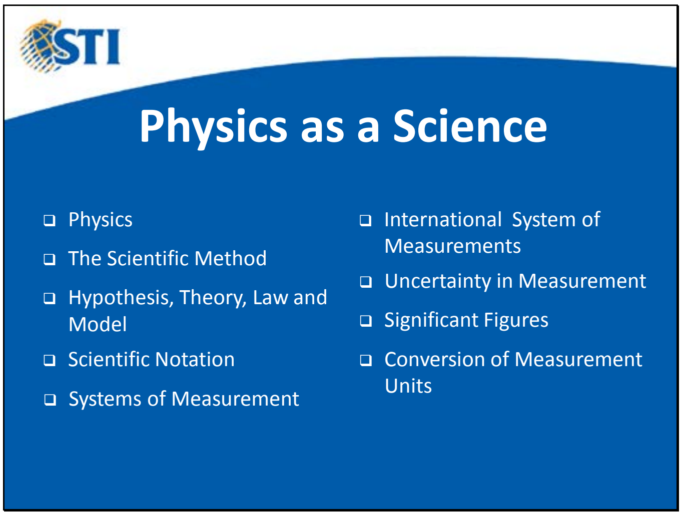
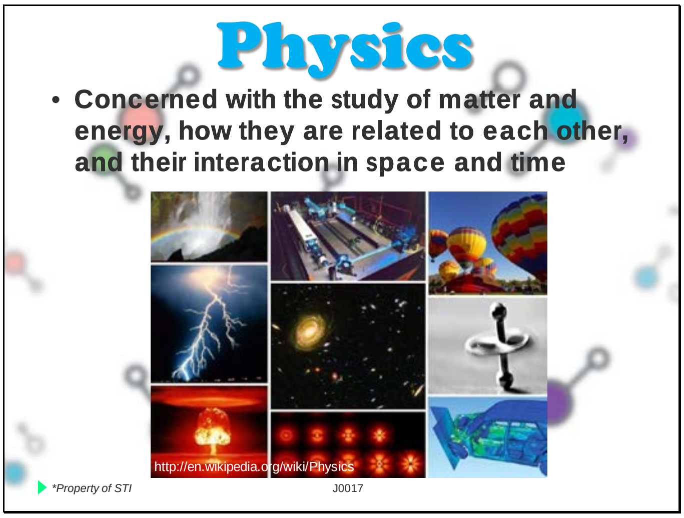


Physics as a Science

- ❑ Physics
- ❑ The Scientific Method
- ❑ Hypothesis, Theory, Law and Model
- ❑ Scientific Notation
- ❑ Systems of Measurement
- ❑ International System of Measurements
- ❑ Uncertainty in Measurement
- ❑ Significant Figures
- ❑ Conversion of Measurement Units



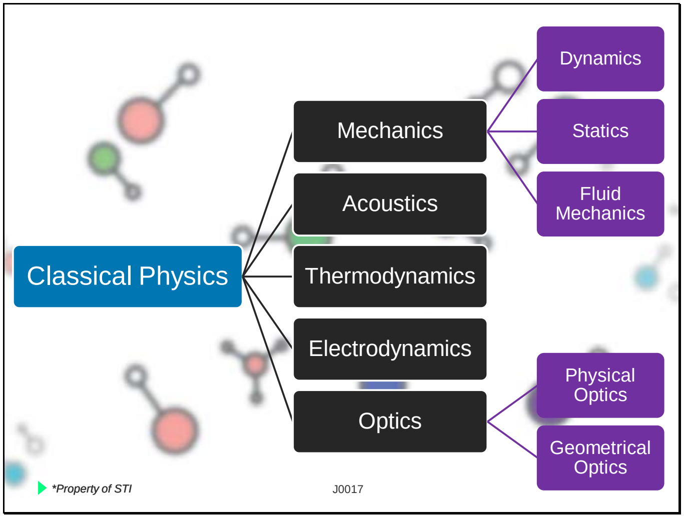
Physics

- Concerned with the study of matter and energy, how they are related to each other, and their interaction in space and time

http://en.wikipedia.org/wiki/Physics

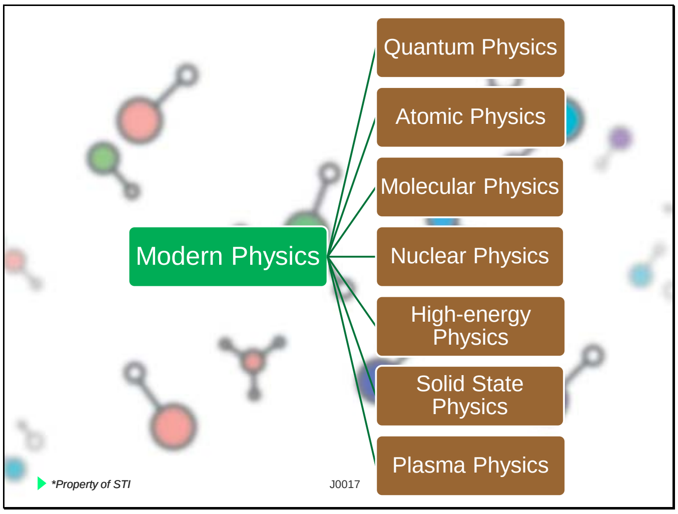
http://www.aboutten.com/2014/10-best-iphone-gps-navigation-apps/

Figure 1.1. "The Apple "iPhone" is a common smart phone with a GPS function. Physics describes the way that electricity flows through the circuits of this device. Engineers use their knowledge of physics to construct an iPhone with features that consumers will enjoy. One specific feature of an iPhone is the GPS function. GPS uses physics equations to determine the driving time between two locations on a map" (*Openstax College*, 2013).



