Scientific Method

Scientific Method, Metrics

Objectives

- Define Physical Science and understand its place in science.
- Present steps of the scientific method and be able to distinguish each and explain their components.
- Use the Metric System versus the English System. Interconvert metric units using prefixes.

Have you noticed that a word can have more than one meaning?

- General - used in a common way
- Specific - used for a particular purpose
- Technical - exclusive to a specific branch of science or knowledge

Science: knowledge gained through study or practice

- How many people enjoy science?
- How many can live without science?

SCIENCE

Can simply refer to knowledge or study;

Can refer to a **method**;

Can refer to Biology, Chemistry, etc.

Are you a scientist?

Scientist: the person who gathers, organizes, and communicates information in a "**scientific method**" or process with the goal of solving a problem or gaining understanding.

- Are you a scientist? (consider the music you like, the food you eat, the clothes you wear, behavior in different environments, appliances, etc.
- … eventually, all point to the need to be scientific.

Who is your favorite scientist?

EXAMPLE: Music Group

- Look and act cool or appealing (**Observation**) – appeals to or utilizes the senses in which one can immediately recognize that group

- How do the groups form and become popular? (**Hypothesis**) – they consider their audience and what they think their audience would like, kind of an educated guess

EXAMPLE: Music Group

- Sing a certain kind of song (**Experiment**) – expecting to get a certain kind of response (test the audience): girls faint, guys yell, etc. at a particular song … and sell a million copies, go on MTV, etc.

- Is this group liked everywhere? (**Theory**) – they go on tour because the music is liked around the country or the world, they establish a recognizable pattern which is repeatable that people enjoy listening to

EXAMPLE: Music Group

- Will their music last for generations? (**Law**)
- Many people "outgrow" certain groups, but often a group and their particular style of music remains (this is actually one true meaning of "classical" music: it is accepted by everyone for its place in the music field and there are no known exceptions over time)
- e.g. the Beatles from the 1960's … their tunes are recognized worldwide and well-liked … even to change the words yet keep the melodies

Scientific Method … the proper handling of science especially to solve a problem

(*the scientific way to approach matters*)

- Observation
- Hypothesis
- Experimentation
- Theory
- Law

CONTRASTING Point of View

- To make things clear, it is always good to look at a contrast.
- E.g. we know “bright” because of “dark;” love/hate, happy/sad, tall/short, big/little, active/passive, etc.
- How can we contrast Science?

"Jumping to Conclusions"

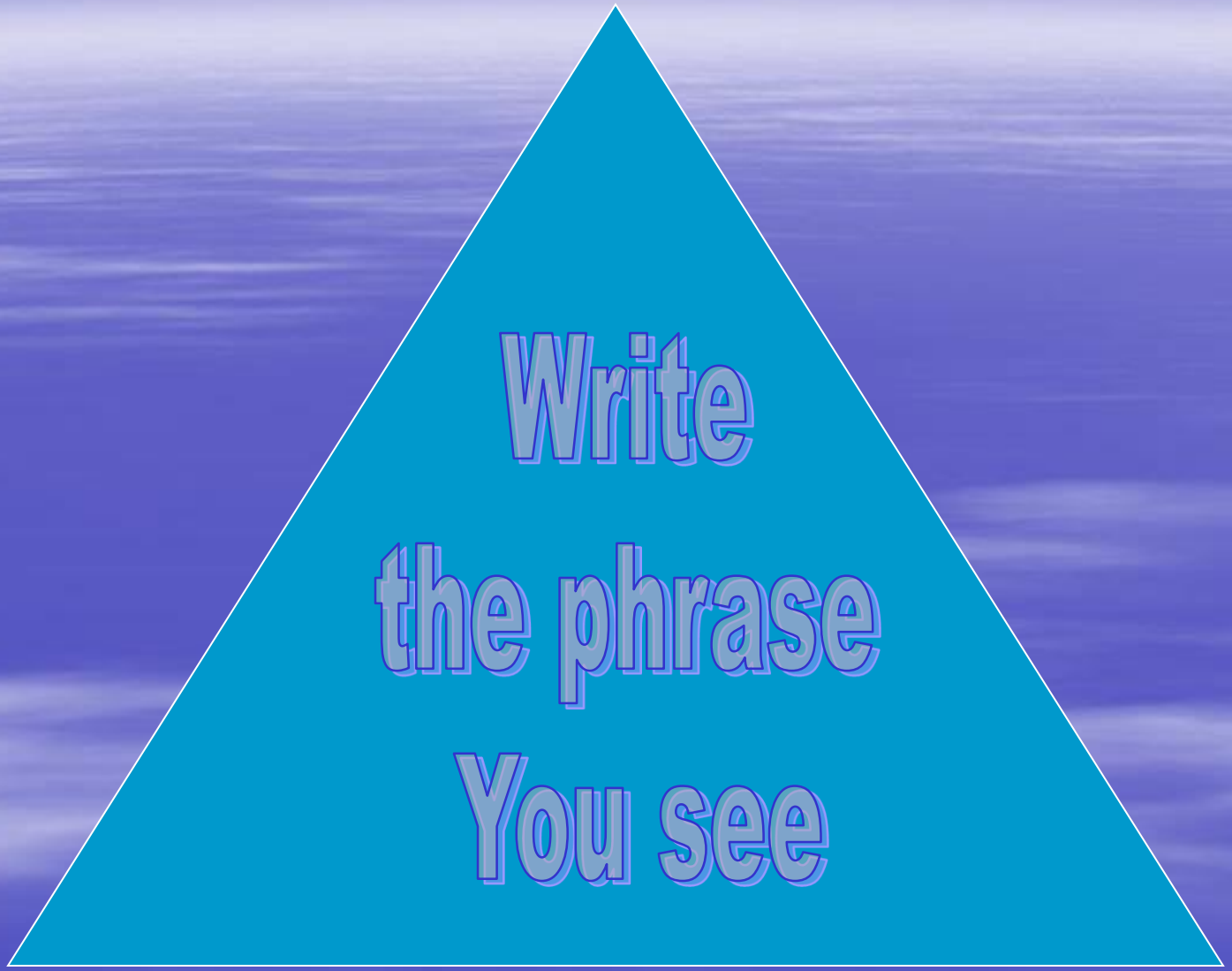
- The Opposite of the scientific method
- Making a conclusion without accurate observation
- Using improper or inadequate data to make a conclusion
- Theorizing (explaining) without proper experimentation
- Etc.

