**Experiment 1**

**Title:** Dissolution

**Objective:** To investigate the relationship between temperature of water and time taken for the salt to dissolve completely.

**Problem statement:** How the temperatures of water affect the dissolution rate?

**Hypothesis:** When the temperature of water increases, the time taken for the salt to completely dissolve decreases.

**Apparatus and Materials:** 4 beakers, 50mL of water with temperature 20°C, 40°C, 60°C and 80°C, 40g of salt, stopwatch and glass rod.

**Variables:**

i. Manipulated: temperature of water
ii. Responding: time taken for the salt to completely dissolve
iii. Controlled: mass of salt

**Procedures:**

1. Label the four beakers and pour water of different temperatures as below.

| Beaker | Temperature of water (°C) |
|---|---|
| A | 20 |
| B | 40 |
| C | 60 |
| D | 80 |

2. Add 10g of salt in the beaker labelled A and stir it by using glass rod.
3. Record the time taken to completely dissolve by using stopwatch.
4. Repeat steps (2-3) with beaker labeled B, C and D.

5. Record the data obtained.

**Results / Observations:**

| Temperature of water (°C) | Time taken for the salt to completely dissolve (minutes) |
|---|---|
| 20 | 3.0 |
| 40 | 2.5 |
| 60 | 1.8 |
| 80 | 1.0 |

The table shows that 10g of salt takes longer time to dissolve in the water with temperature of 20°C compared to 80°C.

**Science behind it:**

In hot water, molecules are moving around more, so there are more collisions between the water molecules and a solid.

A solvent is a substance that can dissolve other substances – water is a good solvent. Dissolving a solid requires energy input to disrupt the forces holding the molecules together, both in the solid and the water.

Most solids, including sugar and salt, become more soluble with increasing temperature. This is because heat increases molecular movement, causing more collisions between the water molecules and the solid. But the opposite is true for gases, which tend to become less soluble as a solvent's temperature increases. As the gas molecules become more active, they can break free from the liquid, which explains why drinks soon lose their carbon dioxide fizz on a hot day.

**References:**

https://www.sciencefocus.com/science/why-is-hot-water-a-better-solvent-than-cold-water/

**Experiment 2**

**Title:** Combustion

**Objective:** To study the relationship between the size of gas jar and time taken for the candle time to extinguish.

**Problem statement:** How the size of gas jar can affect the time taken for the candle to extinguish.

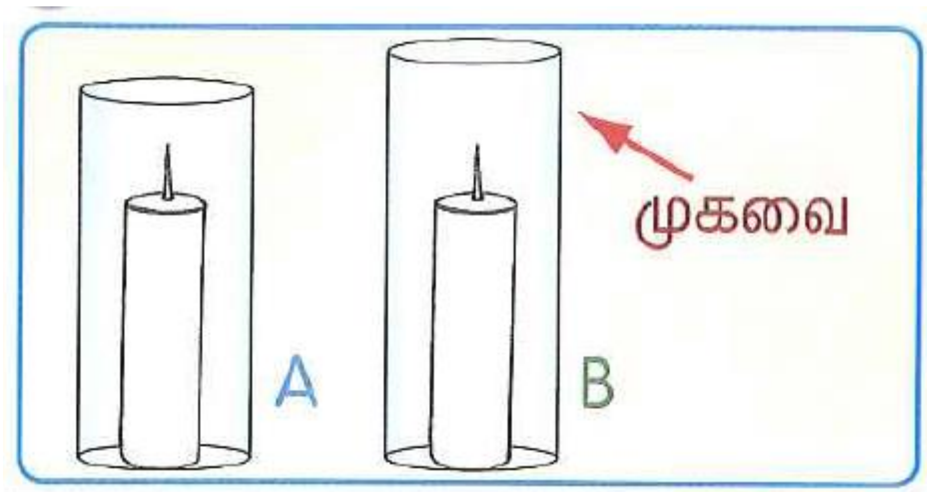
**Hypothesis:** The bigger the size of gas jar, the longer the time taken for the candle to extingusih.

**Apparatus and Materials:** 2 gas jar with different sizes, matchbox, candles and stopwatch.

**Variables:**

i. Manipulated: size of gas jar.
ii. Responding: time taken for the candle to extinguish.
iii. Controlled: type of candles

**Procedures:**




1. Label the bigger gas jar as A and small gas jar as B.
2. Light up a candle and cover it with gas jar A.
3. Record the time taken by the candle to extinguish by using stopwatch.
4. Repeat the experiment with gas jar B.
5. Record your data in the bale provided.

**Results / Observations:**

| Gas jar | Time taken for the candle to extinguish (seconds) |
|---|---|
| A | 45 |
| B | 20 |

Candle inside the bigger gas jar ( Gas jar A) took longer time to extinguish compared to smaller gas jar (gas jar B).

**Science behind it:**

Combustion needs oxygen. Bigger gas jar can occupy more oxygen compared to smaller gas jar. So the candle inside bigger gas jar burns longer time until all the oxygen completely used.

**Experiment 3**

**Title:** Elasticity

**Objective:** To study the relationship between the mass of pendulum bob and length of spring.

**Problem statement:** How does the mass of pendulum bob can increasesthe length of spring when hang on it?

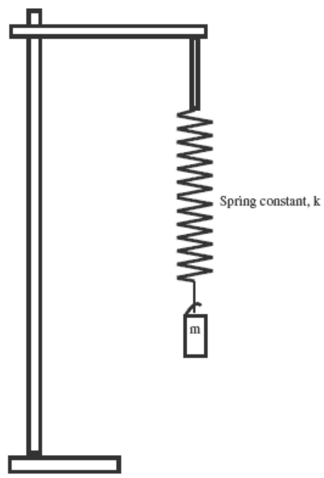
**Hypothesis:** The more the mass of pendulum bob, the longer the length of spring.

