Practical Investigation?

Lesson: Designing & planning an investigation

In this topic, you will undertake a practical investigation, largely of your own design.

The focus of this investigation is **not** on arriving at a ……. conclusion, or proving something that is already known.

You will learn about the ……. of scientific method, research or investigation.

You will be provided with **two** possible topics for investigation and a further list of possibilities that would require some extra thinking on your part.

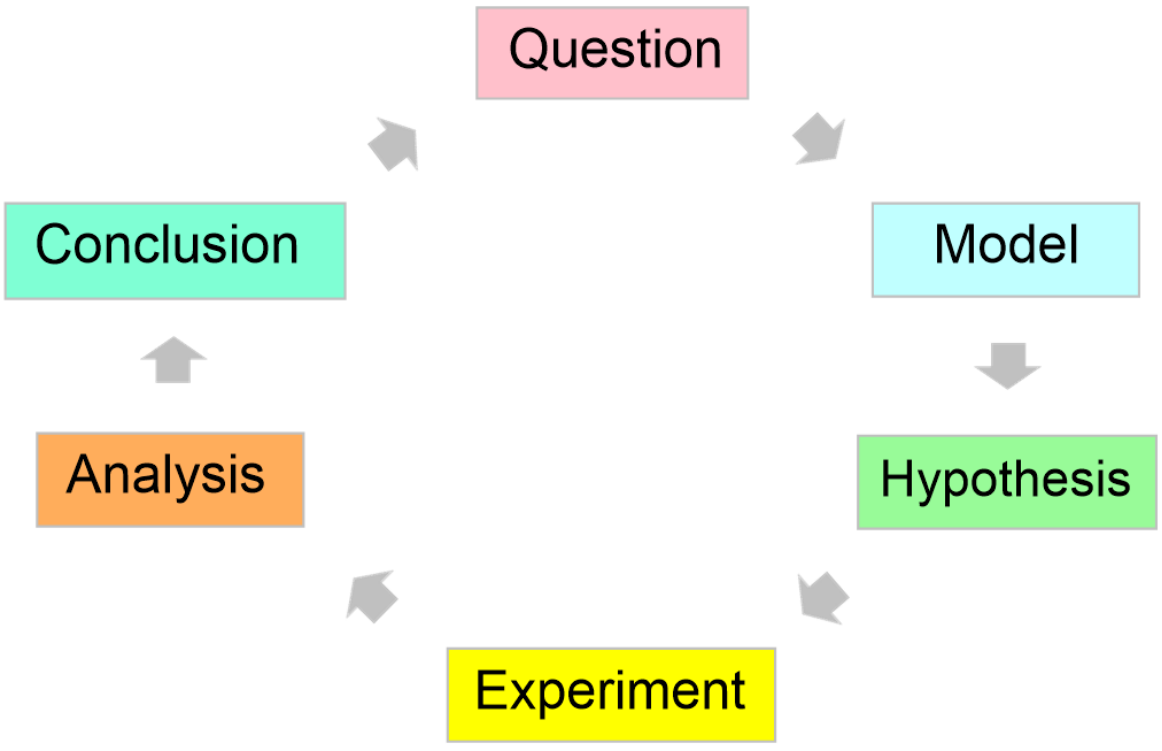
This lesson will take you through the steps involved in carrying out a hypothetical investigation into a physics question related to thermal effects.

By the end of this lesson you will be able to confidentially choose a topic and design and undertake your own practical investigation.

What is Scientific Method?

a method of procedure that has characterized natural science since the 17th century, consisting in systematic observation, measurement, and experiment, and the formulation, testing, and modification of hypotheses.

*"criticism is the backbone of **the scientific method**"*



Question

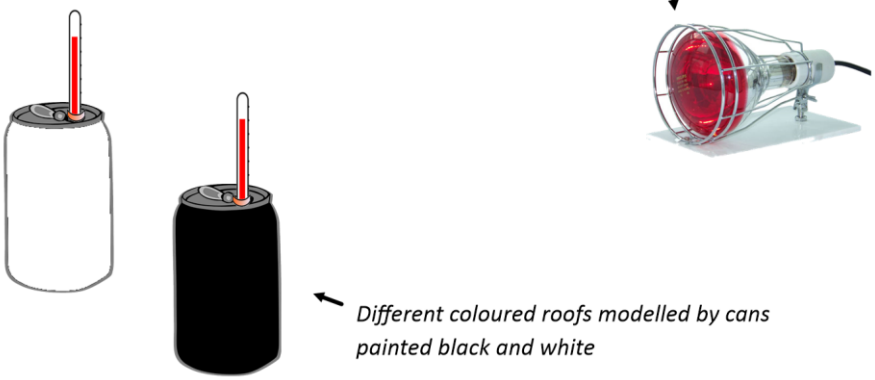
You are building a house in a warm location. Which colour of roof would keep you coolest in summer?

