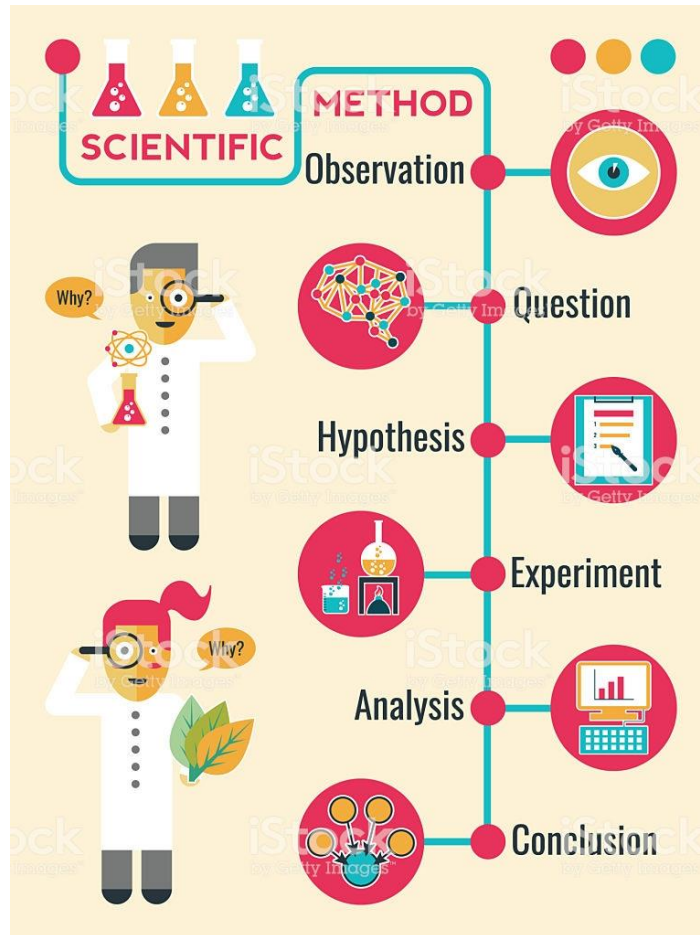




# Lesson 16



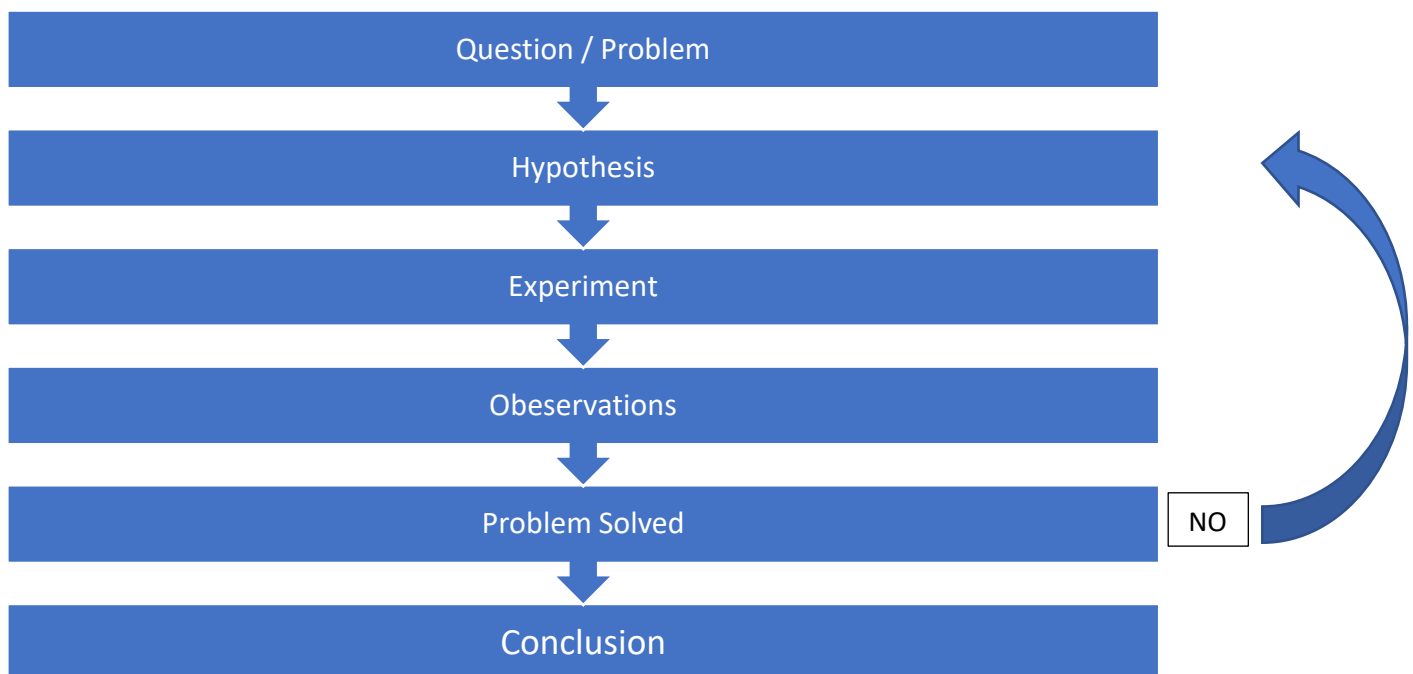
## Scientific Method

## Planning and Investigation

Science is more than knowledge and understanding of the world around us. Scientific investigation is also a way of learning about the world by observing things, asking questions, proposing answers, and testing those answers. Science is also about sharing information that is collected during an investigation.

All scientific investigations use a similar process to find answers to questions. In most cases, this process attempts to find relationships between variables. A variable is any factor that can change in an investigation. Sometimes you can control the variables and other times you cannot.

The following flowchart describes the steps taken in the method of studying Science and solving problems. The flowchart shows the steps of the **Scientific Method**.



### Question / Problem

People, who are curious about the world around them, ask scientific questions. Our experiences and observations of the world may lead us to ask questions that interest us. To be considered scientific, you must be able to test to idea and answer the question.

For example, you probably know that balloons stick to walls if you rub them on your head. This might lead you to wonder about a few things: Does a balloon stick better if you rub it more times? Does it matter how inflated the balloon is or what colour it is?

