Physical Science
Unit 1

- Safety
- Metrics & Measurement
- Scientific Method

DANGER

Laboratory Safety Rules

Lab Safety

Pleasant Valley High School
Science Department

Lab Safety Begins Before You Go to the Lab!

- ***Always*** **read through the lab instructions the day before you go to the lab.**

- **Ask any questions you may have concerning the lab BEFORE you begin.**

To Protect Your Stuff…

- Make sure you put away all of your personal belongings when we are in lab.
  - This keeps your area free of clutter and prevents accidents.

Proper Lab Behavior

- ***Never*** **indulge in practical jokes or behavior that could lead to injury of others.**

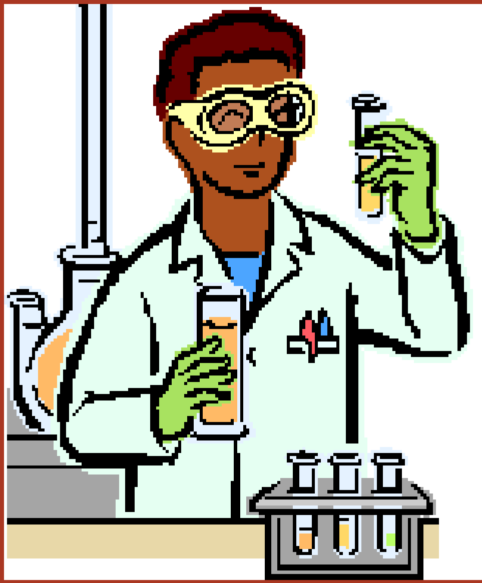
Dressing for Lab

- Use goggles, gloves, and lab aprons when instructed to do so.
(** Note: If you wear contact lenses make sure to have your Goggles on at all time!)

SAFETY
FIRST

GOGGLES
REQUIRED

Lab Safety



- ***Never*** look directly into a test tube. View the contents from the side.

- Point test tubes that are being heated ***away from*** you and others.

Lab Safety

- ***Never*** **taste any material in the lab.**
  - **This includes eating or drinking things found in beakers, graduated cylinders, flasks, test tubes, etc…**
- **Food, drink and gum are prohibited in lab.**

Safe Lab Practices (cont.)

- Never smell a material in a test tube or flask directly. Instead, with your hand, "fan" some of the fumes to your nose carefully.

In the Event of a Lab Accident……

- Report ***all*** accidents ***regardless of how minor*** to your teacher.
- For minor skin burns, immediately plunge the burned area into cold water ***and notify the teacher***.

In the Event of a Lab Accident…… (cont.)

- If you get ***any*** chemical in your eye, immediately wash the eye with the eye-wash fountain ***and notify the teacher.***

- Immediately notify the teacher of any chemical spill and we will handle it.

At the End of Your Lab Time…

- Return all lab materials and equipment to their ***proper places*** after use.
- Dispose of all chemicals AS DIRECTED BY YOUR TEACHER!
- Wash and dry all equipment, your lab bench and your clean-up area.

Lab Safety

- **Learn the location of safety equipment in the room.**
  - **Safety Map Time**

http://lansce.lanl.gov/training/FST2004/images04/chemicals1.gif

Observation vs. Inference

What's the difference?

Observation:

1. Using one of the **5 senses** to understand the world around you.

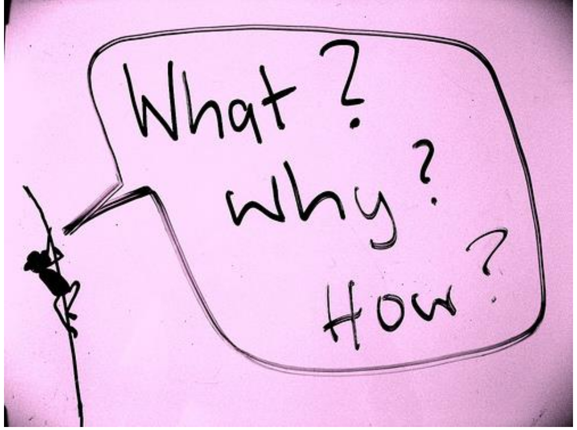
   A. Sight, touch, hearing, smell, **taste** (NOT in science class!)

   A. **FACTS!!!** Example: There is one TV in the room.

Observation vs Inference

2. Types of observations:
   A. Qualitative: Description based on observations or "relative" comparison; <u>color, "larger", felt "warmer"</u>
   B. Quantitative: Measured & numerical; <u>23grams, 37°C</u>

3. Recorded as **<u>DATA</u>** in an experiment.
   A. Data = <u>RECORDED DATA</u>



Inference

<u>Inference</u>

1. **Logical** interpretation/explanation.

2. Using **<u>reasoning</u>** to make sense of what you are observing

3. **BASED** on observations

Inferences

4. Example: You entered the classroom and a new adult was by my desk. You might infer that I am sick or that the person is a substitute teacher.

5. Clues You Are Making an Inference; I think.., Like…, Because…

6. Used in writing the CONCLUSION of a lab report.

Observation or Inference?

- 1. The temperature at noon was 78 degrees.
- 2. It is a very hot day.
- 3. The price of gasoline is rising.
- 4. Bill's car is very fast.
- 5. The test was very easy.
- 6. The candle weighed 71 grams.

Metric System

Metrics

- Scientists are very lazy, they don't want to have to remember all of those different conversions.
- So instead we use the Système International (SI) *Its French!*
- Or we can just say the **Metric System**.
- Its all based on the number 10.

Metrics - Distance

What is Distance?

Definition:

The space between two points.

Tool:

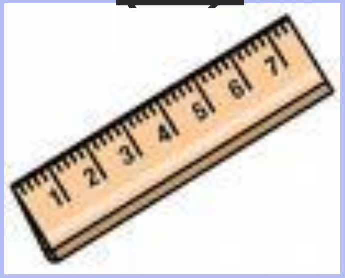
Meter Stick

Ruler

Unit:

Meter

(m)



Metrics - Volume

What is Volume?

Definition:

The amount of space something takes up.

Tool:

Graduated Cylinder

Ruler

(Length x Width x Height)

Unit:

Liter

(L)

Metrics - Mass

What is Mass?

Definition:

The amount of stuff (or Matter) inside an object.

Tool:

Electric or Mechanical Balance

Unit:

Gram (g)

Metrics - Temperature

What is Temperature?

Definition:

How fast the particles of an object are moving (due to heat).

Tool:

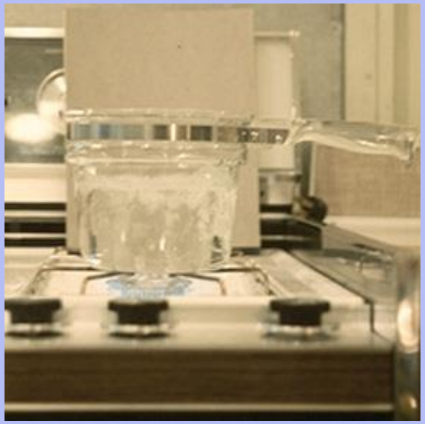
Thermometer.

Unit:

Degrees Celsius (^{o}C)

Metrics - Temperature

- So remember:
  - 0 º Celsius is when water freezes
  - 100 º Celsius is when water boils.