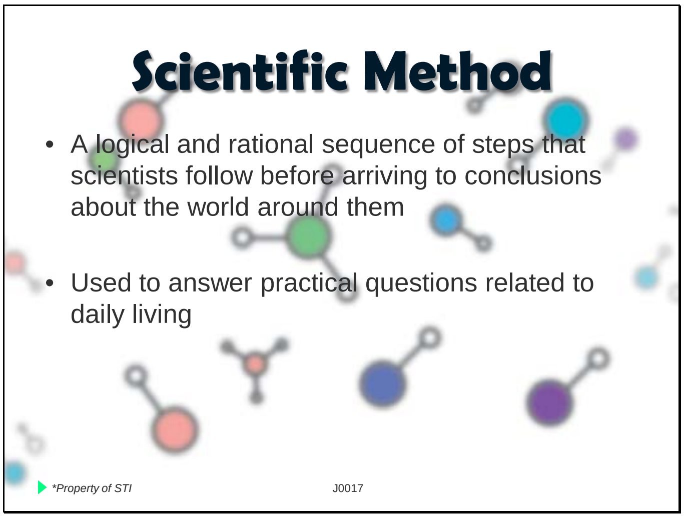
Classical Physics

- Mechanics
  - Dynamics
  - Statics
  - Fluid Mechanics
- Acoustics
- Thermodynamics
- Electrodynamics
- Optics
  - Physical Optics
  - Geometrical Optics



Modern Physics

- Quantum Physics
- Atomic Physics
- Molecular Physics
- Nuclear Physics
- High-energy Physics
- Solid State Physics
- Plasma Physics



Scientific Method

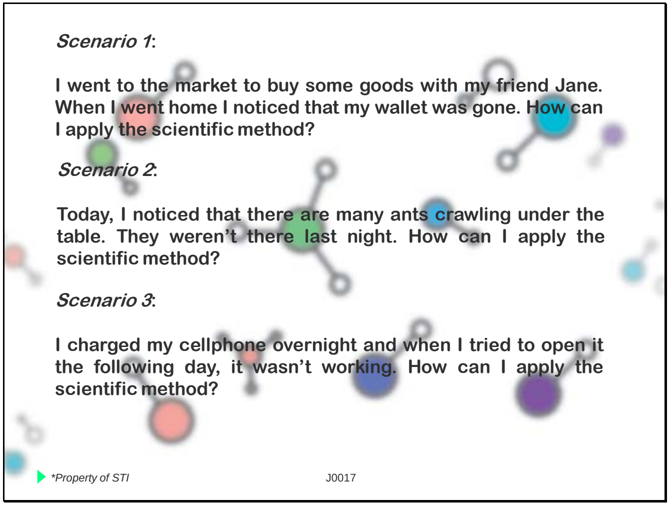
- A logical and rational sequence of steps that scientists follow before arriving to conclusions about the world around them
- Used to answer practical questions related to daily living

Steps in Scientific Method

1. **Observation**
2. **Research**
3. **Hypothesis**
4. **Prediction**
5. **Experimentation**
6. **Conclusion**

http://fairmontparkpeacepatchblog.blogspot.com/

https://www.garden.org/howtos/index.php?q=show&id=1287



Scenario 1:

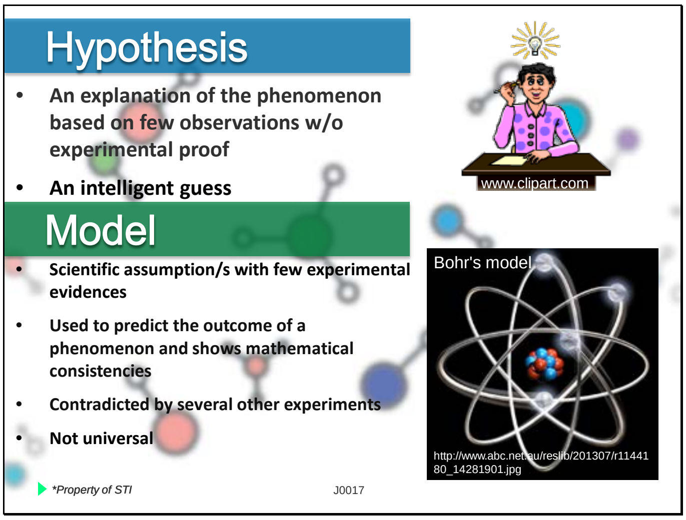
I went to the market to buy some goods with my friend Jane. When I went home I noticed that my wallet was gone. How can I apply the scientific method?