A scientific question is often about cause-and-effect relationships. These questions are often stated in the form “What will be the effects on ‘one thing’ if we change ‘another thing’”. A proper scientific way of asking the question from our example could be “What will the effect be on the length of time that a balloon sticks to the wall if you change the number of times you rub the balloon on your hair?”

The one variable in the experiment that you intentionally change is called the **independent variable**. For example, the number of times you rub the balloon on your hair is something you can change – you are changing the independent variable. The variable that shows an effect (the length of time that balloon sticks to the wall) is called the **dependent variable** because it “depends” on the independent variable. A scientific question that asks what happens to a dependent variable when you change the independent variable is a question that can be answered through scientific investigation.

### **Hypothesis**

A hypothesis is a possible explanation of why one variable affects another. It is an educated guess based on previous knowledge and experiences. From your past experiences of rubbing balloons on your head and sticking them to the wall may lead you to hypothesize, the more times you rub the balloon on your head the longer it will stick to the wall. This hypothesis is then tested to gather evidence to prove or disprove your educated guess.

### **Experiment**

The experiment consists of a list of materials needed and a procedure. The procedure is a set of detailed steps that describe how you will conduct your experiment. It is important to be able to write an experimental procedure clearly, concisely, and accurately. Anyone who is interested in your experiment should be able to understand how it was performed so that it can be repeated.

## Procedure

When writing a procedure, use numbered steps with only one instruction in each step. For example, the first three, and last, steps of a procedure could look like this:

1. Wear safety goggles, a lab apron, and rubber gloves.
2. Set up the experiment as shown in the diagram
3. Measure the temperature of the water every five minutes.
- .
- .
8. Return materials to the storage cabinet.

Your first step should refer to any safety precautions that must be followed. The last step in your procedure should relate to cleaning up of the area, including any necessary waste disposal.

## Observation

When collecting observational data it is recommended to have a table for recording purposes. Use the following checklist to help you create an effective table:

- Give each table a short title that describes the information it contains
- List the independent variable in the left column.
- List the dependent variable in the right column.
- Be sure to include units of measurement with each variable in the title of each column, but NOT inside the table.

Example:

Observation Chart

| Number of Rubs on the Head | Time (Seconds) |
|----------------------------|----------------|
| 0                          | 0              |
| 1                          | 1              |
| 2                          | 3              |
| 3                          | 6              |

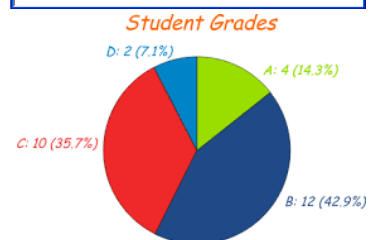
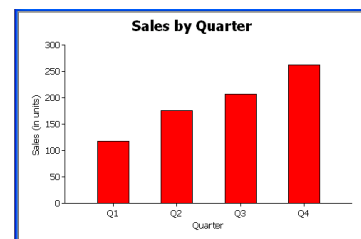
The measurements used in experiments have been limited to seven particular units. The international scientific community of many countries have agreed on a system of measurement called **SI** (système international d'unités). In this system, all physical quantities can be expressed as a combination of seven SI units, called base units. The seven SI base units are listed in the following table.

| Quantity Name       | Unit Name | Unit Symbol |
|---------------------|-----------|-------------|
| Length              | Metre     | m.          |
| Mass                | Kilogram  | Kg          |
| Time                | Second    | S           |
| Electric Current    | Ampere    | A           |
| Temperature         | Kalvin    | K*          |
| Amount of substance | Mole      | Mol         |
| Light Intensity     | Candela   | Cd          |

\*Although the base unit for temperature (T) is kelvin (K), the common temperature (t) unit is degree Celsius (°C)

### Displaying the data

After recording your observations is wise to prepare the information gathered into a graphic display. Graphs make it easier to see patterns and trends in your observations. A graph is an easy way to see whether a relationship or pattern exists between two or more variables. It also allows you to see what the relationship is so it can be accurately described in words or mathematics. Graphs will also help you determine whether the observations support your hypothesis.



### Problem Solved

At this point in the experiment you have analyzed the data collected and have discovered if the original problem has been solved. If the problem has not been solved then the opportunity to view any errors that may have occurred during the investigation and the experiment is retried. If the problem has been solved then the final stage of the Scientific method is completed, the conclusion.

**Conclusion**

A conclusion is a statement that explains the results of an investigation. This statement should refer back to the original hypothesis. It should reveal whether the results support, partially support, or do not support the hypothesis. Don't worry if your hypothesis is not supported – scientists usually need to revise and repeat experiments many times to obtain the solution they are looking for.

**Suggesting Further Experiments**

Work in science does not end with a single experiment. Investigations can be repeated many times. The following guidelines may help you suggest further experiments:

- You may suggest repeating the experiment using:
  - A new or improved design that fixes any flaws that were noted
  - Better equipment to make more precise measurements
  - A revised procedure to collect additional evidence
  - Better skills in using the equipment
- Review the hypothesis and look for new ways to test it or suggest a new hypothesis

## Task

To design and construct a Rotocopter that will take the longest time to fall to the ground from a height of 2 m and that will remain intact for three trials.

## Materials

- Construction paper or poster board
- Pencil
- Ruler
- Paper clips
- Scissors
- Stopwatch or watch with a second hand

