# Planning an Investigation

Unit 1 Lesson 7

## Learning Objectives:

Plan an investigation which includes:

- A hypothesis
- Identification of the three types of variables.
- A logical step-by-step method for an investigation.

## Key Vocabulary:

Controlled variable, Dependent variable, Hypothesis, Independent variable, Method, Scientific investigation, Testable range, Trials, Variable

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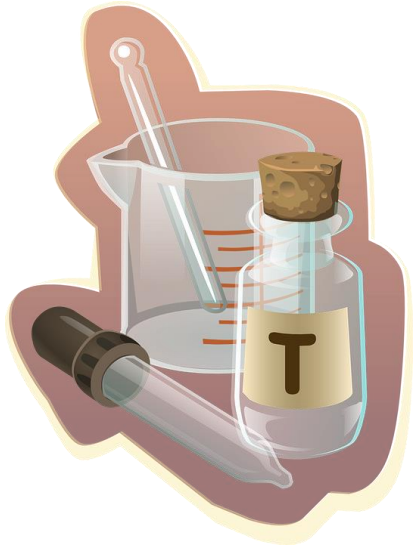
**What is a Scientific investigation?**

- A scientific investigation is the process used to plan and carry out a reliable scientific experiment and find an answer to a question.
- Scientific investigations have three distinct phases:
  1. Planning
  2. Conducting the experiment/ data collection
  3. Reporting or writing up the findings of the experiment.

***Planning***




***Experimentation***

***Reporting***

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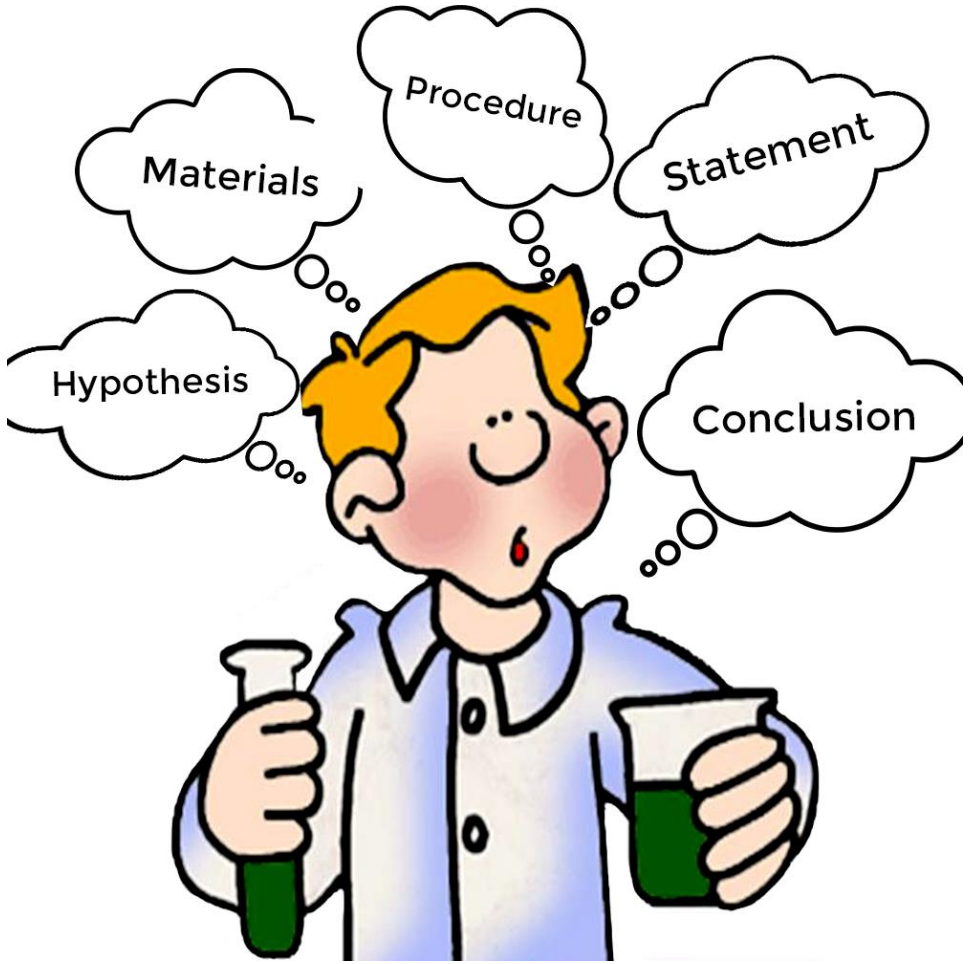
## Planning an Investigation