Scientific Model, a physical or mathematical …… of a scientific phenomenon under investigation.

A good model allows scientists to:

- Formulate a simple hypothesis (or specific …….) about the phenomenon.
- Design an experiment and use …… to record relevant data.
- Analyse the data to test the hypothesis and hence respond to the original question.
- Make further testable …… about the phenomena, leading to further experiments.

Model



The **Hypothesis** proposes a relationship between two variables and should help to answer the original question of interest.

A good hypothesis should:

- Be a simple ……., guided by physics ideas or concepts.
- Relate to the research question (purpose).
- Be …… by an experiment.
- Include an independent and …… variable.

Hypothesis

That temperature of both black and white cans will increase with time and the can with the white coating (corresponding to the lightest color roofing material) will heat up the least over any given time interval.

Experiment

Equipment .....

1 x soft drink can painted white to simulate white roofing.

1 x soft drink can painted black to simulate dark roofing.

Heat lamp to simulate sun as a source of infrared radiation.

1 x thermometer (0 - 50°C) to measure temperature inside each can.

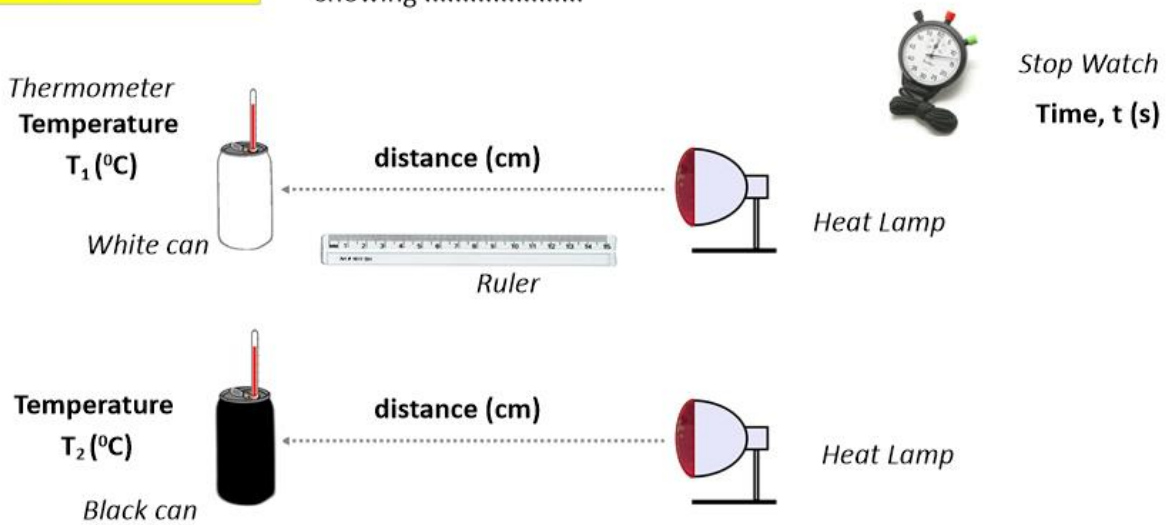
2 x rubber stopper to support thermometer inside can opening and prevent escape of heat.

1 x ruler to measure distance from heat lamp to can(s).

1 x stop watch to measure time.

Experiment

Annotated ..... of experimental setup, showing .....



Variables are the physical quantities are able to change in an experiment. There are three main categories:

Independent variables, d…… variables and **c……. variables.**

- **Independent variables are** the ones that you control by the design of your experiment.

  In this practical investigation, independent variables are **colour of can** and **time**.