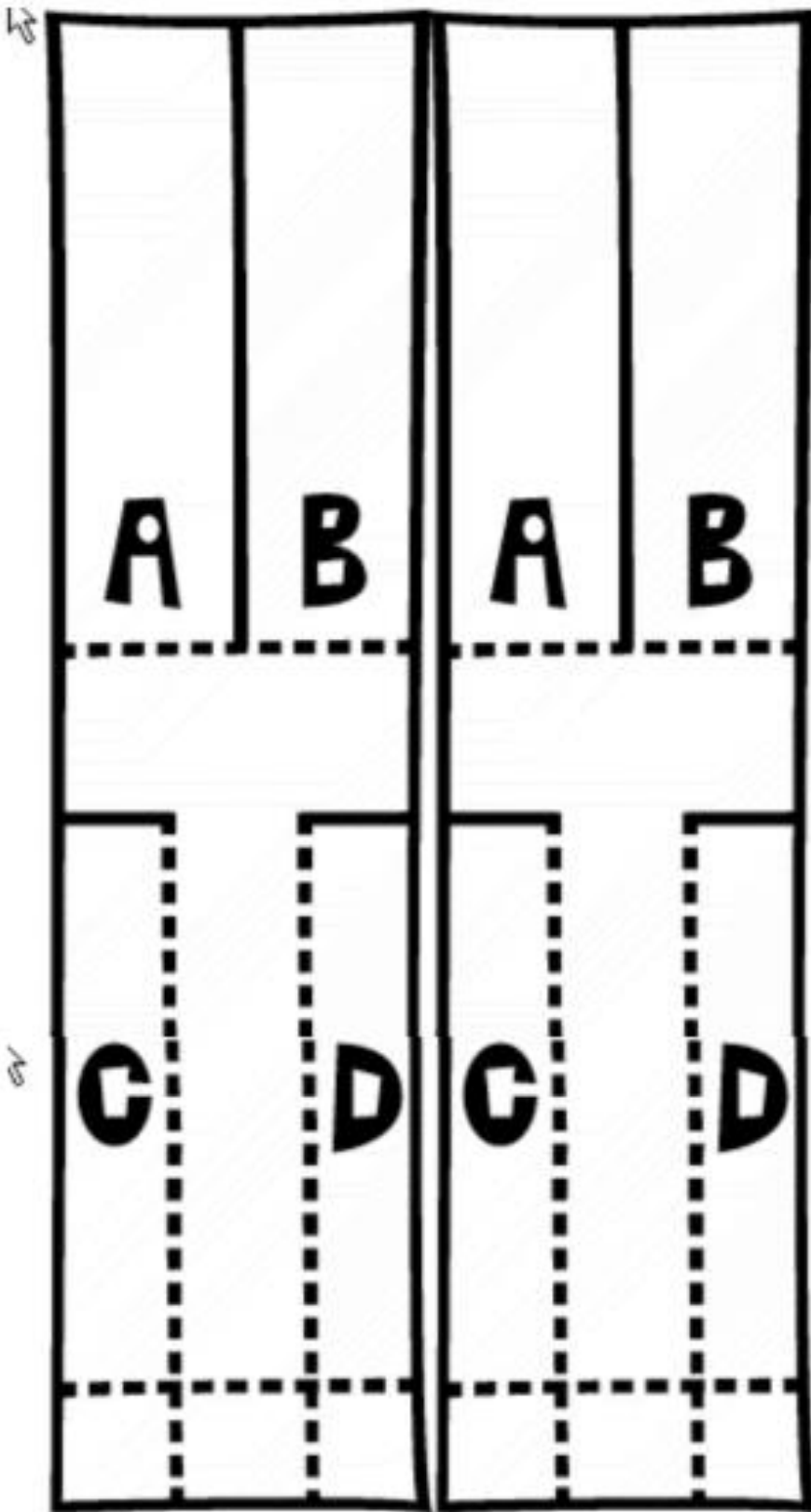
## Design Criteria

- I. Your rotocopter must withstand three drops.
- II. It must be no more than 30 cm long and no more than 10 cm wide.
- III. The stabiliser of your rotocopter must be no more than 30 cm long.
- IV. You must use at least one paper clip.
- V. You must draw a clearly labelled sketch before you begin to construct your rotocopter.

## The directions for making a rotocopter

- Copy the diagram that is on the following page.
- Cut along the vertical solid line between the letters “A” and “B”. Cut along the two short horizontal solid lines above the “C” and “D”.
- Fold along the dotted lines. Fold the “A” portion of the paper in one direction (forward) and fold the “B” in the other direction (backward). These make the blades.
- Fold the C and D portions of the paper in toward one another and put the paper clip here to hold the three folded pieces of paper together. This will make the stem.





**Plan and Construct** – Complete on a separate sheet of paper.

1. Brainstorm as many ideas as you can about how rotocopters behave when they are dropped.
2. Consider three possible designs and make rough sketches of them.
3. Make a detailed sketch of each of the designs. Label the rotor, the stabilizer, and their dimensions (measurements), as well as the position and number of paper clips you will use. (6 marks)
4. Use the materials provided to build your rotocopters' design.

5. a) Each model is allowed three trials.

b) Drop each rotocopter from a height of 2 metres and time how long it takes to reach the ground. Record the results in a table (see the following table). **(18 marks)**

| Dimensions used | Materials Used | Time in trial # 1 | Time in trial # 2 | Time in trial # 3 | Average time |
|-----------------|----------------|-------------------|-------------------|-------------------|--------------|
|                 |                |                   |                   |                   |              |
|                 |                |                   |                   |                   |              |
|                 |                |                   |                   |                   |              |

6. Calculate the average time for each rotocopter to fall to the ground. Which design had the slowest falling time? **(1 mark)**

Average time = time trial #1 + #2 + #2 divided by 3

### **Evaluate**

1. Evaluate your designs. Consider the dimensions and materials of the slowest falling rotocopter. What was the same and what was different between the fastest and slowest models? **(4 marks)**
2. Make a revised model using all the information gathered from the three rotocopters. Test your new rotocopter against the one that fell the most slowly. How does your rotocopter's falling time compare now? **(3 marks)**

# Lesson 17



## Scientific Skills and Tools

## Scientific Skills and Tools

There are many different skills and tools that science uses in investigations that are also utilized in daily life. For example, stopwatches, scales, balances, microscopes, voltmeters and ammeters.

### Using Timing Devices

There are many different timing devices each with its unique features and is suited to different tasks.

A stopwatch is a small handheld device that measures time. It is turned on and off by an observer as an event occurs. Stopwatches are most useful for timing events that take more than a few seconds, and most stopwatches can take only one measurement at a time.



An ultrasonic probe is a new technology in schools. It is a small instrument that sends out an ultrasonic (can't be heard by humans) sound wave and detects the reflection of this wave off a nearby object. The time difference between sending and receiving the sound wave is converted to a distance. The sound waves are sent out many times a second so the probe can calculate the movement of the object. These probes are usually attached to desktop computers or graphing calculators and the object's movement can be shown on a graph.

### Using the Voltmeter and the Ammeter

As we cannot see electrons flowing in electric circuits, we have to rely on instruments that can detect and measure electricity. There are at least two you are likely to use: the voltmeter and the ammeter.



A voltmeter measures the voltage difference between two difference points in a circuit. The voltmeter is always connected in parallel with the component you want to investigate. The ammeter measures the amount of electric current flowing in a circuit.



