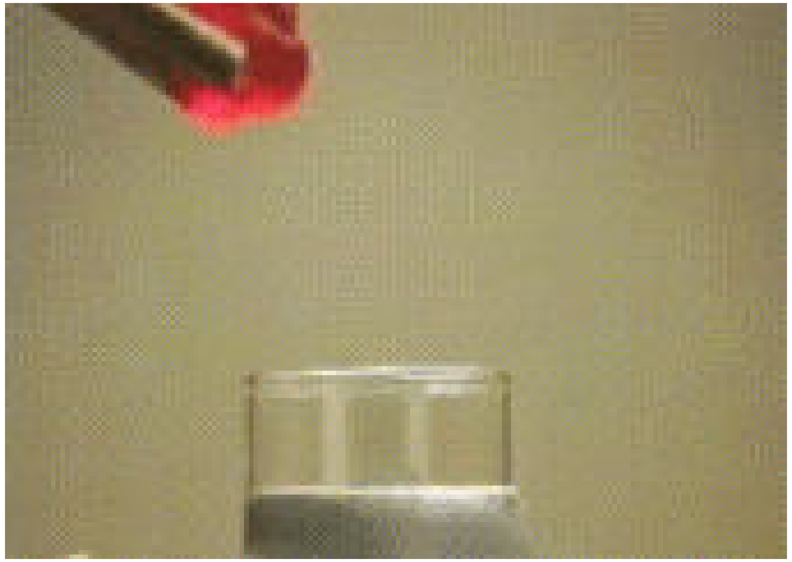
Unit 1: Measurement & Data Analysis

What is chemistry?

The study of matter and energy

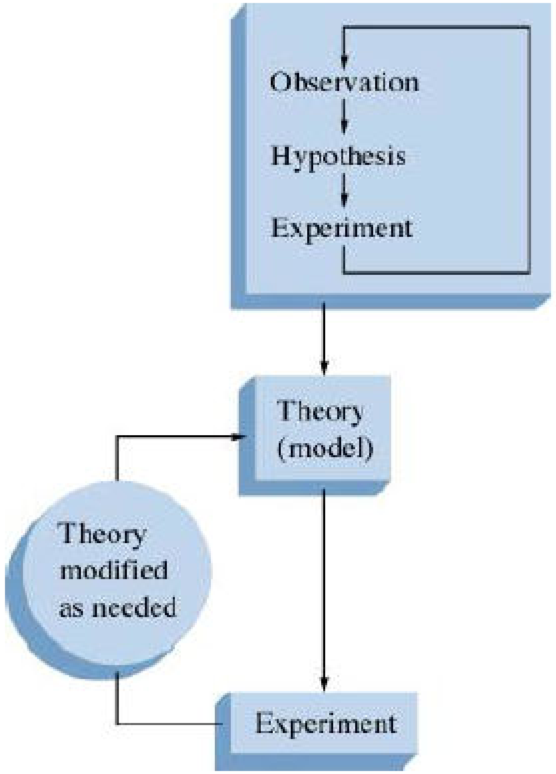


Scientific Method

Science is a procedure for solving a problem/understanding certain information.

Steps in the Scientific Method:

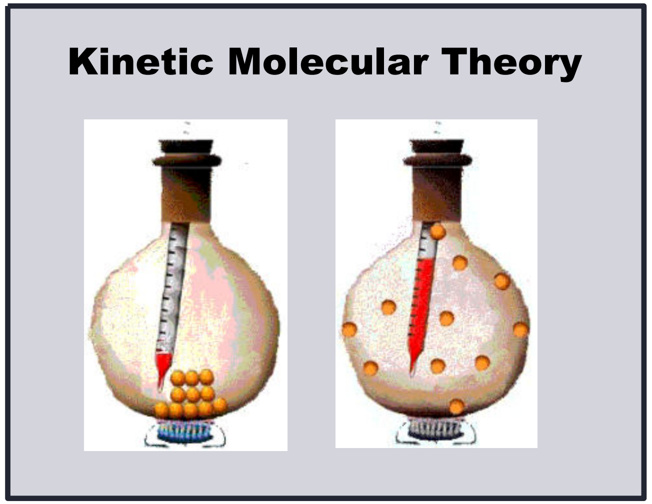
- Identify the problem/question and make observations
- Form a hypothesis
- Carry out an experiment (or multiple experiments)
- Steps may be repeated until a conclusion is made



Theories & Laws

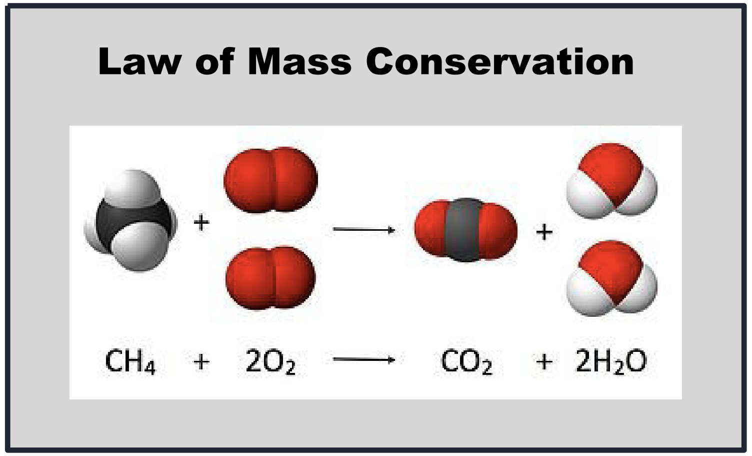
<u>Theory (model) – set of hypotheses</u>