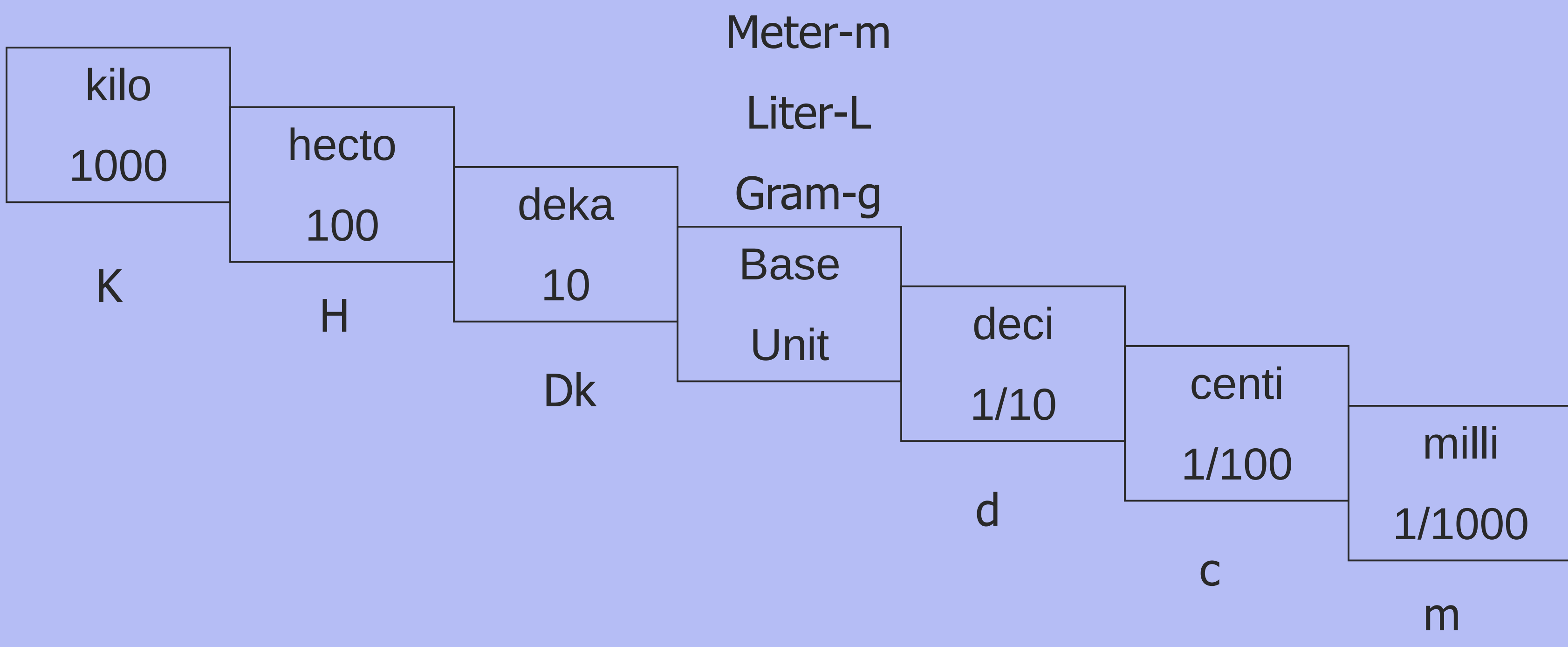
Metrics – Powers of Ten

kilo- (K) 1000	hecto - (H) 100	deka- (D) 10	Liter (L) Meter (m) Gram (g)	deci- (d) .1	centi- (c) .01	milli- (m) .001

Metrics – Powers of Ten

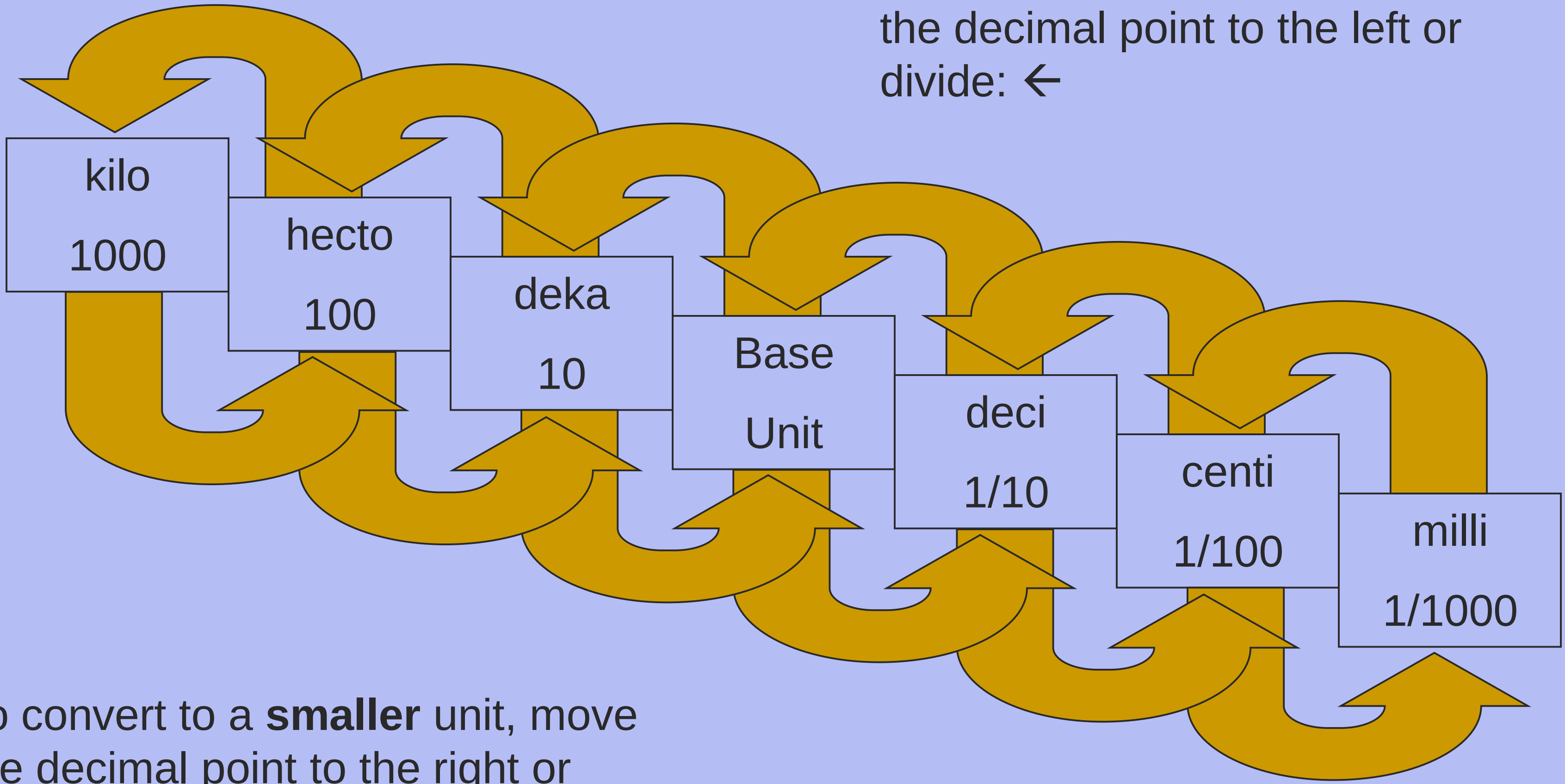
- As we change from different types of measurements, we change our prefix.
- For example 30 millimeters = 3 centimeters
- They are both measures of length, but a millimeter is **ten times** smaller than a centimeter.
- Let's practice a few conversions.

