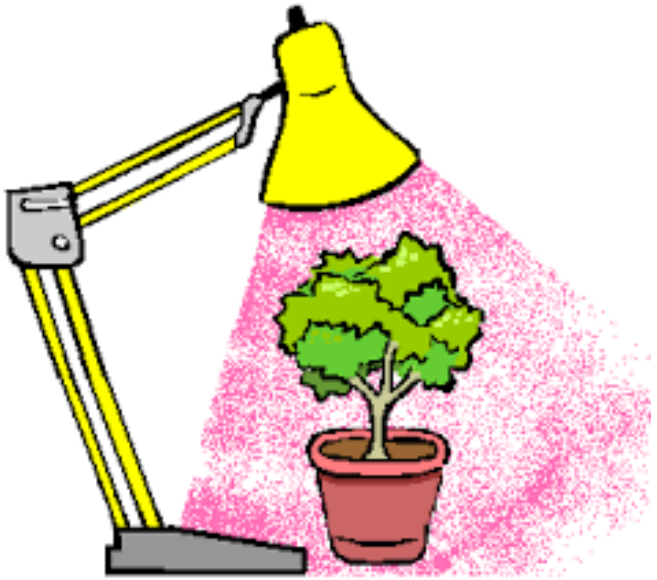
THE SCIENTIFIC PROCESS

Use the following format for all your lab write ups!

1) Start with a problem statement:

- Question based on observation that will be answered in the experiment. You write it in the form of a question

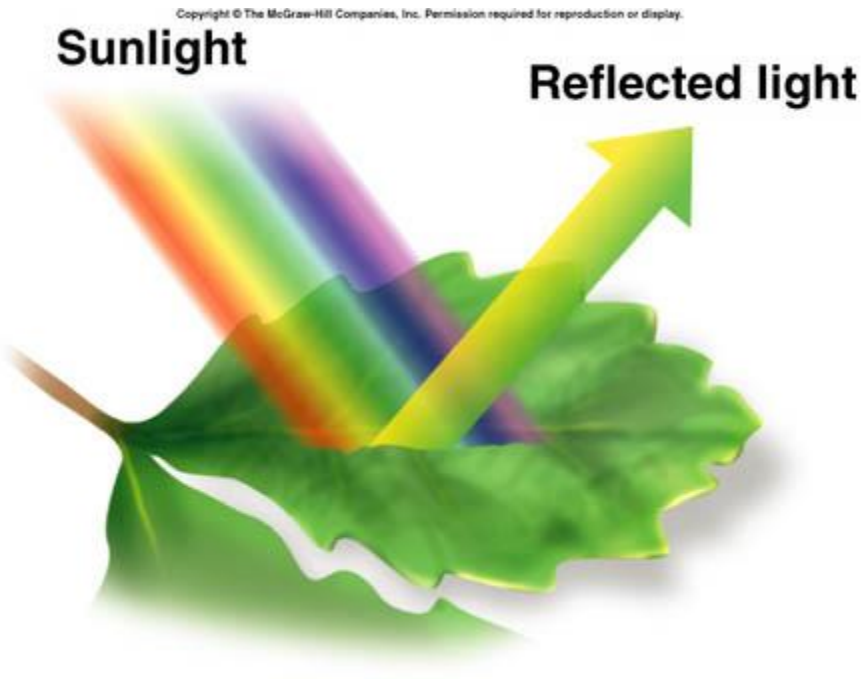
"What is the effect of MV on RV?"



Ex: Does the color of light affect the growth of pumpkin plants?

2) Formulate a Hypothesis:

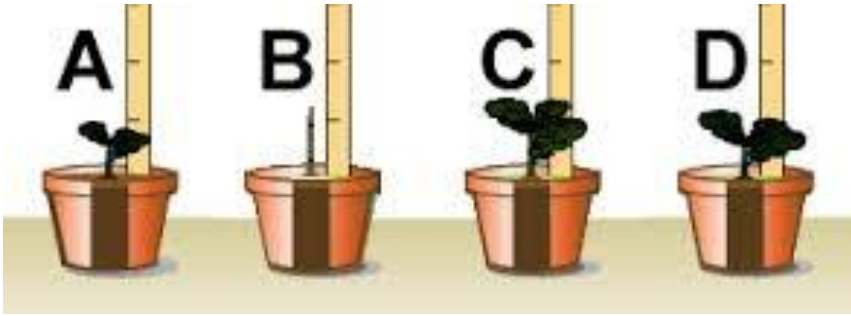
- If (manipulated variable)… then (responding variable)… because (relevant explanation).