**Apparatus and Materials:** Pendulum bob, spring, retort stand and metre ruler.

**Variables:**

i. Manipulated: the mass of pendulum bob.
ii. Responding: the length of spring
iii. Controlled: type of spring

**Procedures:**




1. Hang the spring on the retort stand.
2. Measure and record the initial length of spring.
3. Attach 20g of pendulum bob with the srping.
4. Record the change in the length of spring.
5. Repeat the experiment with 40g, 60g, 80g and 100g of pendulum bob.
6. Record your observations.

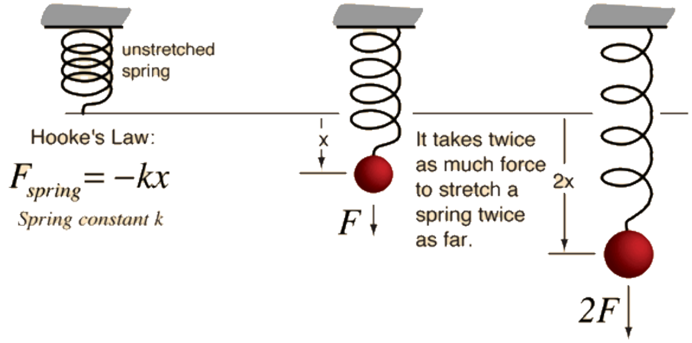
**Results / Observations:**

Initial length of spring= 20cm

| Mass of pendulum bob (g) | Length of spring (cm) (final length) | Change in length of spring (cm) |
|---|---|---|
| 20 | 22 | 2 |
| 40 | 26 | 6 |
| 60 | 30 | 10 |
| 80 | 34 | 14 |
| 100 | 38 | 18 |

**Science behind it:**

Elasticity




Elasticity is the property of an object or material which causes it to be restored to its original shape after distortion. It is said to be more elastic if it restores itself more precisely to its original configuration. A rubber band is easy to stretch, and snaps back to near its original length when released, but it is not as elastic as a piece of piano wire.

The piano wire is harder to stretch, but would be said to be more elastic than the rubber band because of the precision of its return to its original length. A real piano string can be struck hundreds of times without stretching enough to go noticeably out of tune. A spring is an example of an elastic object - when stretched, it exerts a restoring force which tends to bring it back to its original length. This restoring force is generally proportional to the amount of stretch, as described by Hooke's Law. For wires or columns, the elasticity is generally described in terms of the amount of deformation (strain) resulting from a given stress (Young's modulus). Bulk elastic properties of materials describe the response of the materials to changes in pressure.

One of the properties of elasticity is that it takes about twice as much force to stretch a spring twice as far. That linear dependence of displacement upon stretching force is called Hooke's law.

**References:**

http://hyperphysics.phy-astr.gsu.edu/hbase/permot2.html

**Experiment 4**

**Title:** Response to stimuli in plants.

**Objective:** To study the response to stimuli in plants.

**Problem statement:** Plants response to what?

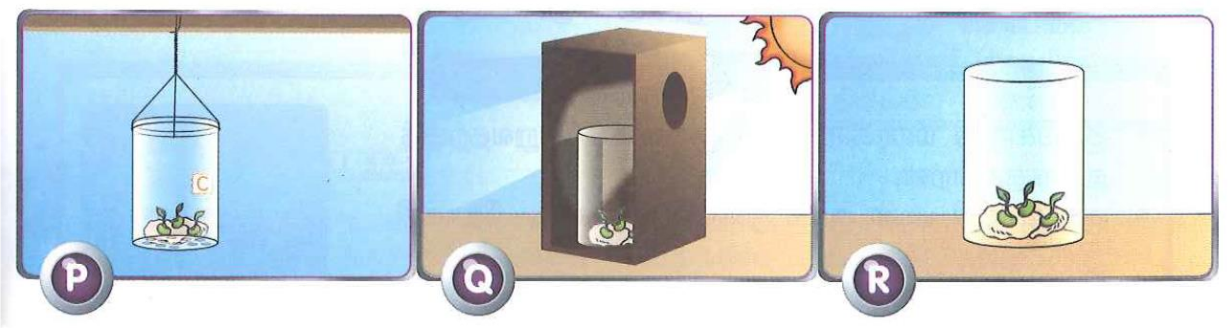
**Hypothesis:** Plants response to sunlight, water and gravity.

**Apparatus and Materials:** mung beans, box, cotton wool, 3 plastic container and water.

**Variables:**

i. Manipulated: medium for the response to occur
ii. Responding: type of response
iii. Controlled: type of plant

**Procedures:**




1. Place the mung beans until can see small parts growing up.
2. Label the plastic containers as P, Q and R.
3. Make holes at the lower part of plastic container labelled P.
4. Immersed the cotton wool in water and place it inside every plastic container.
5. Put 3 same size mung beans in each plastic container.
6. Hang the plastic container P and pour water.
7. Make a hole on box and place plastic container Q inside it. Place the box under sunlight.
8. Label C at the corner of plastic container R and pour water at the labelled part every day.
9. Observe the changes happen with mung beans and record it.

**Results / Observations:**

| Plastic container | Observations |
|---|---|
| P | The roots of the plant growing towards down. |
| Q | The shoot of plant directs to the sunlight area. |
| R | The roots of plants growing towards the water. |

**Science behind it:**

- ✓ Tropisms

A tropism is a biological phenomenon, indicating growth or turning movement of a biological organism, usually a plant, in response to an environmental stimulus. In tropisms, this response is dependent on the direction of the species. The word tropism comes from the Greek trope (“to turn” or “to change”). Tropisms are usually named for the stimulus involved and may be either positive (towards the stimulus) or negative (away from the stimulus).