- When planning an investigation there are several steps that you must go through to develop a well-organized and workable plan.
- This ensures that you have the appropriate equipment and information available to help the experimentation/data collection process run as smoothly as possible.

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**Planning an Investigation**

A good scientific plan includes the following:

1. A scientific question
2. A hypothesis
3. Variables
4. A method
5. Trials

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1. **A Scientific Question**

- All scientific investigations begin with a question which needs to be answered. This is the focus of your investigation.
- The question may arise from research that you have done, or from observations from previous experiments.
- Sometimes your teacher may give you a question on which to focus your investigation. This question may be phrased as an aim or learning objective i.e., " to find out if…" .

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## 2. A hypothesis

- A hypothesis is a prediction about what you think will happen.
- A good hypothesis is:
  - ✓ based on research,
  - ✓ is easy to measure,
  - ✓ a clear cause and effect relationship

**2. A hypothesis**

- In many cases you can rephrase the question from the previous step to form your hypothesis.
- You can use the following model to construct a hypothesis:

*"If....is changed, then.... will happen."*

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## 2. **A hypothesis:** *Examples:*

Write a hypothesis for each of the questions below:

| Question | | Hypothesis |
|---|---|---|
| 1. Does a blue or yellow flame heat water to 100$^{o}$C faster? | → | |
| 2. How does hot water change the speed that sugar crystals dissolve? | → | |
| 3. How does the mass of a truck affect its stopping distance? | → | |

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## 2. **A hypothesis:** *Examples:*

Answers

| Question | | Hypothesis |
|---|---|---|
| 1. Does a blue or yellow flame heat water to 100$^{o}$C faster? | → | The blue fame will heat water to 100$^{o}$C faster than a yellow flame. |
| 2. How does hot water change the speed that sugar crystals dissolve? | → | The hotter the water, the faster the sugar crystals will dissolve. |
| 3. How does the mass of a truck affect its stopping distance? | → | The heavier the truck, the longer it takes to stop. |

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## 3. Variables

- When developing your hypothesis any factors which will affect your investigation need to be carefully considered.
- These factors are known as variables.
- There are three main types of variables which you will need to identify…
  - The independent variable
  - The dependent variable.
  - Controlled variables.

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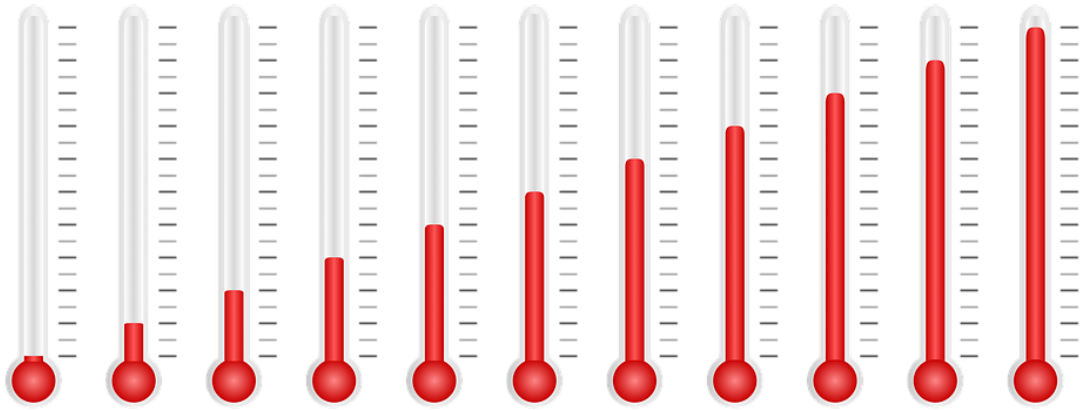
## 3. Variables: The Independent Variable

- This variable is the only one which you will change during your investigation.
- It must be mentioned in your hypothesis.
- The independent variable will have a list of values called the testable range.
- For example:

  If you are changing the temperature your range may be 20°C, 30°C, 40°C, and 50°C. Usually, a range of between 3 and 5 values will provide a good amount of data to show a pattern in the results.



