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8+

WARNING!

Not suitable for children under three years. To be used under the direct supervision of an adult. Choking hazard – small parts can be ingested or inhaled. Cut or stab wounds of the skin by sharp functional edges and points. Instructions for the parents or other responsible persons are included and must be followed. Contains some chemicals that are classified as harmful. Prevent chemicals from coming in contact with the body. Hold small children and animals away while experimenting. Keep Experiment Set out of reach of children under three years. Eye protection for supervising adults is not included. Keep the packaging and manual because they contain important information!

0-3

MANUAL WITH EDUCATIONAL INFORMATION AND EXCITING EXPERIMENTS

CHEMIE 1000
CHEMISTRY 1000

BRESSER®

NATIONAL GEOGRAPHIC™

General Warnings

- Read these instructions before use, follow them and keep them for reference.
- Keep young children, animals and those not wearing eye protection away from the experimental area.
- Always wear eye protection.
- Store this experimental set and the final crystal(s) out of reach of children under 8 years of age.
- Clean all equipment after use.
- Make sure that all containers are fully closed and properly stored after use.
- Ensure that all empty containers are disposed of properly.
- Wash hands after carrying out experiments.
- Do not use any equipment which has not been supplied with the set or recommended in the instructions for use.
- Do not eat or drink in the experimental area.
- Do not allow chemicals to come into contact with the eyes or mouth.
- Do not replace foodstuffs in original container. Dispose of immediately.
- Do not apply any substances or solutions to the body.
- Do not grow crystals where food or drink is handled or in bedrooms.
- Take care while handling with hot water and hot solutions.
- Ensure that during growing of the crystal the container with the liquid is out of reach of children under 8 years of age.

Declaration of Conformity

Bresser GmbH has issued a ‚Declaration of Conformity' in accordance with applicable guidelines and corresponding standards. This can be viewed any time upon request.

DISPOSAL

Dispose of the packaging materials properly, according to their type, such as paper or cardboard. Please take the current legal regulations into account when disposing of your device. You can get more information on the proper disposal from your local waste-disposal service or environmental authority.

Get exclusive new Experiments – only available online!

Media about this product

You can dowload further media (experiments, manuals, etc.) from the BRESSER website* over the following QR code/weblink.

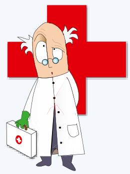
http://www.bresser.de/download/9130300

* Offer subject to the availability of media.

General first aid information

- **In case of contact with eyes:** wash out eye with plenty of water, holding eye open if necessary. Seek immediate medical advice.
- **If swallowed:** wash out mouth with water, drink some fresh water. Do not induce vomiting. Seek immediate medical advice.
- **In case of inhalation:** remove person to fresh air.
- **In case of skin contact and burns:** wash affected area with plenty of water for at least 10 minutes.
- In case of doubt, seek medical advice without delay. Take the chemical and its container with you.
- In case of injury always seek medical advice.

Write the telephone number of the local poison centre or hospital in the space below. They may be able to provide information on countermeasures in case of poisoning.



In case of emergency dial
Europe 112 | UK 999
USA 911 | Australia 000

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Warranty and warranty term extension

The warranty term is two years from the date of purchase. Please keep your proof of purchase. Register at **www.bresser.de/warranty** and fill out a brief questionnaire to get your warranty term extended to **five years**. Registration must be completed within three months of purchase (date of receipt) to validate the warranty. If you register thereafter, the warranty term will not be extended.

If you have problems with your device, please contact our customer service first. Do not send any products without consulting us first by telephone. Many problems with your device can be solved over the phone. If the problem cannot be resolved by phone, we will take care of transporting your device to be repaired. If the problem occurred after the warranty ended or it is not covered by our warranty terms, you will receive a free estimate of repair costs.

Service Hotline: +49 (0) 2872 - 80 74-210

Important for any returns:
Please make sure to return the device carefully packed in the original packaging to prevent damage during transport. Also, please enclose your receipt for the device (or a copy) and a description of the defect. This warranty does not imply any restriction of your statutory rights.

Your dealer:.. Art. No.: ....

Description of problem:...

Name:.. Telephone: ....

Street:.. Date of purchase: ....

City/Postcode:... Signature: ....

General disclaimer. Bresser GmbH has used their best endeavors to ensure that the Information in this book is correct and current at the time of publication but takes no responsibility for any error, omission or defect therein.

Index

List of chemical substances supplied

<table>
<tr><th>Chemical substance</th><th>Chemical formula</th><th>CAS number</th><th></th></tr>
<tr><td>Ammonium iron (III) sulfate</td><td>$NH_4Fe(SO_4)_2 \cdot 12H_2O$</td><td>7783-83-7</td><td>
Warning</td></tr>
<tr><td colspan="4"><u>Hazard Statement:</u>
H315: Causes skin irritation.
H319: Causes serious eye irritation.
<u>Precautionary Statement — Response:</u>
P305 + P351 + P338: IF IN EYES: rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.</td></tr>
<tr><td>Citric acid</td><td>$C_6H_8O_7$</td><td>77-92-9</td><td>
Warning</td></tr>
<tr><td colspan="4"><u>Hazard Statement:</u>
H319: Causes serious eye irritation.
<u>Precautionary Statement — Prevention:</u>
P264: Wash hands thoroughly after handling.
P280: Wear protective gloves/protective clothing/eye protection/face protection.
<u>Precautionary Statement — Response:</u>
P305 + P351 + P338: IF IN EYES: rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P337+P313: If eye irritation persists: Get medical advice/attention.</td></tr>
<tr><td>Potassium hexacyanoferrate (II) (Potassium Ferrocyanide)</td><td>$K_4(Fe(CN)_6).3H_2O$</td><td>14459-95-1</td><td>
Warning</td></tr>
<tr><td colspan="4"><u>Hazard Statement:</u>
H412: Harmful to aquatic life with long lasting effects.
<u>Precautionary Statement — Prevention:</u>
P273: Avoid release to the environment.</td></tr>
<tr><td>Sodium carbonate</td><td>Na_2CO_3</td><td>497-19-8</td><td>
Warning</td></tr>
<tr><td colspan="4"><u>Hazard Statement:</u>
H319: Causes serious eye irritation.
<u>Precautionary Statement — Prevention:</u>
P260: Do not breathe dust/fume/gas/mist/vapours/spray.
<u>Precautionary Statement — Response:</u>
P305 + P351 + P338: IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.</td></tr>
<tr><td>Litmus (tournesol) powder</td><td></td><td>1393-92-6</td><td></td></tr>
</table>

Disposal of used chemicals

When you're disposing chemical substances, please refer to national and/or local regulations. Do not throw chemicals into sewers and garbage. For more details, please refer to a competent authority. For disposal of packaging, make use of specific collection points.

Advice for supervising adults

- Read and follow these instructions, the safety rules and the first aid information, and keep them for reference.
- The incorrect use of chemicals can cause injury and damage to health. Only carry out those experiments which are listed in the instructions.
- This experimental set is for use only by children over 8 years.
- Because children's abilities vary so much, even within age groups, supervising adults should exercise discretion as to which experiments are suitable and safe for them. The instructions should enable supervisors to assess any experiment to establish its suitability for a particular child.
- The supervising adult should discuss the warnings and safety information with the child or children before commencing the experiments.
- The area surrounding the experiment should be kept clear of any obstructions and away from the storage of food. It should be well lit and ventilated and close to a water supply. A solid table with a heat resistant top should be provided.

Kit contents

Description:	Quantity:
1. Protective goggles	1
2. Lab coat	1
3. Pipettes	3
4. Measuring cups	2
5. Measuring cup lids	2
6. Ammonium iron(III) sulfate (Mohr's Salt)	1
7. Potassium ferrocyanide	1
8. Citric acid	1
9. Sodium carbonate	1
10. Litmus powder	1
11. Plastic spoon	1
12. Test tube lids	5
13. Test tubes	5
14. Bottle for tournesol	1
15. pH strips	5
16. Protective gloves	1

1. Experiments

When conducting experiments that require stabilising a test tube, you can construct a stand using modeling clay.