Scenario 2:

Today, I noticed that there are many ants crawling under the table. They weren't there last night. How can I apply the scientific method?

Scenario 3:

I charged my cellphone overnight and when I tried to open it the following day, it wasn't working. How can I apply the scientific method?



Hypothesis

- An explanation of the phenomenon based on few observations w/o experimental proof
- An intelligent guess

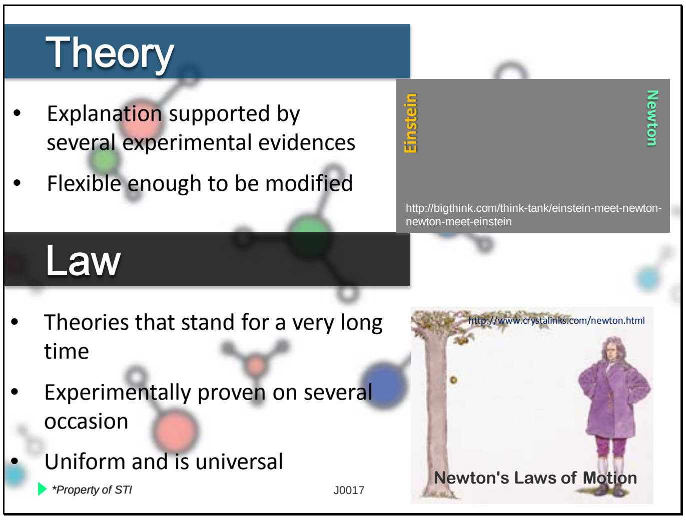
www.clipart.com

Model

- Scientific assumption/s with few experimental evidences
- Used to predict the outcome of a phenomenon and shows mathematical consistencies
- Contradicted by several other experiments
- Not universal

Bohr's model

http://www.abc.net.au/reslib/201307/r1144180_14281901.jpg



Theory

- Explanation supported by several experimental evidences
- Flexible enough to be modified

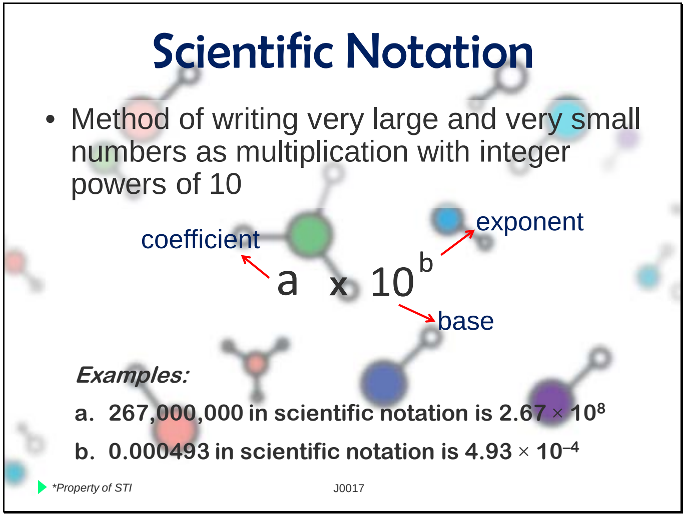
http://bigthink.com/think-tank/einstein-meet-newton-newton-meet-einstein

Law

- Theories that stand for a very long time
- Experimentally proven on several occasion
- Uniform and is universal

http://www.crystalinks.com/newton.html

Newton's Laws of Motion



Scientific Notation

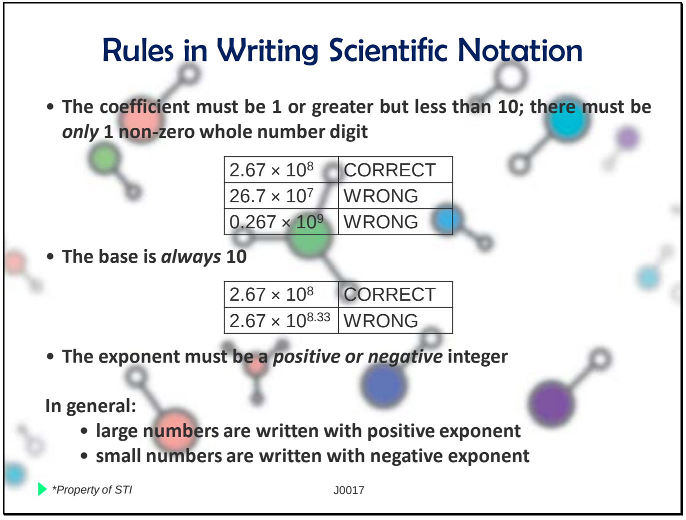
- Method of writing very large and very small numbers as multiplication with integer powers of 10

$$a \times 10^{b}$$

Examples:

a. 267,000,000 in scientific notation is 2.67×10^8

b. 0.000493 in scientific notation is 4.93×10^{-4}



Rules in Writing Scientific Notation

- **The coefficient must be 1 or greater but less than 10; there must be *only* 1 non-zero whole number digit**