- attempt to EXPLAIN a phenomenon
- explains WHY something happens
- can be changed based on new information



Law – observation that applies to many different situations

- - tells WHAT happens
- - does not provide an explanation



Material Safety Data Sheets

MSDS's or SDS's show:

- which company manufactured or sold the chemical
- hazard information and toxicity levels
- first aid and emergency procedures
- Physical and chemical properties
- Safe storage and handling procedures
- Methods for transporting or disposing

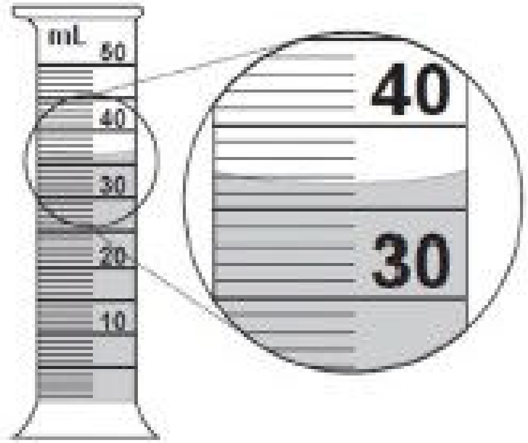
Measurement

- Measurements must have ____**units**________ to give meaning to the number.
- What can be measured?

Mass

Time

Volume



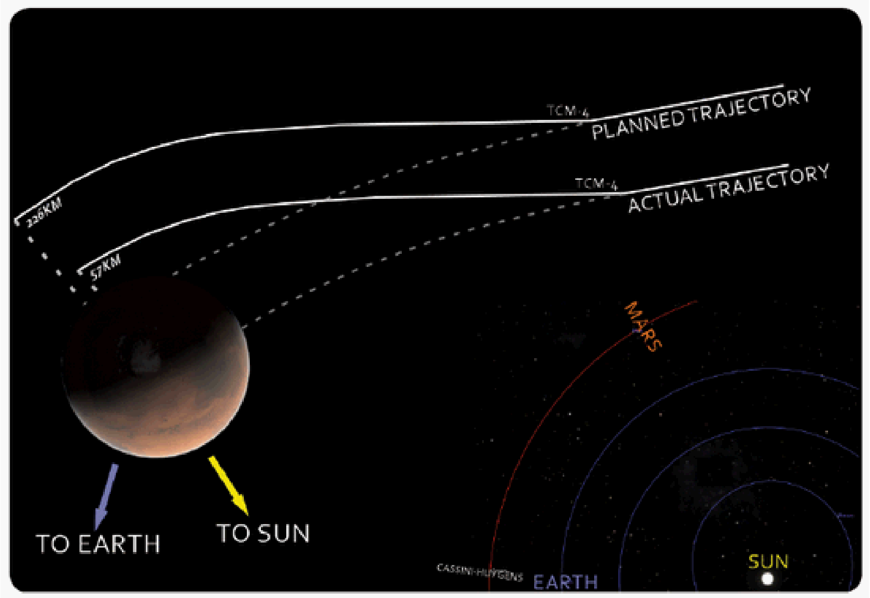
Length

Energy

Wrong Units Used by NASA

On September 23, 1999, the Mars Climate Orbiter disintegrated in the atmosphere of the planet and was never heard from again.

The error occurred because the orbiter adjusted thrust based on **Newtons**/second; however, the scientists sending it updates were using **pounds**/second.



Lend me a hand!

Working with a partner, measure the length and width of your whiteboard using someone’s hand. Write your measurements on your whiteboard. Calculate the area of your board. (Area = length x width)