Experiment 1
Saturated solution

What you will need:

- Sugar
- Water
- Large measuring cup (100 ml)
- Wooden spatula
- Plastic spatula

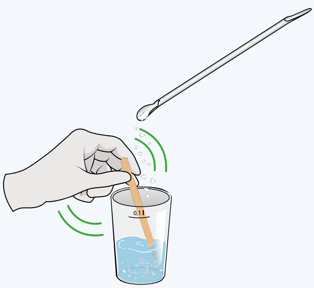
Steps:

1. Fill half the cup with water.

2. With the plastic spatula, add spoons of sugar to the cup.

3. Stir the water and sugar mixture, with the wooden spatula.

4. Continue adding sugar to the mixture until it becomes impossible to dissolve anymore.



What type of solution is this?

Explanation:

If we continue adding sugar and stirring the solution with the wooden spatula, we reach a saturation point that makes impossible to dissolve all the sugar added, in other words, the solution gets saturated!

Saturated solution: Solution which contains the maximum amount of solute in a certain volume of solvent and a given temperature.

Experiment 2
Water solubility

Background to the experiment:

The next experiment is based on the behavior of substances when mixed with water. This is called **solubility**. In order to get a better grasp of this concept, let's first look at some amazing properties of water.

Water - its structure and properties

Water is one of the most important molecules in the human body; 60-70% of the human body is made of water.

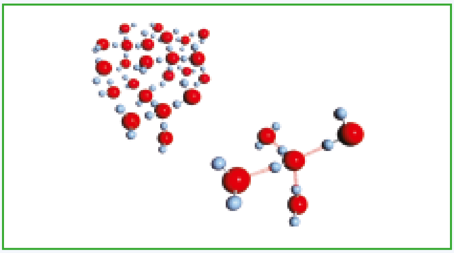


Image 1. Water Molecule Structure.

The special properties are the reason that water plays such an important role in the life of human beings, and the world in general. These properties originate in the molecule´s chemical structure and the type of bonds that it forms.

Water is made of an atom of oxygen (half an O_2 molecule), which bonds with two atoms of hydrogen (H). The chemical formula is therefore H_2O.

Some of the most important water **properties** are:

1. Water lacks taste, odour, and colour; however if we look closely, we can notice a small change in colour depending on the matter state (solid, liquid or gas).

2. Chemically, one of the most important characteristics is that water is a polar molecule, which means electrons are distributed in an asymmetrical manner, the electrons being on the side of the oxygen.

Polarity influences how water interacts with other substances. Substances composed of polar molecules dissolve in water while non-polar substances, like oil, do not.

According to this property we can classify substances in two groups:

- Hydrophobic: from *hydro* (water) and *phobia* (fear). These are substances that repel or avoid water, meaning they do not dissolve. These substances are composed of non-polar molecules.

- Hydrophilic: from *hydro* (water) and *philia* (love). These substances have a chemical affinity to water, which means they dissolve when placed in it. They are composed of polar molecules.

3. Water molecules are held together by van der Waals forces, which are fundamental in determining water's characteristics, such as great superficial tension.

"Surface tension" refers to the amount of energy needed to "break" water's surface. It is a fundamental property.

Insects are able to travel across the surface of water without breaking it thanks to water's superficial tension.

Image 2. Insect on the water surface.

4. Water has a great force of adhesion (capacity to stick to something), that together with cohesion (capacity of molecules to stick to themselves) enable the phenomenon of capillarity, which is the ability of water to flow against gravity, like climbing up a thin water tube.

5. Boiling point: is the temperature at which a substance changes from a liquid to a gas.

This depends on atmospheric pressure; at sea level water boils at 100ºC (212ºF), whilst on the top of a mountain where atmospheric pressure is lower, water boils at temperatures as low as 68ºC (154.4ºF).

6. Water has a high specific heat capacity that influences the ability of water to absorb heat. This property stems from the hydrogen bridges that hold the molecules together.

Water is a great thermal regulator, and it is thanks to water that the temperature on our planet is moderate. You can absorb water's capacity to absorb heat every time you take a shower.

If you do not dry yourself straight away, water will start absorbing your body's heat and you will get cold.

It is this property that also ensures temperature variations in coastal regions are not as extreme as those in non-coastal regions.

7. The **density** of water is an extremely important characteristic for living beings. Water density is very stable and varies only slightly with changes in temperature or pressure.

Liquid water has a minimum density of 958.4 kg/m^3 at 100ºC (212ºF). When the temperature lowers, density increases (at 80ºC [176ºF] for example the density is 971.8 kg/m^3).

The increase in density will be constant until the temperature reaches 4ºC (39.2ºF) which is the point of maximum density.

Below that temperature, density lowers again. When the change from liquid state to solid state occurs, there is a sudden decrease in density. That is why ice (water in the solid state) floats in water, like icebergs in the ocean.

Solutions

A solution is a homogeneous mixture of two or more substances. The substance that is dissolved is called solute and is generally present in small quantities.

One of the first things you need to know regarding the chemistry of solutions are the relative quantities of solutes, in respect to the quantity of solvents in the mixture.

To say that a solution is diluted or concentrated is relative.

When you want to be precise, the concentration of a solution is generally expressed by the percentage of weight or volume of the solute in relation to the solvent.

For example, an aqueous solution of salt at 4% means that in each 100g of solution, 4g are salt and the remaining 96g are water.

Solution	Solvent	Solute	Examples
Gaseous	Gas	Gas	Air
Liquid	Liquid	Liquid	Alcohol in water
Liquid	Liquid	Gas	O_2 in H_2O
Liquid	Liquid	Solid	NaCl in H_2O

Legend: NaCl - salt.

Solubility

Solubility refers to the maximum quantity of a solute that you can dissolve in a solvent at a certain temperature. Several factors affect the solubility of a substance and it is necessary to have them in mind when preparing a solution. Some of these are:

Contact surface: the solute-solvent interaction increases as the contact area between them gets larger, meaning a substance dissolves faster in a powder form than when in a block.

Stirring: when a solution is stirred, new layers of solute will come into contact with the solvent, thus allowing the solute to dissolve quicker in the solvent.

Temperature: a higher temperature increases the movement of molecules, which means it is easier to dissolve a solute in a warm or hot solvent than in a cold solvent.

Pressure: the dissolution of a gas in liquid (at constant temperature) is directly proportional to the water pressure; the higher the pressure, the greater the solubility in liquid.

Conducting the experiment:
As we have seen, different substances have different solubility. In this experiment, we will compare the solubility of several substances verifying which takes the least time to dissolve and which takes the longest.

What you will need:
- Plastic spoon
- Pasteur pipette
- Measuring cup
- Salt
- Yeast
- Baking soda
- Flour
- Detergent powder
- Graphite
- Chalk
- Lemon juice
- Coffee
- Sugar
- Black Pepper
- Cocoa

Steps:
1. With the help of a plastic spoon, place one portion of a substance inside a measuring cup. This is now cup A.

2. Fill another cup with water. This is now cup B.

3. With the Pasteur pipette, remove water from cup B and put it into the cup A. At the same time, stir the solution with the spoon.

4. Observe what happens and write down the results.

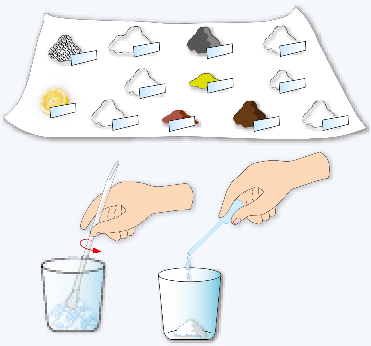
5. Continue the experiment, repeating these steps for the rest of the substances. Do not forget to wash the spoon and cup A thoroughly, between experiments.

Which substance dissolved the fastest?

Which substance dissolved the slowest?

Which substance did not dissolve?

TIP: Do not forget that you have to use the same quantities of each solute and solvent and perform the mixtures under the same conditions to make it a fair test.