Ex: If a pumpkin plant is exposed to green light it will grow less than a pumpkin plant exposed to red light, because leaves reflect green light.

3) Identify the variables:

- **<u>Manipulated (MV)</u>:** The variable that is changed (include units if applicable)



- **<u>Responding (RV)</u>:** The variable that is measured due to the change (include units if applicable)

Ex:

Manipulated: color of light

Responding: growth of plant in mm

Control (fixed) variables: variables that do not change

- At least three **CONTROLLED VARIABLES** are required, but more may be necessary.
- **Materials used and measurement techniques are NOT controlled variables** (they are validity measures). While materials and techniques must be consistent, a true variable is something that could directly influence the responding variable, not just how it is measured.

Ex:

- **Type of plant is kept the same (all pumpkins)**
- **Amount of water the plants are given is kept the same**
- **Size of pot is kept the same for all pumpkins**
- **Amount of soil kept the same for all pumpkins**
- **Time let to grow kept the same for all pumpkins**

4) Identify the Groups:

NEW for you!!

- **Experimental group-** set-up that **has the Manipulated Variable**
- **Control group-** set-up with **no Manipulated Variable**

**How you set up the Groups need to be included in the procedure

Experimental group: pumpkins exposed to different colors of light.

Control group: pumpkins exposed to normal, white light

Why are control groups important?

- Without a control group, we can't be certain that the effects we observe are caused by the manipulated variable.

- A control group serves as a baseline of what should happen normally, in nature without any manipulation.

5) Materials and Apparatus list:

- Bulleted list
- Includes quantities and size
  - Be as specific as possible (example: ‘50 mL beaker’ instead of ‘beaker’).

6) Procedure:

- Include a **DIAGRAM OR PHOTOGRAPH** of how you set up the experiment. Be sure your diagram includes a title and any necessary labels. It is recommended that this be annotated to illustrate how the variables were involved.
  - Diagram includes labels and should be 1/3 to half a page in size.

6) Procedure:

- Steps are Numbered.
- Logical steps to repeat the lab.
  - Explains how to set-up control and experimental groups
  - Include what and when to record data
  - Your procedure must include a few **VALIDITY MEASURES** (i.e. cleaning test tubes prior to use, cleaning the microscope lenses, using the same ruler…). Validity measures are things kept constant to make sure experimental measurements are valid and consistent.
- Indicate trials (repeating the experiment)

6) Procedure:

- You should always have at least 3 levels of manipulation in your experimental group.

For example, with the pumpkin we choose 3 different colors of light for the experimental group.

7) Data Collection:

- Record data accurately and neatly
- Includes both qualitative and quantitative
- Data table must include appropriate units, headings and DESCRIPTIVE title
- Averages included when trails are indicated
- See sample data table

Descriptive title

Manipulated Variable (+ unit of measurement):	Responding Variable (+ unit of measurement):				
	Trials				
Levels of MV	#1	#2	#3		Average of Trials

This table can be made using MS Word, MS Excel or by hand.

Data Tables drawn by hand:

- Use a ruler.
- Neat and legible.
- Make it big enough that I can read it!

8) Data Analysis:

- Process data in a meaningful way
- Look for patterns and trends
- Graph and or mathematical calculations

Graph: See example…..

