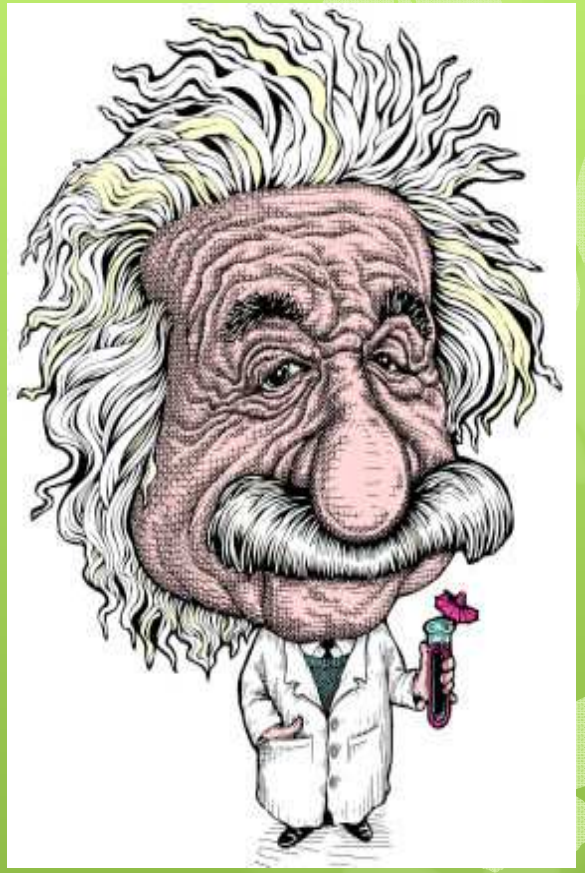
I CAN…..

1. List and explain the steps to the scientific method
2. Differentiate between the types of observation and variables
3. Design a controlled experiment
4. Read and calculate accurate measurements

What is Science?

What Is Science? - YouTube



- Organized way of using evidence to learn about the Natural World
- Science is an ongoing process or a search for a degree of understanding that is as close to reality as possible
- It is NOT based on faith or religion.

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Goal of Science

- **To <u>understand</u> the <u>world</u> around us**
  - **EX**. Does life appear from non-living matter?
- **To <u>explain</u> events by making <u>predictions</u>**
  - **EX**. Life doesn't appear from non-living matter.
- **To <u>investigate</u> predictions**
  - **EX**. Setting up an experiment to see if life comes from non-living matter, or from living things

Video: How scientists work

How could you use the scientific method in your daily life?

- One example to make a friend: http://www.youtube.com/watch?v=k0xgjUhEG3U

Observation & Inference

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Observations*- *Gathering evidence

- **It all starts here!**
- **Information gathered using your 5 SENSES**
  - **Quantitative:**
    - Observation using **numbers** and **measureme**
    - **EX.** 40 grams, 10 cm
      - Can you make a *quantitative* observation in this classroom?
        - # of desks, students, length of desk, etc..
  - **Qualitative:**
    - Observation that doesn't involve numbers
    - **EX**. The color or shape of an object.
      - Can you make a *qualitative* observation in this classroom?
        - The lab tables are black, walls are white, etc…..

Qualitative or Quantitative ?????

Non-measurable traits

Your Senses

Data

5 Oxygen Bubbles

Feather Colors

Counts / Measuring

Quantity

Quality

Inferences- Interpreting the Evidence

- **<u>INTERPRETATION</u> based on observation and prior knowledge or experience**
  - **EX**. *iPhones are the easiest smartphones to use.*
    - <u>Observation</u> = Most smartphones I see are iPhones.
    - <u>Prior knowledge</u> = My iPhone is easy to use.
- **Can you make an inference about one of your observations?**
  - The lab tables are black because they are made of coal.
    - Observation = lab tables are black
    - Prior knowledge = coal is black

Observation and Inference

Can you Name the Object????

Statement	Observation	Inference
Object A is round and orange.	X	
Object A is a basketball.		X
Object C is round and black and white.	X	
Object C is larger than Object B.	X	
Object B is smooth.	X	
Object B is a table-tennis ball.		X
Each object is used in a different sport.	X	X

- **Object A is a basketball.**
- **Object B is a table-tennis ball.**
- **Object C is a soccer ball.**

HMMMM??????

- How can we determine if something is a fact or an opinion?
- How can we determine an answer to a problem?
- Design an experiment using the ……..