## Using a Mass Balance

To measure mass you must use some type of balance or scale. Several types of balances are available. Which one you choose will depend on what's available, how heavy the object is, and the accuracy you need. The most common type of balance is the triple beam balance.

However, if you need to measure with high degree of accuracy you may use an electronic balance.



## Using the Microscope

Because cells are small, you must make them appear larger than they really are in order to see and study them. To view cells closely, you can use a compound light microscope. It employs two lenses and a light source to make the object appear larger. The object is magnified by a lens near your eye, the ocular lens (eyepiece), and again by a second lens, the objective lens, which is just above the object. The comparison of the actual size of the object with the size of its image is referred to as magnification.



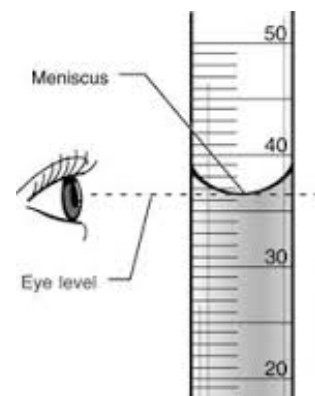
## The Stereo Microscope



The stereo microscope, or dissecting microscope, is used for observing any small three-dimensional object. You can use it when it is not appropriate to look at a sample on a slide, for example, to observe live specimens that are too large to fit under a cover slip.

## Measuring Liquids

When you read a scale on the side of a container with a meniscus, such as a graduated cylinder or volumetric flask, it's important that the measurement accounts for the meniscus. Measure so that the line you are reading is even with the bottom of the meniscus.



# Task

## Measuring Reaction Time (5 Marks)

Log into a computer and open a web browser.

Go to <https://www.humanbenchmark.com/tests/reactiontime>

This website is going to measure your reaction time and compare it to everyone else that has used the site. You will do 5 trials, after that scroll down and see your average time.

1. Write down your average time.
2. What is the average time of others who have done the reaction time test?
3. Were you faster or slower than the average person who took the test?
4. What is this test measuring?
5. What is the unit of measurement in this experiment?

On the ADSB launch page, click on the *Student* tab. Find the *Gizmos* app and launch it. In the top right corner of the screen, click on the *Login/Enroll* link. Type in the code given to you by your teacher.

## Measuring Reaction Time Part 2 (5 Marks)

This can either be done online or it can be done in the classroom with a partner.

*Option 1. Online version:*

In the Gizmos page, click on the *Reaction Time 1 (Graphs and Statistics)* Gizmo. Select either *Catch the Ruler* or *Click the Target (moving)*. Circle the one that you will complete. *Catch the Ruler*      *Click the Target*

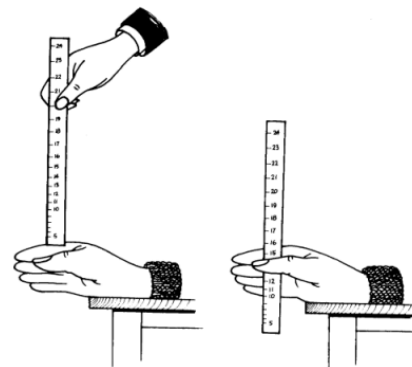
Do at least 5 Trials.

1. What is this experiment measuring, distance or time? Explain how you know. (2)
2. What was your average time or distance? (1)

- Do you think there is anything that you could do to improve your reaction in the experiment? Explain. (2)

*Option 2. Classroom version:*

Find a ruler and someone who can drop a ruler for you. Place your arm and wrist on a desk so that your hand overhangs the edge of the desk as seen in the figure to the right. Hold your hand so that it looks like a LEGO figures hand. Your partner will hold the ruler so that the zero mark on the ruler is at the highest point of your hand. Your partner will unexpectedly drop the ruler and you will need to catch it as fast as you can. Look at the ruler to see how far the ruler dropped and record your score.



| Trial 1 | 2 | 3 | 4 | 5 | Average |
|---------|---|---|---|---|---------|
|         |   |   |   |   |         |

To find the average, add up all 5 trial scores and then divide by 5

- What is this experiment measuring, distance or time? Explain how you know. (2)
- What was your average time or distance? (1)
- Do you think there is anything that you could do to improve your reaction in the experiment? Explain. (2)

**Measuring Mass with a Triple Beam Balance (5 Marks)**

Open a web browser and go to [www.youtube.com](http://www.youtube.com)

Type in “How to use a triple beam balance”. Any of the first few videos will be fine.

After you have viewed the video, open the Gizmo called *Triple Beam Balance*.

Find the Mass of each object.

| Paperclips | Cone | Light Bulb | Cube |
|------------|------|------------|------|
|            |      |            |      |

What is the unit of measurement being used?

**Microscope (5 Marks)**

Open a web browser and go to [www.youtube.com](http://www.youtube.com)

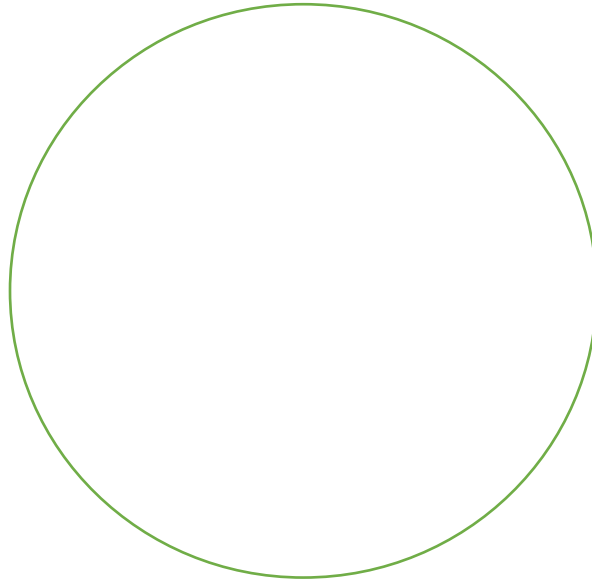
Type in “How to use a microscope”. **BIOLOGY 10 - Basic Microscope Setup and Use** is good one to view but others would work well as well if you cannot find that one.

After you have viewed the video, open the Gizmo called *Cell Types*. We will not be looking at the cell types right now as we are using to learn the basics of microscope use.

