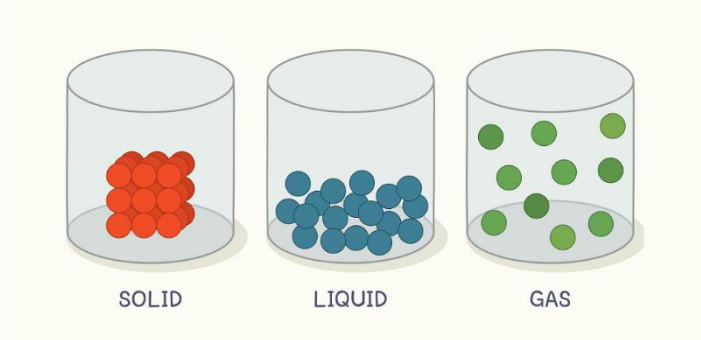
Substance and Mixtures

L1 Solids, liquids, and gasses

Solids, liquids, and gases are all made up of tiny particles called atoms and molecules. These particles are so small that you can't see them with your eyes. Imagine them as mini-LEGO bricks that make up everything around us!

Particle Arrangement:

Solids: In solids, the particles are tightly packed, like a group of friends huddled closely together. They vibrate but don't move around much. This tight arrangement gives solids their shape and makes them firm.



Liquids: In liquids, the particles are still close, but they have a little more room to move. They flow past each other, like friends dancing at a party. This allows liquids to take the shape of their container.

Gases: Gases are like a party where everyone is all over the place! Gas particles are spread out and move freely, bumping into each other and the walls of their container. They don't have a fixed shape.

<u>Properties of Solids, Liquids, and Gases:</u>

Now, let's talk about the properties of these states of matter and how they occur:

Solids:

- Shape: Solids have a fixed shape because their particles are tightly packed and can't move much.
- Volume: They also have a fixed volume because their particles are so close together.
- Hardness: Solids are usually hard because their particles can't move past each other easily.
- Sound: When you tap a solid, it makes a sound because the particles vibrate and pass on the energy as sound waves.

Liquids:

- Shape: Liquids take the shape of their container because their particles can flow and move past each other.
- Volume: Like solids, liquids also have a fixed volume.
- Flow: They can flow because their particles are not as tightly packed as solids.
- Pourability: You can pour liquids because their particles can slide over one another.

Gases:

- Shape: Gases have no fixed shape because their particles are spread out and move freely.
- Volume: They don't have a fixed volume either; they can fill any container.
- Compressibility: Gases can be squished into smaller spaces because their particles have lots of room to move closer together.
- Expansion: When you heat a gas, it expands because its particles move faster and spread out more.

How Properties Occur:

The properties of solids, liquids, and gases happen because of how their particles behave:

Solids: The tight arrangement of particles makes them firm and gives solids their shape and hardness.

Liquids: The ability of particles to flow past each other allows liquids to take the shape of their container and flow.

Gases: Gas particles are free to move, so they have no fixed shape or volume. They can be compressed and expand when heated.

Independent practice

1. What are solids, liquids, and gases made of?
2. **Extended writing (paragraph required):** Describe the arrangement of particles in solids, liquids and gasses.
3. How do particles in liquids behave?
4. Why can liquids take the shape of their container?
5. What's the main difference between solids and liquids in terms of shape?
6. Explain why gases don't have a fixed shape.
7. **Extended writing (paragraph required):** Compare and explain the properties of liquids and gasses.
8. What makes solids hard?
9. Can gases be compressed into smaller spaces? Why?
10. What happens to a gas when you heat it?
11. Give an example of something that is a solid.
12. Why does a glass of water take the shape of the glass?
13. Why does a balloon expand when you blow air into it?
14. How does the behaviour of particles in solids, liquids, and gases affect their properties?
15. Why is it important to learn about solids, liquids, and gases in science?

L2 Change in State

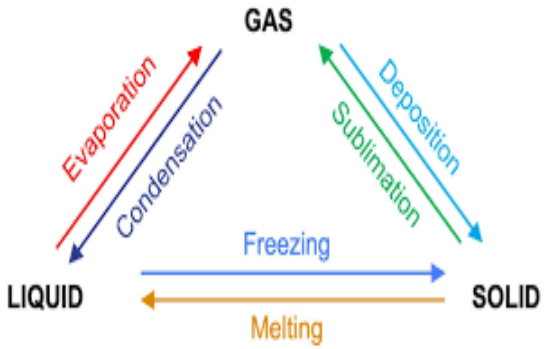
State changes, also known as phase changes, occur when a substance changes from one state of matter to another. There are three main states of matter: solids, liquids, and gases. These state changes are all about how the tiny particles that make up everything around us, called atoms and molecules, behave.