- ✓ Phototropism

Phototropism is the growth response of a plant in response to light direction. Different parts of a plant exhibit different reactions to light. Stems exhibit positive phototropism while most roots exhibit negative phototropism.

- ✓ Geotropism

Geotropism is the growth response of a plant in response to gravity. Roots exhibit positive geotropism while stems and leaves exhibit negative geotropism.

- ✓ Thigmotropism

Thigmotropism is the growth response of a plant to physical contact (touch). Plants that cling to physical structures such as walls exhibit positive thigmotropism.

- ✓ Hydrotropism

Hydrotropism is the growth response of a plant to water. Roots exhibit positive hydrotropism.

**References:**

http://leavingbio.net/plant-responses/

**<u>Experiment 5</u>**

**Title:** Basic needs of plants (Sunlight)

**Objective:** To study the effect of sunlight on plants.

**Problem statement:** How the sun contribute for the growth of a plant?

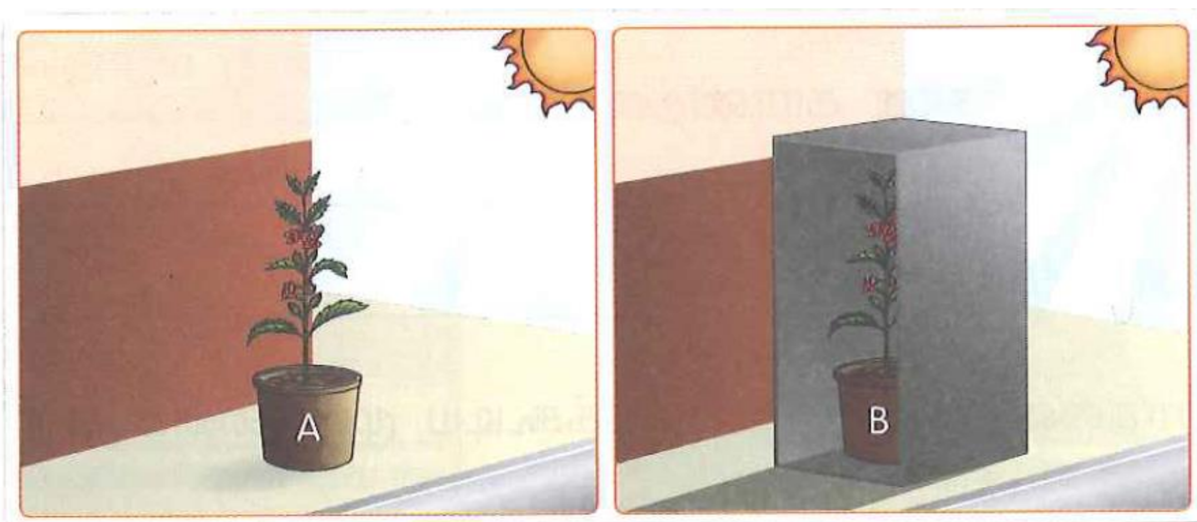
**Hypothesis:** Plants need sunlight to stay alive.

**Apparatus and Materials:** 2 balsam plants with same number of leaves, pencil, notebook and a black box.

**Variables:**

i. Manipulated: the presence of sunlight
ii. Responding: height of plant / leaves condition
iii. Controlled: balsam plants with same number of leaves

**Procedures:**




1. Label the balsam plants as A and B.
2. Place plant A exposed to sunlight and plant B inside the black box.
3. Water both plants every day.
4. Every two days measure the height of the plants and observe the condition of leaves.

**Results / Observations:**

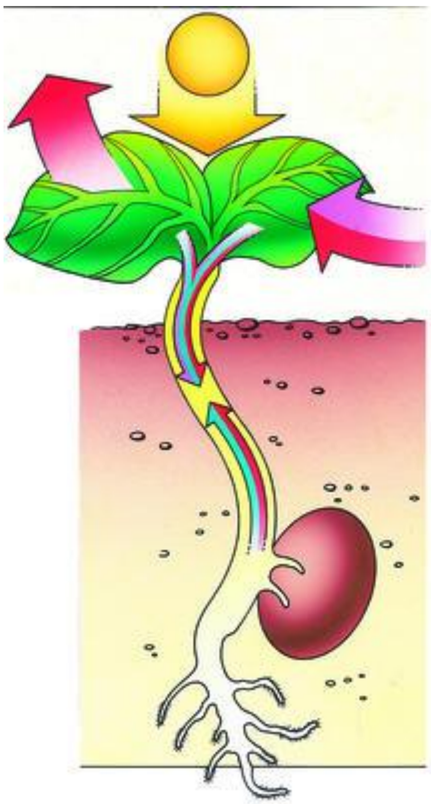
| Days | Height of plants / Condition of plants | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Plant | 2 | | 4 | | 6 | | 8 | | 10 | | 12 | |
| | H.P | C.P | H.P | C.P | H.P | C.P | H.P | C.P | H.P | C.P | H.P | C.P |
| A | | | | | | | | | | | | |
| B | | | | | | | | | | | | |

H.P – height of plants

C.P – condition of plants

After 12 days, plant A will increase in height and new leaves are grown. The plant also looks healthy and green. While plant B, looks wilt and brown color. The number of leaves in plant B also decreases.

**Science behind it:**



Plants make their own food by combining a gas called carbon dioxide, which they get from the air, with water from the soil. This process is called photosynthesis. To power the process, the plant uses the energy of sunlight. A green pigment in the leaves called chlorophyll traps the Sun's energy.

Does the color of light affect plant growth?

The color of light can affect plant growth when it comes to artificial lighting. For example, in the presence of blue light, plants will likely be more compact, with leaves that are thicker. When red light is present, plants will be larger and have longer stems. With red light, plants may also have more flowers.