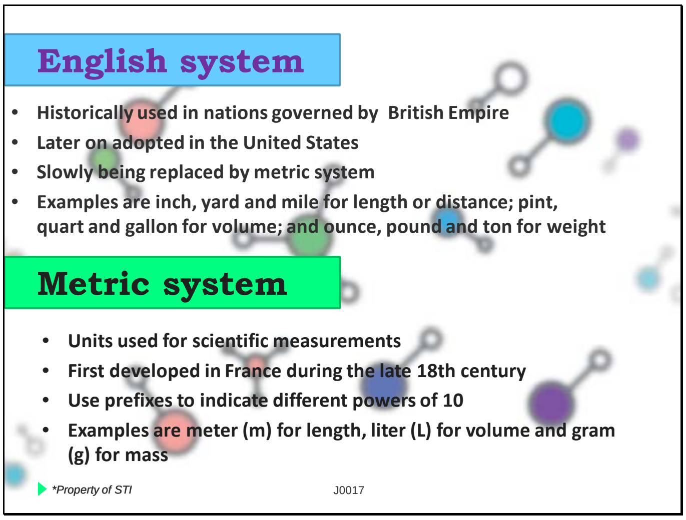
2.67×10^8	CORRECT
26.7×10^7	WRONG
0.267×10^9	WRONG

- **The base is *always* 10**

2.67×10^8	CORRECT
$2.67 \times 10^{8.33}$	WRONG

- **The exponent must be a *positive or negative* integer**

In general:
- **large numbers are written with positive exponent**
- **small numbers are written with negative exponent**

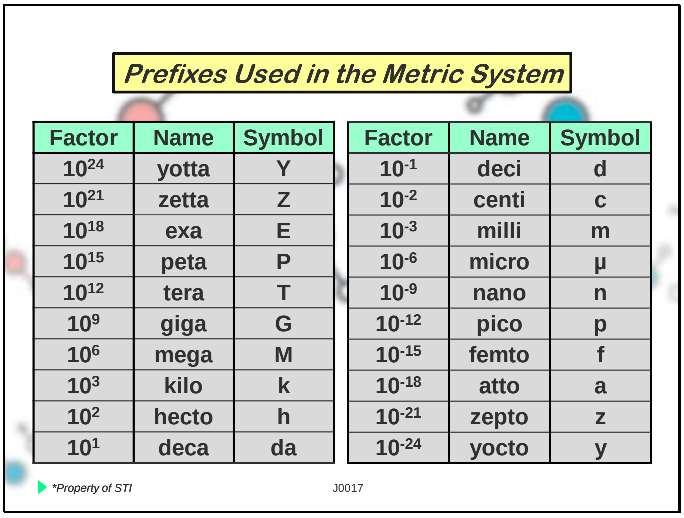


English system

- Historically used in nations governed by British Empire
- Later on adopted in the United States
- Slowly being replaced by metric system
- Examples are inch, yard and mile for length or distance; pint, quart and gallon for volume; and ounce, pound and ton for weight

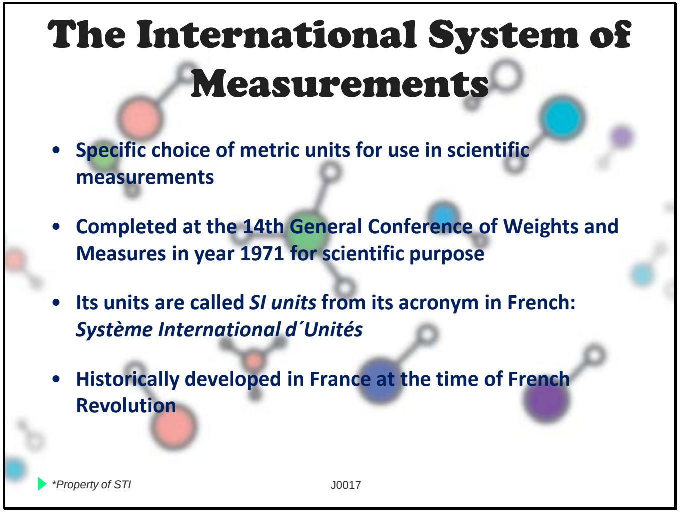
Metric system

- Units used for scientific measurements
- First developed in France during the late 18th century
- Use prefixes to indicate different powers of 10
- Examples are meter (m) for length, liter (L) for volume and gram (g) for mass



