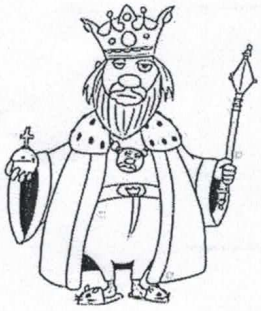
DERIVED UNITS - Built from base SI units

DERIVED UNIT	(CALCULATION)	UNITS
AREA	length x length	m^2
VELOCITY	length/time	m/s
DENSITY	mass/volume	kg/m^3
VOLUME OF A SOLID	length x height x width	m^3

- Usually **derived units** are expressed with positive/negative exponents (ex. m^2)

Can do Under Elmo —

PREFIXES



Prefixes go in front of the unit

Prefix	Symbol	Multiply Base Unit by	Example
tera	T	1,000,000,000,000	teragram = Tg = 10^{12} g
giga	G	1,000,000,000	gigaliter = GL = 10^{9}L
mega	M	1,000,000	megagram = Mg = 10^{6} g
kilo	k	1,000	kilogram = kg = 10^{3} g
hecto	h	100	hectogram = hm = 10^{2} m
deka	da	10	decagram = dag = 10 g
deci	d	1/10	deciliter = dL = 10^{-1} L
centi	c	1/100	centimeter = cm = 10^{-2} g
milli	m	1/1000	millimeter = mm = 10^{-3} m
micro	μ	1/1,000,000	microgram = μg = 10^{-6} g
nano	n	1/1,000,000,000	nanoliter = nL = 10^{-9} L
pico	p	1/1,000,000,000,000	picogram = pg = 10^{-12}g
femto	f	1/1,000,000,000,000,000	femtomole = fmol= 10^{-15} mol

Metric Conversions by Moving the Decimal

10^3	10^2	10^1	10^0	10^{-1}	10^{-2}	10^{-3}	10^{-6}
*K*ilo	*H*ecto	*D*eka	(*u*nit)	*D*eci	*C*enti	*M*illi	*M*icro
(k)	(h)	(da)	meter Liter Gram	(d)	(c)	(m)	(μ)

*K*ing *H*enry *D*ied *U*nexpectedly *D*rinking *C*hocolate *M*ilk __ __ *M*oo

KHDUDCM__ __ μ

Practice

Steps to move decimal

1. Start at given prefix
2. Count # of letters (prefix initials) to get to desired prefix
3. Note direction
4. Move decimal same number as letters counted in same direction
5. May need to add zeros to the left or right of original decimal.

0.5000

0.5 km = 5000 dm

KHDUDCM__ μ
4R

2,000 cm = 20 m

KHDUDCM__ μ
2L
2,000

SKIP Slides 2nd Day

PRECISION

- Reproducibility
  - Check by _____
  - Poor precision results from _____

ACCURACY

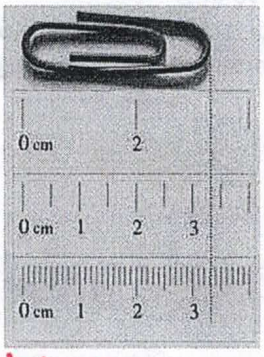
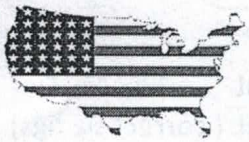
- Correctness
  - Check by _____
  - Poor accuracy results from _____

%Error

Accuracy if often determined by calculating the %Error the data. If the %Error is less than _____ the data is considered _____.

$$\%\text{Error} = \frac{\text{Actual} - \text{Experimental}}{\text{Actual}} \times 100$$