1. Pick a sample from the environment, any of them will do and you can do more than one if you want. I like the Protist one. Write down which one you picked.
2. Click on the microscope tab and start to view the specimen. What happens if you try to focus with the fine adjustment knob before getting it into focus with the course adjustment knob first? (1)
3. What happens to the image when you move the stage to the left? (1)
4. What happens to the image when you move the stage up? (1)



5. Put the microscope on the highest power (400x) and center one of the cells in the field of view. Draw the cell and label the organelles that are visible. To identify the organelles, click the box that says *Show Labels*. (2)



### Microscopes (3 Marks)

Research the different types of microscopes and fill in the provided chart.

|  | Dissecting<br>Microscope | Compound<br>Microscope | Electron<br>Microscope |
|--|--------------------------|------------------------|------------------------|
| Maximum<br>Magnification                                     |                          |                        |                        |
| When would you<br>need to use this<br>type of<br>microscope? |                          |                        |                        |
| Cost \$  |                          |                        |                        |



# Lesson 18



## The Fair Test

## The Fair Test

Scientists use an experiment to search for **cause and effect** relationships in nature. In other words, they design an experiment so that changes to one item cause something else to vary in a predictable way.

These changing quantities are called **variables**. A variable is any factor, trait, or condition that can exist in differing amounts or types. An experiment usually has three kinds of variables: independent, dependent, and controlled.

The **independent variable (manipulated Variable)** is the one that is changed by the scientist. To insure a fair test, a good experiment has only one independent variable. As the scientist changes the independent variable, he or she observes what happens.

The scientist focuses his or her observations on the **dependent variable (responding variable)**, to see how it responds to the change made to the independent variable. The new value of the dependent variable is caused by and depends on the value of the independent variable.

For example, if you open a faucet (the independent variable), the quantity of water flowing (dependent variable) changes in response you observe that the water flow increases. The number of dependent variables in an experiment varies, but there is often more than one.

Experiments also have controlled variables.

**Controlled variables** - are quantities that a scientist wants to remain constant and must observe them as carefully as the dependent variables.

**Example:** If we want to measure how much water flow increases when we open a faucet, it is important to make sure that the water pressure (the controlled variable) is held constant.

- Water pressure and the size of opening both affect the amount of water flow.
- If both are changed at the same time, we cannot be sure if it was due to water pressure or the amount the tap was opened.
  - This would not be a fair test

- Most experiments have more than one controlled variable.
  - Sometimes controlled variables are called **constant variables**.

In a good experiment, the scientist must be able to **measure** the values for each variable.

- Weight or mass is an example of a variable that is very easy to measure.
- However, imagine trying to do an experiment where one of the variables is love. There is no such thing as a "love-meter." You might have a belief that someone is in love, but you cannot really be sure, and you would probably have friends that don't agree with you. So, love is not measurable in a scientific sense; therefore, it would be a poor variable to use in an experiment.

### Examples of Variables

| Question   | Independent Variable<br>(What I change)               | Dependent Variables<br>(What I observe)                | Controlled Variables<br>(What I keep the same)  |
|--|---|--|---|
| How much water flows through a faucet at different openings? | -Water faucet opening (closed, half open, fully open) | -Amount of water flowing measured in litres per minute | <ul style="list-style-type: none"> <li>• The Faucet</li> <li>• Water pressure, or how much the water is "pushing"</li> </ul> To insure a fair test I want to keep the water pressure and the faucet the same for each faucet opening that I test. |

### Time as an Example of an Independent Variable

In some experiments, time is what causes the dependent variable to change. The scientist simply starts the process, then observes and records data at regular intervals.

| <b>Question</b>              | <b>Independent Variable<br/>(What I change)</b> | <b>Dependent Variables<br/>(What I observe)</b>   | <b>Controlled Variables<br/>(What I keep the same)</b>  |
|------------------------------|---|---|---|
| How fast does a candle burn? | Time measured in minutes                        | Height of candle measured in centimetres at regular intervals of time (for example, every five minutes) | <ul style="list-style-type: none"> <li>• Use same type of candle for every test</li> <li>• Wind--make sure there is none</li> </ul> |

For the following experiment, decide which statement is/are the independent variable, dependent variable, control variables, and the question. Place Number in the correct spots in the table below.

|  |  |
|--|--|
| <ol style="list-style-type: none"> <li>1. Does fertilizer make a plant grow bigger?</li> <li>2. Make measurements of growth for each plant at the same time</li> <li>3. Same type of plant in each pot</li> <li>4. Same size pot for each plant</li> </ol> | <ol style="list-style-type: none"> <li>5. Amount of fertilizer measured in grams</li> <li>6. Growth of the plant measured by its height</li> <li>7. Growth of the plant measured by the number of leaves</li> <li>8. Same amount of water and light</li> </ol> |
|--|--|

| <b>Question</b> | <b>Independent Variable<br/>(What I change)</b> | <b>Dependent Variables<br/>(What I observe)</b> | <b>Controlled Variables<br/>(What I keep the same)</b> |
|-----------------|---|---|--|
|                 |   |   |  |

## Investigation Steps

### Planning

- What is it you are trying to find out? What could you change?
- The things, which could change, are called variables.
- Choosing what you will change, what you measure and what you keep the same.
- Deciding how you will carry out the investigation.

### Making a Prediction/Hypothesis

- Asking questions: Will changing this variable (independent variable) make a difference to the other (dependent) variable?

### Collecting Evidence

- Carrying out the experiment
- Noting, carefully, what happens.

### Recording and presenting

- Making up a table of the results
- Drawing a graph of these results.

### Interpreting and evaluating

- Are there any trends in the results?
- Do the results tell you anything?
- Was your prediction correct?
- What can you conclude from this investigation?

## Example of an outline of an investigation

How do the number of layers of cloth affect the heat loss from a container?

### Planning the experiment

Deciding on key variables

- What will change? Number of layers
- What will you measure? Temperature after 20 minutes

### Make a Prediction/hypothesis

When I increase the Number of layers I think the Temperature after 20 minutes will be greater in the container with the most layers of insulation.