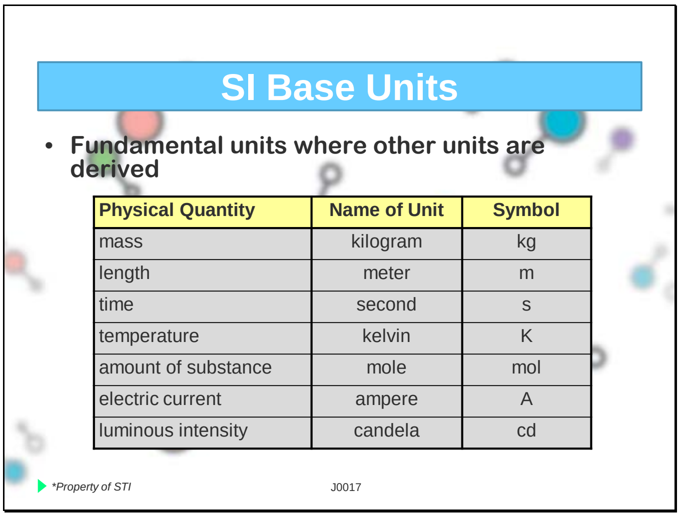
Prefixes Used in the Metric System

Factor	Name	Symbol	Factor	Name	Symbol
10^{24}	yotta	Y	10^{-1}	deci	d
10^{21}	zetta	Z	10^{-2}	centi	c
10^{18}	exa	E	10^{-3}	milli	m
10^{15}	peta	P	10^{-6}	micro	μ
10^{12}	tera	T	10^{-9}	nano	n
10^{9}	giga	G	10^{-12}	pico	p
10^{6}	mega	M	10^{-15}	femto	f
10^{3}	kilo	k	10^{-18}	atto	a
10^{2}	hecto	h	10^{-21}	zepto	z
10^{1}	deca	da	10^{-24}	yocto	y



The International System of Measurements

- Specific choice of metric units for use in scientific measurements
- Completed at the 14th General Conference of Weights and Measures in year 1971 for scientific purpose
- Its units are called *SI units* from its acronym in French: *Système International d´Unités*
- Historically developed in France at the time of French Revolution



SI Base Units

- Fundamental units where other units are derived

Physical Quantity	Name of Unit	Symbol
mass	kilogram	kg
length	meter	m
time	second	s
temperature	kelvin	K
amount of substance	mole	mol
electric current	ampere	A
luminous intensity	candela	cd

Derived SI Units

- Combinations (can be a product or a quotient) of two or more SI base units

Quantity	Dimension	Unit	Symbol
area	length squared	square meter	m^2
volume	length cubed	cubic meter	m^3
density	$\frac{\text{mass}}{\text{length cubed}}$	kilogram per cubic meter	kg/m^3

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Exact numbers

- Those numbers that are known exactly
  - ➢ Number of count nouns
  - ➢ Conversion factors (a ratio expressing how many of one unit are equivalent with another)
    - ❖ *Chain-link conversion* - altering the units in which physical quantities are expressed by the use of conversion factors

$$\frac{1\ \text{kg}}{1000\ \text{g}} = 1 \quad \text{and} \quad \frac{1000\ \text{g}}{1\ \text{kg}} = 1$$

Inexact numbers

- Those numbers whose values have some uncertainty
  - ➢ Numbers obtained by measurement
  - ➢ Very large numbers even if they represent count nouns

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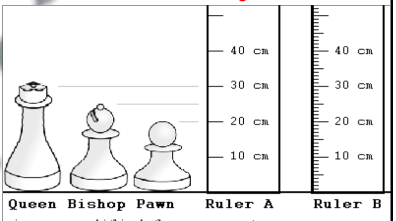
Significant Figures

- The method with which the scientists represent the accuracy and precision of the measuring instrument used to obtain the recorded data

Accuracy, describes how close a measured value is to the true value of the quantity measured. (*Serway & Faugn*, 2002)

Precision, refers to the degree of exactness with which a measurement is made and stated (*Serway & Faugn*, 2002)

Precision of a measuring device and recording data



images modified from www.artvex.com

	Ruler A	Ruler B
Queen	30 cm	30.0 cm
Bishop	25 cm	25.0 cm
Pawn	20 cm	20.0 cm

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Rules for Determining the Number of Significant Figures (SF)

Rules	Examples
Exact numbers are considered to have infinite number of significant figures	4 cabinets 9 tables 30 students infinite SF
All non-zero digits are significant.	1583 L 4 SF 82.9 cm 3 SF 752.33 g 5 SF
Zeros between other nonzero digits are significant.	a. 40.5 kg has three SF b. 302.08 miles has five SF
Zeros before nonzero digits (at the leftmost part) are not significant.	a. 0.4051 cm has four SF b. 0.00864 cm has three SF
Zeros that are at the end of a number and also to the right of the decimal are significant.	a. 4800 liters has four SF b. 503.000 m^2 has five SF