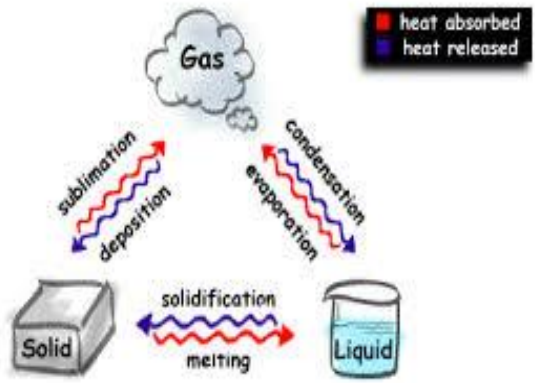
Energy Changes During State Changes:

One of the key things to understand about state changes is that they involve changes in energy. When a substance changes from one state to another, it either absorbs energy (becomes cooler) or releases energy (becomes warmer).

The Key Processes:

- **Melting:** This is when a solid turns into a liquid. It happens when you add heat energy to the solid. For example, when you heat an ice cube, it melts into water.
- **Freezing:** Freezing is the opposite of melting. It's when a liquid turns into a solid. This happens when you take away heat energy from the liquid. For example, when water in a puddle freezes into ice.
- **Evaporation:** Evaporation is when a liquid turns into a gas. It happens when you add heat energy to the liquid. For instance, when you leave a puddle of water in the sun, it slowly evaporates into water vapor.
- **Condensation:** Condensation is the opposite of evaporation. It's when a gas turns into a liquid. This occurs when you take away heat energy from the gas. Think about how water droplets form on a cold windowpane when warm air hits it.
- **Sublimation:** Sublimation is when a solid turns directly into a gas without becoming a liquid first. A common example is dry ice (frozen carbon dioxide), which turns into carbon dioxide gas when it warms up.





Energy Changes:

Now, let's talk about energy changes during these processes. Whenever a state change happens, energy is involved. There are two main types of energy changes: heating and cooling.

- Heating: This is the process of adding heat energy to a substance to raise its temperature. For example, when you heat an ice cube, it absorbs heat energy and melts into water.
- Cooling: Cooling is the opposite. It involves removing heat energy from a substance to lower its temperature. When you put water in the freezer, you're cooling it down, and it freezes into ice.

Heating Curves:

To better understand these state changes and energy changes, scientists use something called a "heating curve." It's like a graph that shows how the temperature of a substance changes as it's heated or cooled.

Imagine you have a block of ice at a very low temperature. As you add heat energy to it, the temperature starts to rise until it reaches the melting point (0 degrees Celsius for water). At this point, the ice begins to melt, but the temperature stays the same until all the ice has turned into water. Once it's all water, adding more heat energy will make the temperature rise again until it reaches the boiling point (100 degrees Celsius for water). Then, the water starts turning into steam.

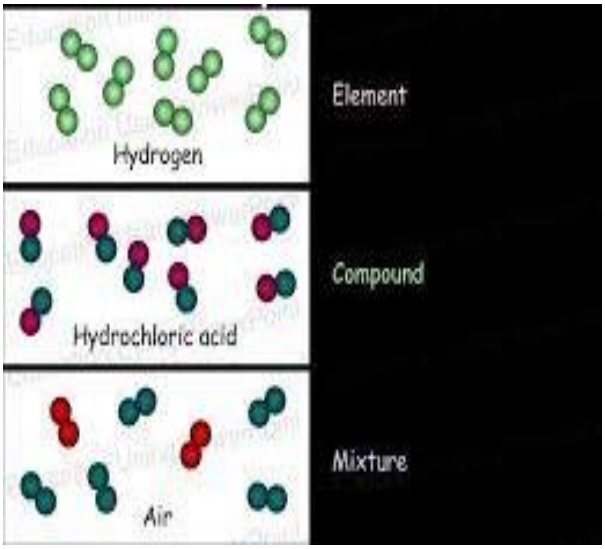
Independent practice

1. What are state changes, and why are they important in science?
2. Name the three main states of matter.
3. **Extended writing (paragraph required):** What happens during melting, and can you give an example?
4. Describe the process of freezing. How is it different from melting?
5. Explain what evaporation is and provide a real-life example.
6. When does condensation occur, and how is it related to evaporation?
7. What is sublimation, and can you give an example?
8. What is heating, and when does it occur in state changes?
9. Describe cooling. How does it relate to state changes?
10. **Extended writing (paragraph required):** What is a heating curve, and how does it help us understand state changes?
11. What happens to the temperature of ice as you heat it from a very low temperature to its melting point?
12. At what temperature does water melt and boil on the Celsius scale?
13. Why does the temperature stay the same during a state change?
14. Can you think of any other substances that go through state changes similar to water?