### Carrying out the experiment

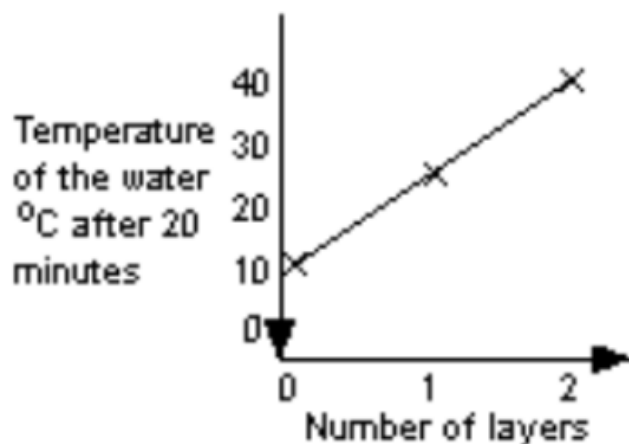
3 identical containers each with 20 ml of hot water at 50°C and a thermometer in each with 0 layers, 1 layer, and 2 layers.

### Recording and Presenting

Make a table of results.

| Number of Layers | Temperature of water after 20 min (°C) |
|------------------|--|
| 0                | 10                                     |
| 1                | 25                                     |
| 2                | 40                                     |

Draw a Graph of the Results



### Interpreting and Evaluating

Finding a pattern in the results:

- When I increase the **Number of layers** the **Temperature after 20 minutes** stays at a higher temperature in the container with the most layers of insulation.

### Conclusion

The more layers of insulation, the less heat energy is lost.



## Task

### The Bouncy Ball Experiment

Using the information given in this lesson, you will make a bouncy ball and compare it to another ball. Use the instructions from sciencebob.com to make the bouncy ball for your experiment. (Attached)

An example of how you can collect data from dropping a ball is seen below.

Rebounds can be compared if the balls are dropped from the same height onto the same surface.

1. Place a meter stick against the wall.
2. Hold the ball so that the bottom of the ball is at the 2 meter mark on the meter stick.
3. Drop the ball and have your partner record what height the bottom of the ball reaches.
4. The **rebound ratio** can be calculated by dividing the rebound height by the height that the ball was dropped.
5. Test a ball at least three times and then take an average of the three rebounds.

A basketball was dropped 200 cm to a wooden floor.

**Rebounds:** Trial 1: 113 cm      Trial 2: 115 cm      Trial 3: 114 cm

**Total of Rebounds:** 113 cm + 115 cm + 114 cm = 342 cm

**Average Rebound** =  $342 \div 3 = 114$  cm

Once you know the average rebound, you can compare how balls bounce by using a ratio.

**Rebound Ratio** =  $114 \text{ cm} \div 200 \text{ cm} = 0.57$

Use the headings from the outline to keep your investigation neat and in order.  
 Planning and materials needed (4 marks)

Making a Prediction/Hypothesis (1 mark)

Collecting Evidence – Make a Table to collect data

Step-by-step procedure (4 marks)

Recording and presenting (9 marks)

Interpreting and evaluating (4 marks)

Explain why your experiment is a fair test of the variables. Give an example of an 'unfair test' for your experiment and why it would be considered unfair. (4 marks)

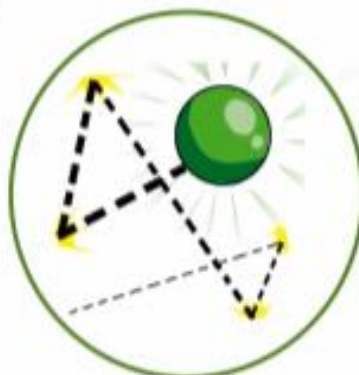
## EXPERIMENT WHILE MAKING A BOUNCY BALL!

### YOU WILL NEED:

- Borax (found in laundry section)
- warm water
- corn starch
- glue (clear glue makes a see transparent ball and white glue makes an opaque ball)
- 2 small mixing cups
- a stirring stick (plastic spoon)
- food coloring (optional)

### WHAT TO DO

1. Label one cup 'Borax Solution' and the other cup 'Ball Mixture'.
2. Pour 4 ounces (120ml) of warm water into the cup labeled 'Borax Solution' and 1 teaspoon of the borax powder into the cup. Stir the mixture to dissolve the borax.
3. Pour 1 tablespoon of glue into the cup labeled 'Ball Mixture'. Add 3-4 drops of food coloring, if desired.
4. Add 1/2 teaspoon of the borax solution you just made and 1 tablespoon of cornstarch to the glue. Do not stir.
5. Allow the ingredients to interact on their own for 10-15 seconds and then stir them together to fully mix.
6. Once the mixture becomes impossible to stir, take it out of the cup and start molding the ball with your hands. The ball will start out sticky and messy, but will solidify as you knead it. Once the ball is less sticky, continue rolling between your hands until it is smooth and round!



### HOW DOES IT WORK?

This activity demonstrates an interesting chemical reaction, primarily between the borax and the glue. The borax acts as a "cross-linker" to the polymer molecules in the glue – basically it creates chains of molecules that stay together when you pick them up. The cornstarch helps to bind the molecules together so that they hold their shape better.

### MAKE IT AN EXPERIMENT:

You can turn this activity into a true experiment by adjusting the amount of borax, glue, and cornstarch to get the highest bounce. You can also experiment to discover the best way to get the bouncy ball to keep its bounce over time. Have fun!

# Lesson 19



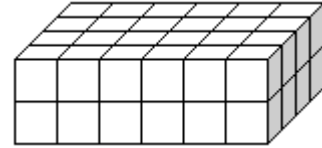
## Volume and Density

## Calculating Volume in everyday life

### Science in Everyday life part 1

#### Volume

- Volume measures how much space an object occupies.
- Volume is measured in cubic units.



#### Calculating Volume

How many cubes are in this rectangular prism (cuboid)?

We can count the cubes although it is quicker to take the length, width, and height and use multiplication. The rectangular prism above has a volume of 48 cubic units.

The volume of a rectangular prism is = length x width x height

Example 1:

What is the volume of a block with the dimensions: Length 3 cm, Width 3cm and height 2cm?

Volume = length x width x height

Volume = 3 cm x 2 cm x 2 cm

Volume = 12 cm<sup>3</sup>

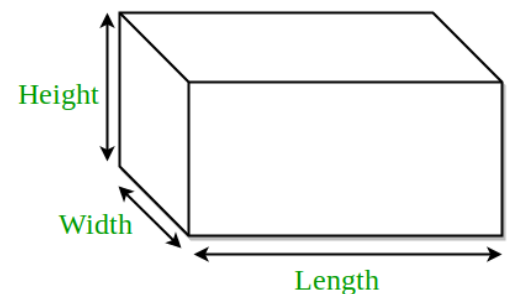
Example 2:

Find the volume of the shape shown to the right.