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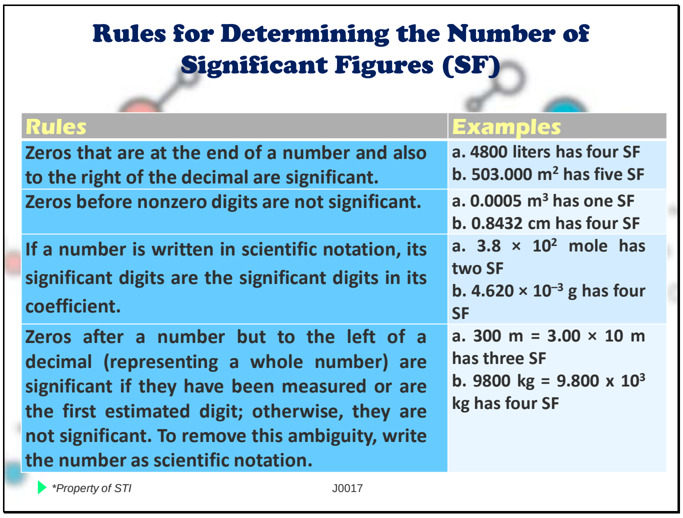
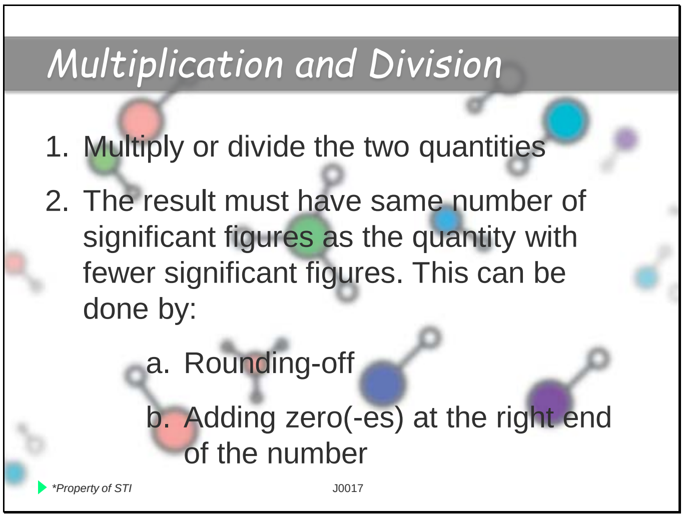


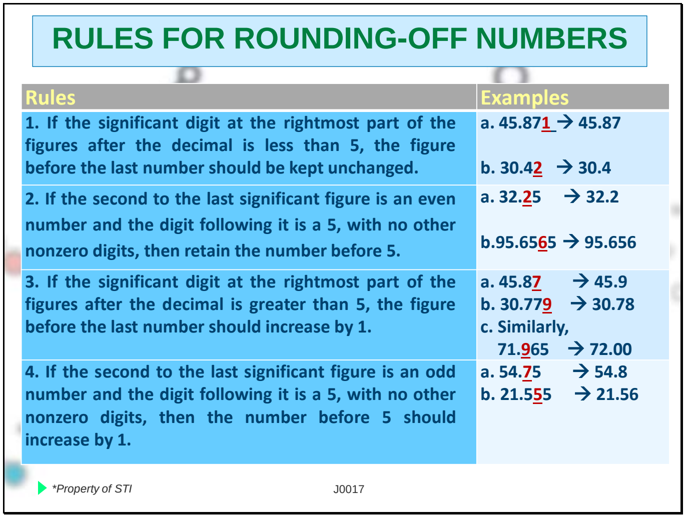
Rules for Determining the Number of Significant Figures (SF)

Rules	Examples
Zeros that are at the end of a number and also to the right of the decimal are significant.	a. 4800 liters has four SF b. 503.000 m^2 has five SF
Zeros before nonzero digits are not significant.	a. 0.0005 m^3 has one SF b. 0.8432 cm has four SF
If a number is written in scientific notation, its significant digits are the significant digits in its coefficient.	a. 3.8×10^2 mole has two SF b. 4.620×10^{-3} g has four SF
Zeros after a number but to the left of a decimal (representing a whole number) are significant if they have been measured or are the first estimated digit; otherwise, they are not significant. To remove this ambiguity, write the number as scientific notation.	a. 300 m = 3.00 × 10 m has three SF b. 9800 kg = 9.800×10^3 kg has four SF



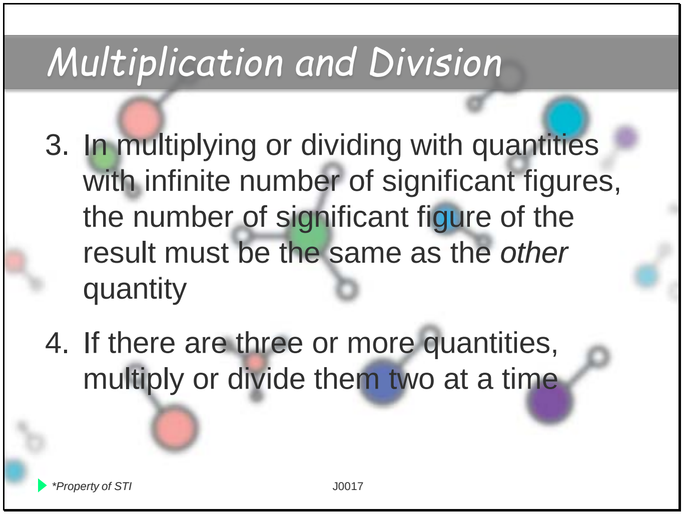
Multiplication and Division

1. Multiply or divide the two quantities
2. The result must have same number of significant figures as the quantity with fewer significant figures. This can be done by:
    a. Rounding-off
    b. Adding zero(-es) at the right end of the number