The Scientific Method involves a series of steps that are used to investigate a natural occurrence.

Scientific Method

1. State the Problem/Question
2. Form a Hypothesis
3. Controlled Experiment
4. Collect Data
5. Analyze Results
6. Conclusion
7. Communicate the Results

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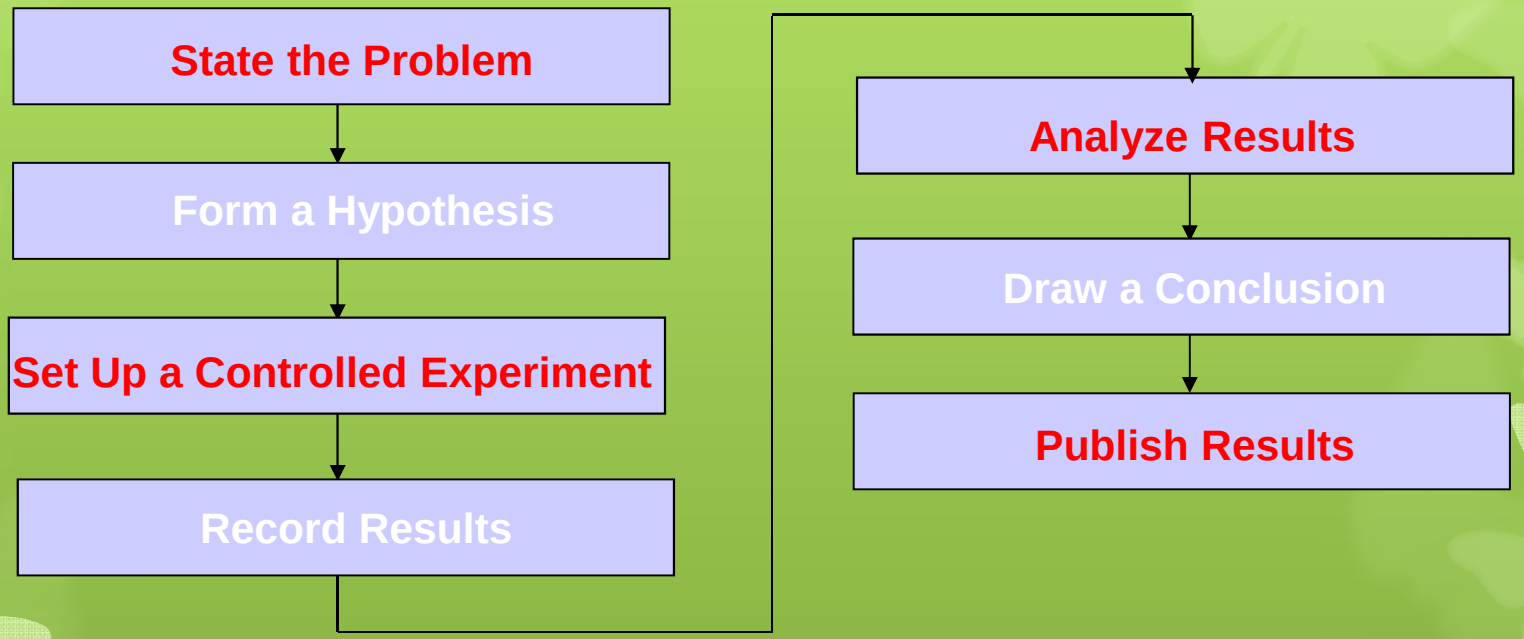
Designing an Experiment



1. State the Problem

- This is the question you want answered; also called the "purpose".

2. Form a Hypothesis

- A suggested solution to the problem; Predicts an outcome

- Must be testable
- Sometimes written as If…Then… statements
  - Example: If soil temperatures rise, then plant growth will increase.

3. Set up a Controlled Experiment

- Develop and follow a procedure that test your hypothesis
- Include a detailed materials list
- Conduct several trials to reduce error
- A good or "valid" experiment will contain only ONE variable and 2 groups (control & experiment)!

LET'S SEE HOW IT WORKS!
The Scenario

- A group of scientists would like to know the affects of ozone on plant life.
- They set up several "mini" ecosystems in separate domes to conduct their experiment.
- Each dome receives a different amount of ozone and one dome receives none.