Accuracy & Precision

A

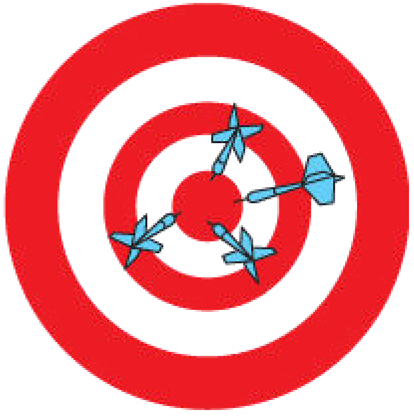
A bit accurate but not precise

B

Precise but not accurate

C

Neither accurate nor precise

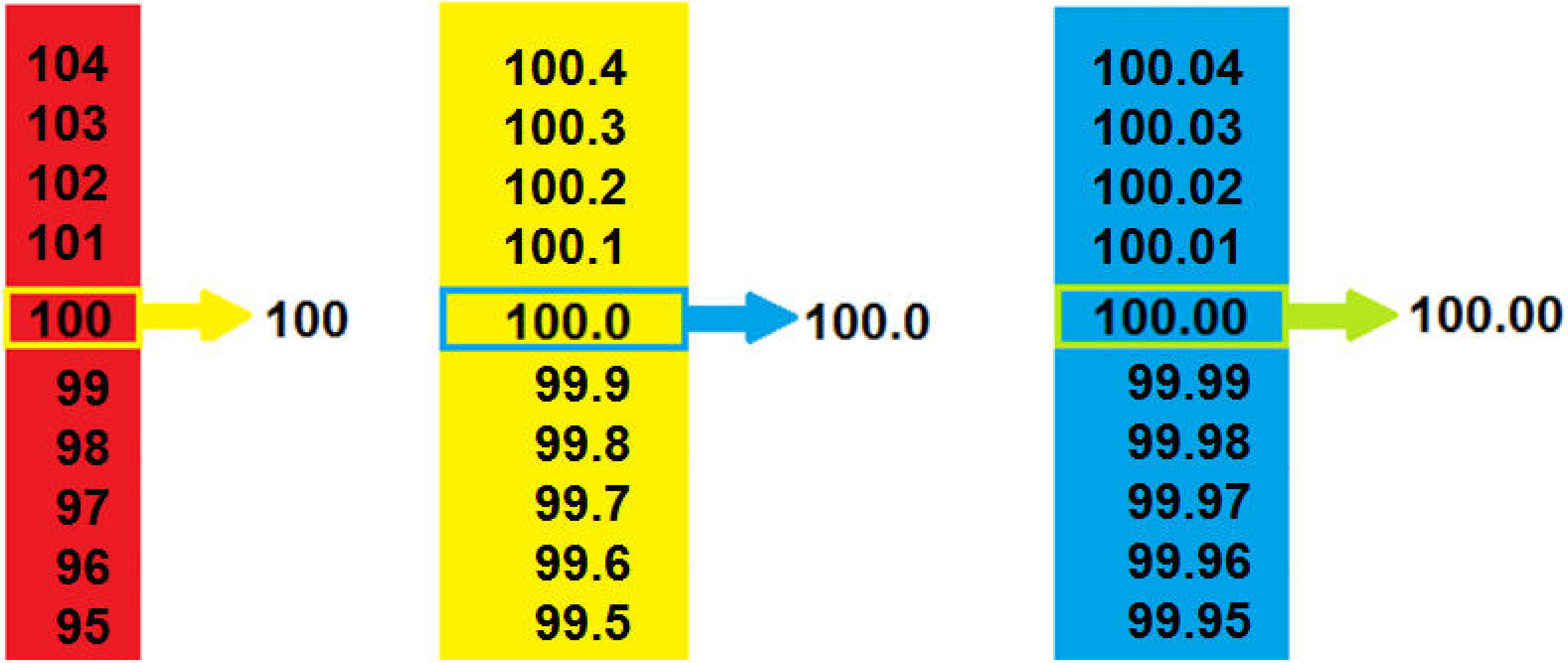


D

Both accurate and precise

Levels of precision

- Each time you add a digit to the right, you gain a higher level of precision.
- Adding a digit to the right gets you closer to the actual true value.
- When recording a measurement, you can only add one digit of precision beyond what you can see on the device you use to take the measurement.



Significant Figures

Significant figures include all the numbers 1 – 9, and any zeros that are in the middle or at the end with a decimal.

123456789
~~0.00~~1234
1200034
1234~~000~~

1.234000
1234.000
123400.0
1234000.

Note that when there is a decimal, end zeros are always significant.

Why do we need scientific notation?

- Sometimes it is necessary to measure very large quantities.

602,214,141,070,409,084,099,072 atoms

(Amount of atoms in 1 mole.)

6.02×10^{23} atoms

- Sometimes it is necessary to measure very small quantities.

0.000000654 meters

(Wavelength of Red Light)

6.54×10^{-7} meters

Scientific Notation

When a number is written in scientific notation,

all digits in front of the x are significant.

Examples: 2×10^{-2} 2.0×10^{2} 2.010×10^{2}

The first number written in scientific notation can ***NEVER*** be a zero!!!!

WRONG: 0.35×10^{-4}

The CORRECT way is 3.5×10^{-5}

Scientific Notation

$$0.0000567 \rightarrow 5.67 \times 10^{-5}$$

coefficient base exponent

For numbers *less than 1*:

- Determine which digits are **significant**. *(It's the #'s after the zeros.)*
- Move the decimal **to the right**. *(Keep going until...)*
- Stop behind the first non-zero number.
- Count how many times you moved the decimal **(# of hops).**
- The number of hops becomes a **negative** exponent.

Scientific Notation

$$2{,}503{,}000 \rightarrow 2.503 \times 10^{6}$$

exponent

coefficient

base

For numbers *more than 1*:

- Determine which digits are **significant**. *(It's the #'s before the zeros, or all #'s if there is a decimal)*
- Move the decimal **to the left**. *(Keep going until...)*
- Stop behind the significant digit furthest to the left.
- Count how many times you moved the decimal **(# of hops).**
- The number of hops becomes a **positive** exponent.