Converting Metrics



Converting Metrics

To convert to a **larger** unit, move the decimal point to the left or divide: ←

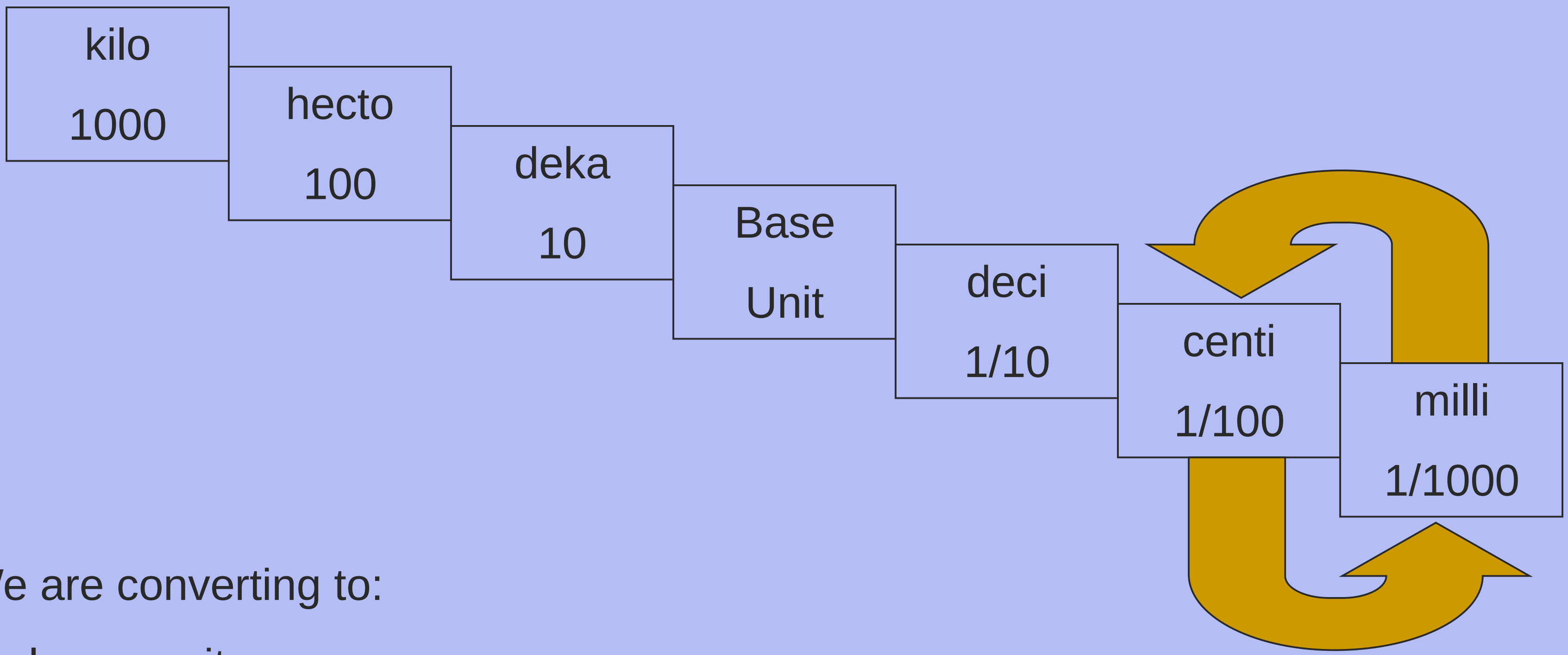


To convert to a **smaller** unit, move the decimal point to the right or multiply: →

Converting Metrics

Convert 6 cm = ______ mm

Convert 6 cm = 60 mm



We are converting to:

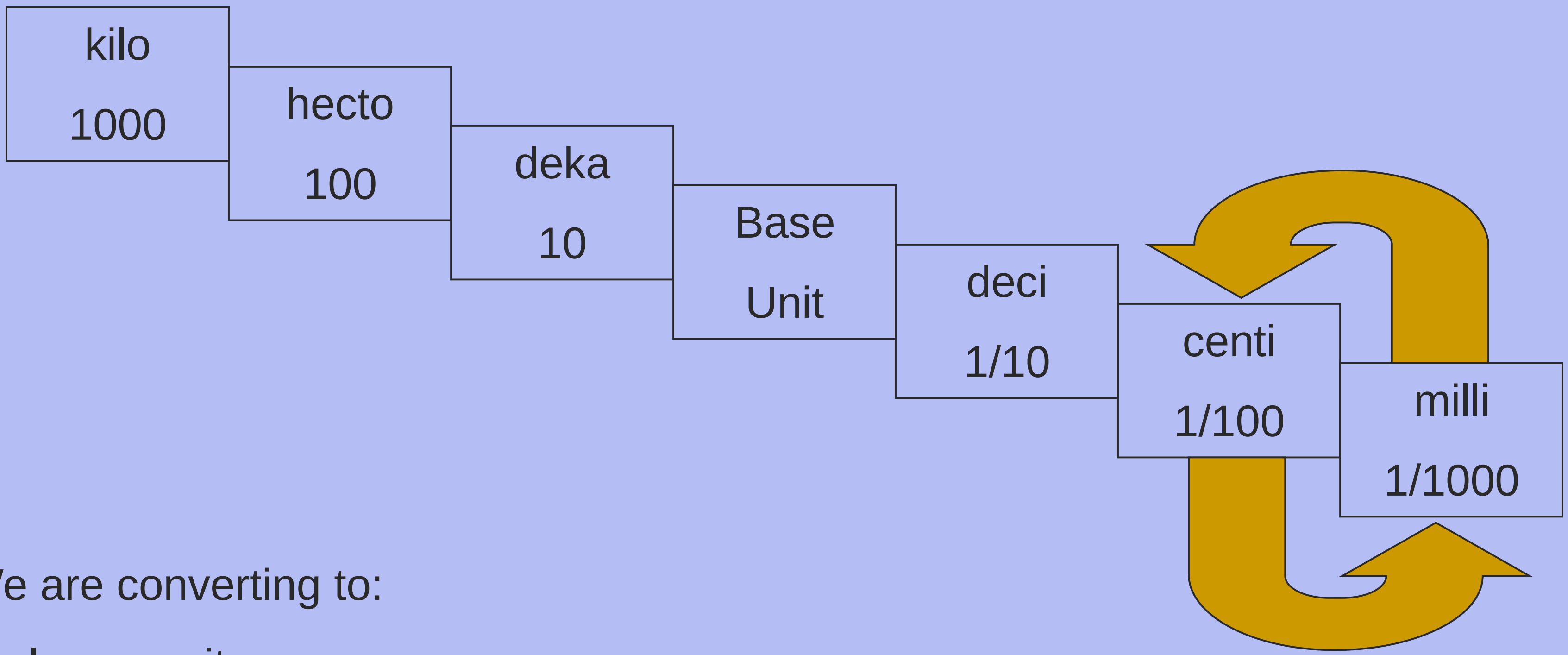
a) larger unit

b) smaller unit

Converting Metrics

Convert 40 mm = _____ cm

Convert 40 mm = 4 cm



We are converting to:

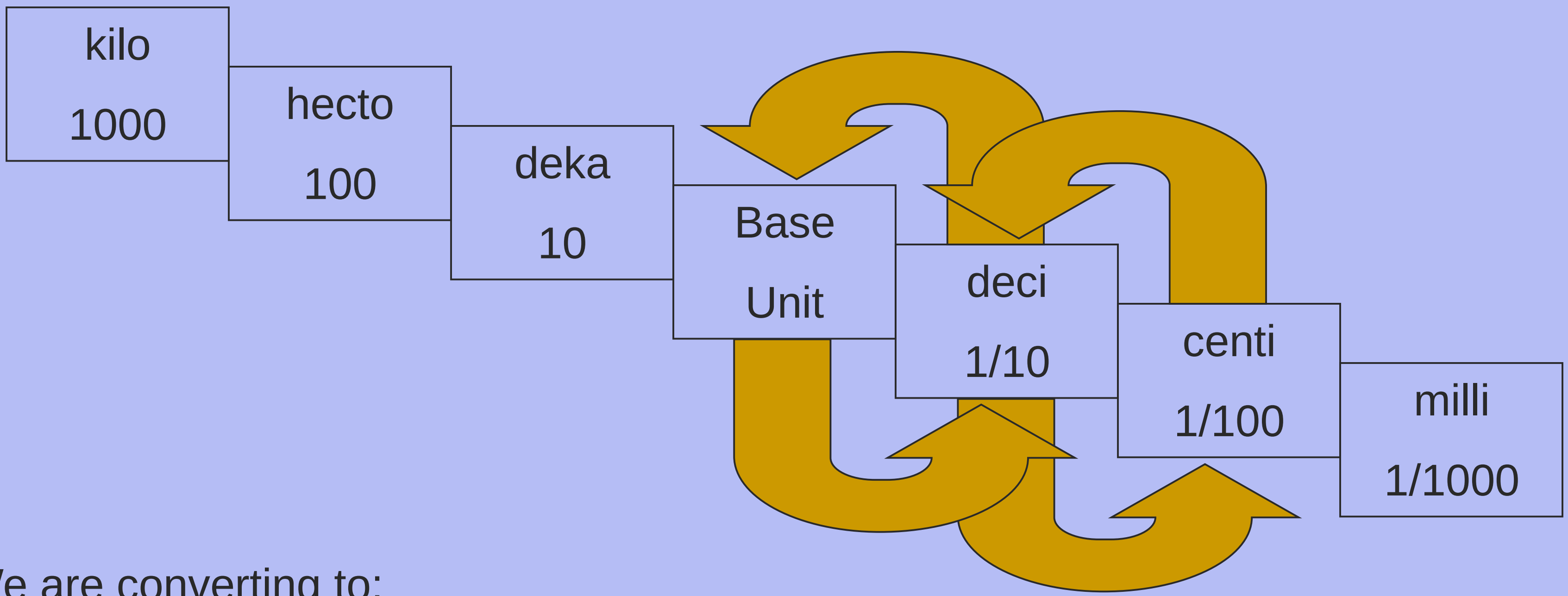
a) larger unit

b) smaller unit

Converting Metrics

Convert 90 cm = _____ m

Convert 90 cm = 0.9 m



We are converting to:

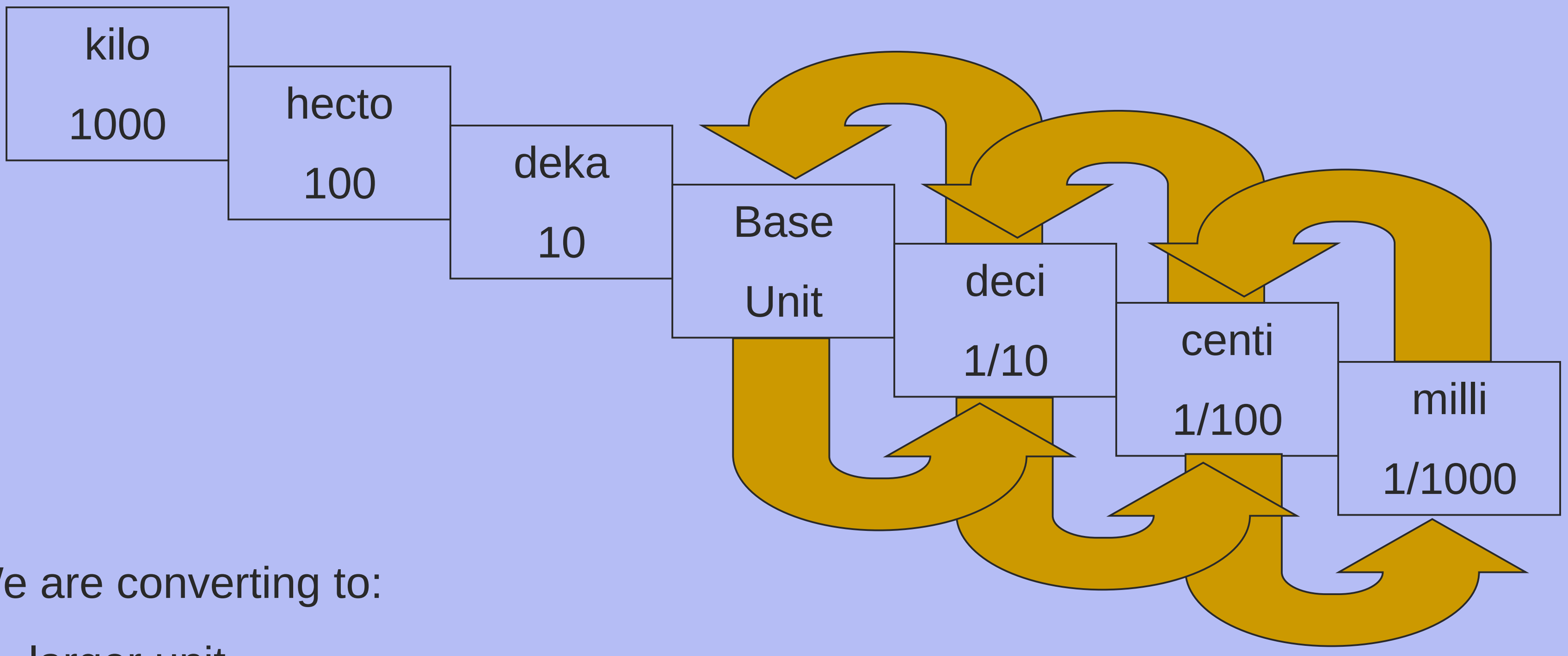
a) larger unit

b) smaller unit

Converting Metrics

Convert 200 mm = _____ m

Convert 200 mm = 0.2 m



We are converting to:

a) larger unit

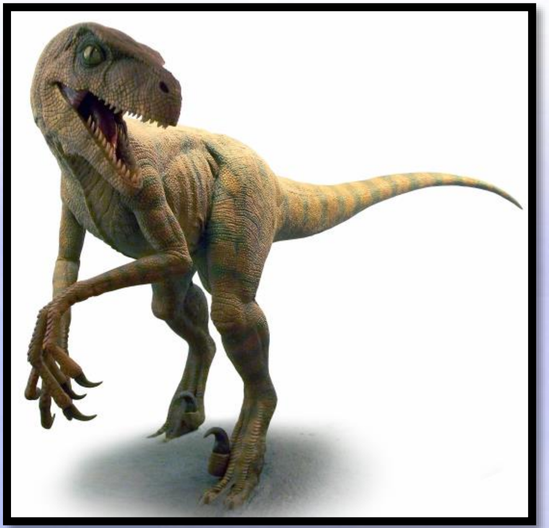
b) smaller unit

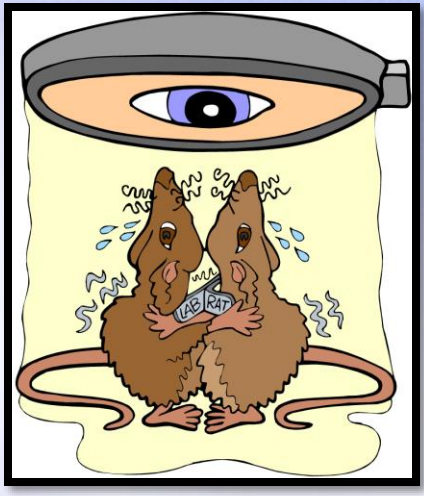
Converting Metrics

1000 mg	**=**	**1**	**g**
1L	**=**	**1000**	**mL**
160 cm	**=**	**1600**	**mm**
14 km	**=**	**1400**	**Dm**
109 g	**=**	**1090**	**dg**
240 m	**=**	**24,000**	**cm**

Converting Metrics (More Practice)

43g	**=**	**43000**	**mg**
85 cm	**=**	**0.85**	**m**
911 DL	**=**	**9110000**	**mL**
8701 m	**=**	**8.701**	**Km**
0.26 Hg	**=**	**260**	**dg**





INTRODUCTION TO SCIENCE AND THE SCIENTIFIC METHOD

What is Science?

The goal of science is to investigate and understand the natural world, to explain events in the natural world, and to use those explanations to make useful predictions.

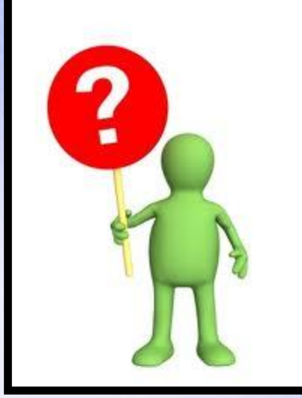
1. Science deals only with the natural world.

2. Scientists: collect and organize information

3. Scientists propose _explanations_ that can be _tested_ by examining evidence.

4. Science is an organized way of using evidence to learn about the natural world.

How is Science Done?



Science begins with an __observation__.

This is the process of gathering information about events or processes in a careful, orderly way.

Data is the information gathered from making observations.