Setting up a Controlled Experiment

Important Terms- What are variables

- **Variable:**
  - Things that can be manipulated or changed by scientist during experiment
  - A controlled experiment tests ONE variable, while the others must stay the same
- **Independent Variable:**
  - Manipulated **(CHANGED)** by scientist
  - Variable that is being tested
  - **I** am testing **INDEPENDENT**
  - **Example from video clip:**
    - Ozone gas is being tested

- **Dependent Variable:**
  - Changes in response to the tested variable
  - The "things" the scientist is measuring
  - DEPENDENT-DATA, DEPENDENT-DATA, DEPENDENT-DATA
  - **Example from video clip:**
    - Plant height, leaf count, rate of photosynthesis

Important Terms- What makes it a controlled experiment?

- **Controlled Variables:**
  - Things that must be kept constant during experiment
  - If altered, can affect results and be used to show error in experiment.
  - **Examples from video clip:**
    - Sunlight, amount of water, type of soil, type of plant
- **Control Group:**
  - Experimental setup that does **NOT** receive the variable that is being tested
  - All other groups are compared with the results of this group to see if there is any change to the test subject
  - Often called the "standard for comparison"
  - **Example from video clip:**
    - Dome *without* ozone gas
    - NO ozone gas

goes on the X - Axis

Used to test a

Must have two types of groups

Has 3 types of variables

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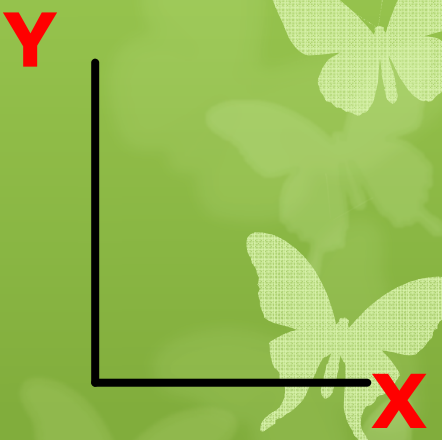
4. Collect Data

- **This section includes all of the data and <u>information</u> collected.**

- **How do you present your data?**
  <u>Diagrams, tables, charts, graph</u>

- **Graphing: Placement of variables on the axis**
  - **Independent Variable goes on the <u>X – Axis</u>**
  - **Dependent Variable goes on the <u>Y- axis</u>**

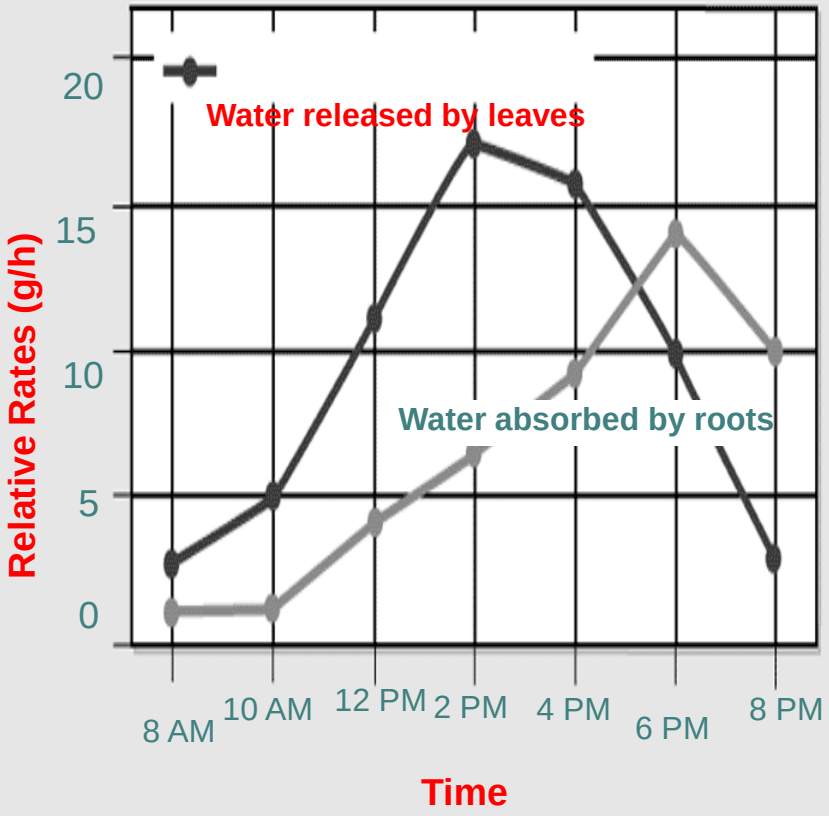


Making a Graph From A Data Table

Section 1-4

Water Released and Absorbed by Tree

Time	Absorbed by Roots (g/h)	Released by Leaves (g/h)
8 AM	1	2
10 AM	1	5
12 PM	4	12
2 PM	6	17
4 PM	9	16
6 PM	14	10
8 PM	10	3