EXAMPLES OF

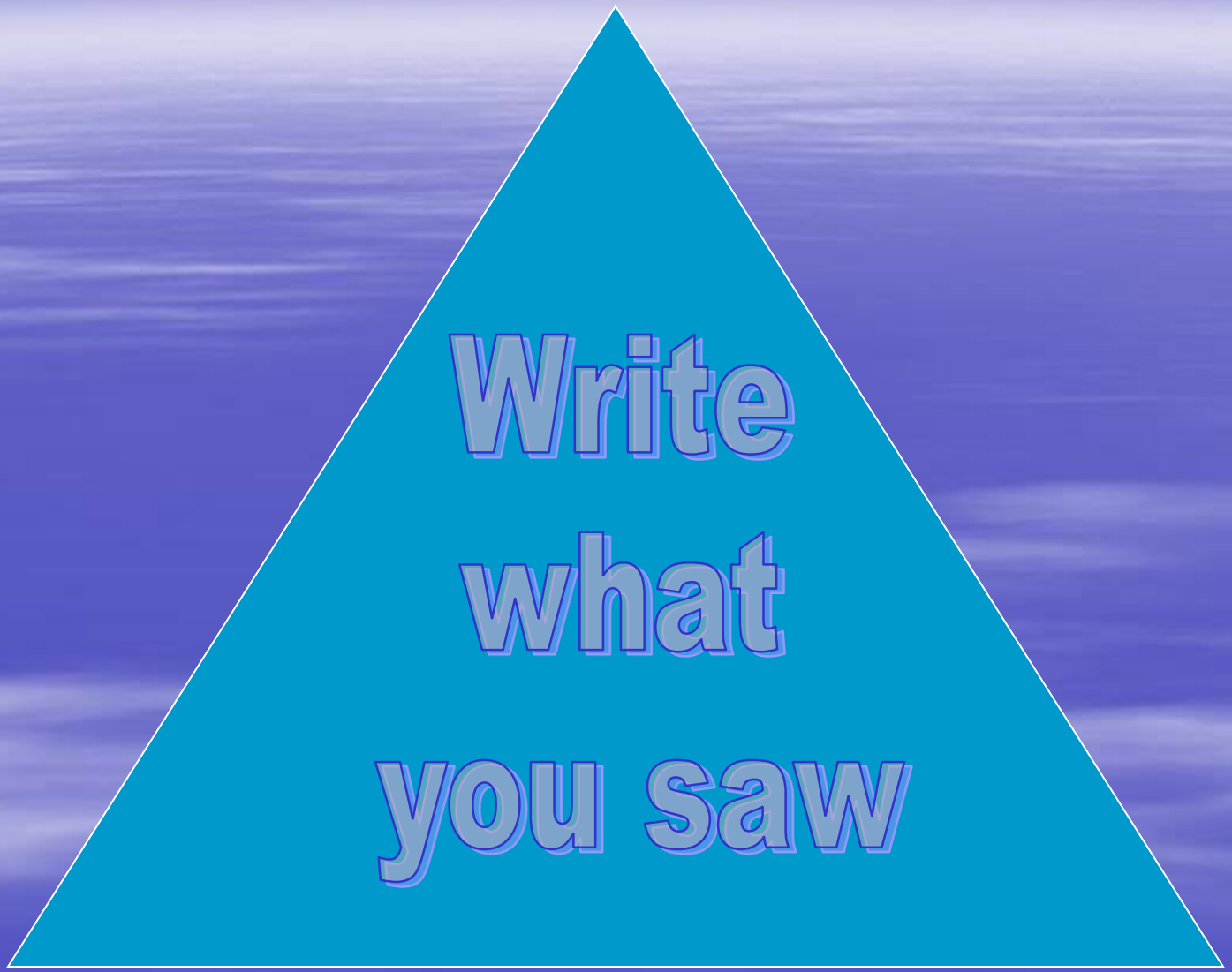
"JUMPING TO CONCLUSIONS"

Visual:

- Draw a triangle on a piece of paper as shown on the next slide … big enough to have something written inside of it.
- You will have THREE seconds to observe The contents of the triangle.
- Click on the triangle, observe, and write EXACTLY what you observe


Write
the phrase
You see


Paris
in the
the spring


Write
what
you saw

Look Again:

Notice the extra "the"

SCIENCE IS IMPORTANT BECAUSE

… We tend to make poor observations

Acoustic:

- Listen to the sound bite (on the next slide)
- Write down your response to “How many sheep are left?”
- Listen to the sound bite again to check your answer

http://somup.com/cqjOXxetNJ

59 sheep are left

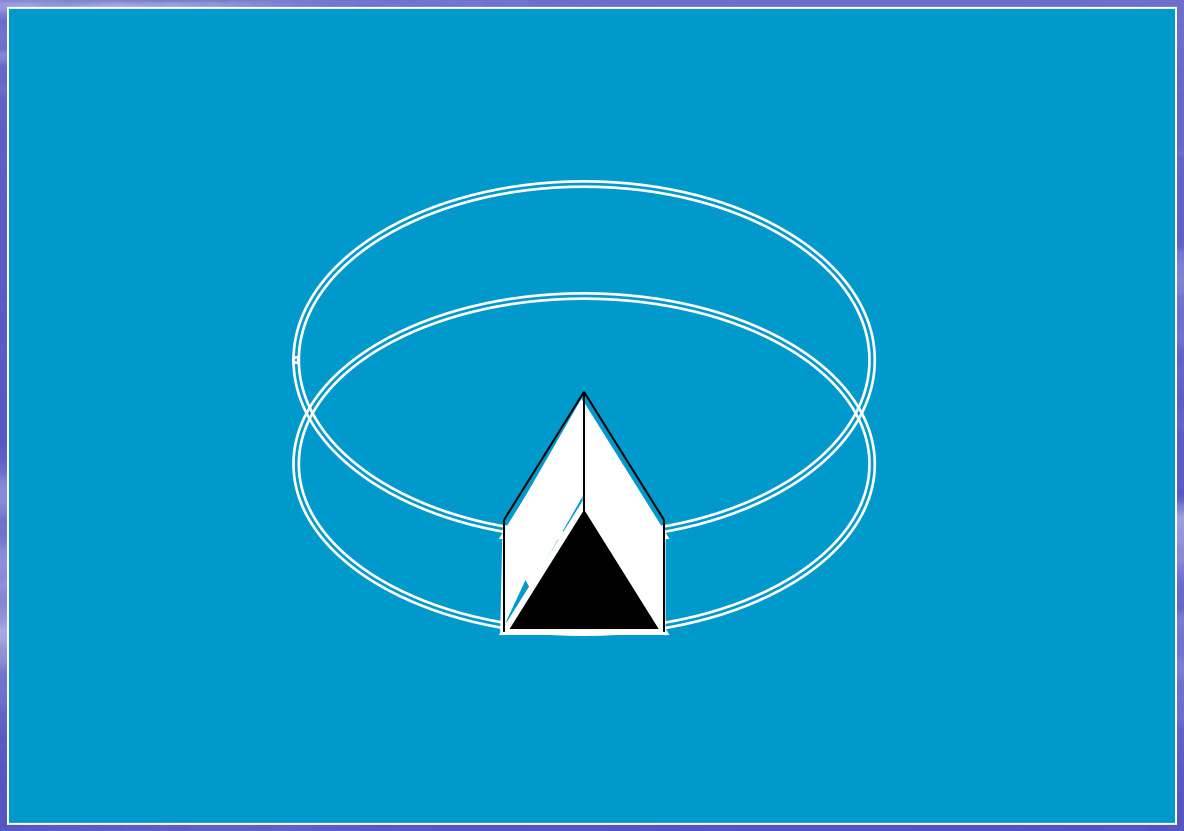
- If you listen closely, the sound bite says, “A man had sixty SICK sheep and one dies …

- Observations (including hearing) are very crucial to accurate data collection and solving of problems.

SCIENCE IS IMPORTANT BECAUSE …

- We often make observations with bias.
- In other words, we have a prejudged solution BEFORE observing.
- OR we make the observation FIT INTO OUR already decided mindset.

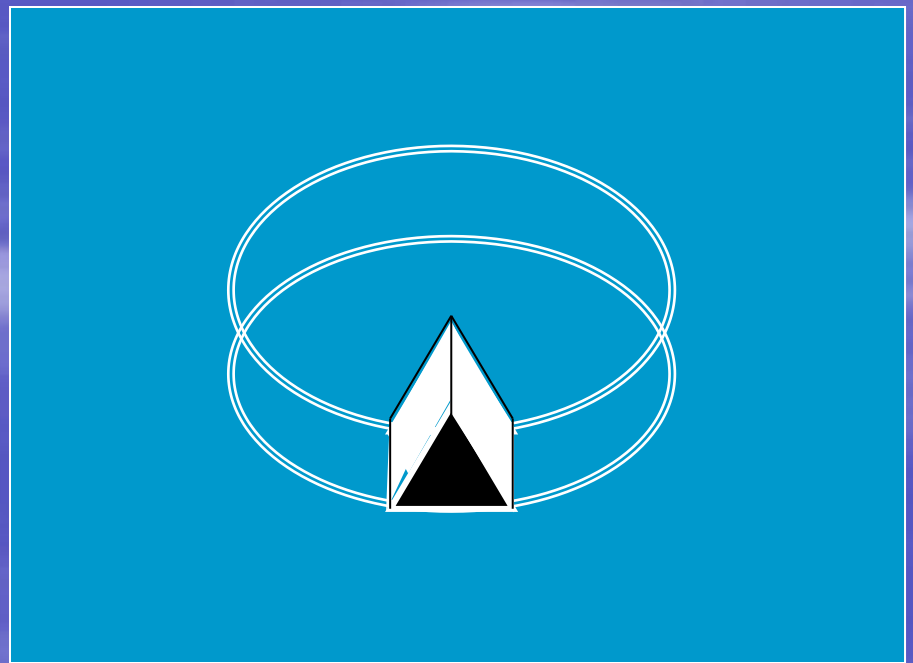
How many cakes can you see?