- Variables listed with units of measurement
- Even increments on both X and Y axis
- Ruler used whenever hand drawn for all straight lines

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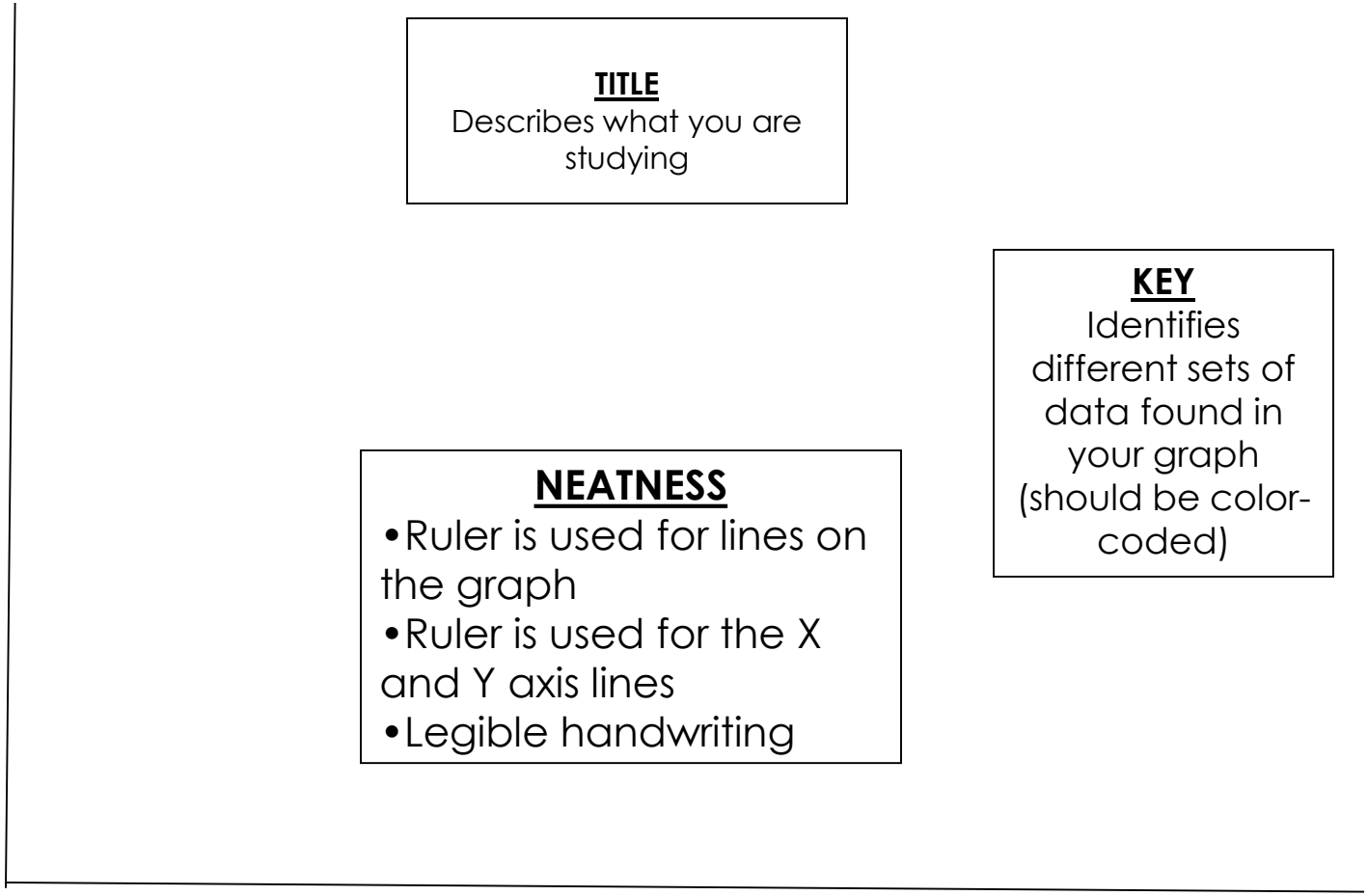
TITLE
Describes what you are studying

KEY
Identifies different sets of data found in your graph (should be color-coded)

Y-AXIS
Responding Variable & Unit of Measurement

NEATNESS
- Ruler is used for lines on the graph
- Ruler is used for the X and Y axis lines
- Legible handwriting



X-AXIS
Manipulated Variable & Unit of Measurement

9) Develop Conclusions:

4 parts

- **State whether your hypothesis is "supported" or "not supported"**

- **Evidence that your hypothesis is supported or not supported…. Use concrete data. Use range of data when available**

- **Errors/improvements (realistic)**

- **Modifications to the procedure**

Reminders:

- NO ABBREVIATIONS
- Include all the parts indicated in the directions
- Metric, metric, metric……