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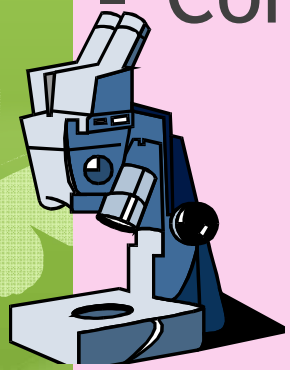
Go to Section:

5. Analyze Results

- After your data is organized you must be able to interpret the data
- Modify the procedure if needed.
- Confirm the results by retesting.

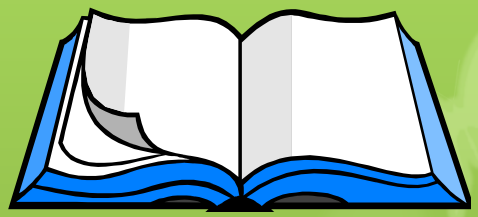


6. Conclusion:

- Outcome
- Was your hypothesis supported?
- Accept or Reject (refute)
- Make recommendations for further study and possible improvements to the procedure.

7. Communicate the Results:

- **Can your experiment be retested and always get same results?**
- Expect questions from the audience….**Peer review**



Scientific Theory:

- **A hypothesis that is so well supported by many different scientific investigations**
- **A well tested explanation that unifies a broad range of observations**
- **Remember: Theories can be revised.**

Figure 1-8 Redi's Experiment on Spontaneous Generation

PROBLEM: How do living things arise?

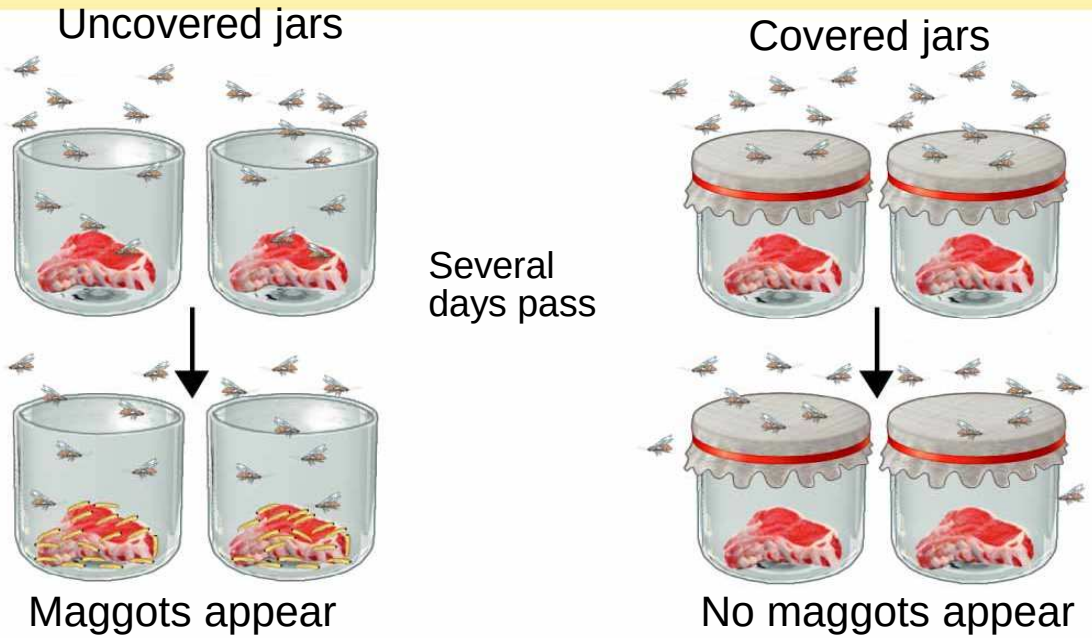
HYPOTHESIS: IF flies are present, THEN maggots will arise.