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## 3. Variables: The Dependent Variable

- This variable will be the data which is collected because of changing the independent variable.
- It must also be mentioned in your hypothesis.
- When describing the dependent variable how and what must be described.

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## 3. Variables: The Dependent Variable

- For example, when measuring the time taken for the reaction to occur, you could describe when to start the stopwatch and when to stop it:
- I.e., “begin timing as soon as the chemicals are combined and then stop once no more fizzing occurs”.

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## 3. Variables: Controlled Variables

- These are the variables which are kept the same throughout the investigation to make the investigation reliable.

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## Identifying Variables

Complete the table to identify the missing variables:

| Hypothesis | | Independent Variable | Dependent Variable | Examples of Controlled Variables |
|---|---|---|---|---|
| 1. The blue fame will heat water to 100ºC faster than a yellow flame. | → | Color of the flame | | • Amount of water<br>• _____ to start/stop timer<br>• Size of beaker |
| 2. The hotter the water, the faster the sugar crystals will dissolve. | → | | Speed that the sugar crystals dissolve. | • _____ of water<br>• Size of _____<br>• Stirring or not? |
| 3. The heavier the truck, the longer it takes to stop. | → | Mass of the truck | | • _____ of truck used<br>• Type of _____ used<br>• _____ to start/stop timer |

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## Identifying Variables Answers:

| Hypothesis | | Independent Variable | Dependent Variable | Examples of Controlled Variables |
|---|---|---|---|---|
| 1. The blue fame will heat water to 100°C faster than a yellow flame. | → | Color of the flame | Time taken to heat water to 100°C. | • Amount of water<br>• When to start/stop timer<br>• Size of beaker |
| 2. The hotter the water, the faster the sugar crystals will dissolve. | → | Temperature of the water. | Speed that the sugar crystals dissolve. | • Amount of water<br>• Size of beaker<br>• Stirring or not? |
| 3. The heavier the truck, the longer it takes to stop. | → | Mass of the truck | Time taken to stop. | • Type of truck used<br>• Type of mass used<br>• When to start/stop timer |

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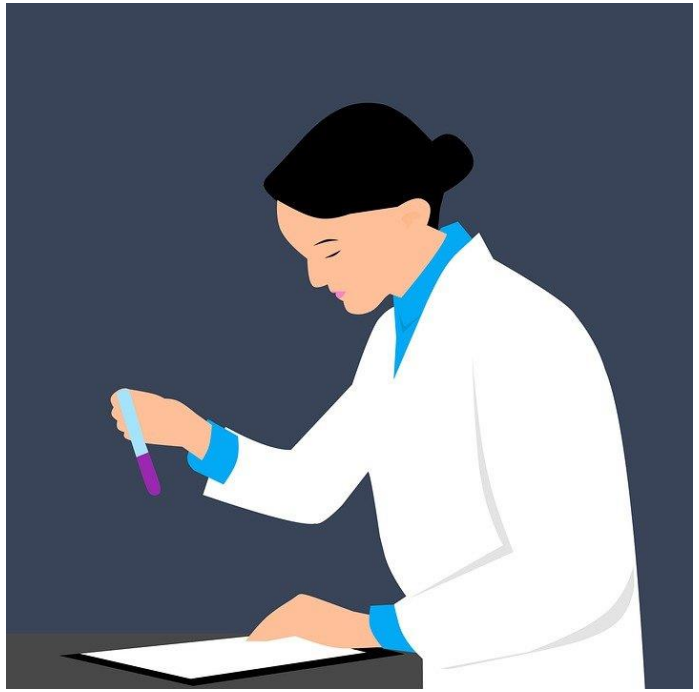
## 4. Write a Method

- A method is a step-by-step description of how to carry out your experiment.
- It should be clear and have enough detail that someone else could follow the steps and arrive at the same result as you.