Volume = length x width x height

Volume = \_\_\_ cm x \_\_\_ cm x \_\_\_ cm

Volume = \_\_\_\_\_ cm<sup>3</sup>



But how can we find the volume if the shape is odd? Example: A Watch

We can sink the object in water; the volume of water displaced will equal the amount of volume that the object contains.

The easiest way to measure the amount of volume is by using an overflow cup. Water is filled up to the point that water starts to pour out of the cup into a graduated cylinder or beaker. Empty any water that pours out before placing the object in the cup.

- The object to be measured is then placed in the overflow cup; the water that overflows is measured. This allows us to calculate the volume of the object.

This works because  $1 \text{ mL of water} = 1 \text{ cm}^3$

This also works in reverse. A soft drink with 591 mL is then equal to  $591 \text{ cm}^3$  of volume.

### Calculating Volume with Water – Lab (10 Marks)

#### Purpose:

To use everyday items to calculate the volume of odd shaped objects.

#### Question:

How accurate is water displacement as a means of calculating volume?

#### Materials:

|              |                    |        |
|--------------|--------------------|--------|
| Overflow cup | Graduated cylinder | Beaker |
| Water        | Solid Objects      | Ruler  |

#### Procedure:

1. Obtain a Solid metal cube from Mr. Hoover and measure each side. **(2)**  
 Length = \_\_\_\_\_, Width = \_\_\_\_\_, Height = \_\_\_\_\_  
 Find the volume Length x width x height (use a calculator if you need to)  
 Volume = \_\_\_\_\_ x \_\_\_\_\_ x \_\_\_\_\_ =
2. Fill up the overflow cup with water until the water starts to pour out into the beaker. Empty the beaker. Slowly lower the cube into the overflow cup making sure that your fingers do not enter the water.
  - a. Pour the water into a graduated cylinder. Remember  $1 \text{ mL} = 1 \text{ cm}^3$
  - b. What is the volume? \_\_\_\_\_ **(1)**
3. Are the two volumes the same? **(1)**

4. Should they be the same? **(1)**
  
5. Obtain a piece of clay. Shape the clay into any odd shape that you can think of. When you are done creating the shape find the volume.
6. Volume of clay shape? \_\_\_\_\_ **(1)**
7. Refill the overflow cup
8. Reshape the clay, this time make it into another shape. Make sure you use all of the clay that you did last time and do not add any more.
9. Place the clay in the overflow cup and measure the volume.
10. Volume of clay shape 2? \_\_\_\_\_ **(1)**
11. Do the clay shapes have the same or different volume? \_\_\_\_\_ **(1)**
12. Should they be the same? \_\_\_\_\_ **(1)**
13. Explain why they should have the same volume. **(1)**
  
14. Clean up all your work area, wash all lab equipment and place it on the drying rack.

**Calculating Mass and Density in everyday life**  
**Science in Everyday life part 2**

**Mass**

- Mass is the amount of matter in a object

**Calculating Mass**

- Mass can be calculated by 2 methods in this classroom.

I. Balance or scale

II. Archimedes principle



## ARCHIMEDES PRINCIPLE

Archimedes was a Greek mathematician who said that

“The buoyant force on an object immersed in a fluid is equal to the weight of the fluid that the object displaces.”

- This means that if an object has a density that is less than water, it will float. If it is greater it will sink.

### But what is density?

Density is the amount of mass that a substance has in a specific amount of volume.

Density is equal to mass  
divided by volume

- If we know 2 out of the 3 variables, then we can calculate the unknown third one.

$$D_{(g/mL)} = \frac{M(g)}{V(mL)}$$

### Calculating Mass

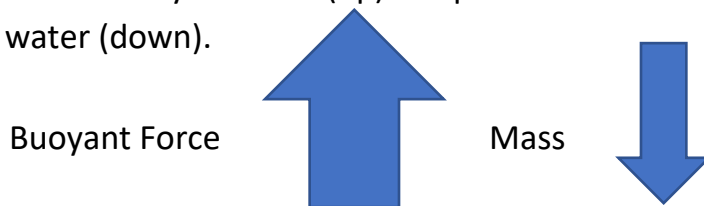
This means that we can calculate the mass of something by seeing how much water (volume) it displaces if it floats.

Since we know that the density of water is 1 g /mL we know that if we displace 1 mL of water the object floating must weigh 1 g.

- In order for something to float, the density of the object must be less than that of water.

### SINKING OR FLOATING?

An object **Floats** when the buoyant force (up) is equal to the force that the object's mass exerts on the water (down).



An object **Sinks** if the mass (down) has a greater force than the buoyant force (up).



### Making a Clay Boat – Lab (20 Marks)

This activity will investigate how we can determine the density of an object and its mass by looking at the displacement of water. It will also allow us to predict if an object will float or not.

As we have learned, buoyancy is the upward force exerted by a fluid onto an object, and according to Archimedes' principle, it is equal to the mass of water the object displaces. We will explore these two principles through the following activity, in which we will observe one object that sinks and one that floats and compare the amount of water displaced by each.

#### Hypothesis:

Make an educated guess whether you think a boat made of clay will sink or float.

#### Materials:

- A ball of clay - Graduated cylinder - Scale / balance
- Beakers – One - Overflow cup

#### Procedure:

1. Fill in the **Hypothesis** section at the top of this page.
2. Using a balance find the **Mass of Clay** \_\_\_\_\_
3. Fill the overflow cup with water.
4. Roll your clay into a ball.
5. Place the ball of clay slowly and carefully the overflow cup of water. Measure the volume of water displaced in the graduated cylinder.