There are at least two cakes

- There is a cake with one piece missing (at the bottom of the cake)

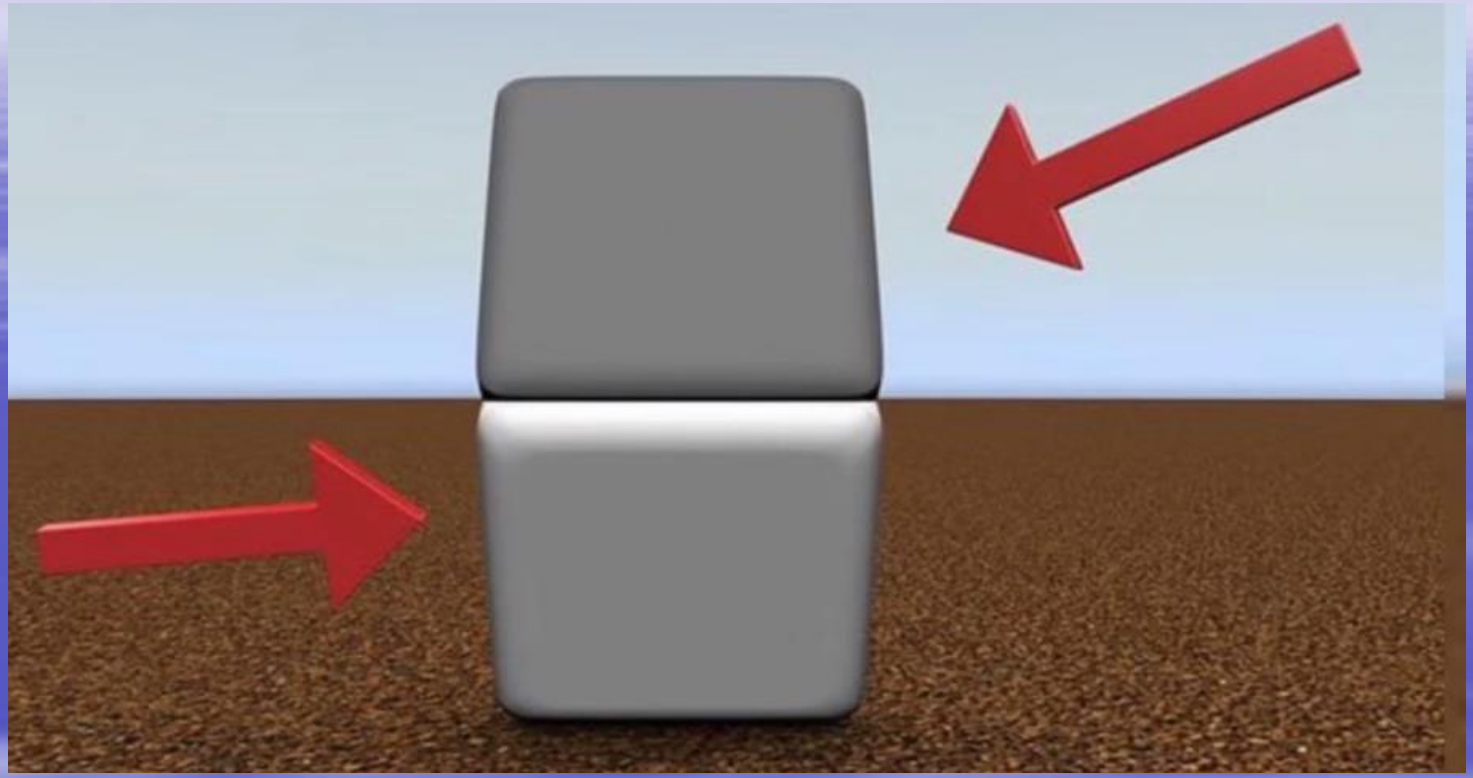
- There is one piece of cake left (at the top of the cake pan)