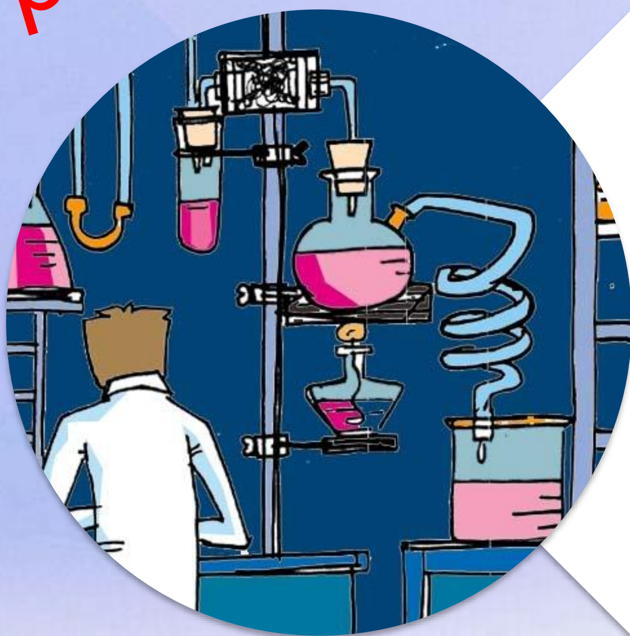
There are two types of data:

Quantitative data are: **numbers from counting or measuring**

Qualitative data are: descriptions (color, shape, other characteristics)

A hypothesis is a <u>scientific explanation</u> for a set of observations.

Hypothesis



A hypothesis must be stated in a way that makes it “testable”. The hypothesis is just a possible answer to a question, and it must be thoroughly tested.

Scientific Methods

The scientific method is:

A series of steps used by scientists to solve a problem or answer a question.

The Steps to the Scientific Method

1. Observation / Asking a Question
2. Form a Hypothesis
3. Design a Controlled Experiment
4. Record and Analyze Results
5. Draw Conclusions

Step 1: Observation / Asking a Question

A problem or a question must first be identified.

How much water can a root hair absorb?

Why does a plant stem bend toward the light?

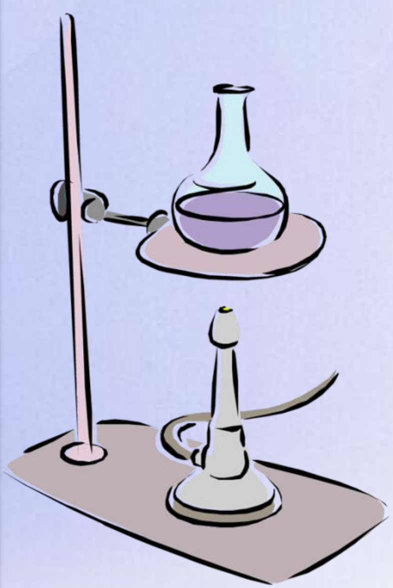
What effect does temperature have on heart rate?

Step 2: Form a Hypothesis

Hypothesis

A possible explanation to the question or problem.

It is simply a prediction and has not yet been proven or disproven.



It must be stated in a way that is testable. A statement is considered "testable" if evidence can be collected that either does or does not support it.

Step 3: Designing a Controlled Experiment

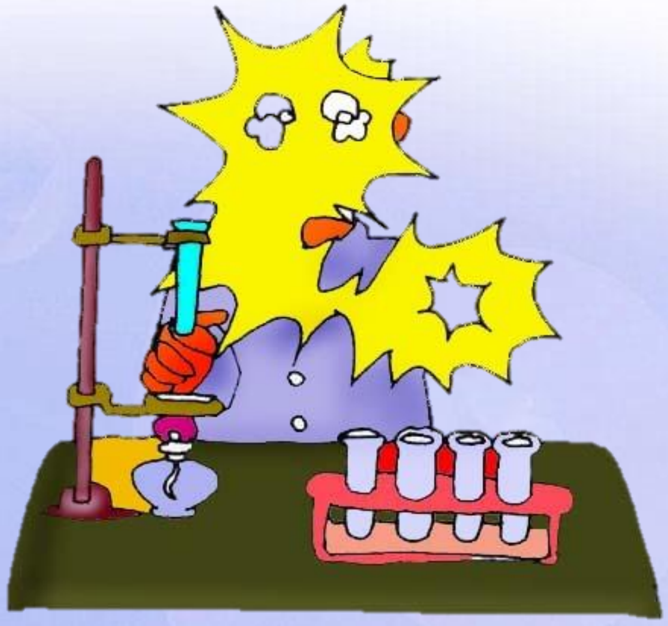
1. The factors in an experiment that can be changed are called variables. Some example of variables would be: changing the temperature, the amount of light present, time, concentration of solutions used.

2. A controlled experiment works with one variable at a time. If several variables were changed at the same time, the scientist would not know which variable was responsible for the observed results.

Step 3: Designing a Controlled Experiment

3. In a "controlled experiment" only one variable is changed at a time. All other variables should be unchanged or "controlled".

4. An experiment is based on the comparison between a control group with an experimental group.
   a) These two groups are identical except for one factor.
   b) The control group serves as the comparison. It is the same as the experiment group, except that the one variable that is being tested is removed.
   c) The experimental group shows the effect of the variable that is being tested.



Example: In order to test the effectiveness of a new vaccine, 50 volunteers are selected and divided into two groups. One group will be the control group and the other will be the experimental group. Both groups are given a pill to take that is identical in size, shape, color and texture.

Describe the control group.

Even though the volunteers are given identical looking pills, the control group will not actually receive the vaccine.

Describe the experimental group.

This group will receive the vaccine.

What variables are kept constant?

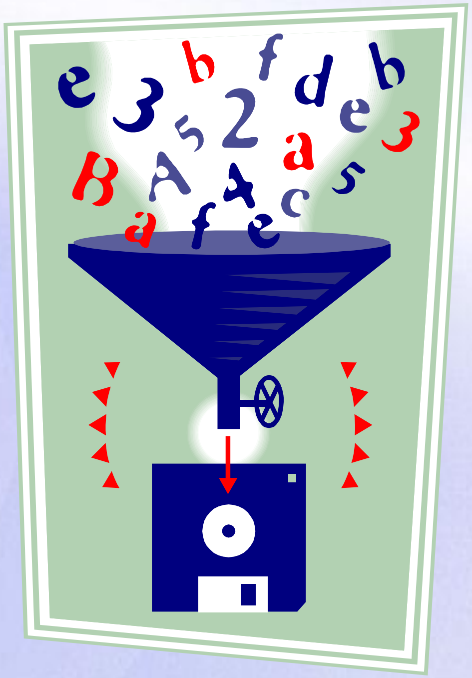
The size, shape, color, and texture of the pill.

What variable is being changed?

Whether or not the pill contains the vaccine.

There are two variables in an experiment:

a) The independent variable is the variable that is changed on purpose by the scientist



c) In the above example, what is the independent variable?

It is the addition of the vaccine to the pills that were given to the volunteers.