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## 4. Write a Method

A good method should have the following:

- ✓ A list of the equipment you will need.
- ✓ A diagram of how you will set up your experiment.
- ✓ How and when to change the independent variable.
- ✓ How and when to measure the dependent variable.
- ✓ How to control any other variables which may impact your results.
- ✓ How many times you will repeat each value for the independent variable.

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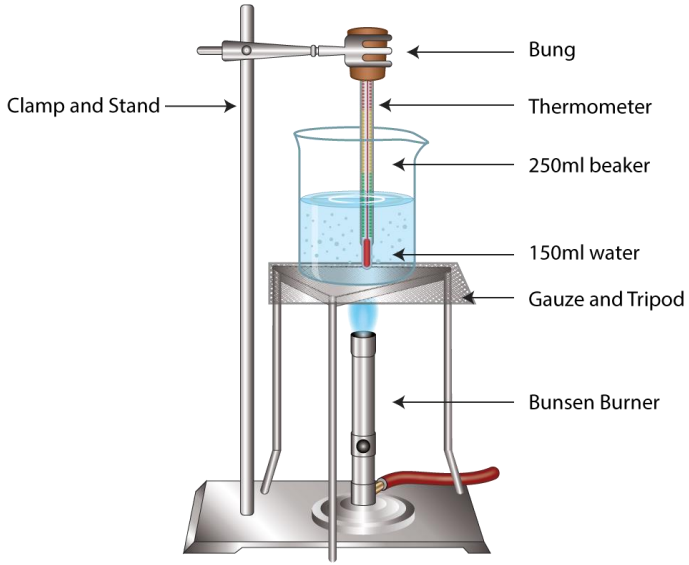
Example:

- The method below describes how to determine which Bunsen flame is the hottest.
- It has been annotated to highlight the key parts which all good methods should have.

**Comparing Bunsen Flames**

1. Fill a 250ml beaker up to the 150ml mark and set up the heating equipment seen in the diagram.
2. Place the first beaker on the heating apparatus.
3. Record the initial temperature of the water using a thermometer.
4. Light the Bunsen and change it to a blue flame.
5. Move then Bunsen carefully under the beaker and start the stopwatch.
6. Monitor and record the temperature each minute until the water reaches 100$^{o}$C.
7. Turn off the Bunsen.
8. Repeat entire method will a new beaker of water twice more using a blue flame.
9. Repeat the entire method three times using an orange flame by adjusting the collar.

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Example:

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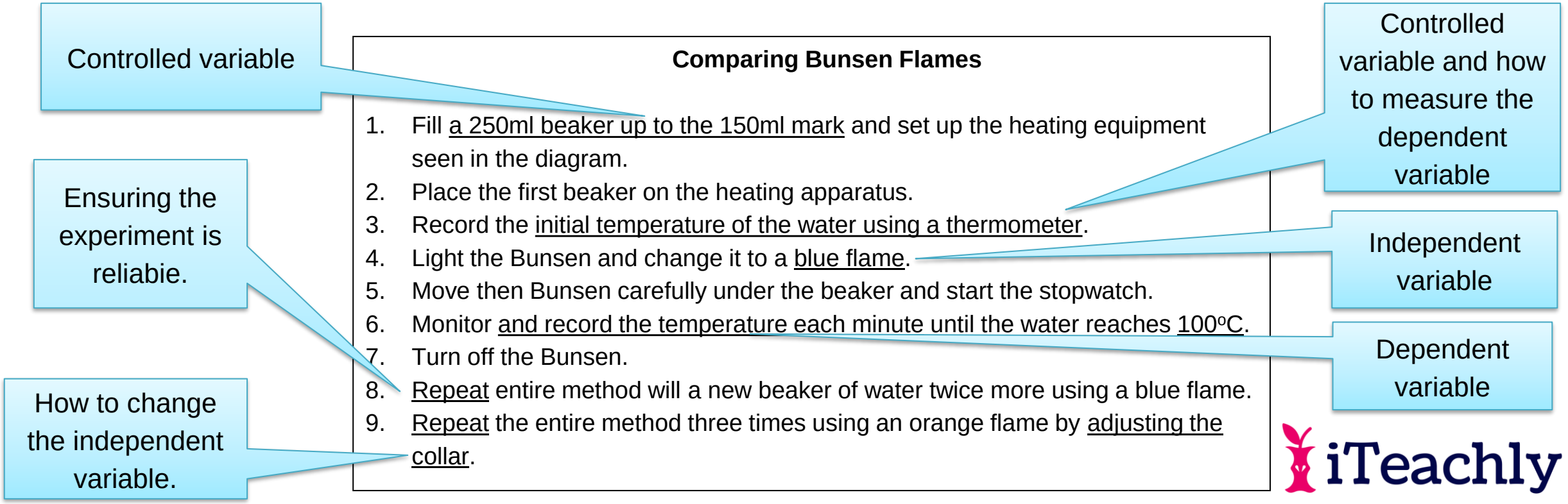