PROCEDURE

Controlled Variables: jars, type of meat, location, temperature, time

Independent Variables: gauze covering that keeps flies away from meat

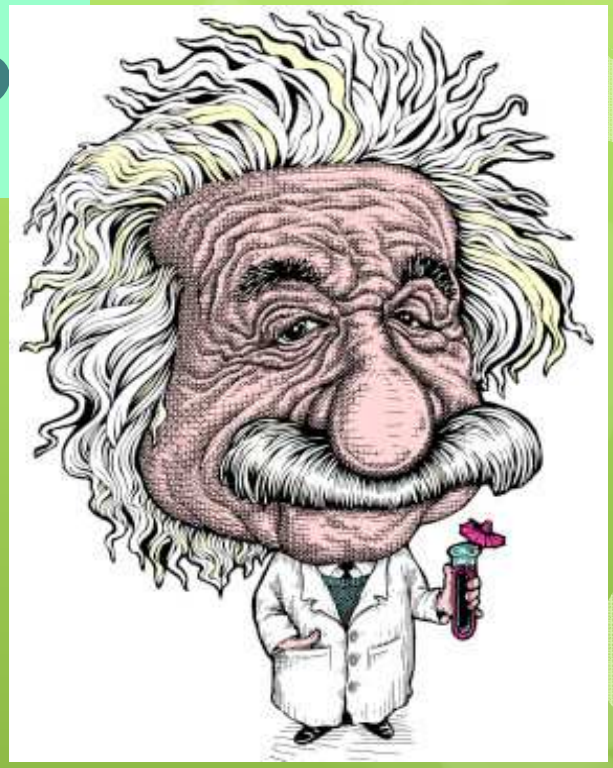
Dependent Variable: whether maggots appear



CONCLUSION: Maggots form only when flies come in contact with meat. Spontaneous generation of maggots did not occur.

PEER EVALUATION: Redi's experiment was tested and accepted by other scientists including Luis Pasteur

Think you can name all steps?



Analyze Data

Design a Controlled Experiment

Collect Data

Form a Hypothesis

Perform Calculations

Draw a Conclusion

State the Problem

IV. Measurement Skills!!! …….Tools for Measurement

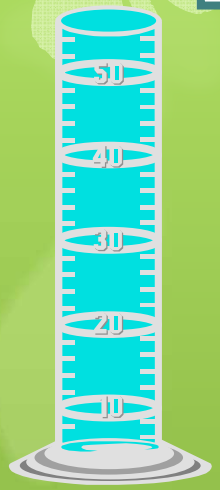
Calibrated…

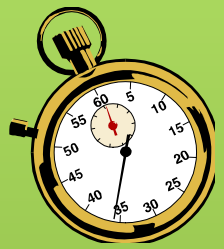
- Synonym for **scaled**
- Think….

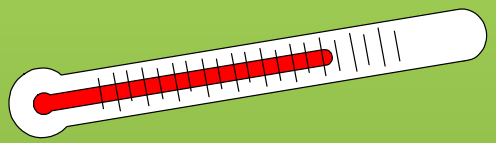
  "What is the unit of measurement?"

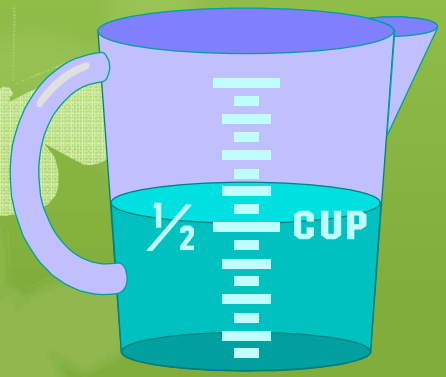
Measurement

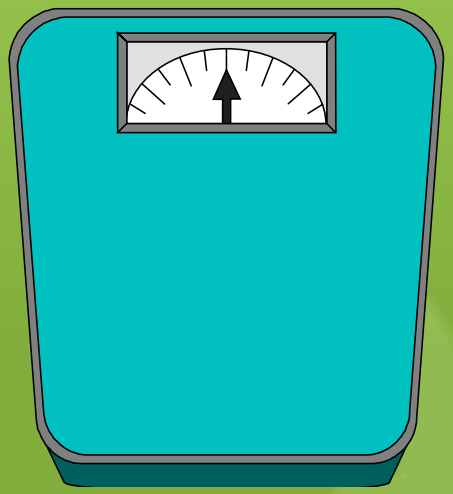
Some Tools for Measurement











Which tool(s) would you use to measure:

A. temperature

B. volume

C. time

D. weight

Measuring Length

- Metric ruler or meter stick
- Units are centimeters (cm) or **millimeters** (mm).
  - 1cm = 10mm
- Micrometers (um) are very tiny units that are used to measure objects through the microscope.
  - 1000um = 1mm