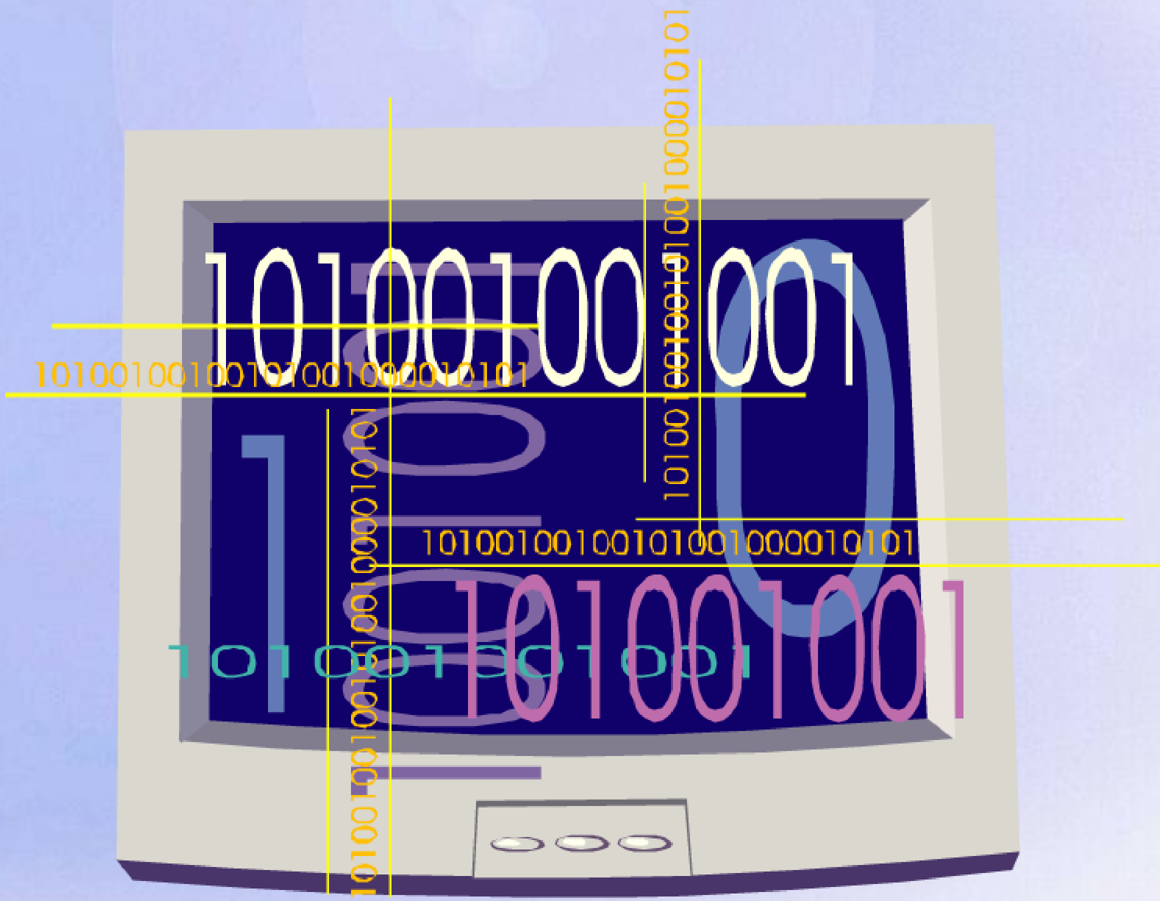
b) The dependent variable is the one that is measured during the experiment. The dependent variable is the data we collect during the experiment. This data is collected as a result of changing the independent variable.

d) In the above example, what is the dependent variable?

The observed health of the people receiving the pills.

Step 4: Recording and Analyzing Results

1. The data that has been collected must be organized and analyzed to determine whether the data are reliable.

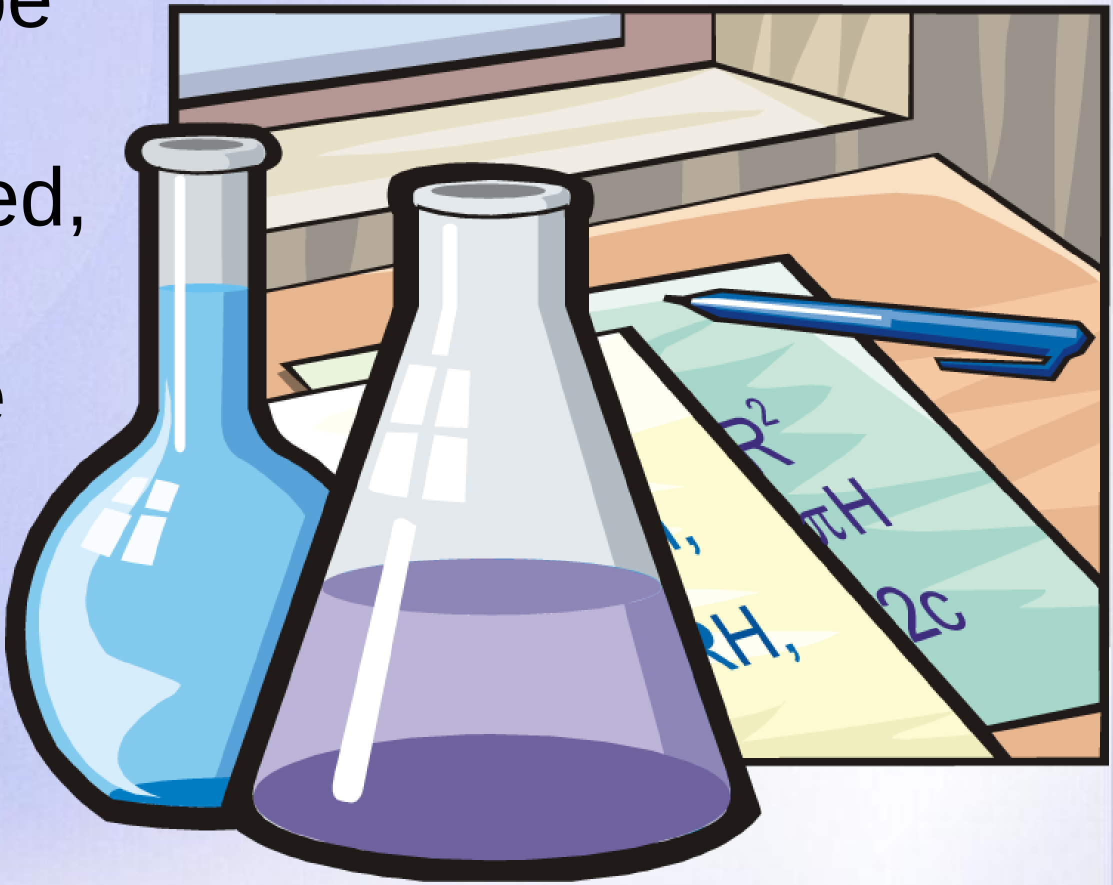


2. Does the data support or not support the hypothesis?

Step 5: Drawing Conclusions

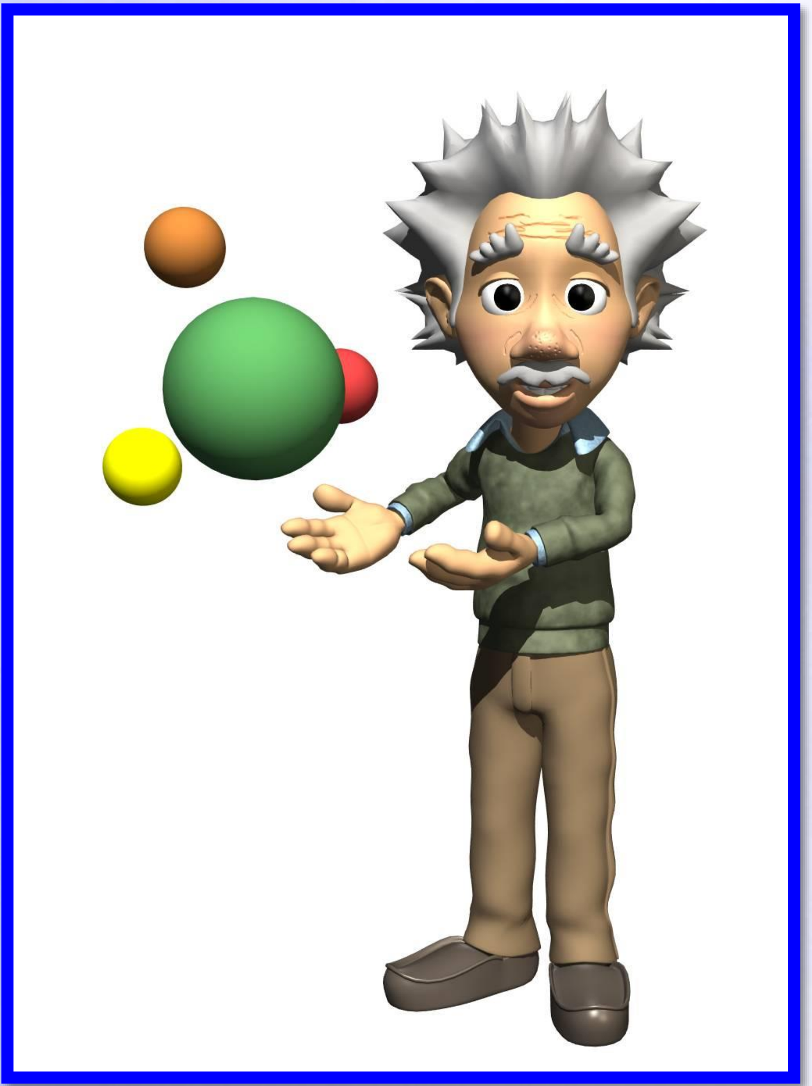
The evidence from the experiment is used to determine if the hypothesis is <u>proven or disproven.</u>

Experiments must be repeated over and over. When repeated, the results should always be the same before a valid conclusion can be reached.