Plants use green light for photosynthesis or they reflect it. The leaves look green due to green light that is reflected.

**References:**

https://gridclub.com/subscribers/info/fact_gadget_2009/best_ever_qa/nature/plant_life/1627.html

https://www.ambius.com/learn/online/plant-doctor/why-do-plants-need-light/

<u>**Experiment 6**</u>

**Title:** Water displacement method

**Objective:** To study about water displacement method.

**Problem statement:** How to find the volume of irregular objects?

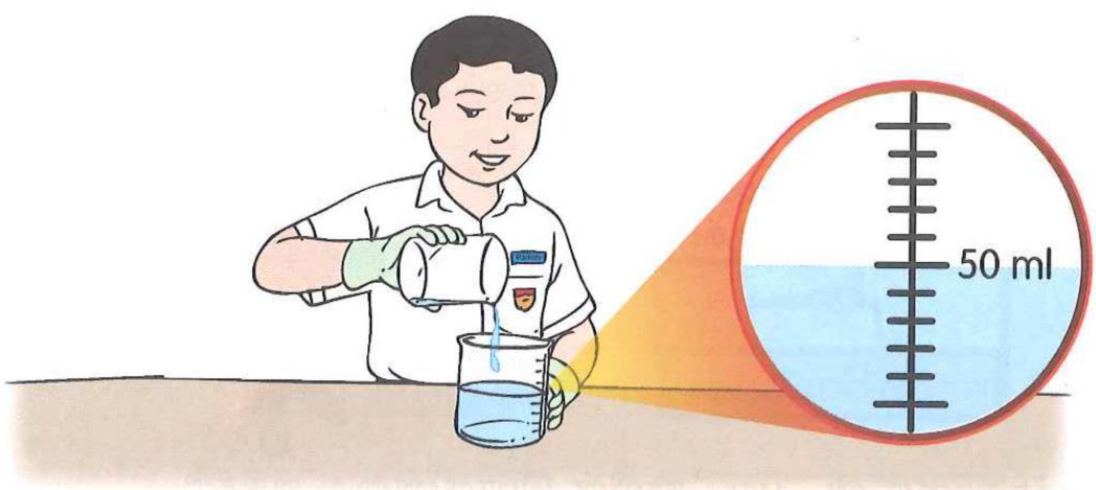
**Hypothesis:** Volume of water used to determine the volume of irregular objects.

**Apparatus and Materials:** measuring cylinder, three 20 cent coins, 5 marbles, 4 small stones, 1 pen and 1 magnet bar.

**Variables:**

i. Manipulated: objects with different shape and size
ii. Responding: final volume of water in measuring cylinder
iii. Controlled: initial volume of water in measuring cylinder

**Procedures:**




1. Fill 50mL of water in measuring cylinder.
2. Place the three 20 cents coins in the measuring cylinder.
3. Record the volume of water rise in measuring cylinder.
4. Repeat the steps with 5 marbles, 4 small stones, 1 pen and 1 magnet bar.
5. Record your data obtained in the table.

**Results / Observations:**

| Objects | Initial volume of water in measuring cylinder (mL) | Final volume of water in measuring cylinder (mL) | Volume of object ($cm^3$) |
|---|---|---|---|
| three 20 cent coins | 50 | | |
| 5 marbles | 50 | | |
| 4 small stones | 50 | | |
| 1 pen | 50 | | |
| 1 magnet bar | 50 | | |

**Science behind it:**

Water displacement happens when an object is submerged in a fluid and the fluid is pushed out of the way (or displaced) to make room for the object. The amount of water displaced is directly related to the volume of the object.

Measuring the volume of an irregularly shaped object using geometry is often difficult and complicated. The easiest way to do this is by using the water displacement method.

**References:**

https://happyhooligans.ca/water-displacement-activity/

https://sciencing.com/volume-vs-mass-density-5759475.html

**<u>Experiment 7</u>**

**Title:** Parachute

**Objective:** To investigate the relationship between length of string and hang time of parachute.

**Problem statement:** How does the length of the string affect the hang time of the parachute?

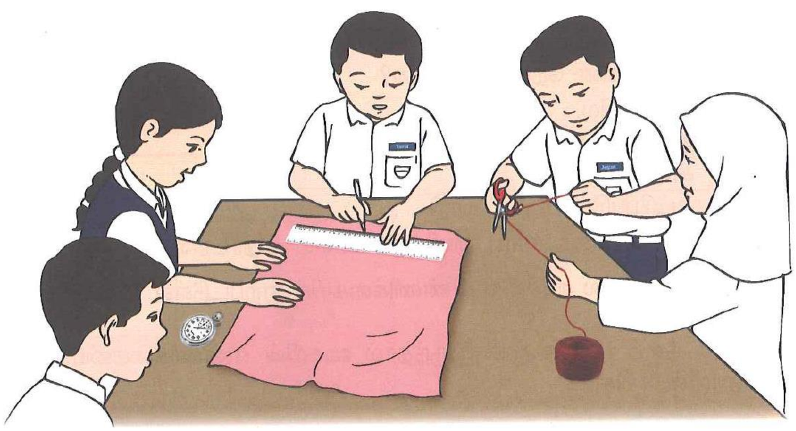
**Hypothesis:** The longer the length of string, the longer the hang time of parachute.

**Apparatus and Materials:** string, plastic bag, stopwatch, marker, scissors and meter ruler.

**Variables:**

i. Manipulated: the length of string
ii. Responding: hang time of parachute
iii. Controlled: the height where the parachute dropped

**Procedures:**



1. Cut the plastic bag with length of 30cm X 30cm to make sunshade.
2. Tie the string at every corner of the sunshade and tie together all the string as shown in the diagram.