Experiment 3
Solubility: Crystals

Background to the experiment:
Most solids in nature are crystalline, which means their atoms, molecules or ions are ordered geometrically in space. This ordered structure is not always visible to the naked eye since these solids are formed by groups of micro-crystals organised in different ways, forming an apparently amorphous (without a precise shape) polycrystalline structure.

The order found in many solids contrasts with the disorder found in gases and liquids. When a solid does not have a crystalline structure, it is said to be amorphous.

The compounds, bonded by ionic bonds, display an organised structure that is called crystal.

The crystal lattice is an arrangement of molecules that consists of a structure with an undefined number of ions, in which the number of negative charges is equal to the number of positive charges, with the whole being electrically neutral.

In this experiment, we will use sugar to find out how this substance turns into crystals. A minor detail about sugar: The sugar we use in our daily life is scientifically called sucrose. It is a disaccharide, which means it is formed from two simple sugars: glucose and fructose. The chemical formula of sucrose is $C_{12}H_{22}O_{11}$.

When we dissolve this substance in water, it seems to disappear. In reality, it is only hidden and when water evaporates, it appears again.

In certain conditions, the substance forms crystals that can be observed with the naked eye.

Conducting the experiment:
We will dissolve some substances in order to verify some of the previous statements.

What you will need:
- Plastic spoon
- Pasteur pipette
- Measuring cups
- Salt (NaCl)
- Sugar
- 2 Glass tumblers

Steps:
1. With the plastic spoon, place four portions of sugar in one of the measuring cups. This will be cup A.

2. Fill the other measuring cup with hot water.

3. Quickly, and with the help of a Pasteur pipette, place some hot water inside cup A and stir the sugar water solution.

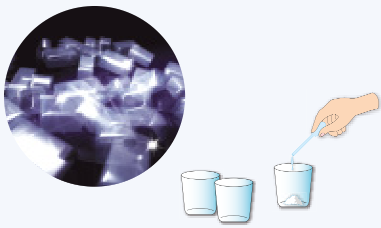
If it does not dissolve completely, add some more water until the sugar is completely dissolved.

4. Pour the solution into one of the glass cups and leave it somewhere to rest for several days.

5. As time goes by, the water will evaporate and sugar crystals will start to appear in the bottom of the glass.

6. Repeat these steps with salt (NaCl).

Do the crystals formed by both substances look alike?



Explanation:
Depending on their components and their internal structure, different substances form different crystals.

Experiment 4
Sugar crystals

Warning: These sugar crystals are not edible!

What you will need:
- A pot
- A wooden spoon
- A glass jar
- Sugar
- Water
- Food colouring
- Wooden skewers

Steps:

1. Pour one glass of water and two spoons of sugar into the pot.

2. Ask an adult to put the pot on the stove until the water boils. Stir constantly so that nothing sticks to the bottom.

3. Remove the pot from the stove and add more sugar, spoon by spoon, until it cannot dissolve in the water.

4. If you want, add some food colouring and stir.

5. Pour the liquid in the glass jar, dip the skewers in the liquid and afterwards, sprinkle them with some more sugar. Leave the skewers to dry.

6. When the skewers are dry, place them in the jar again.

7. Place the jar in a dark place to set for about a week, or until the crystals have formed.

Image 3. Sugar crystals.

Explanation:
As the water evaporates, dissolved substances precipitate. Once the process slows down, crystals begin to form. Their colour is determined by the food colouring used.

Experiment 5
Acid or base

We can use our senses to identify substances. One sense that we can use is taste. This sense allows us to recognise if a substance is an acid or not. You can do this with many substances but you must be sure that they are edible, otherwise it can be very dangerous. Never taste unknown substances or those you do not know to be edible.

In chemistry, other more scientific methods are used to determine if a substance is an acid or not, regardless of its edibility. If you were asked to name an acid, you would probably think of vinegar or lemon. Lemon juice and vinegar are acids and to find that out, you only need to put a small portion in your mouth. When we ingest food, areas of our tongue called taste receptors analyse it and send the information to the brain. These receptors only perceive four basic tastes: sweet, salty, sour and acid.

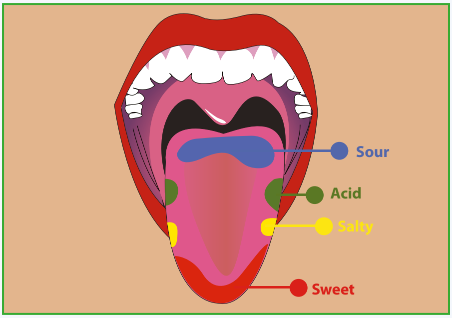


Image 4. Detection of flavours by the tongue.

However, in chemistry, the concept of acid is much more complex and throughout history, many different definitions and concepts have arisen.

Lavoisier's definition

Lavoisier defined acids in terms of their quantity of oxygen or "acid creator" - in Greek, *oxys* means acid and *ginomai* means to create. This definition remained an absolute truth for more than 30 years.

Liebig's definition

This definition was put forward in 1838 and ended the distinction between oxygen-based acids and hydrogen-based acids previously used.

According to Liebig, an acid is a substance that contains hydrogen which could be substituted by a metal. This definition was used until the adoption of the Arrhenius definition.

The Arrhenius definition

This definition awarded Arrhenius the 1903 Chemistry Nobel Prize. It defined acid-based reactions as those in which acids are the elements that dissociate in water forming hydrogen ions (H^+) later known as hydronium cations (H_3O^+). The bases are those that form hydroxide anions (OH^-).

The creation of water from hydronium and hydroxide ions are representative of the Arrhenius theory:

$$H^+ (H_3O^+) (aq) + OH^- (aq) \dashrightarrow H_2O$$

Brönsted-Lowry's definition

This definition relies on the ability of acids to donate hydrogen ions (H^+) to bases that in turn accept them. This is the idea of the protonation of bases through the de--protonation of acids.

The Brönsted-Lowry definition does not refer to the formation of salts and water but to the formation of combined acids and combined bases produced through the transfer of an acid proton to the base.

It follows that an acid is a compound that can donate a proton and a base is a compound that can receive a proton (notice that a proton is a particle with a positive electrical charge that is present in the nuclei of every atom).

The elimination of the H^+ from hydrochloric acid (HCl) produces the chloride anion (**Cl^-**). This is the reaction:

$$HCl \dashrightarrow H^+ + Cl^-$$

The addition of hydrogen ions (H^+) to the hydroxide anion (OH^-) - a base - produces water:

$$H^+ + OH^- \dashrightarrow H_2O$$

Another example is the protonation of ammonia (NH_3) - a base - to form the ammonium cation (NH_4^+) - its conjugated acid:

$$H^+ + NH_3 \dashrightarrow NH_4^+$$

This reaction may occur in the abscence of water, like in the reaction between ammonium and acetic acid (CH_3COOH).

Acetic acid is also known as vinegar and you will be able to confirm the following reaction.

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$$CH_3COOH + NH_3 \text{--->} NH_4^+ + CH_3COO^-$$

This definition also provides an explanation to the spontaneous dissociation of water with low concentrations of hydronium and hydroxide ions:

$$H_3O^+ + OH^- \text{--->} 2H_2O$$

DID YOU KNOW...
Water can act as an acid or a base? When a water molecule functions as an acid by providing an H^+ ion and forming a base OH^-, and a second water molecule functions as a base accepting the H^+ ion and forming H_3O^+ it is called **amphoteric**.

The general formula for the acid-base reactions according to Brönsted-Lowry is:

$$AH + B \text{--->} BH^+ + A^-$$

Where AH represents the acid, B represents the base and BH^+ represents the conjugated acid of B, and A- represents the conjugated base of AH.

Lewis' definition

Lewis' definition determines that a base (Lewis' base) is a compound that can donate an electronic pair and an acid (Lewis' acid) as a compound that can receive the aforementioned electronic pair.

For example, we will see the following acid-base reaction:

$$HCl\,(aq) + NaOH\,(aq) \text{--->} H_2O\,(l) + NaCl\,(aq)$$

The H^+ ion, being the acid, and the OH^- ion, being the alkali, have an electronic pair which is not shared. Therefore, this acid-base reaction, according to Lewis' definition, is the donation of the OH^- ion electronic pair to the H^+ ion.
This forms a bond between H^+ and OH^- that produces water.

pH concept

This is the concept used to measure acidity or basicity of a solution or compound which is defined by the quantity of H^+ and OH^- present in the mentioned solution or compound.