SCIENCE IS IMPORTANT BECAUSE …

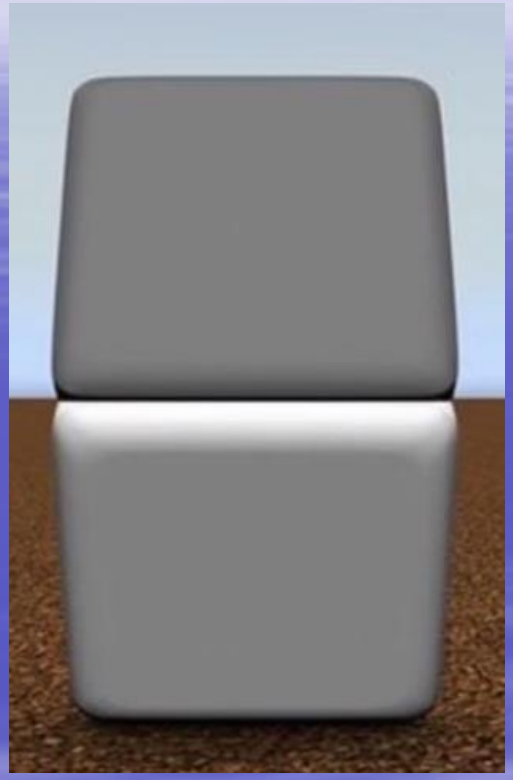
- We may make observations correctly, but we may not describe them or record them accurately.
- Consider the game “telephone” in which someone passes a message along a chain of people.
- Very seldom does the original message get accurately passed on.

Observation:



- Describe what you see.
- Are these two squares the same color?

Observation:



- Put your finger across the screen at the center where the two squares meet.
- The two squares are the same color!

SCIENCE IS VERY IMPORTANT BECAUSE …

- We may not be able to think beyond what we know, so we need to know more or practice a "different" kind of thinking.

- e.g. How many times did Thomas Edison try before he successfully made a light bulb that could last indefinitely?

- Over 9000 times!!!!

SCIENCE IS VERY IMPORTANT BECAUSE …

- We need to try things even if we don't think they will work.
- This is why it is good to try many things in life (sports, music, hobbies, travel, etc.) in order to find out what you can do.
- Science always progresses and develops. We should too!

The Scientific Method

Summarized step by step

Scientific Method

Click link:

https://screencast-o-matic.com/watch/cF6erAYlWN

- What was that?
- How did that happen?
- Can that happen again?
- Where was that?

Observation:

- **Use the senses:** sight, hear, touch, taste, smell, pain/pressure (headache)
- **Ask questions**
- **Collect data**
- **Organize facts**

Hypothesis:

- We make an **educated guess** … based on what we already know and what we've already **observed** (without accurate observation, one cannot have a solid hypothesis)

- This is **a possible solution to the problem** without "jumping to conclusions"

Experiment:

Test the hypothesis

- **Collect more data and/or Compile more facts for further exploration** (graphs, charts, pictures, etc.)
- **Variables** (the part of the experiment being tested … a true experiment tests only ONE variable at a time)
- **Control** (the aspects of the experiment that do not change)
- **Conclusion:** a state whether the hypothesis was correct or not based on evidence / supporting data

Theory:

- Establishes a **recognizable pattern** which can be repeated anywhere in which conditions are the same.
- Provides a **general explanation** for our observations.
- Can be **modified** (does not necessarily account for all factors). **Never proven.**

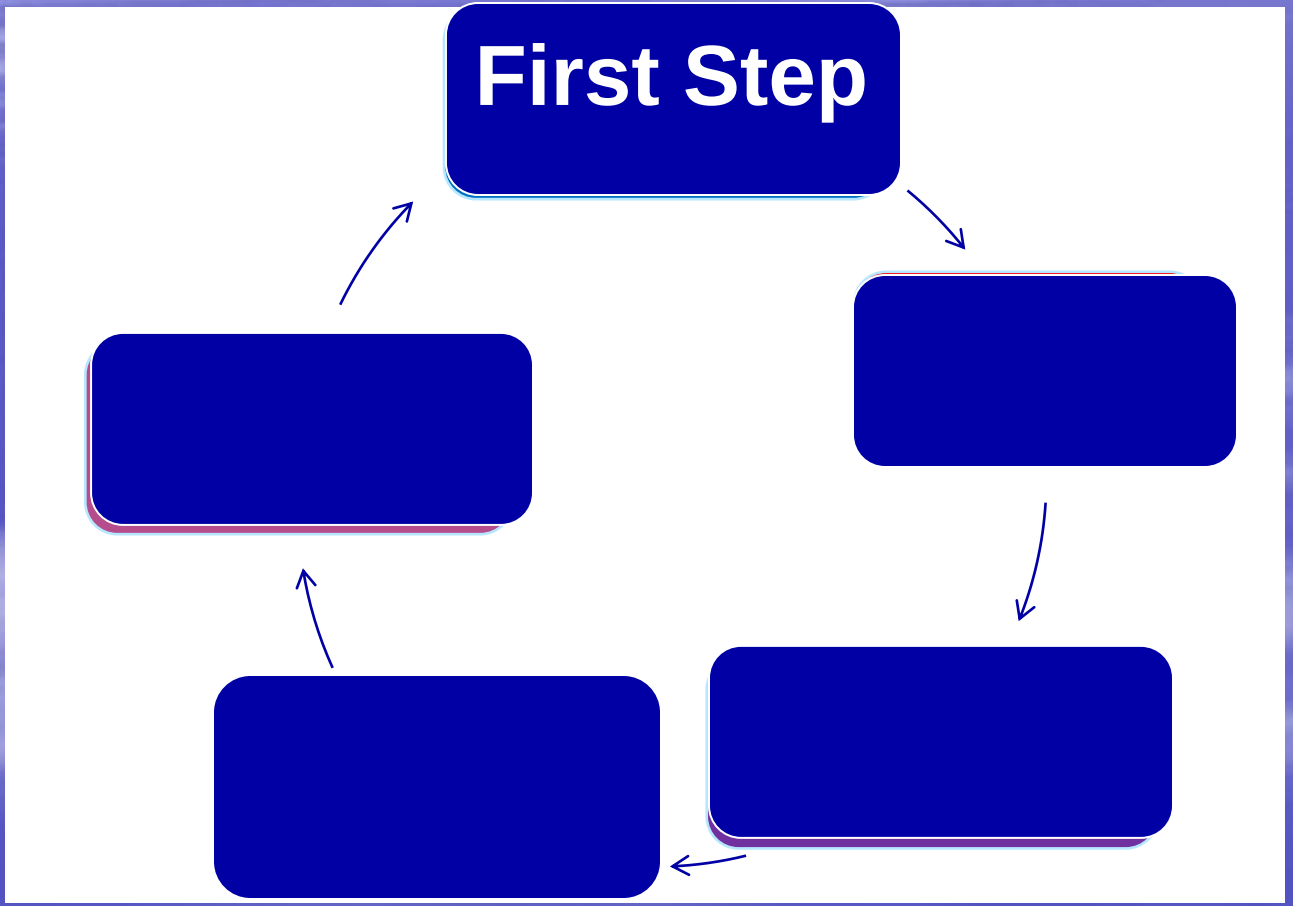
Law:

- States a consistent, **unchanging relationship** between observed facts (under the same conditions).
- **Describes events in nature** … but does not explain them as a theory tries.
- There are **no exceptions** to the "rule" under the same conditions.

LESSON QUESTION

The Nature of a Scientific Law:

An educated guess, confirmed over and over again by experimentation



Place in the boxes

- Experimentation
- Hypothesis
- Law
- Observation
- Theory

LESSON QUESTION

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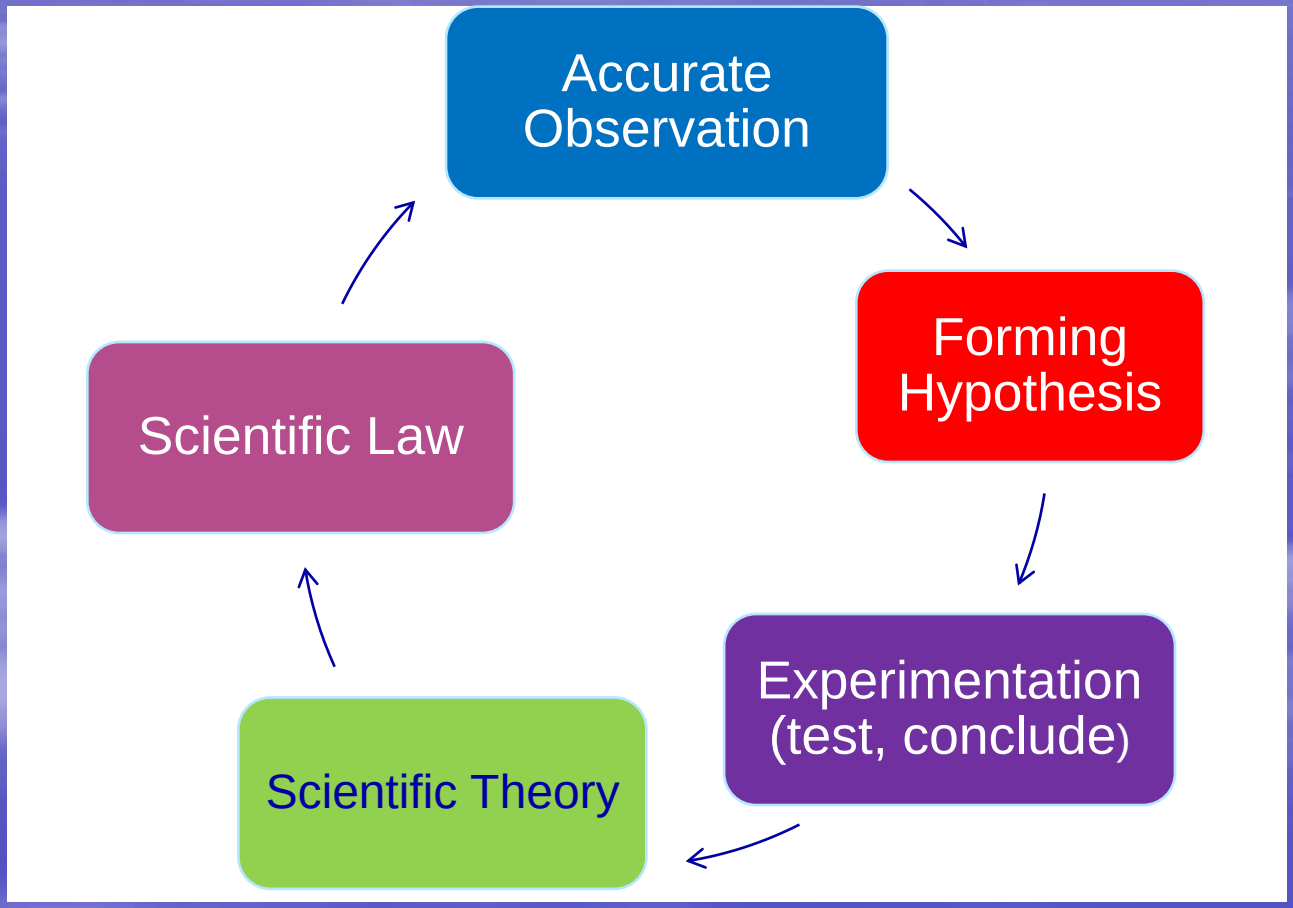