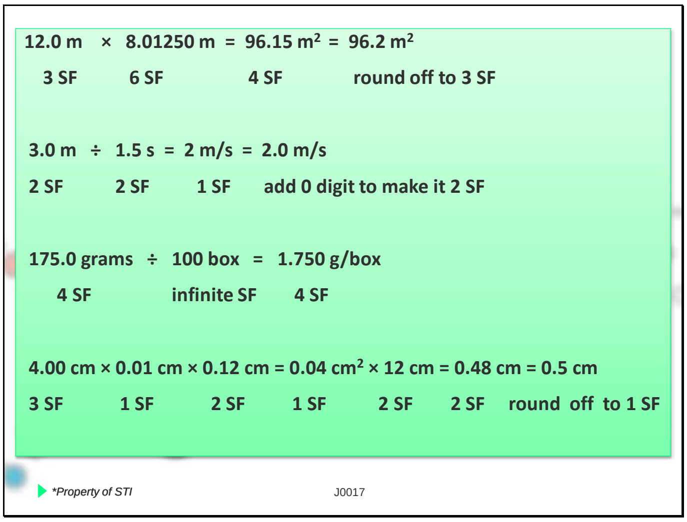
RULES FOR ROUNDING-OFF NUMBERS

Rules	Examples
1. If the significant digit at the rightmost part of the figures after the decimal is less than 5, the figure before the last number should be kept unchanged.	a. 45.871 → 45.87 b. 30.42 → 30.4
2. If the second to the last significant figure is an even number and the digit following it is a 5, with no other nonzero digits, then retain the number before 5.	a. 32.25 → 32.2 b.95.6565 → 95.656
3. If the significant digit at the rightmost part of the figures after the decimal is greater than 5, the figure before the last number should increase by 1.	a. 45.87 → 45.9 b. 30.779 → 30.78 c. Similarly, 71.965 → 72.00
4. If the second to the last significant figure is an odd number and the digit following it is a 5, with no other nonzero digits, then the number before 5 should increase by 1.	a. 54.75 → 54.8 b. 21.555 → 21.56



Multiplication and Division

3. In multiplying or dividing with quantities with infinite number of significant figures, the number of significant figure of the result must be the same as the *other* quantity
4. If there are three or more quantities, multiply or divide them two at a time



12.0 m × 8.01250 m = 96.15 m^2 = 96.2 m^2

3 SF 6 SF 4 SF round off to 3 SF

3.0 m ÷ 1.5 s = 2 m/s = 2.0 m/s

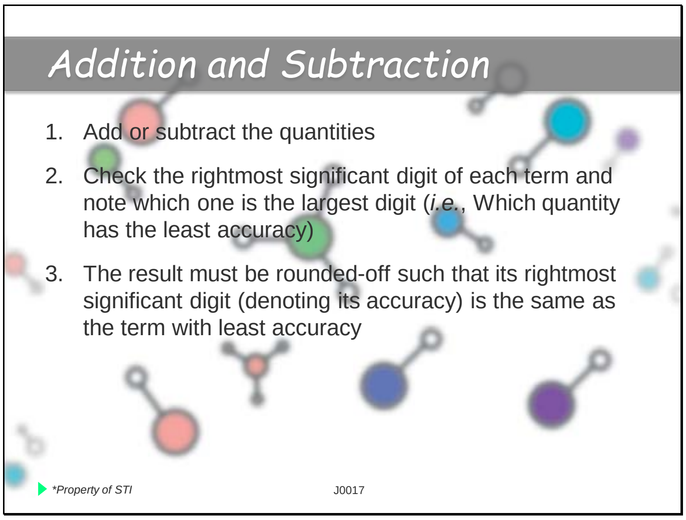
2 SF 2 SF 1 SF add 0 digit to make it 2 SF

175.0 grams ÷ 100 box = 1.750 g/box

4 SF infinite SF 4 SF

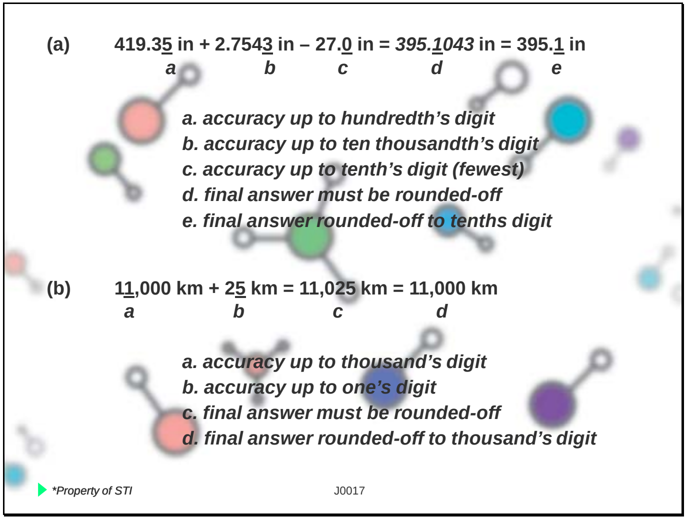
4.00 cm × 0.01 cm × 0.12 cm = 0.04 cm^2 × 12 cm = 0.48 cm = 0.5 cm