Measuring Volume

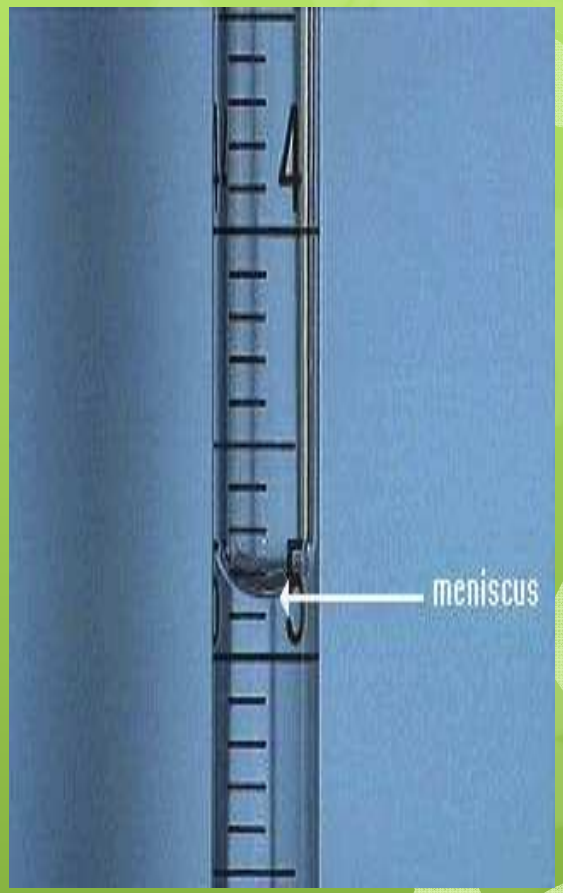
- **Graduated Cylinder**
- The amount of **space** something occupies.
- Graduated Cylinders are calibrated in milliliters (mL) or **liters (L)**

Meniscus

- Curved surface when measuring fluids when placed in the narrow tube of a graduated cylinder.
- Correct steps to read the volume of a liquid.

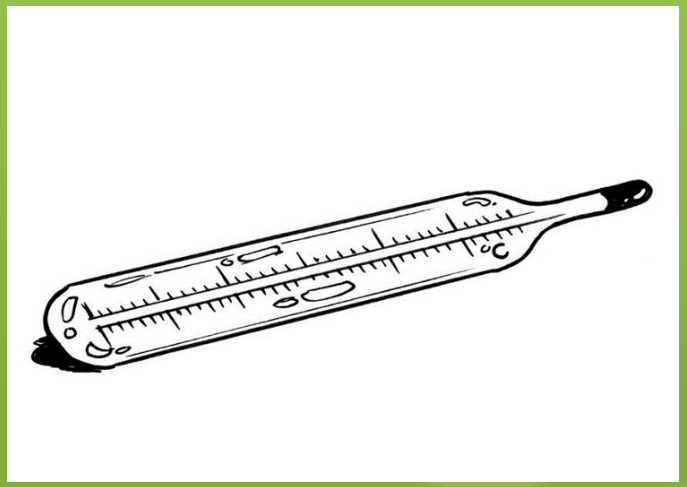
  1. Place the cylinder on a flat surface

  2. Read from the bottom of the curved meniscus at eye level.



Measuring Temperature

- Measured in degrees Celsius.
- Freezing point of water is 0°C.
- Boiling point of water is 100°C.
- Human body temperature is 37°C.



Measuring Mass

- Mass = the quantity of **matter** in something
- Measured with a **balance:** Triple Beam or electronic