If you have a pool, or have seen someone do the maintenance of a pool, you may have noticed that one of the steps in the process is to measure the pH level of the water.

The acidity of the water is measured so it can be kept at levels that prevent the water from getting dirty, due, in part, to the presence of small animals or plants.

The acidity level must also be kept within limits that are not harmful to our health.

The pH scale was established to calculate acidity levels, being numerically expressed by the following formula:

$$pH = -\log [H^+]$$

You can also calculate levels of alkalinity - expressed through the pOH scale:

$$pOH = -\log [OH^-]$$
$$pH + pOH = 14$$

These formulas can be used to solve several questions regarding acids and bases. The scale ranges from 0 (the most acidic) to 14 (the most basic), 7 being considered the neutral level - in which the amount of H^+ and OH^- is the same.

You may have heard that the skin's pH level is 5.5 and therefore slightly acidic. It is the acidity level of the skin that creates a shield

against the attacks of microorganisms that cannot survive in an acidic environment.
This is a pH scale with examples of several common compounds:

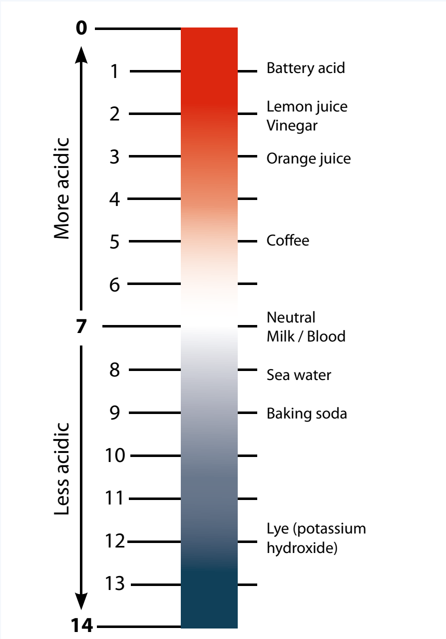


Image 5. pH scale.

Dissolutions

As for dissolutions of acids and bases:

- If we dissolve an alkaline substance in pure water, the concentration of hydroxide ions (OH^-) increases. In order to keep the ionic balance of water, the concentration of hydronium ions (H_3O^+) must decrease.

- If we dissolve an acidic substance in pure water, the protons (H^+) separate, therefore increasing their concentration and diminishing the concentration of hydroxide ions (OH^-) in order to reach water's ionic balance.

REMEMBER: Water's ionic balance is:

$$2\,H_2O \text{ ---> } H_3O^+\,(H^+) + OH^-$$

So, you have the following relationships:

- There is an acidic dissolution when:
$$[H^+] > [OH^-]$$

- There is a neutral dissolution when:
$$[H^+] = [OH^-]$$

- There is an alkaline dissolution when:
$$[H^+] < [OH^-]$$

Since in a neutral water dissolution the principle is that $[H_3O^+] = [OH^-] = 10^{-7}$ **M**, we have:

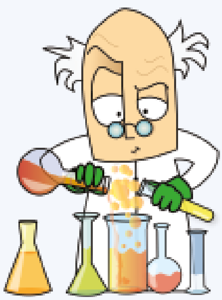
- Acidic dissolution when:
$$[H_3O^+] \text{ or } [H^+] > 10^{-7}\text{ M ---> pH} < 7$$

- Neutral dissolution when:
$$[H_3O^+] \text{ or } [H^+] = 10^{-7}\text{ M ---> pH} = 7$$

- Alkaline dissolution when:
$$[H_3O^+] \text{ or } [H^+] < 10^{-7}\text{ M ---> pH} > 7$$

Conducting the experiment:

WARNING: You will need the help of an adult. As we said, substances can be acidic or alkaline. Let's produce solutions with substances you use in your daily life and discover which are acidic or basic.



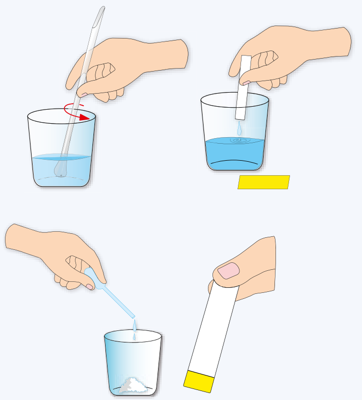
What you will need:
- 2 Measuring cups
- Plastic spoon
- pH test strips
- Pasteur pipettes
- Lemon juice (citric acid)
- Baking soda
- Salt
- Sugar

Steps:
First part: Making an acidic solution

1. Squeeze the juice of half a lemon into a measuring cup. Alternatively, if you have some citric acid powder you can dissolve it in the cup with some water.

2. Now put the grey part of the pH test strip in the liquid.

Explanation:
The strip changes colour. Now it is yellow. Why did this happen? We introduced the pH measurer paper in an acidic solution causing the colour change.



Second part: Preparing a baking soda solution

3. Place some baking soda in the measuring cup and add some water. Stir well.

4. Place the pH test strip in the cup and observe the colour.

5. With the Pasteur pipette, add some baking soda solution to the acidic solution and observe the gradual change of colour in the first pH test strip.

TIP: To see the opposite change in a solution's pH, you can first insert a pH test strip into the alkaline solution and measure the pH level.

Afterwards, add some acidic solution to the alkaline solution and observe the change in colour.

If the pH test strip does not work properly, try increasing the concentration of your solutions a bit more by adding more citric acid or baking soda.

Explanation:
The strip changes colour as you add baking soda because baking soda is a base and as you add it to the acid, you will neutralise the solution.

If you continue to add baking soda, there will be a point where the pH indicator will turn green. At this point, you have turned an acidic solution into a neutral solution.

Experiment 6
Natural pH indicator

First part: Prepare your natural pH indicator!

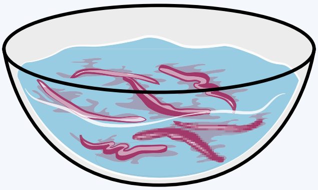
What you will need:
- Red cabbage
- Knife
- Large and wide container
- Wooden spoon
- Hot water
- Container with lid

Steps:

Attention: **Ask an adult for help.**

1. Put hot water in a large and wide container.

2. Ask an adult to cut the red cabbage in small parts and put them in hot water.



3. Stir it with the wooden spoon for some minutes.

4. Save this indicator in a container with lid, so that you may use it in the following experiments.

Observe the pH scale for the natural pH indicator!

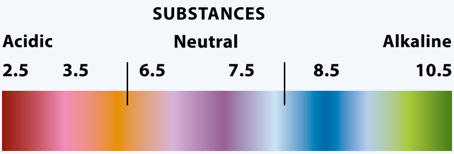


Image 6. pH scale for the natural pH indicator.

Explanation:

Red cabbage has a natural pH meter. It's a pigment called anthocyanin which isn't soluble in water. When placing red cabbage in hot water we are separating the anthocyanin from the red cabbage and dissolving it in water. Anthocyanin molecules change colour depending on the pH of the environment where placed. This pigment can also be found in apple peels, corn flakes, grapes, corn poppy and plums.

Second part: Let's test your natural pH indicator!

What you will need:

- Natural pH indicator
- Test tube
- Plastic spatula
- Pasteur pipettes
- Lemon juice (citric acid)
- Baking soda
- Salt
- Sugar

Steps:

1. Put a small volume of the indicator in a test tube, with the help of the Pasteur pipette.

2. Squeeze a bit of lemon juice into a cup.

NOTE: Alternatively, if you have some citric acid powder you can dissolve it in a cup with some water.

3. Add, with a Pasteur pipette, 3 drops of lemon juice to the test tube with the pH indicator.

What do you observe? What colour does the red cabbage indicator become?

4. Put a small volume of the indicator into another test tube.

5. With the plastic spatula, add a little of baking soda to the test tube.

What do you observe scientist? Which is the colour obtained?

