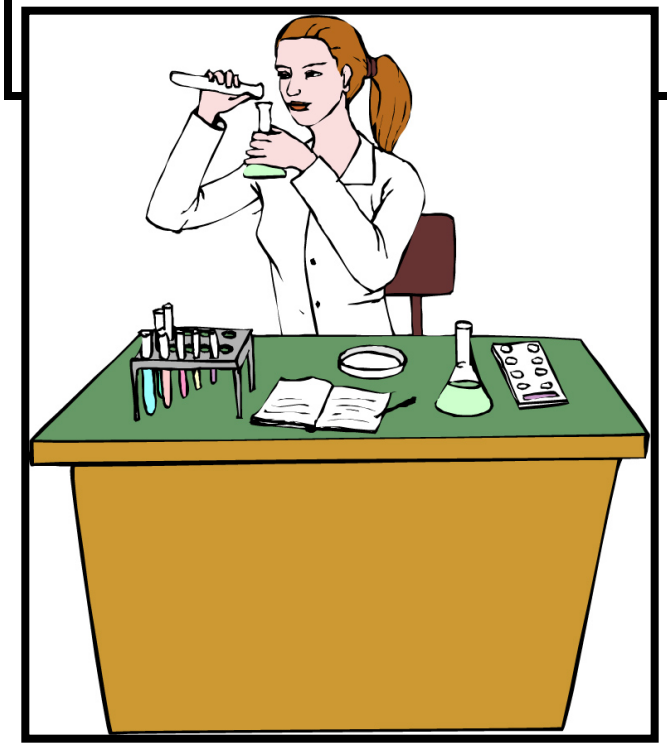
# Scientific Processes/Practices



# Steps to Solving a Problem
## (The Scientific Method)

Identify the Problem

State the problem to be solved or the question to be answered.

Collect Information/Research

Obtain facts and ideas from books, journals, internet, etc. that provide insight regarding your problem/question. Cite these resources.

Form a Hypothesis

Based on the information/research you collect, propose a solution or "best guess" that will help guide your experimentation and attempt to answer the proposed problem/question.

Test Your Hypothesis – "Experiment"

Describe, design, and conduct an experiment that will give you information or data that supports (or not) your hypothesis.

Accept or Reject Your Hypothesis – "Analysis"

Determine whether your data/results from the experiment supports (or not) your hypothesis; if not, it may be necessary to review your information/research and revise your hypothesis.

Report Your Results – "Conclusion"

Formulate a conclusion that answers the original question from step one and share the results with the scientific community (or the community at large).

***Please keep in mind that this is a traditional approach to being scientific and investigating a question or problem does not necessarily require all of these steps, or for them to be performed in a particular order.***

# Observations

- information that are descriptions of qualities such as shape, color, taste, feel, etc…
- acquired by using your senses
- Two Types:
  1. Objective observation
  2. Subjective observation

# 2 Types of Observations

## Objective

- an observation based on fact

fact – a piece of information that can be strictly defined and proved true.

## Subjective

- an observation based on opinion

opinion – a statement that expresses a belief, value, or feeling

# Objective or Subjective?

- Science looks like fun today!

**Subjective**

- Kanye West's songs sound good!

**Subjective**

- The counter-tops in class are black!

**Objective**

- School French fries taste good!

**Subjective**

- The summer was too short!

**Subjective**

- There are sixty seconds in a minute!

**Objective**

# Objective or Subjective?

- Which type of observations should be used in science?

**<u>Objective</u> observations should be used in science because they are based on facts and the basis of science is to identify the facts!**

# Inference

- an explanation that tries to make sense of your observations
- influenced by your experiences/prior knowledge
- these explanations may not be true

**Example**

Observation:

John was breathing heavily as he walked into the classroom.

Possible Inferences:

1. He ran to class because he was going to be late
2. He just played basketball in gym

# What would you infer?

1. Everyone is closing their book because…

2. Many students buy French fries because…

3. Students arrived to class sweaty because…

4. All of the students are laughing because…

# Hypothesis

- a working explanation or trial answer to a problem
- an "educated guess"
- can be written in the form of an "If..., then..., because..." statement
- is not necessarily proven correct just because data/results from one experiment supports it
- when repeatedly supported by the same results → theories → laws

**Example**

**If** an individual increases his/her activity level, **then** their heart rate will increase **because** the body's muscles (cells) will require more oxygen to function at a higher level. A faster beating heart will increase blood flow; thus, allowing an increased concentration of oxygen to reach the cells in need.

# Data

- factual information
- Two Types

1. Quantitative
2. Qualitative

# 2 Types of Data

## Quantitative

- data consisting of numbers

**Example**

Heart rate (80 beats/minute)

## Qualitative

- data consisting of verbal descriptions or information gathered using scales without numbers

**Examples**

Verbal description of heart rate (fast or slow)

# Repeated Trials

- experimental tests done more than once
- necessary to provide more accurate results; data is averaged together
- lessens the impact of a chance error on the experimental results

**Examples**

In the heart rates lab each participant recorded their heart rates after performing various activities. Each participant's data (for resting, walking, and running) represents a trial. If five total individuals performed the activities and gathered data, then there were a total of five trials.

# Variables

- Factors that can be assigned or take on different values in an experiment
- any factor that can change
- Two Types

1. Independent
2. Dependent

# Two Types of Variables

**Independent**

- variables that are purposely changed or manipulated in an experiment
- the factor that you wish to test
- usually expressed after the word "if" in the hypothesis
- could be thought of as the "cause" in a cause and effect relationship

**Example**

The activity level (resting, walking, running)

**Dependent**

- variables that may change as a result of the independent variable
- the factor you measure to gather results
- usually expressed after the word "then" in the hypothesis
- could be thought of as the "effect" in a cause and effect relationship

**Example**

The person's heart rate

# Identify the Variables

1. If a student chooses to not study, then they will earn a poor grade.

independent variable

independent variable

dependent variable

2. If you drink Gatorade before a soccer game, then you will score more goals.

dependent variable

independent variable

3. If you increase the mechanical advantage of a pulley system used to move an object, then the input force becomes less.

dependent variable

# Control or Control Group

- a group of subjects in an experiment that are not given any special treatment
- something that is not manipulated
- same as the experimental group in every possible way, except for the factor being tested
- a neutral point of reference for comparison – it allows you to see what changing a variable does by comparing it to not changing anything.

**Example**

The resting heart rate represented the baseline heart rate to which any increase in activity level was compared to.

# Constants

- Factors in an experiment (both in the experimental and control groups) that are kept the same and not allowed to change

**Examples**

1. One minute was consistently the amount of time allotted to perform the necessary activity
2. The type of activity performed
3. The stopwatch used during data collection
4. The method used to measure the heart rate