3. Make the length of string 30cm.
4. Drop the parachute from 4 meter height.
5. Measure and record the time taken for the parachute to fall down.
6. Repeat the experiment with string length of 25cm, 20cm and 15cm.
7. Record your observations.

**Results / Observations:**

| String length (cm) | Hang time of the parachute (seconds) |
|---|---|
| 30 | |
| 25 | |
| 20 | |
| 15 | |

When the string length is 30cm, it takes longer time to fall down from 4 meter height compared to 15cm string length.

**Science behind it:**

Once we dropped the parachute air resistance was acting on it. The longer string caused the surface area to be bigger, which caused there to be more air resistance.

- ✓ Gravity

A parachute is a length of light-weight fabric attached to a heavier object, such as a human body. As gravity works to pull the object toward the Earth, the parachute is opened, releasing the fabric that works against the gravity, slowing it down. The parachute, of course, does not stop gravity. The object eventually reaches the ground. The parachute slows it enough that the object lands much more softly than it would without one. Parachutes reduce gravity to the point that a human body can safely fall from an airplane while using one.

- ✓ Air Resistance

When a parachute opens, it is a second force that works against gravity. This is air resistance. Air collects under the fabric parachute, pushing it up as gravity pulls the heavy object attached to it down. This pushing slows the fall of the object by resisting the air under the parachute. Air resistance is a non-conservative force, in that the work it does is dependent on the downward motion of the heavy object pulled by gravity toward the Earth.

- ✓ Terminal Velocity

When a heavy object falls, it reaches a speed called terminal velocity. This is the speed the object will continue to fall unless something stops it. For instance, landing on the ground ends terminal velocity. Opening a parachute changes terminal velocity, making it much slower than the terminal velocity of an object in free fall. The open parachute results in air resistance that is greater than the pull of gravity. Terminal velocity reduces until there is a balance again, which happens at a speed slow enough for the falling object to make a safe landing.

**References:**

https://prezi.com/nfss0l2rquva/how-does-the-length-of-the-string-affect-the-hang-time-of-th/

**<u>Experiment 8</u>**

**Title:** Electricity Conductivity

**Objective:** To study the electric conductivity in metals and non-metals.

**Problem statement:** How does the electric current can pass through metals?

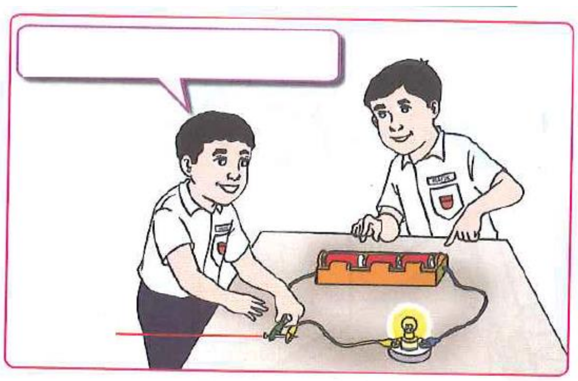
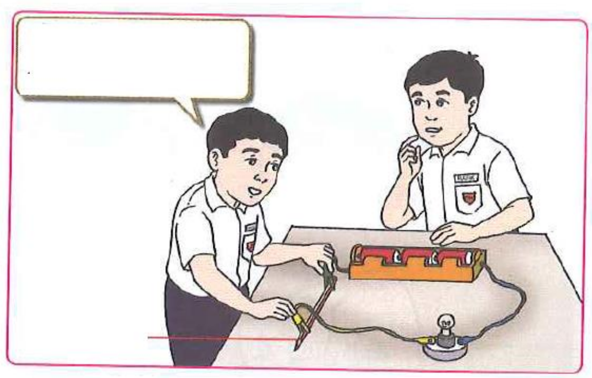
**Hypothesis:** Electric current can pass through metals rather than non-metals.

**Apparatus and Materials:** bulb, 3 batteries, wires, switch, metal spoon, nails, metal ruler, straw, wood ruler, needle, cents, marbles, pen, glue bottle, rubber band and plastic bag.

**Variables:**

i. Manipulated: type of objects (metals or non-metals)
ii. Responding: conductivity of electricity
iii. Controlled: number of batteries

**Procedures:**

1. Form a circuit as shown in the diagram.
2. Replace the switch with metal spoon.
3. Observe whether the bulb lights up or not.
4. Record your observations.
5. Repeat the experiment with other objects and record your observation.

**Results / Observations:**

Tick your observations.

| Objects | Metal | Non-metal | Bulb lights up |
|---|---|---|---|
| Metal spoon | | | |
| Nails | | | |
| Metal ruler | | | |
| Straw | | | |
| Wood ruler | | | |
| Needle | | | |
| Cents | | | |
| Marbles | | | |
| Pen | | | |

| | | | |
|---|---|---|---|
| Glue bottle | | | |
| Rubber band | | | |
| Plastic bag | | | |

Objects which are categorized as metals can conduct electricity and the bulb lights up. Non-metals can't conduct electricity and the bulb not lights up.

**Science behind it:**

Metallic bonding forms a closely packed lattice structure of positive ions with delocalized electrons (these are the electrons of the outer shell of the metal atom). Because these electrons are delocalized, they can move freely within the metal structure when an electrical current is applied.

Metals conduct electricity well because they have a very low resistance that decreases the difficulty that there is for the current to pass through them (around 0.0001 ohms). They also have a lot of free electrons in them which provided the electricity to move more efficiently, consequently, copper (a metal Cu) is used to make wires.