Scientific Notation

- Write 4,560,399.20 in scientific notation :

  4.56039920×10^{6}

- Write 0.00089087 in scientific notation :

  8.9087×10^{-4}

- Write 7.908×10^{3} in standard notation :

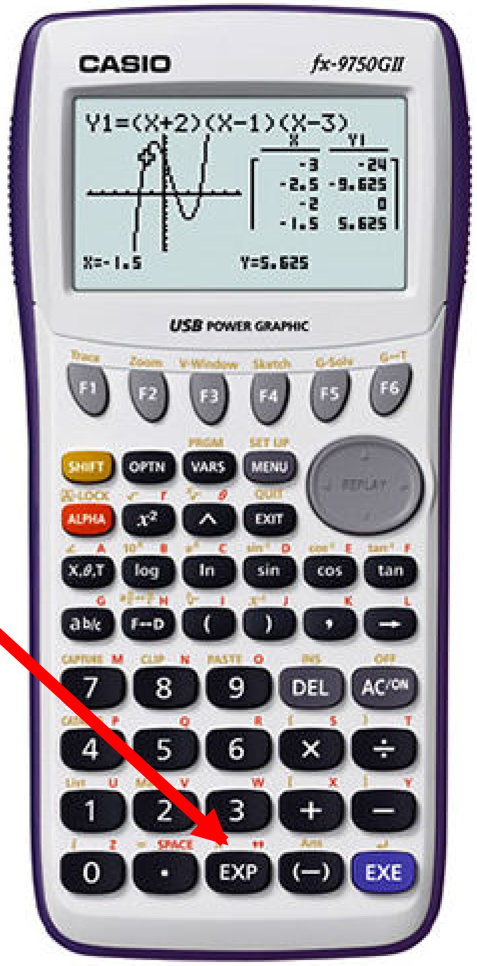
  7908

- Write 4.56×10^{-5} in standard notation :