UNITS OF MEASUREMENT
BASIC UNITS IN METRIC SYSTEM

- Mass
- Length
- Volume
- Time
- Temperatue
- Energy
- Amount of substance

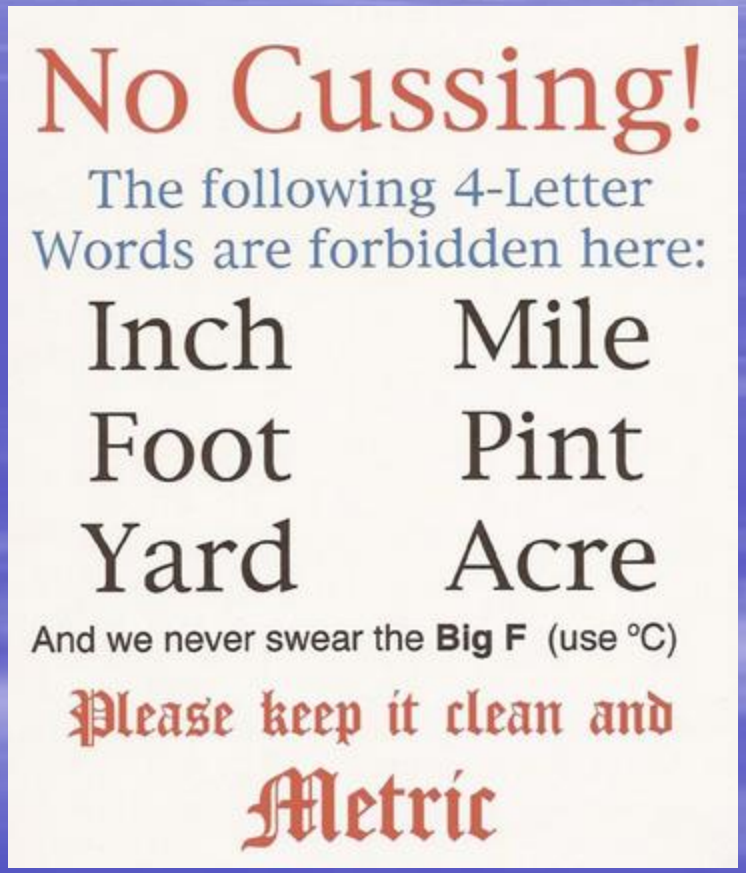
- Kilogram
- Meter
- Liter
- Second

- Kelvin
- joule
- Mole
- Second

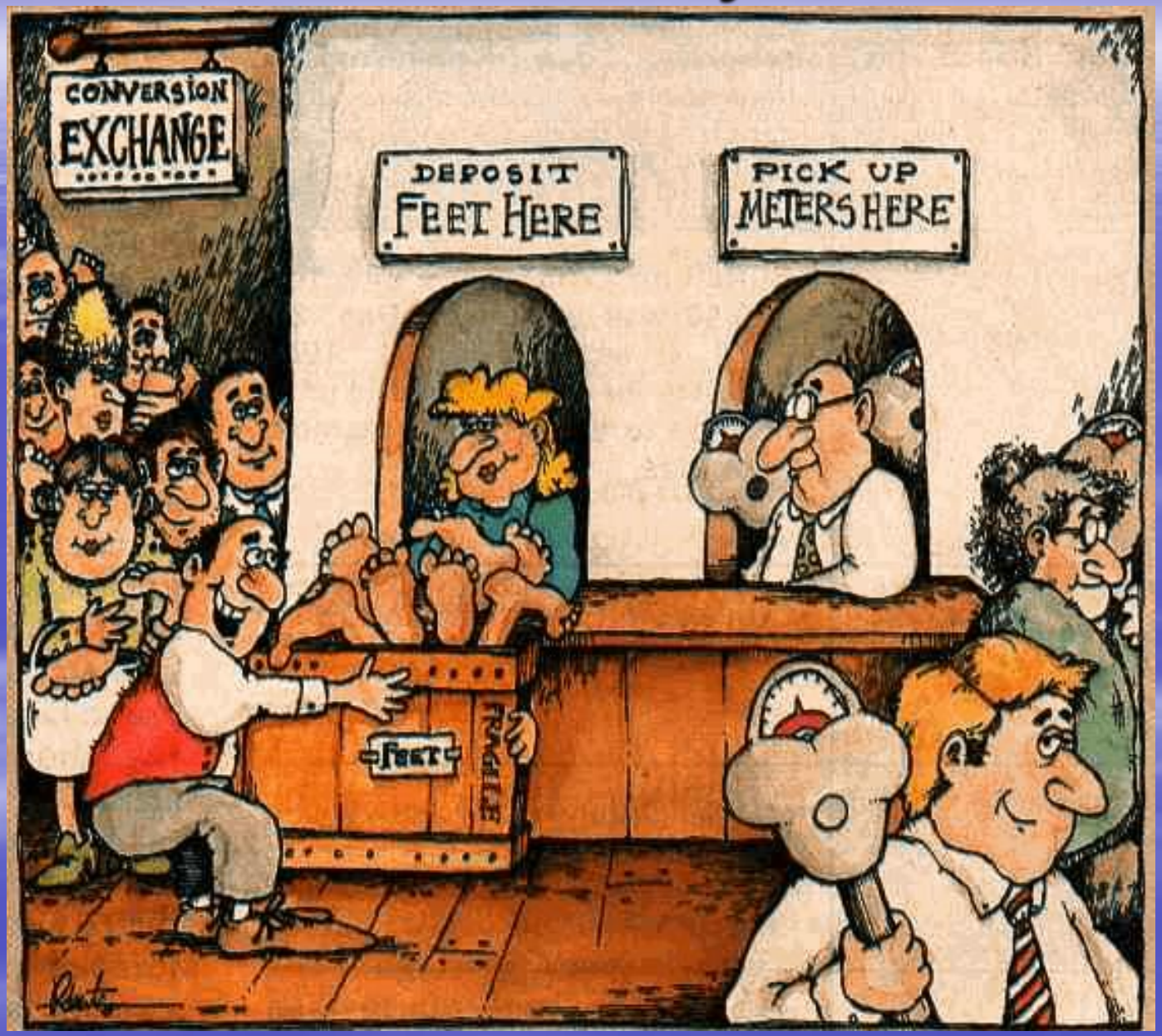
The Metric System

Click on:

http://prezi.com/zc-alvezwvy9/metric-versus-english-measurement/



The Metric System



The Metric System

- **Metric System Versus the English System**
  - The English System is Complicated
    - The English system utilizes many different names for each major measurement (units of mass, volume, distance)
      - DISTANCE: Rod, furlong, hand, foot, yard, mile, nautical mile
      - VOLUME: Pinch, gill, teaspoon, tablespoon, ounce, cup, pint, quart, gallon, peck, bushel
      - MASS/WEIGHT: Penny, grain, ounce, pound, short ton, standard ton

The Metric System

- **Metric System** Versus the English System

Simplicity

- The metric system uses ONE unit for each category of measurement
- Gram (mass), liter (volume), meter (distance)

https://screencast-o-matic.com/watch/cF6hIaYo00 (2:44)
Meters, Liters & Grams Song

The Metric System

- Metric System Versus the **English System**

The English System is Inconsistent

- The English system has no consistency between units
  - DISTANCE: Rod, furlong, hand, foot, yard, mile, nautical mile
  - VOLUME: Pinch, gill, teaspoon, tablespoon, ounce, cup, pint, quart, gallon, peck, bushel
  - MASS/WEIGHT: Penny, grain, ounce, pound, short ton, standard ton