3 SF 1 SF 2 SF 1 SF 2 SF 2 SF round off to 1 SF



Addition and Subtraction

1. Add or subtract the quantities
2. Check the rightmost significant digit of each term and note which one is the largest digit (*i.e.*, Which quantity has the least accuracy)
3. The result must be rounded-off such that its rightmost significant digit (denoting its accuracy) is the same as the term with least accuracy



(a) 419.3$\underline{5}$ in + 2.754$\underline{3}$ in – 27.$\underline{0}$ in = *395.$\underline{1}$043* in = 395.$\underline{1}$ in

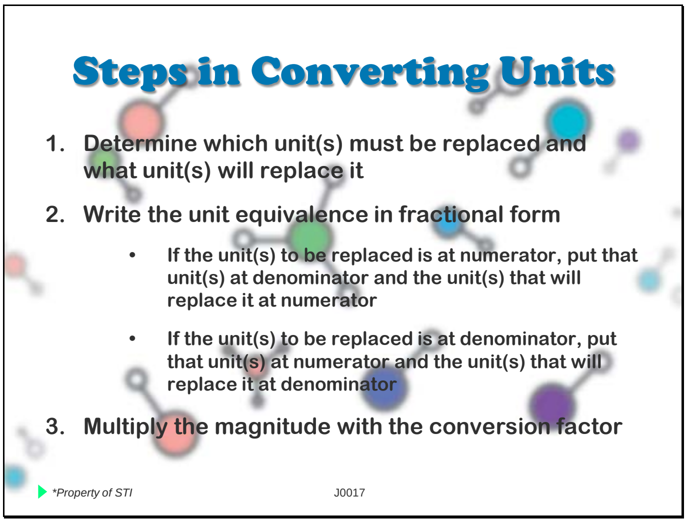
a b c d e

a. accuracy up to hundredth's digit
b. accuracy up to ten thousandth's digit
c. accuracy up to tenth's digit (fewest)
d. final answer must be rounded-off
e. final answer rounded-off to tenths digit

(b) 1$\underline{1}$,000 km + 2$\underline{5}$ km = 11,025 km = 11,000 km

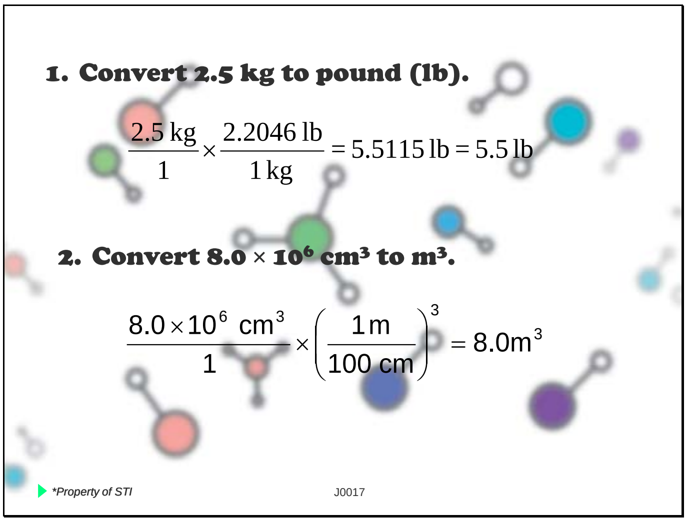
a b c d

a. accuracy up to thousand's digit
b. accuracy up to one's digit
c. final answer must be rounded-off
d. final answer rounded-off to thousand's digit



Steps in Converting Units

1. Determine which unit(s) must be replaced and what unit(s) will replace it
2. Write the unit equivalence in fractional form
    - If the unit(s) to be replaced is at numerator, put that unit(s) at denominator and the unit(s) that will replace it at numerator
    - If the unit(s) to be replaced is at denominator, put that unit(s) at numerator and the unit(s) that will replace it at denominator
3. Multiply the magnitude with the conversion factor



1. **Convert 2.5 kg to pound (lb).**

$$\frac{2.5\,\text{kg}}{1}\times\frac{2.2046\,\text{lb}}{1\,\text{kg}}=5.5115\,\text{lb}=5.5\,\text{lb}$$

2. **Convert 8.0 × 10^6 cm^3 to m^3.**

$$\frac{8.0\times10^{6}\ \text{cm}^{3}}{1}\times\left(\frac{1\,\text{m}}{100\,\text{cm}}\right)^{3}=8.0\text{m}^{3}$$