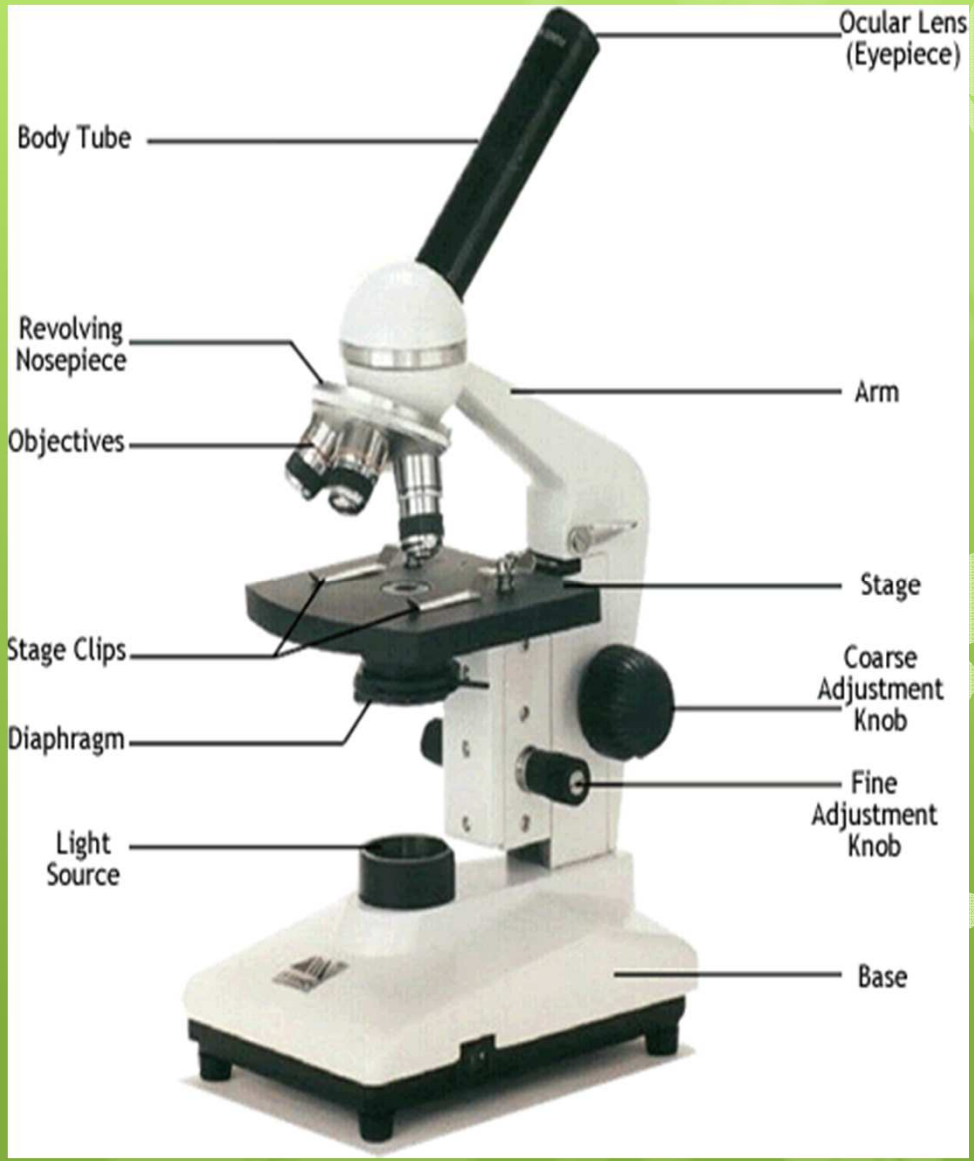
Triple Beam Balance

- Single pan and three bars (beams) that are calibrated in grams.
- Steps to using this balance…

1. Make sure pan is empty
2. Pointer and all riders (devices that move along the beams) are on zero.
3. Calibrate scale
4. Weigh object using the beams until the pointer is at zero.

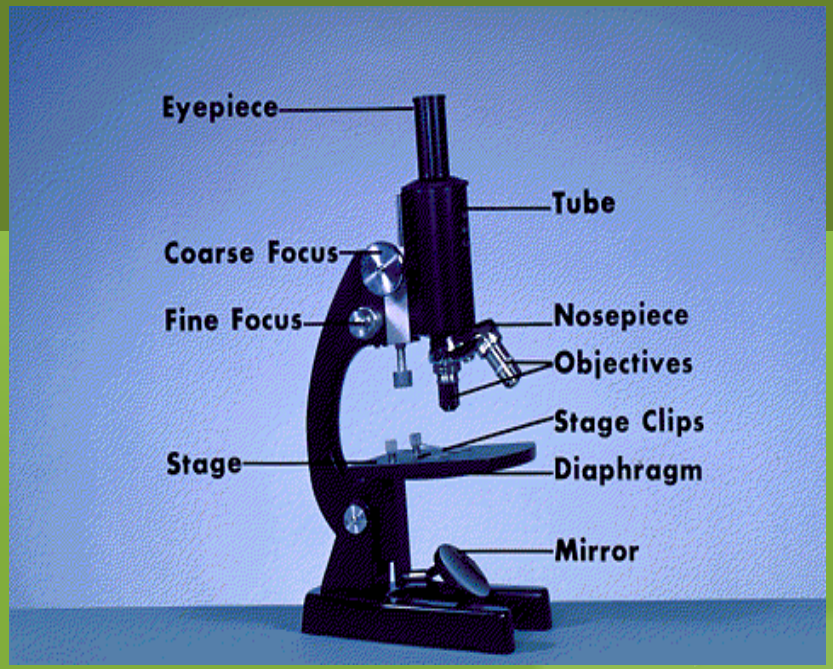
Compound light microscope

- allows light to pass through
- uses two lenses form image
- 1 ocular and light source