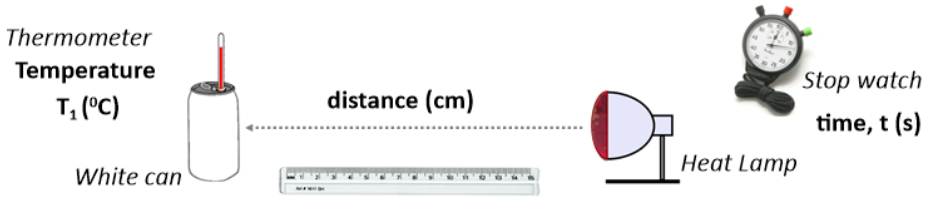
  Colour of can is a *discrete* or *qualitative* variable as it can only be observed but not measured
  Time is a *continuous* or ……variable because it can be measured (with a stop watch).

- The **Dependent variable** is the one that changes in response to a change in the independent variable. This is the variable that you ……. or observe.
  In this practical investigation, the dependent variable is **t……..** It is also a *qualitative* variable because it can be measured using a thermometer.
- **Controlled variables** are the variables that must be kept fixed during the investigation.

  In this practical investigation, controlled variables are d……. from lamp to can, volume or size of can, t……. of can walls, can material (Aluminium), power of lamp, room t…… and initial temperature.

Experiment

The **Method** is the step-by-step p…… that must be followed.



1. Set up equipment as shown above, using the ruler to maintain a distance of 15cm between lamp and can for all trials.
2. Measure the intial room temperature (in °C) using the thermometer.
3. Measure the temperature inside the white can (in °C) every 30 seconds up to 270 seconds.
4. Switch off lamp and allow the white can to cool to room initial room temperature.
5. Repeat steps 2 to 4 two more times. This will provide three temperature measurements for the white can for each time value, increasing the reliability of the experiment.
6. Record all results in a suitable table.
7. Replace the white can with the black can, keeping distance from lamp to can at 15cm.
8. Repeat steps 1 to 6 for the black can.
9. Ensure that controlled variables including distance from lamp to can, size of can, thickness of can walls, can material (Aluminium), power of lamp, room temperature and initial temperature are held constant throughout the experiment.

The method should be written so that any other student could follow your methodology and take similar measurements.
That is, the experiment should be ***r…….*** *and* ***repeatable****.*

Experiment

Safety considerations

Identify any ..... associated with your experiment and how you overcome them. For this investigation safety considerations include:

Ensuring that power leads supplying the heat lamp have been checked for safety.

Avoiding contact with hot surface of heat lamp during experiments.

Careful handling of glass thermometer to avoid breakage.

Overcoming Difficulties

The method may need to be ***m.....*** *as the investigation is carried out.*

Make sure that all modifications, and the reasons for them, are ***r.....*** *and detailed in your* ***log book****.*

Experiment

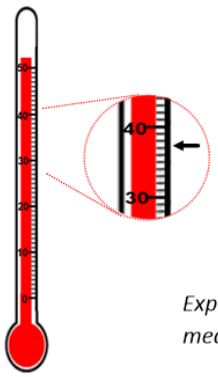
Recording Data

The ***a.....*** *of an instrument is the minimum difference that an instrument can measure.*

Accuracy *refers to the ability to obtain the correct measurement, given any limitations of the experimental setup.*

Margin or E..... Error *can be expressed as a a plus or minus (+/-) value or as a percentage error*

Less than 5% is reasonable.



Rule of thumb for precision.

"Plus or minus ..... a scale division"

Experimental error for temperature measurements = +/- 0.5ºC

Time

Precision for time measurements = +/- 0.5s

Human reaction time adds +/- 0.3s

Experimental error for time measurements = +/- 0.8

Distance

Precision distance measurements = +/- 0.5mm

Parallax errors adds = +/- 0.5mm

Experimental error for distance measurements = +/- 1.0mm

Reliability *of an experiment refers to the idea that consistent results will be achieved if repeated many times over.*
Repeat each measurement at least ***three times*** *and then* ***average the three measurements*** *to ensure good reliability.*
This enables you to identify and discard random errors and reduces overall experimental error.