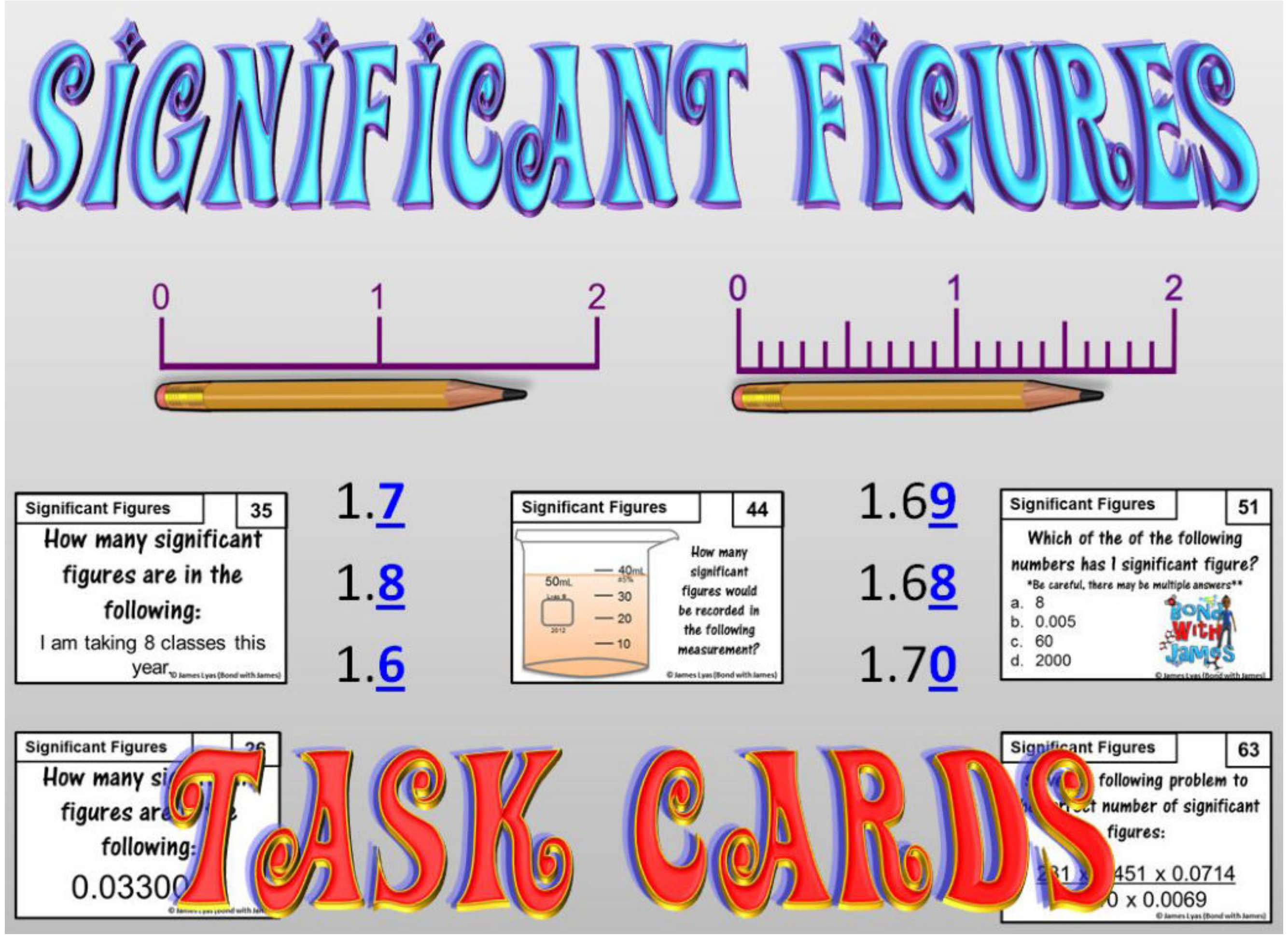
  0.0000456

Using your calculator for Scientific Notation

2^{nd} Function



Warm Up: Chemistry Task Cards



Identify the Number of Sig Figs & Write the Value in Scientific Notation

a) 432 — 3 sig figs — 4.32×10^{2}

b) 6004 — 4 sig figs — 6.004×10^{3}

c) 3,000 — 1 sig fig — 3×10^{3}

d) 3.000 — 4 sig figs — 3.000×10^{0}

e) 0.008 — 1 sig fig — 8×10^{-3}

f) 0.008000 — 4 sig figs — 8.000×10^{-3}

g)

Rounding & Sig Figs

1. Round 13.25 to 3 sig figs	13.3
2. Round 13.25 to 2 sig figs	13
3. Round 13.25 to 1 sig fig	10
4. Round 155, 389 to 4 sig figs	155,400 or 1.554×10^5
5. Round 157, 853 to 2 sig figs	160,000 or 1.6×10^5
6. Round 0.04300053 to 3 sig figs	0.0430 or 4.30×10^{-2}
7. Round 496 to 2 sig figs	5.0×10^2
8. Round 503 to 2 sig figs	5.0×10^2

Significant Figures in Calculations

Addition/Subtraction: round to the least number of ____decimal places____

Ex: 25.6 g + 85.379 g + 145.69 g = **256.669 g … exactly**

But the sig fig answer is **256.7 g**

Multiplication/Division: round to the least number of ____significant figures____

Ex: 52.0 cm x 365 cm x 13 cm = **246, 740 cm^3 … exactly**

But the sig fig answer is **250,000 cm^3** **(or in scientific notation 2.5×10^5 cm^3)**

Special Case: When performing multiple operations in one problem, do not round until the final answer is found. Then assign significant digits based on the highest operation in the problem.

Ex. $(8.35-7.9)/7.9 \times 100$ = **5.696203% … exactly**

But the significant figure answer is: ____**5.7 %**____

Practice Calculating with Sig Figs

1. 237.5 kg – 91.678 kg =

145.8 kg

105 J

2. 2.94 mm × 0.00007 mm =

2.06×10^{-4} mm^2

5. 63.007 J + 0.0001 J + 42 J =

9 m^3

3. (3.21×10^{-4} ft) (5.6×10^{7} ft) =

18000 ft^2

6. 19.2 m × 0.08 m × 5.73 m =

34 m^2

4. (6.467×10^{-3} m) ÷ (2×10^{5} m) =

3×10^{-8}

7. $\dfrac{840\ m^3}{25\ m} =$

102.2 g

8. 137.29 g – 35.1 g =

International System of Units

Table 1.1 The Fundamental SI Units

Physical Quantity	*Name of Unit*	*Abbreviation*
Mass	kilogram	kg
Length	meter	m
Time	second	s
Temperature	kelvin	K
Electric current	ampere	A
Amount of substance	mole	mol
Luminous intensity	candela	cd