**Volume of Clay** \_\_\_\_\_

6. Find the density of the clay.

$$M = \underline{\hspace{2cm}} \quad D_{(g/mL)} = \frac{M (g)}{V (mL)} \quad D = \frac{\underline{\hspace{2cm}} g}{\underline{\hspace{2cm}} mL} = \underline{\hspace{2cm}} g/mL$$

Water has a density of 1 g/mL

7. Is the density of clay greater or less than the density of water?
  8. Does this make sense that it sinks when looking at its density?
  9. Based on what you know about Archimedes principle and density, if we had a block of clay that had a density of 0.8 g/mL, would it sink or float. How do you know?
  10. Shape the piece of clay into a bowl shape; try to make the walls as thin as possible with no leaks. It is better to make a wider bowl than a deep one, but remember that it still needs to fit in the overflow cup. Run a few tests first to make sure that your boat will float before continuing on.
  11. Fill the overflow cup and place the clay bowl in it very gently.
  12. Measure the volume of water displaced by the boat.  
\_\_\_\_\_ mL
- If the boat floats**, this number should allow us to calculate the mass of the boat.
- 1 cm<sup>3</sup> of water = 1 mL of water = 1 gram of water.**
13. If 1 mL of water = 1 g of water. What is the mass of the clay boat?  
\_\_\_\_\_ g
  14. Has the mass of the clay changed from your original measurement taken with the balance?
  15. Based on your answer above, does that make sense? Explain.

The density of the clay has not changed. If we sink it, it will have the same volume as it did when it was a ball. We have changed the buoyancy force by changing the shape of the clay. This is what causes it to float.

## Archimedes Lab - Rubric

|  | Level 1   | Level 2  | Level 3  | Level 4  |
|--|---|--|--|--|
| <b>Knowledge and Understanding</b>   |   |  |  |  |
| <b>Understanding of content</b><br>Question<br>Hypothesis (if applicable)                                      | Student demonstrates limited understanding of content.  | Student demonstrates some understanding of content.  | Student demonstrates considerable understanding of content.  | Student demonstrates thorough understanding of content.  |
| <b>Thinking and Investigation</b>  |   |  |  |  |
| <b>Use of critical/creative thinking processes, skills, and strategies</b><br>Analyzing and Interpreting       | Student uses critical/creative thinking processes, skills, and strategies with limited effectiveness.           | Student uses critical/creative thinking processes, skills, and strategies with some effectiveness.           | Student uses critical/creative thinking processes, skills, and strategies with considerable effectiveness.           | Student uses critical/creative thinking processes, skills, and strategies with a high degree of effectiveness.           |
| <b>Communication</b>   |   |  |  |  |
| <b>Expression and organization of ideas and information in oral, visual, and/or written forms</b>              | Student expresses and organizes ideas and information with limited effectiveness.                               | Student expresses and organizes ideas and information with some effectiveness.                               | Student expresses and organizes ideas and information with considerable effectiveness.                               | Student expresses and organizes ideas and information with a high degree of effectiveness.                               |
| <b>Use of conventions, vocabulary, and terminology of the discipline in oral, visual, and/or written forms</b> | Student uses conventions, vocabulary, and terminology of the discipline with limited effectiveness.             | Student uses conventions, vocabulary, and terminology of the discipline with some effectiveness.             | Student uses conventions, vocabulary, and terminology of the discipline with considerable effectiveness.             | Student uses conventions, vocabulary, and terminology of the discipline with a high degree of effectiveness.             |
| <b>Application</b>   |   |  |  |  |
| <b>Application of knowledge and skills in familiar contexts</b><br>Procedure<br>Skill Builder                  | Student applies knowledge and skills in familiar contexts with limited effectiveness.                           | Student applies knowledge and skills in familiar contexts with some effectiveness.                           | Student applies knowledge and skills in familiar contexts with considerable effectiveness.                           | Student applies knowledge and skills in familiar contexts with a high degree of effectiveness.                           |
| <b>Transfer of knowledge and skills to unfamiliar contexts</b><br>Procedure<br>Skill Builder                   | Student transfers knowledge and skills to unfamiliar contexts with limited effectiveness.                       | Student transfers knowledge and skills to unfamiliar contexts with some effectiveness.                       | Student transfers knowledge and skills to unfamiliar contexts with considerable effectiveness.                       | Student transfers knowledge and skills to unfamiliar contexts with a high degree of effectiveness.                       |
| <b>Making connections between science, technology, society, and the environment</b>                            | Student makes connections between science, technology, society, and the environment with limited effectiveness. | Student makes connections between science, technology, society, and the environment with some effectiveness. | Student makes connections between science, technology, society, and the environment with considerable effectiveness. | Student makes connections between science, technology, society, and the environment with a high degree of effectiveness. |

# Lesson 20



## Workplace Case Studies

**Case Study #1**

Bill the manager at a local fast food restaurant has been informed of a customer that has become sick from the food eaten in their restaurant. The manager explains to the customer that the situation will be taken very seriously and will investigate how this could have happened.

The manager considered the problem.

- Contamination of food products in the process of making the meals sold.

The manager went through the procedures used by the employees. He considered a few possible reasons for the contamination. He then monitored his employees who were following the procedures and made observation notes on the process. He gathered the data over a few days and recorded them into a chart. He then analysed the data. From the analysis he implemented new more strict procedures for his employees. Some of the new procedures included, the employees wearing latex gloves; washing all work surfaces more frequently throughout each work shift; and designated work spaces for certain types of foods.

The manager kept monitoring the procedures he had recently implemented and made observations notes on a daily basis. This continued observation process will help to maintain the integrity of the work place and the products that are being sold to the customer.

**Case Study #2**

Charlene is a clothing store merchandiser. She is trying to decide the best ways to display the clothes in the store to increase sales. She states the problem; do the mannequins in the storefront windows showcase the clothing to entice customers to come into the store and purchase the merchandise?

Charlene surveys random customers throughout a span of two weeks. She asks these customers the same set of questions regarding the mannequins in the storefront window. Charlene also asks the customers what other aspects of the store that grabbed their attention.

She takes the data collected over the allotted amount of time and creates a graph. From the graph she is able to see if the mannequins are one of the main reasons why customers come into the store to purchase clothing.

After the survey is complete and the data analysed Charlene uses the information gathered and implements them into the merchandising of the store. She then monitors the sales of the clothing she has arranged from the information gained from the survey. The quantitative observations will assess if the information gathered from the survey was valuable.

If changes to the store are successful Charlene then can use the new information to sell all the clothing in such a manner.

### **Task**

Make up a realistic workplace situation where a problem has occurred, and a solution needs to be found to fix it. (16 marks)

1. State the workplace situation. (1)
2. Explain the problem. (2)
3. Discuss the process by which the problem is being monitored. (2)
4. Explain the process of gathering the evidence. (2)
5. Display the evidence in an appropriate format. (3)
6. State the conclusion the data showed. (2)
7. Illustrate ways in which the problem can be solved.(3)
8. Describe the procedures that are going to be used to monitor the new processes. (3)