6. Repeat steps 4 and 5 to test the salt and sugar with your natural pH indicator.

What is the pH of these 4 substances?

Explanation:

Solutions with pH lower than 7 are called acidic. Lemon juice contains a compound called citric acid. As the name indicates, this compound is an acid and therefore will change the colour of the natural pH indicator to a color between pink and red, in accordance with what you see in image 6.

Solutions with a pH greater than 7 are called alkaline or basic. Baking soda (or sodium bicarbonate) is a base and will therefore change the colour of the natural pH to a colour between blue and green, in accordance with what we saw in image 6.

A substance that is neither acidic nor basic is called neutral. Salt and sugar are neutral substances. Therefore, they do not change the colour of the pH indicator.

Compare the colours you have just obtained with the colours of the pH test strips from experiment 5.

Experiment 7
Gas factory

In a chemical reaction, we start with two or more substances, which we call reagents, to obtain a new substance - the product - with distinctive characteristics from any of the initial reagents.

In this experiment, we will test two ideas we talked about earlier: solubility and acidity.

Background to the experiment:
Let's repeat one of our earlier experiments only this time we will look at it another way. Let's see how baking soda ($NaHCO_3$) reacts with acidic substances.

You will see how the baking soda decomposes and releases gas (carbon dioxide) when we add lemon juice or vinegar. This happens because these substances are composed of dissolved acids: citric acid (lemon juice) and acetic acid (vinegar).

The chemical reaction that will occur is the following:

$$\mathbf{NaHCO_3 + Acid \dashrightarrow Na\text{-}Acid + CO_2 + H_2O}$$

From this reaction we will obtain two products, an acid salt (Na-acid) that dissolves in water (H_2O) and carbon dioxide that, being a gas, will bubble through the liquid.

DID YOU KNOW...
The gas in fizzy drinks is obtained through a similar process?

Conducting the experiment
Did you know that you can produce bubbles by adding baking soda to other known substances? Let's find out which ones and test them!

What you will need:
- Measuring cup
- Vinegar
- Lemon juice
- Orange juice
- Apple juice
- Cola
- Baking soda

Steps:
1. Place some baking soda in the bottom of the measuring cup.

2. Add some drops of vinegar.

3. Repeat the experiment using lemon juice.

4. Repeat the experiment to see if the baking soda reacts with other acidic beverages like apple juice, cola or orange juice.

Explanation:
In this experiment we are able to observe the phenomenon of effervescence. The higher the concentration of baking soda, the more vigorous the reaction is.

Experiment 8
Efervescence (making bubbles)

What you will need:
- Plastic spoon
- 2 Test tubes
- Baking soda
- Vinegar
- Lemon juice

Image 7. Ingredients used in the experiment.

Steps:

1. Put two big spoonfuls of baking soda in a test tube.

2. Then pour a few drops of vinegar in the test tube. What happens?

3. Repeat the steps with the other test tube using lemon juice instead of vinegar. Does the same reaction happen?

Explanation:

When mixing baking soda (base) with vinegar (acetic acid) or lemon juice (citric acid), a gas forms creating bubbles in the liquid.

This process is called effervescence. The gas that is formed is called carbon dioxide (CO_2).

Experiment 9
Making foam from water

What you will need:
- Plastic spoon
- Test tube
- Baking soda
- Citric acid
- Water

Steps:

1. In a clean and dry test tube pour a big spoonful of baking soda.

2. Next add a big spoonful of citric acid and observe what happens. As you can see, nothing happened.

3. Now add a little bit of water. Does the same thing happen? As you saw in the last experiment, the contents of the tube will make bubbles and form foam.

Image 8. Add water to the baking soda and citric acid.

Explanation:

Many compounds only react with each other when water is added. They dissolve in water in the same way that salt or sugar does. Effervescence is produced when the reaction causes carbon dioxide (CO_2) to be released.

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Experiment 10
Invisible gas

What you will need:
- Plastic spoon
- Test tube
- Baking soda
- Citric acid
- Water
- Matches
- Paper
- Pasteur pipette

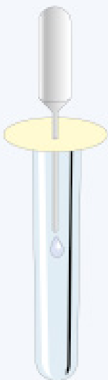
Steps:

1. In a clean and dry test tube put a big spoonful of baking soda.

2. Next, add a big spoonful of citric acid.

3. Cut a circle in the paper and make a small hole in the middle.

4. Now fill the Pasteur pipette with water and place it in the hole (as you can see in the figure on the right) and squeeze its contents in the test tube. Be careful to not let the gas that forms escape.



5. After 10-15 seconds remove the paper and Pasteur pipette, and, with the help of an adult, carefully put a lit match inside. What happens? The match extinguishes rapidly, right?

6. Now put a lit match into the empty test tube. Ask for help from an adult.

Does the same thing happen? As you will see the match will remain lit.

Explanation:
The "empty" test tube is not, in fact, empty. It contains air which is a mixture of two elements: oxygen and nitrogen.

Oxygen is a necessary element in combustion reactions and for breathing. In the test tube with carbon dioxide, the necessary oxygen for the combustion disappears.

Why does this happen?

Because carbon dioxide is heavier than air and when it is formed it pushes all the oxygen outside the test tube. The carbon dioxide doesn't allow the combustion and the match stops burning.

Experiment 11
The candle

What you will need:
- Plastic spoon
- Test Tube
- Baking Soda
- Vinegar
- Candle

Image 9. The carbon dioxide suffocates the candles flame.

Steps:

1. Ask for the help of an adult and light a small candle, placing it on a flat surface.

2. In a clean and dry test tube, put a big spoonful of baking soda.

3. Pour a few drops of vinegar in the test tube until bubbles appear.

4. As the column of foam begins to raise place the opening of the test tube near the flame (as you can see in Image 9).

5. Be careful not to spill the liquid over the candle. What happens? The flame extinguishes.

Explanation:

The foam is suffocated by the carbon dioxide that is released, forming a kind of cover over the candle.

Experiment 12

How to inflate a balloon without blowing

What you will need:

- Balloons
- Baking soda
- Vinegar
- A piece of string
- Plastic spoon
- Plastic bottle

Steps:

1. Fill the bottle halfway with vinegar.

2. Use the small measuring cup and measure 10 ml of baking soda. Pour it inside the balloon.

3. Now stretch the mouth of the balloon over the top of the bottle (without spilling the contents). For more safety, tie a piece of string around the balloon and bottle.

4. Pour the contents of the balloon inside the bottle. What happens?

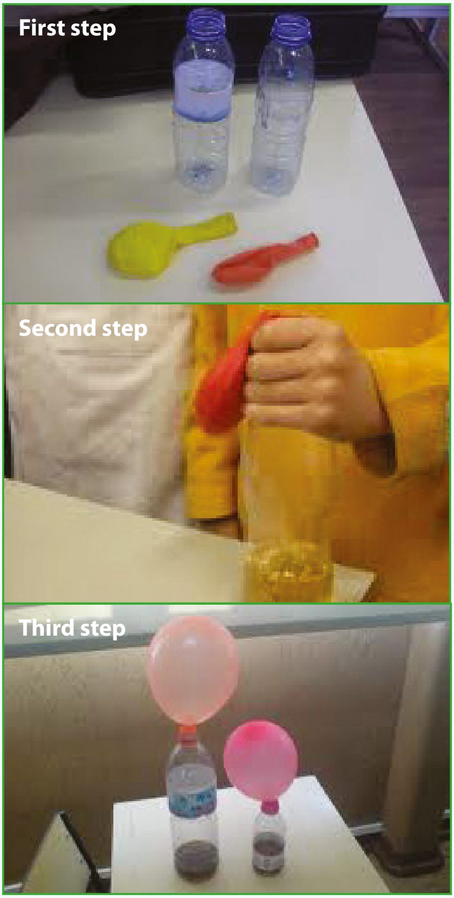


Image 10. Experiment procedure.

Explanation:

When adding baking soda (base) in vinegar (acetic acid) a chemical reaction occurs that releases a large quantity of carbon dioxide (CO_2), enough to inflate the balloon. Experiment this using other acids, for example, with lemon juice instead of vinegar. Does the same phenomenon take place?