Forming a Theory

A theory may be formed after the hypothesis has been tested many times and is supported by much evidence.

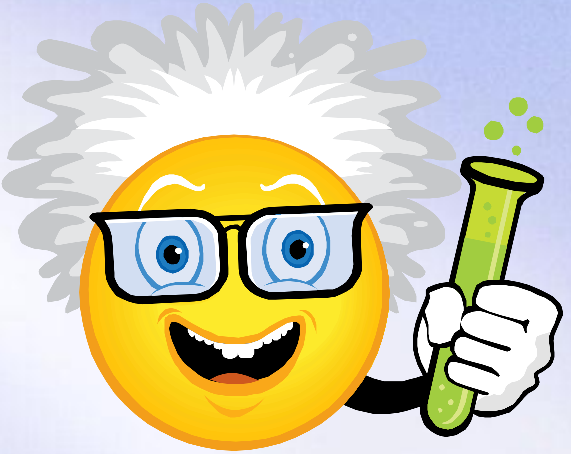


Theory:

A broad and complete statement of what is thought to be true.

A theory is supported by considerable evidence.

Practice Problem:



You want to determine the effects of a certain fertilizer on the growth of orchids grown in a greenhouse. Materials that are available to you include: greenhouse, 100 orchid plants, water, fertilizer, and soil. You want to know if the orchids will grow best with a weak concentration of fertilizer, a medium concentration of fertilizer, or a high concentration of fertilizer. How will you design an experiment to test different concentrations of this fertilizer?

State your hypothesis:

Possible answer:

If the orchids are given the ________________ concentration of fertilizer, then they will ______________________.

How will you set up a controlled experiment?

Here is one possibility:

The 100 plants will be divided into 4 groups as follows:

Group 1: 25 plants will receive plain water.

Group 2: 25 plants will receive a weak concentration of fertilizer.

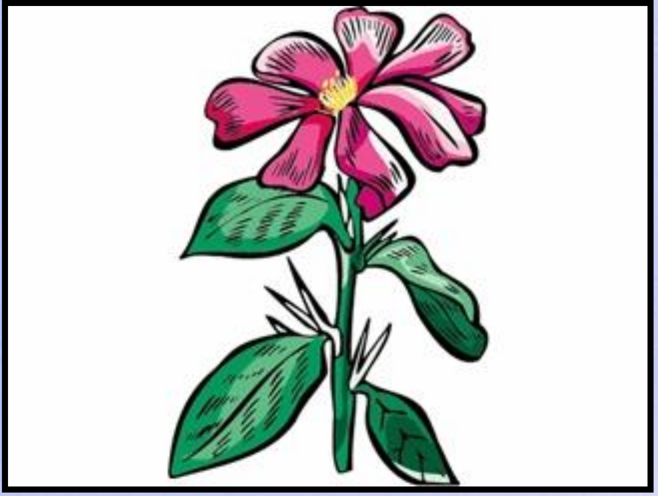
Group 3: 25 plants will receive a medium concentration of fertilizer.

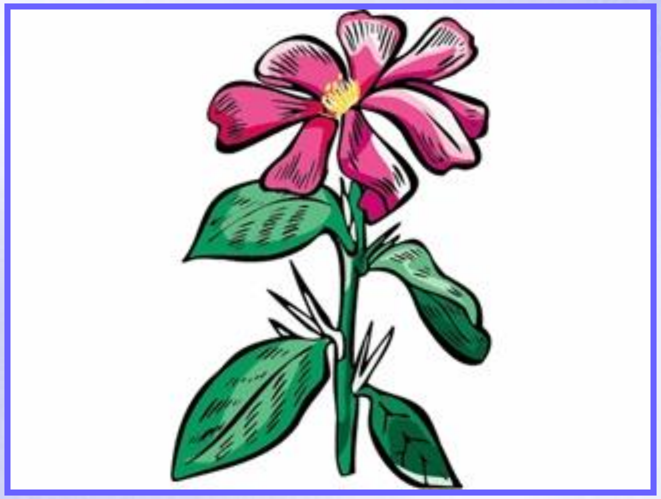
Group 4: 25 plants will receive a high concentration of fertilizer.

The plants will be watered daily. Over a period of a month, the plants will be measured to see which ones grew the tallest.

Control Group	Experimental Group

What is the control group in this experiment?
The control group consists of the 25 plants that are receiving plain water.





What is the experimental group in this experiment?
The experimental group consists of the 75 plants that are receiving various concentrations of fertilizer.

In a "controlled experiment", all variables must be kept constant except the one variable that is being changed.

What variables must be kept constant in this experiment?

✓All plants must receive the same amount of fluid each day.
✓All plants are grown in pots of equal size.
✓All plants are grown at the same temperature.
✓All plants receive the same amount of sunlight.

What variable is being changed in this experiment?
The variable being changed is the amount of fertilizer received by each group of plants.

After one month of measuring the orchids, the following data is obtained:

Group 1 (Control Group): Grew to an average height of 15 cm.

Group 2 (Weak conc.): Grew to an average height of 35 cm.

Group 3 (Medium conc.): Grew to an average height of 28 cm.

Group 4 (High conc.): Grew to an average height of 10 cm.

Is your hypothesis supported or disproved by these results?

We hypothesized that ____________________.

The results do/do not support this.

The results prove/disprove our hypothesis.

After one month of measuring the orchids, the following data is obtained:

Group 1 (Control Group): Grew to an average height of 15 cm.

Group 2 (Weak conc.): Grew to an average height of 35 cm.

Group 3 (Medium conc.): Grew to an average height of 28 cm.

Group 4 (High conc.): Grew to an average height of 10 cm.

What is your conclusion based on these results?

- Orchids grow best with a weak concentration of fertilizer.
- At medium to high concentrations, plant growth is inhibited.

Analysis Questions

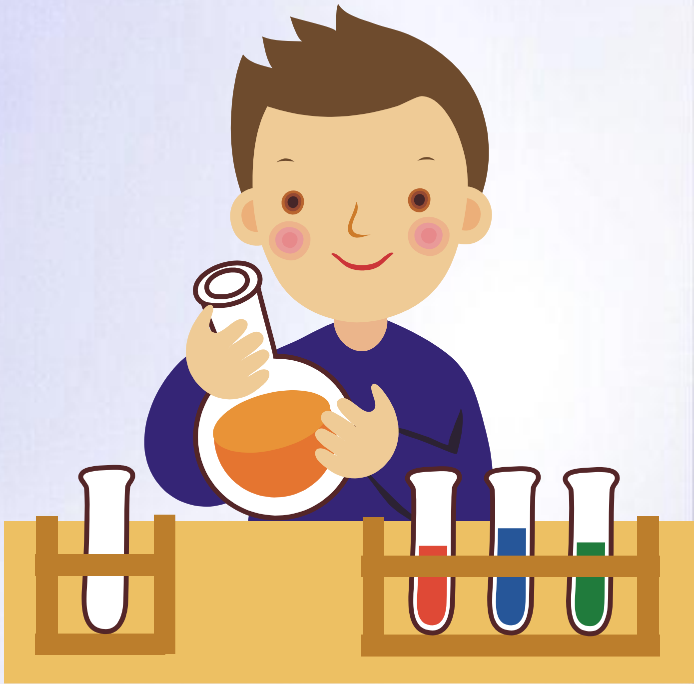
Why is it important to have a large sample size in any experiment?