Experiment

Recording Data (Continued)

Temperature - time data for white can

T_1 (°C)	T_2 (°C)	T_3 (°C)	T_{ave} (°C)	Time (sec)
21	20	21	21	0
23	25	24	24	30
27	25	27	27	60
29	30	27	29	90
29	32	32	31	120
33	31	32	32	150
34	32	34	33	180
35	32	33	33	210
34	35	33	33	240

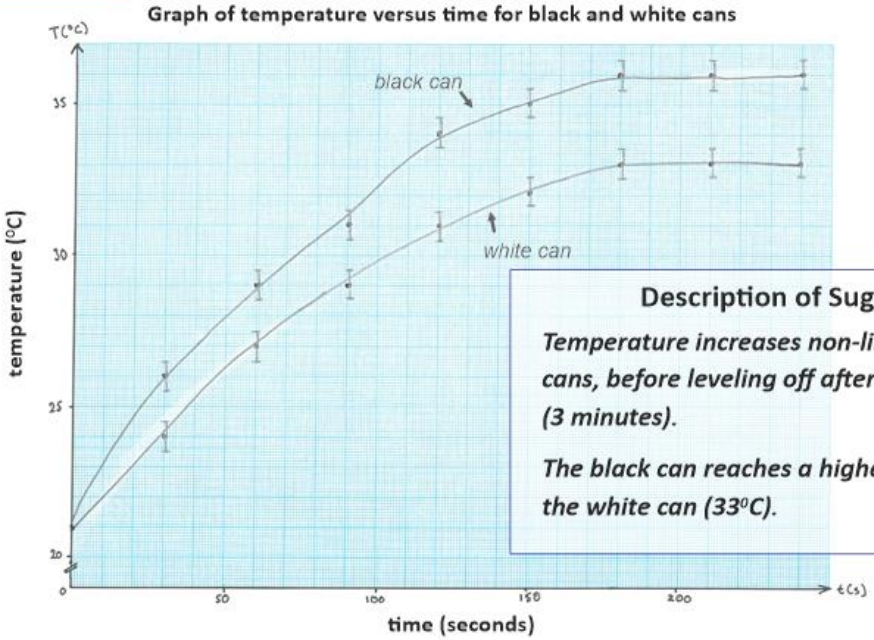
Experimental error for all ..... measurements = +/- 0.8s

Experimental error for all ..... measurements = +/- 0.5°C

Analysis

Plotting Graphs

Graph of temperature versus time for black and white cans

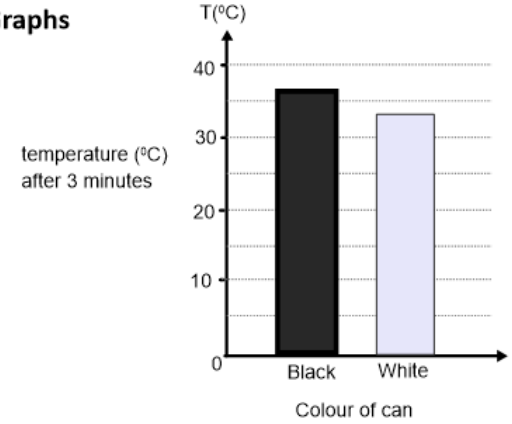


Description of Suggested Relationships

Temperature increases non-linearly with time for both cans, before leveling off after approximately 180 seconds (3 minutes).

The black can reaches a higher temperature (36°C) than the white can (33°C).

Further Graphs



Conclusion

This is a short ..... of the meaning of your results related to the ..... and the original ..... of interest.

Question

You are building a house in a warm location. Which colour of roof would keep you coolest in summer?

Hypothesis

That temperature of both black and white cans will increase with time and the can with the white coating (corresponding to the lightest color roofing material) will heat up the least over any given time interval.

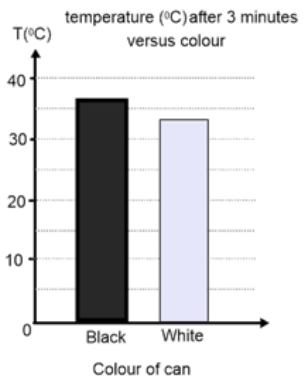
Conclusion

Graphs of temperature versus time for black and white cans support the hypothesis in that:

Temperature will increase for both black and white cans over time with continued exposure to the heat lamp radiation.

The can with the white coating (corresponding to lighter coloured roof material) heats up the least over any given time interval.

Graphs also show that the temperature levels off after three minutes for both cans and the white can (at 33°C) reaches a lower temperature than the black can (at 36°C).



The results of this investigation indicate that when building a house in a warm location, a lighter coloured roofing material will keep the house coolest.