Experiment 13
Homemade extinguisher

Can you extinguish a candle flame without blowing on it?

What you will need:
- Baking soda
- Modeling clay
- A straw
- Yarn
- Vinegar
- 1 Small bottle of water
- 1 Napkin
- 1 Candle
- 1 Plastic spoon

Steps:

1. Place 4 teaspoons of baking soda in the napkin. Use the yarn to tie the napkin closed like a little pouch.

2. Put 5 teaspoons of vinegar into the bottle.

3. Next, place the little bag inside the bottle so that it hangs with one part of the yarn hanging outside (on the top of the vinegar but without touching it).

4. Place the straw inside the bottle without touching the vinegar, and put the modeling clay surrounding it, covering the bottleneck completely.

5. Use your finger to cover the end of the straw and shake the bottle so that the vinegar and baking soda mix.

6. Remove your finger and direct the gas that comes out of the bottle towards the lit candle. Ask for the help of an adult when handling the candle.

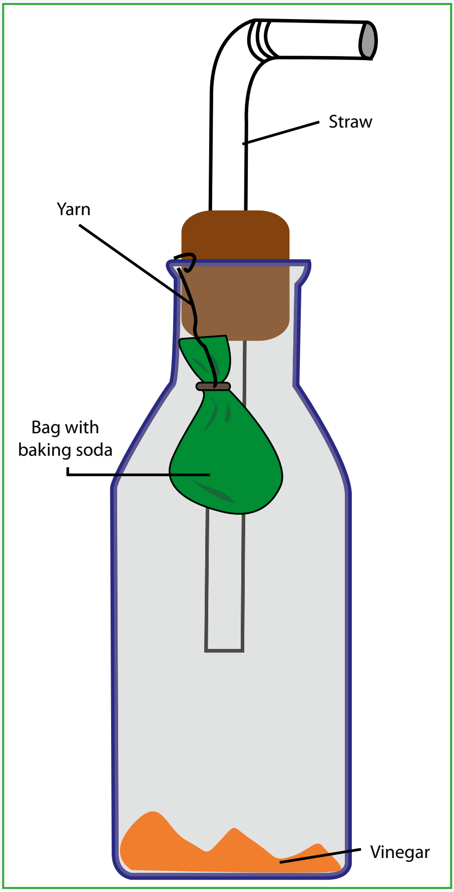


Image 11. Homemade extinguisher.

Explanation:

The chemical reaction between baking soda (base) and vinegar (acid) forms carbon dioxide, filling up the container and exiting out of the straw.

Since carbon dioxide is heavier than air, when it comes into contact with the lit candle it expels the oxygen and extinguishes the candle.

Experiment 14
Indecisive balls

What you will need:
- Baking soda
- Water
- Vinegar
- 1 Big container
- Moth balls
- Plastic spoon

Steps:

1. Put a few moth balls inside the container along with 2-3 teaspoons of baking soda.

2. Add water to it until ¾ of the container is filled.

3. Afterwards, slowly add the vinegar.

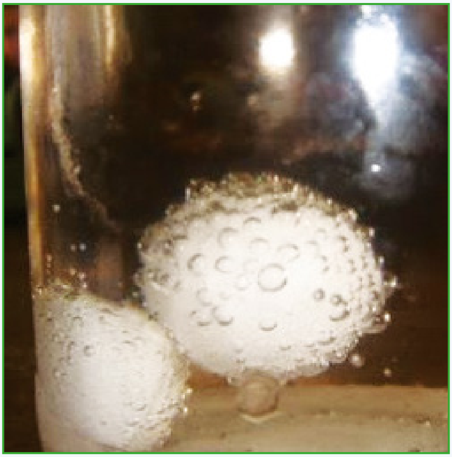


Image 12. Reaction of the baking soda with vinegar.

Explanation:

The reaction between the vinegar and the baking soda forms carbon dioxide (CO_2) that adheres to the moth balls, making them float and sink randomly, when carbon dioxide is released from the balls.

Experiment 15
Dancing noodles

What you will need:
- Baking soda
- 1 Plastic spoon
- Vinegar
- 1 Glass jar
- Vermicelli noodles

Steps:

1. Fill the jar with water and add a few noodles, broken into pieces. Do they float or sink?

2. Take the noodles from the jar and slowly add a few teaspoons of vinegar and baking soda.

3. Place the noodles back in the water. What do you observe?

Image 13. Vermicelli noodles.

Explanation:

Since the noodles are denser than water they tend to sink. However, when adding the baking soda and vinegar, it releases carbon dioxide (CO_2).

Some of these gas bubbles adhere to the noodles, which make them much lighter causing them to float. When reaching the surface, the bubbles are released in the air and the noodles become heavy again and sink.

Experiment 16

Frying an egg in the cold

You can fry an egg without needing a pan, oil, or fire! Discover how with this experiment.

What you will need:
- 1 Egg
- Ethanol (alcohol 96%)
- 1 Plate

Steps:

1. Break the egg and lay it on the plate.

2. Next, pour the ethanol on the top of the egg. It almost instantly begins to turn white, characteristic of a boiled egg. But approximately one hour later it returns to its original colour. The yoke will remain a liquid under a whitish film that looks like the egg white.

WARNING: This egg is not edible!

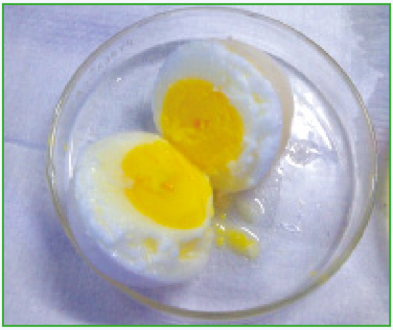


Image 14. Egg with ethanol.

Explanation:

When frying an egg, a structural modification of the protein occurs. That modification (denaturation) can be produced with heat but also with the addition of substances such as ethanol.

Also, this effect can be produced if, before adding the ethanol we beat the egg. In this case, you would get scrambled eggs that will take on the form of the container, like flan pudding does.

Experiment 17

The interesting case of milk

What you will need:
- 2 Jars
- Milk
- Vinegar
- Lemon juice

Steps:

1. Pour the same quantity of milk in each of the jars and then add a bit of vinegar to one and a bit of lemon juice to the other.

2. Shake both containers so that the contents mix. Wait for it to settle.

WARNING: The milk is spoiled and cannot be consumed!

Image 15. Milk with lemon juice.

Explanation:

As with what happened to the egg, the acid in the vinegar (acetic acid) or in the lemon (citric acid) is capable of producing the denaturation of a protein present in the milk called casein.

Experiment 18
Turning milk into glue

What you will need:
- ¼ Cup of lukewarm water
- 2 Tablespoons of powdered milk
- 1 Tablespoon of vinegar
- ½ Tablespoon of baking soda
- 1 Coffee filter
- 1 Glass container
- 1 Funnel made from the top of a plastic bottle

WARNING: ask an adult to help you with this experiment.

Steps:

1. Dissolve the powdered milk in lukewarm water.

2. Add two tablespoons of vinegar and mix well.

3. Microwave for 10 seconds and mix again.

4. Place the paper filter inside the funnel and filter the solution.

5. Use water to clean the cup that had milk and place the white paste that remains in the filtered paper inside the cup. If the paste turns out to be very thick add a bit of water.

6. Add the baking soda and mix well.

Explanation:
Casein is the main protein in milk. While it is soluble in water, its solubility is affected with the addition of acids, like vinegar. In this case, the casein separates from the liquid in the milk. With the addition of baking soda it forms a sodium salt with adhesive properties forming a glue.

Experiment 19
Why do apples turn brown?

Can you preserve apples in the open air?

What you will need:
- 1 Apple
- 1 Knife
- 1 Spoon
- Plastic wrap
- Lemon juice

PRECAUTION: ask an adult to help you with this experiment.

Steps:

1. Cut the apple into 3 pieces, without peeling.

2. Sprinkle one with lemon juice, leave the second piece in the open air and cover the third with plastic wrap.

3. Wait for a few minutes and you will observe that the one with lemon juice retained its characteristic colour.

The piece that was covered with plastic wrap also stayed preserved and the one in the open air turned a brownish colour.