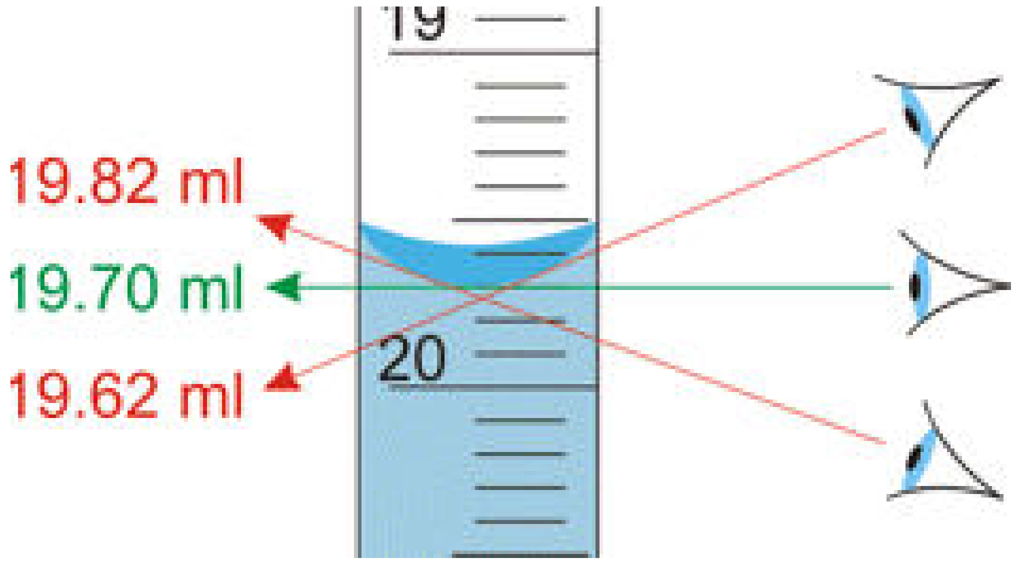
Metric System

King Henry Died By Drinking Chocolate Milk

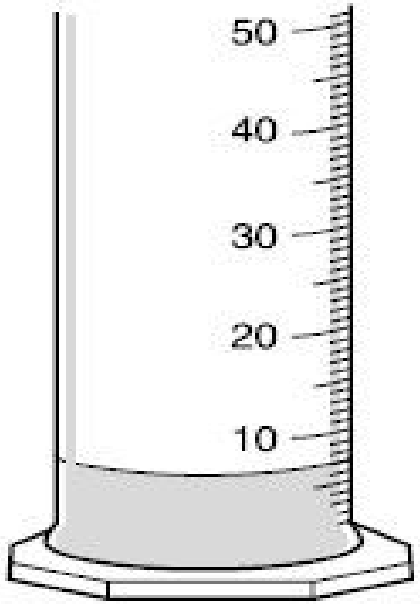
Prefix	Symbol	Relationship to Base	Real Life Example
Mega	M	1,000,000	1 Megawatt of electricity is equivalent to 10 car engines
Kilo	k	1000	1 kg ~ a small watermelon
Hecta	h	100	1 hectare ~ plot of rural property
Deca	da	10	1 decade ~ 10 years
Base	-	1	grams/ Liters/ meters/ seconds/ Joules
Deci	d	0.1	A stopwatch measures time to 1/10 of second
Centi	c	0.01	1 cm ~ length of pinky fingernail
Milli	m	0.001	500 ml ~ plastic soda bottle
Micro	µ	1×10^{-6}	a human hair is 17 t0 181 µm
Nano	n	1×10^{-9}	a DNA molecule is 2 -3 nanometers wide
Pico	p	1×10^{-12}	the radius of an atom is 30 to 300 pm

Using the Meniscus

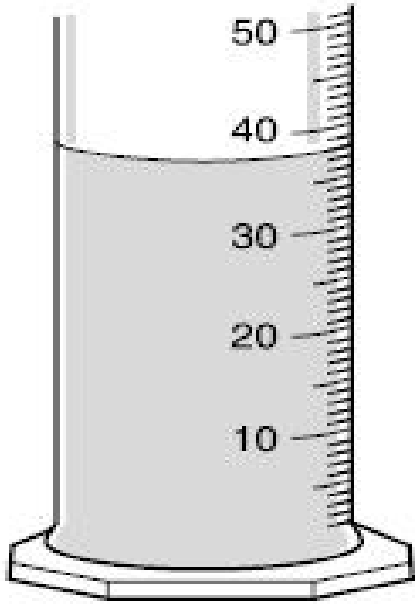
When recording the volume of a liquid in a graduated cylinder, you must adjust your eye level to be in sync with the curvature of the liquid. This curvature is called the <u>**meniscus**</u>.