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1. **Trialing your method**

   - Once you have written your method, your teacher may allow you to carry out limited trials to see if your method works.
   - In this step, you can adjust your method to make sure that it works.

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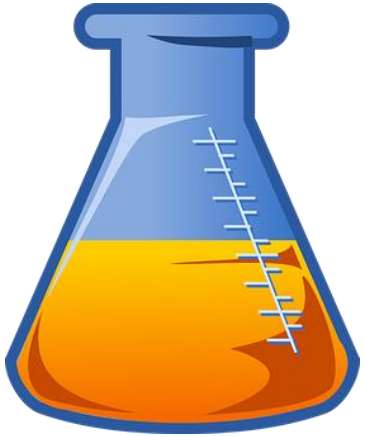
## Conducting Your Experiment/ Collecting Data

- Once you are confident that your method will work and you have checked it with your teacher, you will be expected to conduct your experiment and collect some data to use in the final phase of the investigation.



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## Conducting Your Experiment/ Collecting Data

There are several things to make sure of when carrying out your experiment:

- ✓ Equipment – all equipment is in working order, clean and dry.
- ✓ Lab safety – ensure you are wearing the correct safety equipment and following safety regulations.
- ✓ Lab procedures – use correct procedures for heating substances, lighting Bunsen burners and measuring substances.
- ✓ Have a way to record your results so you can refer to them later.

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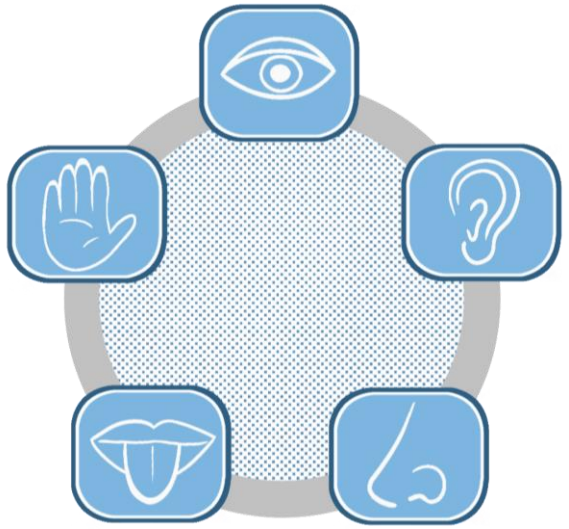
**Recording Results and Observations.**

- Results can be qualitative or quantitative.
- It is essential that you record both types so that you can use them when writing your scientific report.
- Qualitative results can be quickly noted down as descriptions.
- A raw data table is often the best way to record quantitative results which have been obtained through measurement.



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A sample table has been shown below:

| | **Dependent Variable with units:** | | | |
|---|---|---|---|---|
| Independent variable with units: | Trial 1 | Trial 2 | Trial 3 | Average results: |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

Record your results here!

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