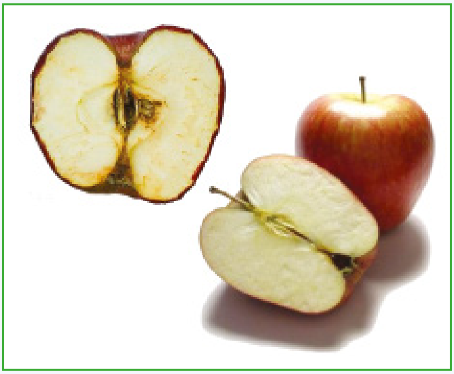


Image 16. Preserved apple and unpreserved apple.

Explanation:
Many fruits become brown when they get old. A major part of this aging process is caused by the existence of oxygen in the air.

Like apples, other fruit can be preserved by refrigerating them, which slows the process of aging, or through isolation with plastic wrap that prevents contact with oxygen.

In this way, the piece that was covered with plastic will stay in better condition than the one that was left out in the air. The piece that was covered with lemon juice will also be in a better state.

The lemon juice contains Vitamin C (ascorbic acid) which is an antioxidant. In other words, it prevents or slows down the effect of oxy-gen on the fruit.

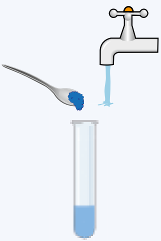
Experiment 20
Tournesol solution

Theme: Acids and Bases

What you will need:
- Ethanol (alcohol 96%)
- Pasteur pipette
- 1 Bottle for tournesol solution
- Water
- Test tube
- Lid to test tube
- Tournesol powder
- Plastic spoon

Steps:

1. Put 3 teaspoons of tournesol powder in a test tube and add about 3 cm of water. Put the lid on the test tube and shake it. Leave it to sit for one day.



2. The next day, gently transfer the solution (that should be dark blue) to the bottle. If there is any black residue in the test tube, try to keep it from entering the solution.

3. Add half a Pasteur pipette of ethanol to the bottle. This will preserve your solution for longer.

4. Lastly, put the lid tightly on the bottle (turn the lid in a clockwise direction).

Explanation:
You have made a solution by dissolving a solid (tournesol powder) in a liquid (water). You will need this solution for a number of the next experiments.

Experiment 21
The appearance of the colour red

Theme: Acids and Bases

What you will need:
- Vinegar
- Pasteur pipette
- Test tube lids
- Test tubes
- Water
- Tournesol solution

Steps:

1. Fill the test tube half way with water.

2. Add 5 drops of the tournesol solution. Watch as some of the blue clouds form in the water.

3. Put the lid on the test tube, shake the tube and then put half of this solution in another test tube.

4. Add some drops of vinegar to the first tube. What happens?

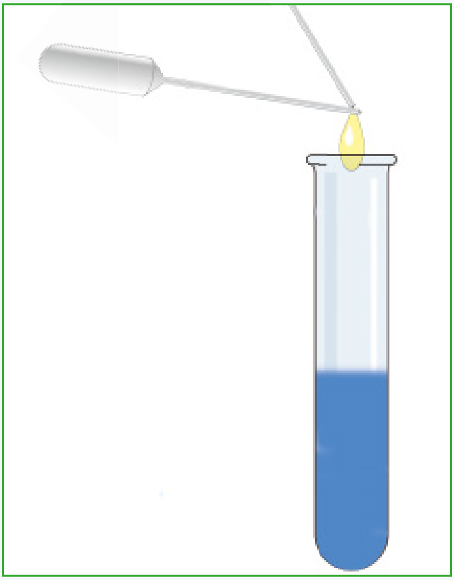


Image 17. Adding vinegar to the tournesol solution.

Explanation:

When adding some drops of an acid substance like vinegar to the tournesol solution, which is a blue colour, this solution changes from blue to red.

Experiment 22
Changing the colour

What you will need:

- Vinegar
- Pasteur pipette
- Test tube
- Test tube lid
- Tournesol solution
- Water
- Baking soda
- Plastic spoon

Steps:

1. Prepare a diluted tornesol solution, fill the test tube halfway with water and add 5 drops of tornesol solution.

2. Add 2 drops of vinegar to make the solution turn red. Transfer this solution to another test tube and save it for the next experiment.

3. Put a teaspoon of baking soda in the first half of the solution. When you shake the test tube the solution will turn blue.

4. Add two drops of vinegar or a bit of citric acid. You will see that the colour of the solution will become red again.

Explanation:

As you can see from the previous experiments, when the solution has a greater acid concentration it becomes a reddish colour. However, when adding a basic substance like baking soda it will return to a bluish colour. If we increase the acid concentration the solution will return to red.

Therefore, the solution will become blue or red depending on if there is more basic or acidic concentration, respectively.

Experiment 23
Blue soap

What you will need:
- A bit of solid soap
- Vinegar
- Test tube
- Test tube lid
- Tournesol solution
- Pasteur pipette

Steps:
1. Add a few drops of vinegar to the test tube with the tournesol solution from the last experiment. It will become an intense red colour.

2. In the other test tube, shave some thin pieces of soap and dilute them with some water by agitating it well.

3. Add this soapy water to the test tube with the red solution you prepared in the last experiment. You will observe that the solution will turn blue. And if you add more acid it will return to red again.

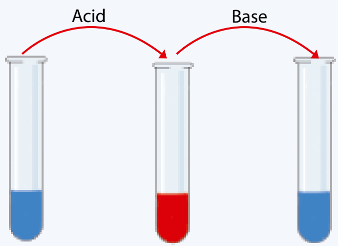


Image 18. Adding acids and bases to the Tournesol solution.

Explanation:
The soapy water, as well as many detergents and cleaning products, have a very similar behavior to baking soda since they are also basic substances, and therefore responsible for the blue colour of the solution. Same as the last experiments, if we add acid, the solution will return to red.

Experiment 24
Magic trick

You can also use the tournesol solution to make magic tricks.

What you will need:
- Citric acid
- Test tubes
- Test tube lids
- Tournesol solution
- Pasteur pipette
- Plastic spoon

Steps:
1. With a Pasteur pipette add 5 drops of the tournesol solution in a test tube with water. Agitate slowly. The "blue paint" is prepared.

2. To the second test tube add a teaspoon of citric acid. If you are some meters away from the crowd they won't know that you have some acid already inside the tube.

3. Say aloud your magic words: "Paint! Listen and obey my command, do what I tell you to and become red." Transfer your blue "paint" to the "empty tube" and gently agitate the tube.

Image 19. Magic trick.

Explanation:
The tournesol solution is blue. When you add this solution to the tube with citric acid it becomes red because of the acids.

Experiment 25
Magic air

Theme: Acids and Bases

What you will need:
- Tournesol solution
- Citric acid
- Baking soda
- Test tubes
- Test tube lids
- Water
- Pasteur pipette

NOTE: this magic trick is a bit difficult, don't give up if it doesn't work the first time.

Steps:

1. In test tube A, add 5 drops of the tournesol solution and water, agitate gently. Naturally, the solution will turn blue.

2. In test tube B, create carbon dioxide by mixing a spoonful of baking soda with citric acid.

3. Pour the carbon dioxide as if it was a liquid into test tube C. Do not let the mixture of baking soda with citric acid fall into this tube. Keep your hand over the tube (as shown in image 20) to prevent the carbon dioxide from escaping.

4. Pour the carbon dioxide into the tournesol solution of test tube A.

Put the lid on and agitate vigorously. The blue colour will gradually become lighter and finally will turn red.

If you want to do this experiment in front of a crowd, perform the first 3 steps without showing anyone, closing the tube C with a lid since it contains the carbon dioxide and perform the last step in front of the crowd.