The Metric System

- **Metric System** Versus the English System

  Consistent

  - All metric units are multiple of 10 or utilize decimal placement
  - Prefixes (milli, centi, deci … deka, hecta, kil) distinguish units.

Manipulating Units in the Metric System

You do need to memorize the metric progression at least from kilo- to milli- (and vice versa).

Video (Metric Progression Song) (1:19)

https://screencast-o-matic.com/watch/cFjtqBquew

The Metric System

- Metric Prefixes from small to large

Nano	Micro	Milli	Centi	Deci	Base Unit	Deka	Hecto	Kilo	Mega	Giga
10^{-9}	10^{-6}	10^{-3}	10^{-2}	10^{-1}	10^{0}	10^{1}	10^{2}	10^{3}	10^{6}	10^{9}
ng	ug	mg	cg	dg	g	Dg	Hg	kg	Mg	Gg
nl	ul	ml	cl	dl	L	Dl	Hl	kl	Ml	Gl
nm	um	mm	cm	dm	m	Dm	Hm	km	Mm	Gm

Prefix	Multiplier	Exponential
yotta	1,000,000,000,000,000,000,000,000	10^{24}
zetta	1,000,000,000,000,000,000,000	10^{21}
exa	1,000,000,000,000,000,000	10^{18}
peta	1,000,000,000,000,000	10^{15}
tera	1,000,000,000,000	10^{12}
giga	1,000,000,000	10^{9}
mega	1,000,000	10^{6}
kilo	1,000	10^{3}
hecto	100	10^{2}
deca	10	10^{1}
	1	10^{0}
deci	0.1	10^{-1}
centi	0.01	10^{-2}
milli	0.001	10^{-3}
micro	0.000001	10^{-6}
nano	0.000000001	10^{-9}
pico	0.000000000001	10^{-12}
femto	0.000000000000001	10^{-15}
atto	0.00000000000000001	10^{-18}
zepto	0.00000000000000000001	10^{-21}
yocto	0.00000000000000000000001	10^{-24}

Click on the link for an overview of the chapter: (2:55)

https://screencast-o-matic.com/watch/cFQbqeqM8v