Calculating Total Magnification:

Eyepiece Power X Objective Power



Practice

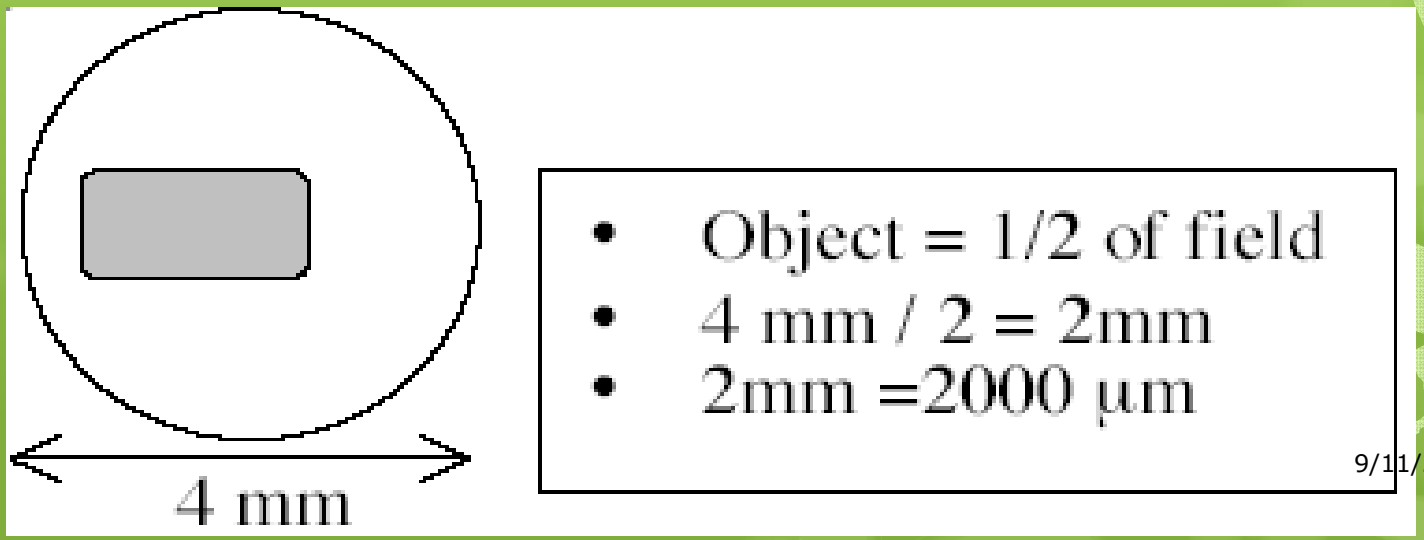
Example: A microscope has a 20 X ocular (eyepiece) and two objectives of 10 X and 43 X respectively.

a) Calculate the low power magnification of this microscope. Show your formula and all work.

b) Calculate the high power magnification of this microscope. Show your formula and all work.

Measuring object in microscope

1. Determine field of view width
2. Estimate how much of the field the object takes up
3. Divide to get length of object
4. <u>1 millimeter = 1000 microns</u>



Measuring length with a Scope

- Micrometers (um) are very tiny units that are used to measure objects through the microscope.
- Remember: 1000um = 1mm
  - mm to um: move decimal 3 places to the right
  - um to mm: move decimal 3 places to the left

Ex. 1 There are lots of kinds of fleas, but all are wingless, bloodsucking parasites. Most are small and have flattened bodies, which helps them to move among the hair of their host. Most have tiny or no eyes and short antennae. Even though they have no wings, the get around pretty well by jumping with their powerful legs

This flea can jump 65 microns at a time. How far (in mm) could the flea go after 10 jumps?

Ex 2. Mosquito!

The mosquito "sucks" blood using a proboscis. This mosquito has a proboscis that measures 1.34 mm.

How large is the proboscis in microns?