**References:**

https://www.mytutor.co.uk/answers/6073/GCSE/Chemistry/How-do-metals-conduct-electricity/

**Experiment 9**

**Title:** Heat conductivity

**Objective:** To study the heat conductivity.

**Problem statement:** What effects heat conductivity?

**Hypothesis:** Metals can conduct heat while non-metals become heat insulators.

**Variables:**

i. Manipulated: type of rulers
ii. Responding: heat conductivity
iii. Controlled: the volume of hot water

**Apparatus and Materials:** plastic ruler, wood ruler, metal ruler, big container and hot water.

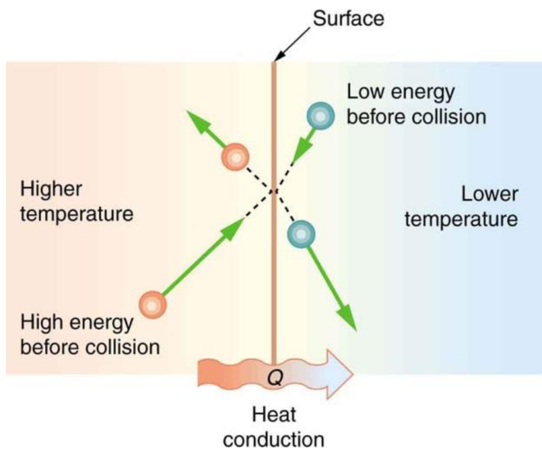
**Procedures:**

1. Pour 8 mL of hot water in a big container.
2. Place the plastic ruler, metal ruler and wooden ruler.
3. Leave them for 10 minutes.
4. Touch the three rulers and record your observations.

**Results / Observations:**

| Rulers | Observations |
|---|---|
| Metal | |
| Plastic | |
| Wood | |

**Science behind it:**




In general, good conductors of electricity (metals like copper, aluminum, gold, and silver) are also good heat conductors, whereas insulators of electricity (wood, plastic, and rubber) are poor heat conductors. The figure below shows molecules in two bodies at different temperatures. The (average) kinetic energy of a molecule in the hot body is higher than in the colder body. If two molecules collide, an energy transfer from the hot to the cold molecule occurs. The cumulative effect from all collisions results in a net flux of heat from the hot body to the colder body. We call this transfer of heat between two objects in contact thermal conduction.

The molecules in two bodies at different temperatures have different average kinetic energies. Collisions occurring at the contact surface tend to transfer energy from high-temperature regions to low-temperature regions.

Heat is an interesting form of energy. Not only does it sustain life, make us comfortable and help us prepare our food, but understanding its properties is key to many fields of scientific research. For example, knowing how heat is transferred and the degree to which different materials can exchange thermal energy governs everything from building heaters and understanding seasonal change to sending ships into space.

Heat can only be transferred through three means: conduction, convection and radiation. Of these, conduction is perhaps the most common, and occurs regularly in nature. In short, it is the transfer of heat through physical contact. It occurs when you press your hand onto a window pane, when you place a pot of water on an active element, and when you place an iron in the fire.

This transfer occurs at the molecular level—from one body to another—when heat energy is absorbed by a surface and causes the molecules of that surface to move more quickly. In the process, they bump into their neighbors and transfer the energy to them, a process which continues as long as heat is still being added.

**References:**

https://www.khanacademy.org/science/physics/thermodynamics/specific-heat-and-heat-transfer/a/what-is-thermal-conductivity

**Experiment 10**

**Title:** Water absorption

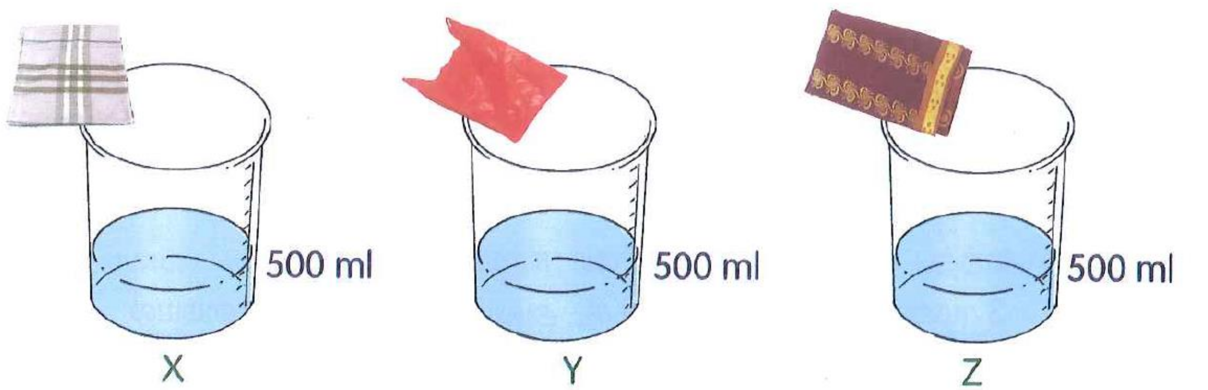
**Problem statement:** Which type of material absorbs more water?

**Apparatus and Materials:** 3 beakers, straw, aluminum foil, silk fabric, food coloring, plastic bag, cotton cloth, measuring cylinder and water.

**Variables:**

i. Manipulated: types of materials
ii. Responding: final volume of water in beaker
iii. Controlled: initial volume of water in beaker / immersion time

**Procedures:**




1. Pour some 1500mL of water in a big container.
2. Add adequate amount of food coloring in the container and mix it thoroughly.
3. Use measuring cylinder to measure 500mL of colored water and pour it in beakers.
4. Label the beakers as X, Y and Z.
5. Immerse cotton cloth in beaker X, plastic bag in beaker Y and silk fabric in beaker Z for one minute.
6. After that, take the three materials simultaneously and record the final volume of water in beaker.
7. Record the data obtained.

