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Planning an Investigation Guided Notes - Teacher Edition

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.

This lesson will cover the first two phases of a scientific investigation. Each of the skills that have been covered so far in this topic will be useful in at least one of these phases.

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.

A good scientific plan includes the following:

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 a learning aim or objective i.e., "to find out if…".

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**, and shows a clear cause and effect **relationship**. In many cases you can rephrase the question (or aim) from the previous step to form your hypothesis. You can also use the following model to construct a hypothesis:

"If….is changed, then…. will happen."

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Examples:

Write a hypothesis for each of the questions in the table below:

Question		Hypothesis
1. Does a blue or yellow flame heat water to 100°C faster?	→	The blue fame will heat water to 100°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.

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.

  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.

- The dependent variable.

  This variable will be the **data** which is collected because you have changed the independent variable. The dependent variable must also be mentioned in your hypothesis. When identifying this variable, it is good practice to describe **how** it will be measured and well as **what** will be measured.

  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".

- Controlled variables.

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

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 100°C faster than a yellow flame.	→	Color of the flame	Time taken to heat water to 100°C.	• Amount of water • When to start/stop timer • 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 • Size of beaker • 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 • Type of mass used • When to start/stop timer

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. 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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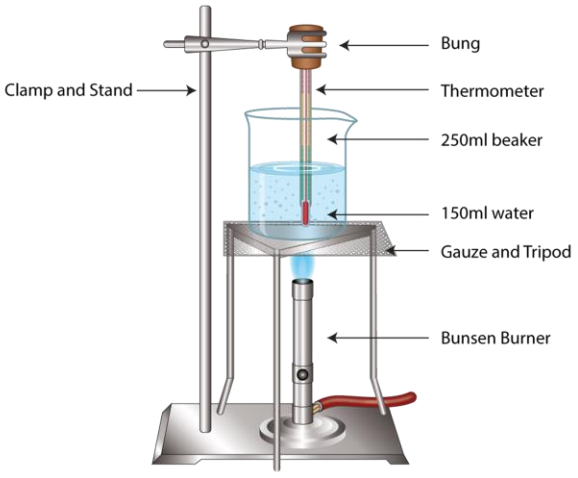
Example:

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 below.
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°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.

Diagram:



Controlled variable

Ensuring the experiment is **reliable**.

How to change the **independent** variable.

Controlled variable and how to **measure** the dependent variable

Independent variable

Dependent variable

5. 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

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works/makes sense.

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. 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.

Recording Results and Observations.

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

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!