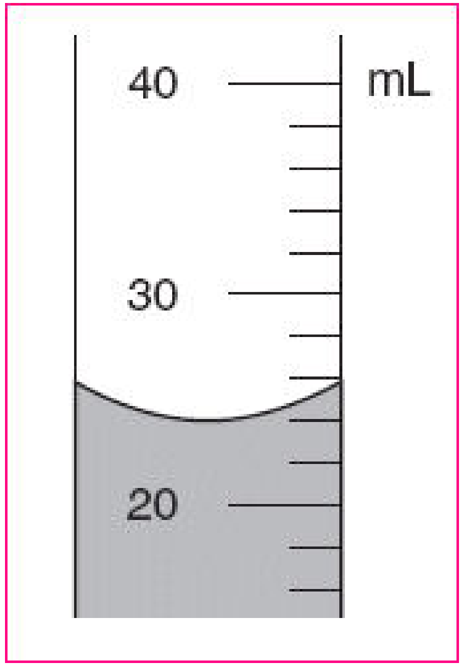
Uncertainty in Measurement



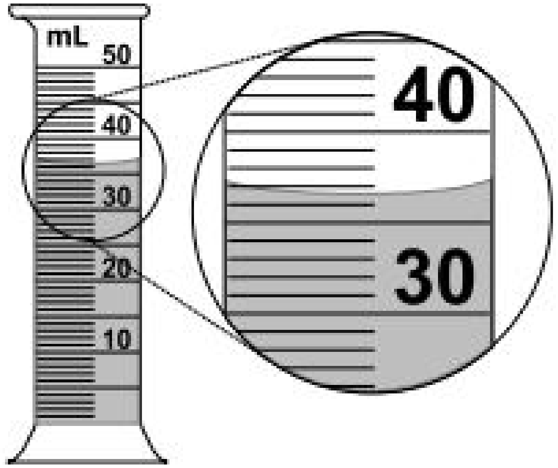
7.0 ml



38.0 ml



24 ml

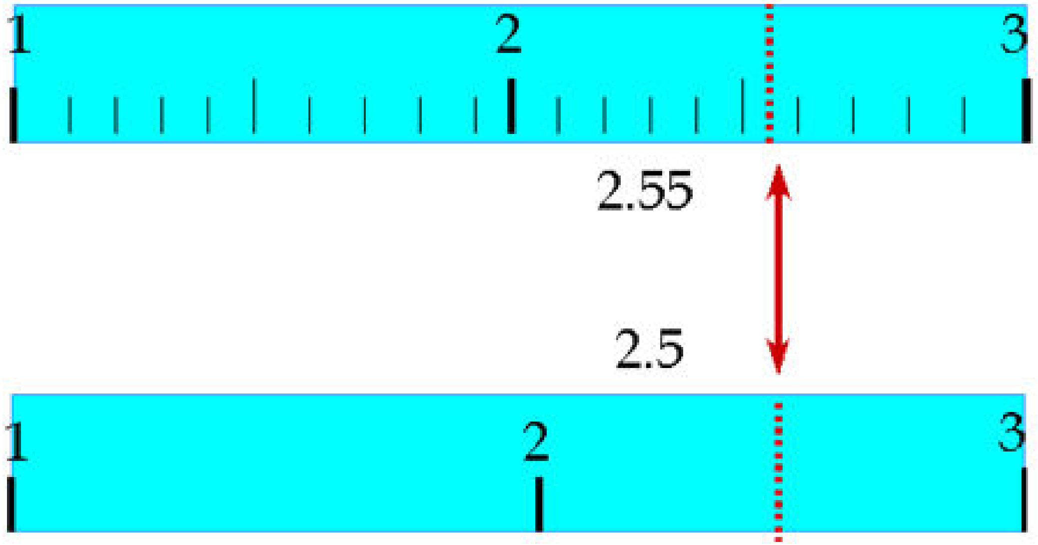


36.5 ml

Sig Figs & Measurements

The **tick marks** you can see represent the **accuracy** part of your measurement.

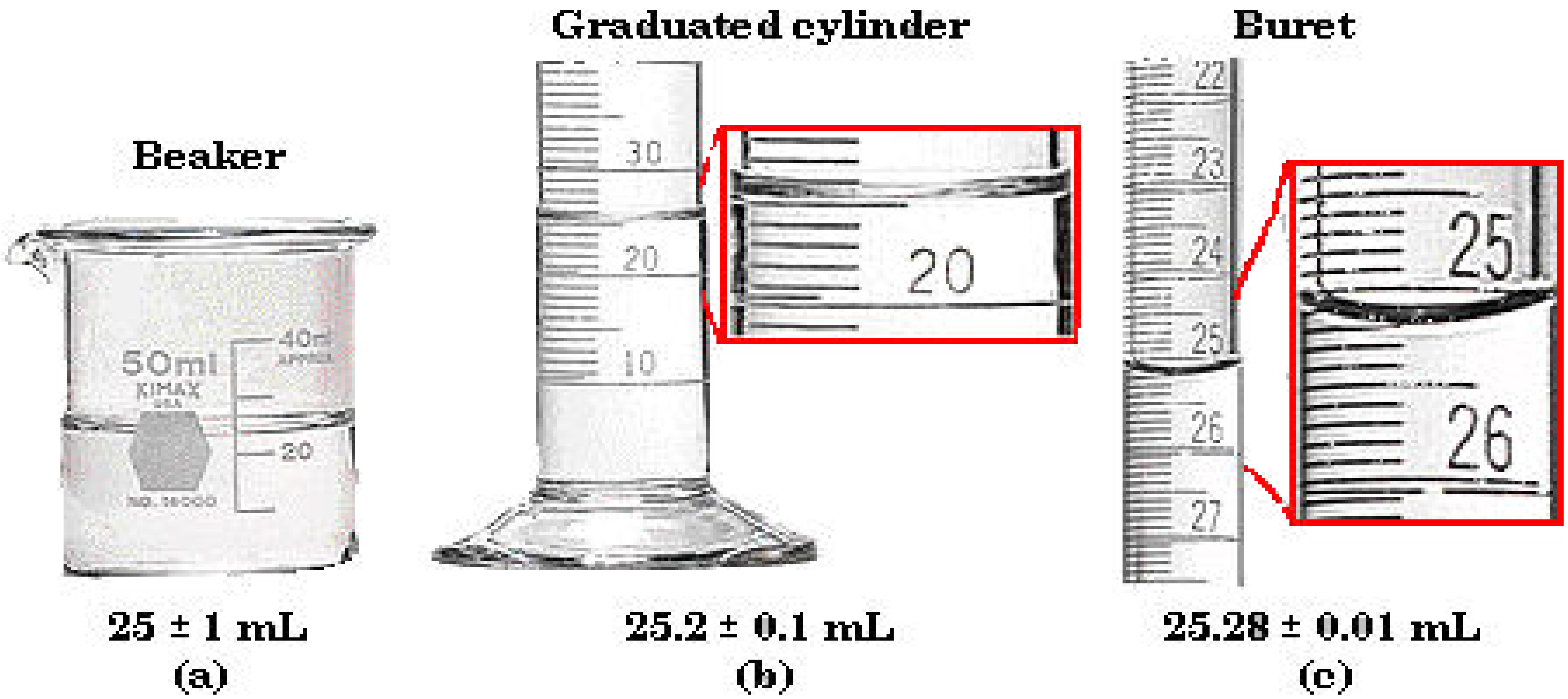
Adding one more digit to the right of that amount represents the **precision** part of your measurement.