**Results / Observations:**

| Beakers | X | Y | Z |
|---|---|---|---|
| **Materials** | **Cotton cloth** | **Plastic bag** | **Silk fabric** |
| **Initial volume of water in beaker (mL)** | 500 | 500 | 500 |
| **Final volume of water in beaker (mL)** | | | |

**Science behind it:**

If a towel is thicker, it has more fibers to absorb water with! The fibers in tissues and paper towels are made of cellulose molecules—big molecules that consist of lots of tiny sugar molecules chained together. Have you ever seen how easily sugar dissolves in water? Because cellulose is made of sugar, water molecules rush into the cellulose fibers when cellulose and water meet.

Terry cloth is usually made out of cotton, another fiber that is almost pure cellulose. The secret behind why terry cloth works so well is that these fibers are looped around and around so that the cloth is thicker and has more fibers per square inch.

Cotton readily absorbs water. This is because the fibers of the cotton have a lot of space between them. This area allows the entry of water when cotton is put in it. Unlike simpler water molecules, cotton is made up of more complex series of atoms, which are linked into what are called "polymer molecules."

Unlike simpler water molecules, cotton is made up of more complex series of atoms, which are linked into what are called “polymer molecules.” These polymer molecules link up in repetitive patterns or chains, creating pure cellulose, a substance which makes cotton absorbent, according to Cotton Inc. One reason cellulose makes cotton absorbent is that it contains a negative charge, which helps attract “dipolar” water molecules and absorb them. Another reason is cotton's “hydrophilic properties.”

**References:**

https://www.education.com/science-fair/article/understanding-absorption/

https://sciencing.com/cotton-absorbent-6662538.html

https://www.quora.com/What-makes-cotton-absorbent

## Experiment 11

**Title**: Rusting

**Objective:** To study the relationship between type of liquids and rusting time of iron nails.

**Problem statement:** Which type of liquids the rusting process?

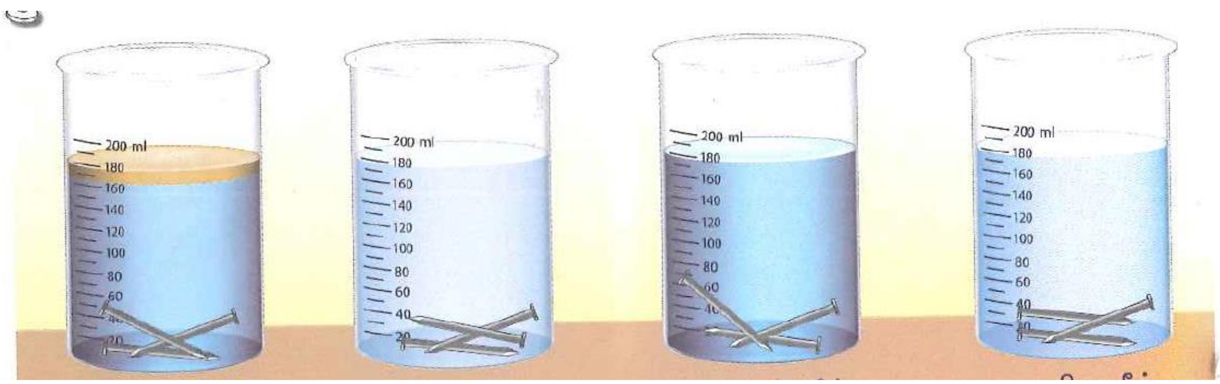
**Hypothesis:**

**Apparatus and Materials:** measuring cylinder, 4 beakers, iron nails, oil, distilled water, hot water, tap water and mineral water.

**Variables:**

i. Manipulated: types of liquid used
ii. Responding: rusting time of iron nails
iii. Controlled: volume of liquid / number of iron nails

**Procedures:**



**Water + Oil** **Hot water** **Tap water** **Mineral water**

1. Put 3 nails inside the 4 beakers and label them as A, B, C and D.
2. Add liquids in beakers as follows.

| Beakers | Liquids |
|---|---|
| A | 160mL of water and 20mL of oil |
| B | 180mL of hot water |
| C | 180mL of tap water |
| D | 180mL of mineral water |

3. Measure the time taken for the nails to rust.
4. Record the date obtained.

**Results / Observations:**

| Beakers | Liquids | Time taken for the nails to rust (days) |
|---|---|---|
| A | 160mL of water and 20mL of oil | |
| B | 180mL of hot water | |
| C | 180mL of tap water | |
| D | 180mL of mineral water | |

**Science behind it:**

Since one of the chemical reactions that causes rust requires the presence of water and the second reaction requires oxygen, rust can only form when both water and oxygen can reach the iron molecules in the nail. Unfortunately, both water and oxygen are readily available in the atmosphere, so even unprotected nails in a desert environment will succumb to rust, although iron exposed to high humidity or seawater will rust much more quickly. Steel rusts as well as iron because it is an alloy chiefly composed of iron.

Everyone knows that iron and steel will go rusty, becoming coated in a reddish orange crust that will, if left for too long, eat away at the metal to the point of weakening the metal severely. Rusting is the corrosion of iron and steel; as that is exactly what the rust is doing, corroding or destroying the metal through a chemical reaction.

Essentially, if water or moisture comes into contact with iron or an alloy of iron, such as steel, which hasn't been protected by any form of coating such as paint, a chemical reaction takes place as the water causes the metal to react with oxygen in the air. This is because electrons from the iron atoms transfer across to the oxygen atoms. This produces an acid; iron oxide, which is just the chemical name for rust. As this reaction changes the chemical structure of iron or steel, over time the metal will deteriorate to a point where no more iron or steel is left, replaced instead by iron oxide or rust.

However, there are other kinds of rust, as concrete can also rust if it has been reinforced with metal reinforcing called rebar. Whilst the reinforcing bars might not be open to the air, the iron of the rebar can come into contact with chlorine as chlorides attack concrete, and the chemical reaction between the iron and chlorine will also produce rust, turning the concrete green.