Continue Slides

How good is your measurement tool?	The measurement you record needs to indicate how "good" your measurement tool is! The last number recorded in a measurement is estimated (your best guess)  3 cm 3.3 cm 3.31cm The more divisions on your measurement tool, the more precise your measurement can be (and the more significant figures it will have).
Significant Figures	Since all measurements are uncertain, we must only use those numbers that are meaningful. In science, that means we record the digits that we are certain of, plus one more that we have to guess. These digits are all referred to as "significant figures". 3 cm 3.3cm 3.31cm **1 significant figure**: we had to take a guess at that one digit **2 significant figures**: we were certain the object was at least 3 cm, but we guessed at the tenths spot. **3 significant figures**: we were certain the object was at least 3.3 cm, but we guessed at the hundredths spot.
Slide or Elmo	
Quick Way to determine #Sig Fig 	<u>Atlantic/Pacific Rule</u> Decimal **P**resent – shoot arrow left to right stop at first number-count 0.00030 2 SF → 203.47 5 SF Decimal **A**bsent – shoot arrow right to left stop at first number-count 789000 3 SF ← 4 1 SF
Rounding For sty review	Quick rules for rounding: 1) Find the place value you want (the "rounding digit") 2) Look at the digit just to the right of it: a) If that digit is less than 5, -do not change the rounding digit -drop all digits to the right of it b) If that digit is greater than or equal to five, -add one to the rounding digit -drop all digits to the right of it Examples: 3.04 rounded to 2 sig figs is 3.0 112.511 rounded to 2 sig figs is 110 0.4203 rounded to 2 sig figs is 0.42

Rounding a Calculated Answer: *Addition & Subtraction*

An answer is no more precise than the least precise measurement used to get the answer.

1) Determine the ***decimal place*** of the last significant figure in each of your measured values.
2) Add or subtract in normal fashion.
3) Round the answer to the *least precise decimal place* seen in the measured values. → or # digits right of decimal

Discuss reasons for answer

The problem	The unrounded answer	The rounded answer	Why?
9.1 + 4.77	13.87	13.9	The last sig fig in 9.1 is in the tenths place. The last sig fig in 4.77 is in the hundredths place. You must round your answer to have its last sig fig in the tenths place.
211 - 111	100	100.	The last sig fig in 211 is in the ones place. The last sig fig in 111 is also in the ones place. You must round your answer to have its last sig fig in the ones place.
22 - 0.934	21.066	21	The last sig fig in 22 is in the ones place. The last sig fig in 0.934 is in the thousandths place. You must round your answer to have its last sig fig in the ones place.

Rounding a Calculated Answer: *Multiplication & Division*

1) Determine the ***total number*** of significant figures in each of your measured values.
2) Multiply or divide in normal fashion.
3) Round the answer to the *fewest total number of significant* figures seen in the measured values.

Discuss reasons for answers

The problem	The unrounded answer	The rounded answer	Why?
27.81 x 20.5	570.105	570.	27.81 has 4 sig figs 20.5 has 3 sig figs You must round your answer to have 3 sig figs
710 ÷ 3.0	236.6666667	240	710 has 2 sig figs 3.0 has 2 sig figs You must round your answer to have 2 sig figs
0.02 x 2.371	0.04742	0.05	0.02 has 1 sig fig 2.371 has 4 sig figs You must round your answer to have 1 sig fig

Practice

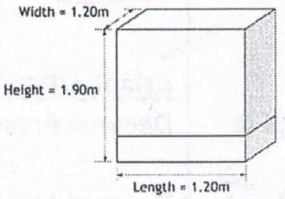
Multiplication

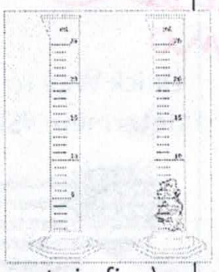
V = L x W x H

V = 1.20m x 1.20m x 1.90 m

V = 2.736 cm³

V = 2.74 cm³ (correct sig figs)





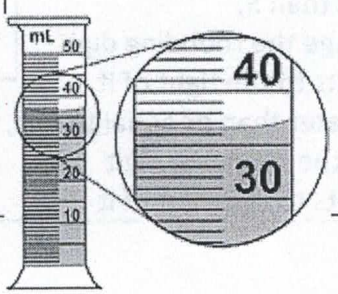
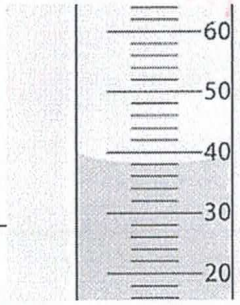
Addition/ Substraction

19.8 mL – 17.1 mL = 2.7 mL

19.8 mL – 17.1 mL = 2.7 mL (correct sig figs)

Both one past decimal

Note on reading graduated lines on lab equipment

Value of incremental lines = $\frac{\text{Large\# - Smaller\#}}{\text{\#of lines in between}}$

Significant Number place value = Value of incremental lines + one place value to the right