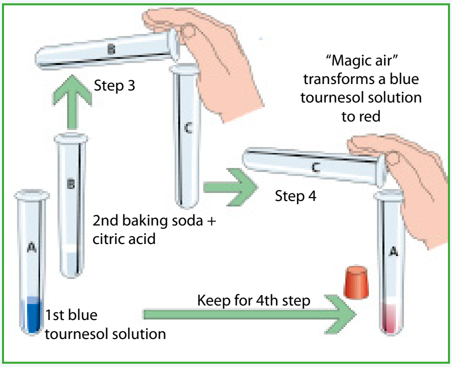


Image 20. Procedure of the experiment.

Explanation:
As indicated by the disappearing blue colour, there must be an acid present. A carbonic acid has formed while the carbon dioxide dissolves in water.

Sparkling water contains a considerable amount of carbon dioxide that is introduced in water under low pressure. For this reason, the water has a slightly acidic flavour and that is why the tournesol solution changes from blue to red.

Experiment 26
Colour change

Theme: Tournesol solution

What you will need:
- Tournesol solution
- Sparkling water or soda water
- Test tube
- Pasteur pipette

Steps:

1. Fill the test tube halfway with sparkling water.

2. Add 5 drops of the tournesol solution. What colour does it become?

Image 21. Laboratory burette and bottle of soda.

NOTE: If there wasn't a change in colour to red it's because the soda is too recent or because it doesn't have enough concentration of carbon dioxide.

Explanation:
When adding the tournesol solution to the liquid there is a higher concentration of carbonic acid and so the solution turns red.

Experiment 27
The droplets

Theme: Acids and Bases

What you will need:
- Tournesol solution
- Test tubes
- Test tube lids
- Baking soda
- Pasteur pipette
- Sparkling water
- Plastic spoon

Steps:
1. Dissolve 4 tablespoons of baking soda into a test tube filled halfway with water.

2. Put the lid on and agitate vigorously until the baking soda dissolves completely. This will be your "starting solution."

3. In another test tube pour a bit of sparkling water and add 5 drops of the tournesol solution.

4. Now, with a Pasteur pipette, add, one drop at a time, the starting solution to the other test tube, and continue to agitate gently after each drop.

In the beginning you will observe a little blue cloud that will vanish when you move the tube. Continue adding the baking soda solution until the colour stays an intense blue for more than 10 seconds.

NOTE: Count of the number of drops you put into the baking soda solution.

5. Repeat the process with sparkling water that has been opened for a long period of time or with tap water. Once again, keep track of the number of drops you add to the solution.

Explanation:

As long as there is carbon dioxide in the water, the effect of the solution you are adding will be nullified. When you initially add drops, the colour will be blue because at this point the concentration of carbon dioxide is high.

But after agitating, the liquids mix and the acid begins to dominate. Only when the acidity is nullified by the basicity of the measurement solution can you obtain a permanently blue colour, after adding more baking soda.

Experiment 28
Fire-resistant balloon

As you know, balloons are very fragile and should be kept away from fire because excessive heat will cause them to burst. But does this always happen? If we put water inside it might not. But why?

What you will need:

- 2 Balloons
- Matches
- Water

PRECAUTION: we recommend that you conduct this experiment under the supervision of an adult

Steps:

1. Fill one balloon with air and tie it.

2. With the help from an adult light one match and put it under the balloon filled with air. What happens? It instantly bursts.

3. Pour half a cup of water inside the other balloon. Fill it with air and tie it.

4. Light another match, and, with the help of an adult, place it under the balloon holding the water.

What you will notice is that it takes much longer for the balloon to burst and sometimes it doesn't burst but creates a black soot mark on the part of the balloon where the flame touches.

Why do you think this is the case?

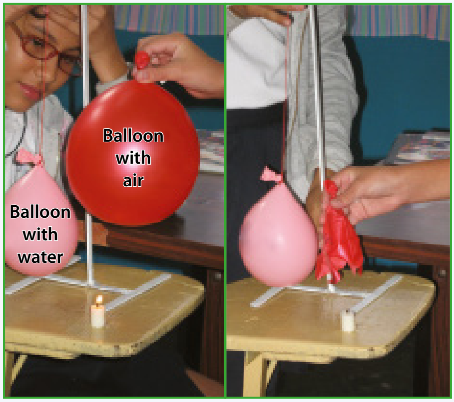


Image 22. The balloon with water is more resistant.

Explanation:

The flame heats everything that is close to it. The balloon rubber without water warms so much that it becomes too weak to resist the pressure of the air inside the balloon and so it bursts.

The balloon with water takes much more time to burst because the water absorbs heat well.

When you place the flame to the balloon the water will absorb the heat, not the rubber, so it will take much longer for it to burst.

Experiment 29
Needle resistant balloon

Theme: Polymers

What you will need:
- Balloons
- 1 Needle
- Tape

PRECAUTION: be careful with the needle, and we recommend that you conduct this experiment under adult supervision.

Image 23. Balloon filled with air.

Steps:

1. Fill a balloon with air (not too much) and tie it.

2. Slowly introduce the needle. What happens? The balloon bursts.

3. Fill another balloon but this time put a piece of tape on it. It must stick well!

4. Slowly introduce the needle where the tape covers the balloon, as you see in image 24. Does it burst?

Explanation:

The balloon rubber is constituted by lots of molecules bonded together. These big molecules are called polymers.

Sometimes the molecules of one polymer intersect. Connections like these keep the molecules together and allow stretching until a certain point. In this experiment, the tape connects to the rubber of the balloon and doesn't allow it to stretch until it bursts.

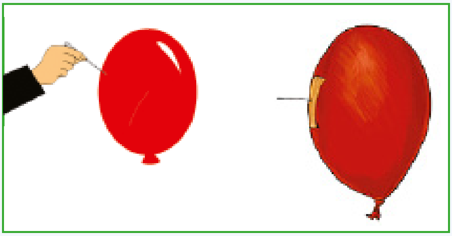


Image 24. Experiment procedure.

Experiment 30
Balloon skewer

Theme: Polymers

What you will need:
- 1 Balloon
- 1 Long wooden skewer

Steps:

1. Fill a balloon with air (don't over fill it) and tie a knot.

2. Introduce the skewer into the top of the balloon where the colour is darkest.

3. Continue to slowly push the skewer through the balloon, taking it out from the bottom. Does it burst or not?

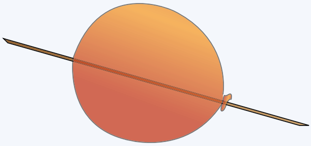


Image 25. Skewer crosses through the balloon without it bursting.

Explanation:
The top of the balloon and the bottom part are the points with the least pressure.

Therefore, when introducing the spikey part of the wooden skewer, the resistance is minimal and the balloon doesn't burst the way it would if you stick it in another spot on the balloon.

Experiment 31
Soap solution

What you will need:
- A bar of soap
- Test tube
- Water

Steps:
1. Fill the test tube 2/3 full with water.

2. Shave some thin pieces of soap and dissolve them with water. Agitate well.

3. Repeat this same experiment in another test tube to create more of this solution.

Explanation:
You will need this solution for the following experiments.

Experiment 32
The hardness of water

What will you need:
- The soap solution (from the last experiment)
- Test tube
- Test tube lid

Steps:
1. Place the soap solution in a test tube.

2. Put the lid on. Agitate it. What happens? You will see a foam layer form.

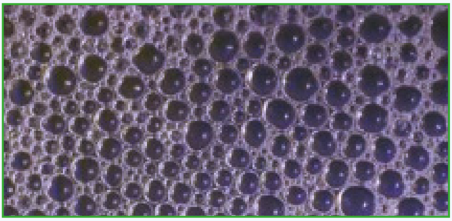


Image 26. Soap bubbles.

Explanation:
The test tube undergoing agitation contains a large quantity of ions that connect with the soap, creating a lot of foam. This is what happens normally. However, it may happen that the water you are using to make the solution is "hard."

The word "hard" is used when water contains a large number of dissolved calcium compounds. When these calcium compounds, (especially calcium carbonate) come into contact with soap, they form an insoluble mixture. This mixture is not useful for cleaning because it actually makes things dirtier. That is why you must used soft water for lots of foam to appear. You shouldn't drink soft water.

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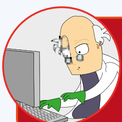

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