The main factor which causes rust, then, is moisture. As such, to prevent iron or steel from rusting, the simplest way is to keep the material away from the elements or the ocean, but inevitably iron and steel are used to construct objects which are used outside all of the time, due to the strength of the materials. Pretty much anything you think of which is used outside, from tools to ships, are made from iron or steel. This is particularly bad news for ships, as the salt in salt water speeds up the reaction which produces rust, making ships very susceptible to rust.

By covering iron or steel with a coating, the problem of rusting or corrosion is immediately removed. If the moisture doesn't touch the surface of the metal directly, the chemical reaction which produces iron oxide can't take place, therefore the metal can no longer rust. This is why painting metal stops iron or its alloys from rusting. For the same reason, galvanizing iron or steel will prevent it from rusting. Zinc, used to galvanize steel or iron, doesn't react with moisture and oxygen in the same way as iron, so acts to protect metal from the rusting reaction. Other metals such as aluminum or titanium will also serve to protect iron, but zinc is most commonly used due to the cheapness of the material. Other forms of coating, such as oil or wax, will also help to prevent rusting for the same reason.

The size of the piece of metal can also affect rusting, as the larger the piece of iron, the more likely it is to have small deficiencies from the smelting process which formed it into shape. The waste product of iron smelting is slag, and many different trace elements will be present in the iron, such as carbon. These small deficiencies can cause small flaws which make it easier for the rust to attack the metal. As thinner metal has generally been heated for longer in order to make it thin, thinner metal will have fewer deficiencies or flaws, so usually won't rust as fast.

Any other form of acid will also cause iron or steel to rust. Even blood can cause steel to rust, as it contains iron, allowing oxidization, and the reaction which produces rust, to occur on the surface of the metal if no sort of protective layer is applied to the metal. This used to be an issue when swords were still used, as blood on the blade would almost instantaneously start the oxidization reaction, pitting the steel of the blade with small spots of rust as the iron in the blood reacting on the surface ate into the blade.

So, rust can fairly easily be prevented if the factors which cause rusting are taken into account. Something as simple as painting iron can prevent the rusting, saving the metal from the corrosion it would otherwise be subject to.

**References:**

http://www.olc.edu.hk/~awong/expt14.php

https://sciencing.com/causes-nail-rust-8267344.html

**Experiment 12**

**Title:** Rusting

**Objective:** To study the ways to prevent rusting process.

**Problem statement:** What are the ways to prevent rusting process?

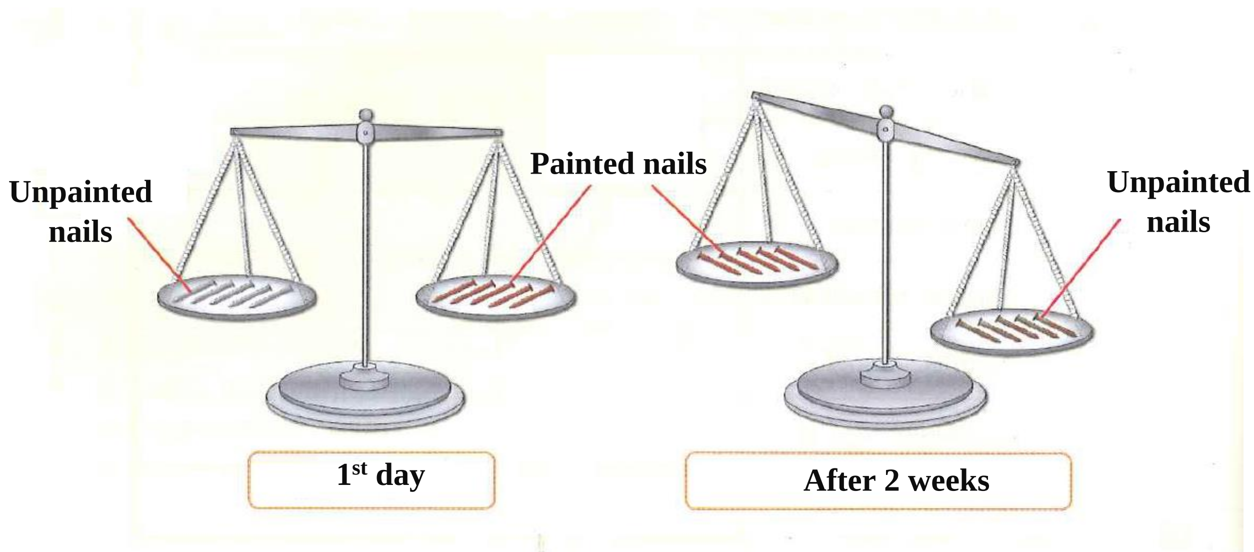
**Hypothesis:** Painting one of the better ways to prevent rusting.

**Apparatus and Materials:** 10 iron nails, paint, and Old antique brass balance.

**Variables:**

i. Manipulated: coating of nails
ii. Responding: mass of nails
iii. Controlled: duration of exposed

**Procedures:**




1. Paint 5 iron nails.
2. Place 5 unpainted nails at one side and another 5 painted nails at other side of old antique brass balance.
3. Leave them two weeks.
4. Record your observations.

**Results / Observations:**

After two weeks, we can observe the mass of unpainted iron nails increases.

**Science behind it:**

When iron rusts - in the presence of moisture and oxygen - iron-oxide is formed. Iron oxide is nothing but a compound of iron and oxygen. There is an increase in the mass of the iron equal to the mass of oxygen that has gone into forming the rust.

**References:**

https://www.quora.com/Why-does-an-iron-nail-gain-weight-on-rusting