It is important to test a large sample in order to get a true picture of the results of the experiment. If the sample size is too small, an inaccurate conclusion may be reached. Results obtained by testing a large number of individuals would be much more accurate than if only a few individuals had been tested.

Analysis Questions

Why is it important to repeat the experiment many times?

Experiments should be repeated to see if the same results are obtained each time. This gives validity to the test results.



Analysis Questions

What is the importance of the control?

The control shows what will happen when the experimental factor is omitted. Without the control, there would be no basis for comparison and you would not know how the experimental factor affected the results.

Analysis Questions

How is a theory different than a hypothesis?

A hypothesis is an “educated guess” that is testable through observations and experimentation. A theory is a broad statement of what is believed to be true based on many experiments and considerable amounts of data.

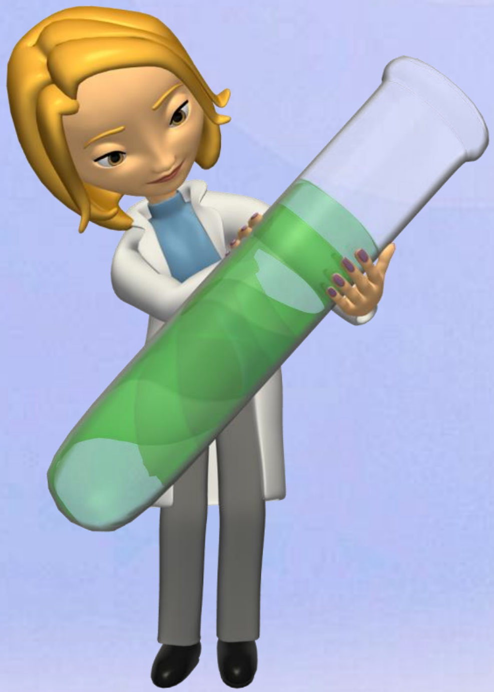
Analysis Questions

Why is it so important that a scientist accurately describes the procedure used in the experiment?

It allows other scientists to repeat the experiment and verify the results.

Analysis Questions

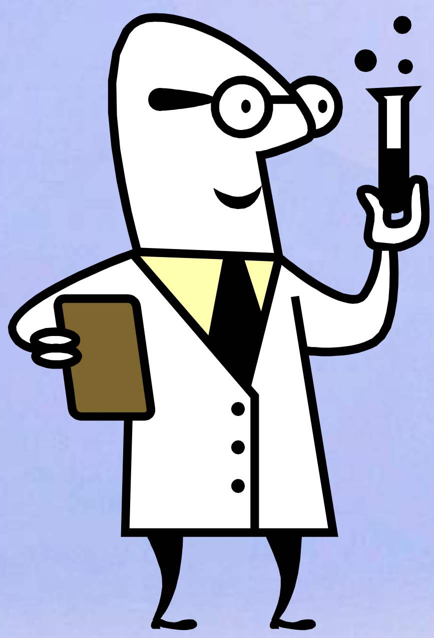
What is the difference between the independent and the dependent variables in an experiment?



The independent variable is the variable that is deliberately changed by the scientist. The dependent variable is the one observed during the experiment. The dependent variable is the data we collect during the experiment.

Analysis Questions

In a "controlled experiment", why must all of the variables, except one, be kept constant throughout the experiment?



If several variables were changed at the same time, the scientist would not know which variable was responsible for the observed results.

Scientific Notation

NOTES

Scientific notation: a way to write numbers using a power of ten (which our number system is based on)

*** ***Usually used to express very large or very small numbers!!***

Key parts: 7.54×10^7 2.8×10^{-4}

a number that is less than 10, but at least 1

Part #1

"× 10"

Part #2

exponent which may be + or –

Part #3

*** **Positive** exponents are for **LARGE** numbers (10 or more)
*** **Negative** exponents are for **SMALL** numbers (less than 1)

****That means: The exponent to use for a number that is at least 1, but less than 10.... is..... ______.

Scientific Notation

To write a number in scientific notation:

1. **Locate the decimal point**
2. **Move it to a location that will give you a number between 1 and 10 (or 1 exactly)**
3. **Write this new number down, followed by "× 10"**
4. **COUNT how many times you had to move the decimal point …use this number as your exponent**
5. **Decide the sign of the exponent.**
   a. **Large number makes exponent positive.**
   b. **Small number makes exponent negative.**
   c. **Number less than 10 but at least 1 makes an exponent of zero.**

1) Write 3,500,000 in scientific notation.

3,500,000 -------->

Examples

2) Write 0.000467 in scientific notation.

0.000467 -------->

3) Write 0.00000506 in scientific notation.

0.00000506 -------->

More Examples

4) Write 83,040,000,000 in scientific notation.

5) Write 46.2 in scientific notation.

6) Write 3 in scientific notation.

Scientific Notation

To write a number in standard notation:

1. **Use the exponent to determine if the number is LARGE OR SMALL**
2. **Determine which way to move the decimal point**
3. **Move the decimal point the number of times the exponent says to**
4. **Write the number you now have**

7) Write 4.59×10^7 in standard form.

4.59×10^7 -------->

Examples

8) Write 2.14×10^{-3} in standard form.

2.14×10^{-3} -------->

9) Write 5.01×10^{-5} in standard form.

More Examples

10) Write 8×10^8 in standard form.

11) Write 2.97×10^{-2} in standard form.

12) Write 4.25×10^{11} in standard form.

Scientific Notation	Standard Notation
7.28×10^{10}	
3.409×10^{-3}	
	0.00000581
9.1×10^{4}	
	9,081,000,000
	27.58
1.54×10^{-5}	
	5.31

6×10^5

0.007009

0.000000004

8.4×10^{-6}

6.02×10^8

56,090,000

4×10^0

Scientific Notation

NOTES

Scientific notation: a way to write numbers using a power of ten (which our number system is based on)

**** Usually used to express very large or very small numbers!!*

Key parts: 7.54×10^{7} 2.8×10^{-4}

Part #1	Part #2	Part #3
a number that is less than 10, but at least 1	"× 10"	exponent which may be + or –

*** **Positive** exponents are for **LARGE** numbers (10 or more)
*** **Negative** exponents are for **SMALL** numbers (less than 1)

****That means: The exponent to use for a number that is at least 1, but less than 10.... is..... ______.

Scientific Notation

To write a number in scientific notation:

1. **Locate the decimal point**
2. **Move it to a location that will give you a number between 1 and 10 (or 1 exactly)**
3. **Write this new number down, followed by "× 10"**
4. **COUNT how many times you had to move the decimal point …use this number as your exponent**
5. **Decide the sign of the exponent.**
   a. **Large number makes exponent positive.**
   b. **Small number makes exponent negative.**
   c. **Number less than 10 but at least 1 makes an exponent of zero.**

1) Write 3,500,000 in scientific notation.

3,500,000 -------->

Examples

2) Write 0.000467 in scientific notation.

0.000467 -------->

3) Write 0.00000506 in scientific notation.

0.00000506 -------->

More Examples

4) Write 83,040,000,000 in scientific notation.

5) Write 46.2 in scientific notation.

6) Write 3 in scientific notation.

Scientific Notation

To write a number in standard notation:

1. **Use the exponent to determine if the number is LARGE OR SMALL**
2. **Determine which way to move the decimal point**
3. **Move the decimal point the number of times the exponent says to**
4. **Write the number you now have**

7) Write 4.59×10^7 in standard form.

4.59×10^7 -------->

Examples

8) Write 2.14×10^{-3} in standard form.

2.14×10^{-3} -------->

9) Write 5.01×10^{-5} in standard form.

More Examples

10) Write 8×10^8 in standard form.

11) Write 2.97×10^{-2} in standard form.

12) Write 4.25×10^{11} in standard form.

Scientific Notation	Standard Notation
7.28×10^{10}	
3.409×10^{-3}	
	0.00000581
9.1×10^{4}	
	9,081,000,000
	27.58
1.54×10^{-5}	
	5.31

6×10^5	
	0.007009
	0.000000004
8.4×10^{-6}	
6.02×10^8	
	56,090,000
4×10^0	