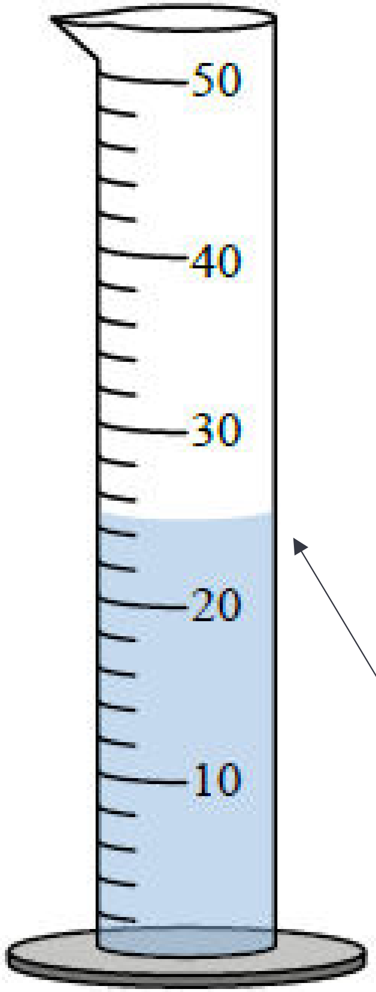
This ruler has tick marks that divide the space between the 2 and 3 into ***tenths***, so you are allowed to guess the ***hundredths*** position.

This ruler does not have tick marks between the 2 and 3, so you are only allowed to guess the ***tenths*** position.

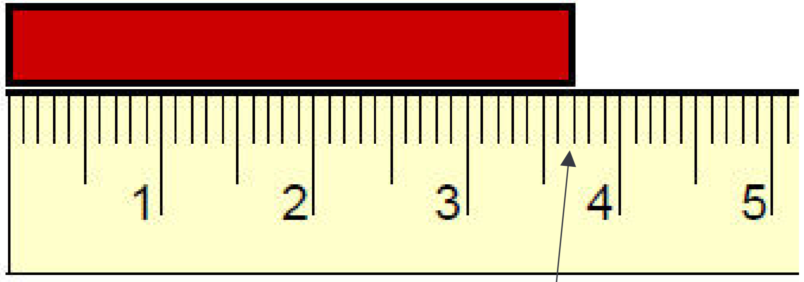
Notice the difference in sig figs for each recording...



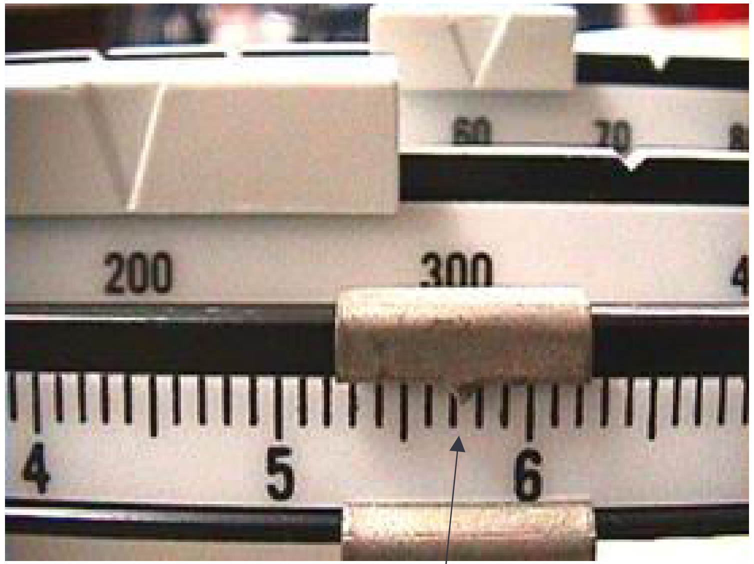
Practice Recording These Measurements



25 ml ± 1 ml



3.70 ± 0.01 mm



265.72 g ± 0.01 g

Lab 1: Numbers in Science

In this activity you will review some important aspects of numbers in science and then apply those number handling skills to your own measurements and calculations.