L3 Pure and Impure Mixtures

Elements and Compounds

Before we dive deeper into mixtures, let's talk about elements and compounds. Elements are like the building blocks of matter. Everything in the universe is made up of elements. For example, oxygen and hydrogen are two elements.



When elements combine chemically, they form compounds. Think of compounds as a team of elements working together. Water (H2O) is an example of a compound because it's made up of two hydrogen (H) atoms and one oxygen (O) atom bonded together.

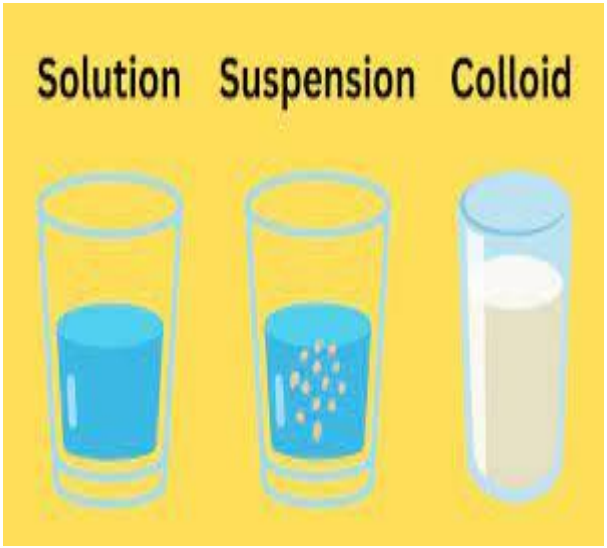
What Is a Mixture?

A mixture is a combination of two or more substances that are not chemically combined. Imagine mixing different types of LEGO blocks, where each block keeps its own shape and doesn't change into something entirely new. Mixtures are all around us, from the air we breathe to the food we eat.

Types of Mixtures

Now, let's get back to mixtures. There are different types of mixtures:

- Solutions: Solutions are mixtures where one substance (called the solute) dissolves completely in another substance (called the solvent). Think of it as sugar disappearing when you stir it into water, creating a sweet solution.
- Colloids: Colloids are like in-between mixtures. The particles in a colloid are larger than those in a solution but smaller than those in a suspension. Milk is a colloid because it contains tiny particles of fat and protein suspended in water.
- Suspensions: Suspensions have larger particles that don't stay mixed for long. If you leave a suspension undisturbed, the particles will eventually settle at the bottom. For example, if you mix sand in water, the sand particles will settle down over time.



Pure and Impure Mixtures

- A pure mixture contains only one type of substance. So, if you have a jar full of salt, it's a pure mixture because it's all just salt.
- An impure mixture contains more than one type of substance. If you have a jar with a mix of salt and sugar, it's an impure mixture because it has both salt and sugar in it.

Understanding elements, compounds, and mixtures forms the foundation of our knowledge about the material world. These concepts help us explain how everything around us is made and why substances behave the way they do.

Independent practice

1. What makes elements different from compounds?
2. **Extended writing (paragraph required):** Can you identify an element you encounter in everyday life, and what sets it apart from compounds?
3. What defines compounds, and can you name a compound you're familiar with?
4. Define a solution and offer an example.
5. Explain the concept of a colloid and provide a common example.
6. Describe a suspension and identify an everyday example.
7. How would you define a pure mixture, and can you offer an example?
8. What defines an impure mixture, and can you think of one you've encountered?
9. **Extended writing (paragraph required):** Can you differentiate between solutions and colloids?
10. Can you identify a compound that plays a role in your daily life?
11. Why do some mixtures, like sand in water, exhibit settling behaviour over time?
12. Are there methods to separate components within mixtures?
13. How is a solution of saltwater commonly utilized in everyday situations?
14. Can you think of an example of a mixture used in cooking or food preparation?

L4 Mixture and Solutions

What's a Mixture?

A mixture is when two or more different substances come together, but each substance keeps its own identity. It's like making a yummy fruit salad where you can still see and taste the individual fruits, like apples, bananas, and grapes, even though they're mixed together.

In a mixture, we have two main players: the solute and the solvent.

- Solute: Think of this as the guest at a party who's joining the fun. The solute is the substance that gets dissolved in another substance. For example, when you stir sugar into water, the sugar is the solute. It dissolves into the water.
- Solvent: The solvent is like the host at the party. It's the substance that does the dissolving. In our sugar and water example, water is the solvent because it's doing the dissolving.
- Solution: Mixing It Up

When the solute (guest) gets mixed up with the solvent (host) so well that you can't see it anymore, we call this a solution. It's like a fantastic dance party where everyone is mingling and having a great time, and you can't tell who's who anymore. So, in a solution, the solute and solvent are so well mixed that they look like one substance.

- Solubility: The Ability to Dissolve

Now, let's talk about something called "solubility." Solubility is the measure of how much of a solute can dissolve in a given amount of solvent. Different substances have different solubilities.

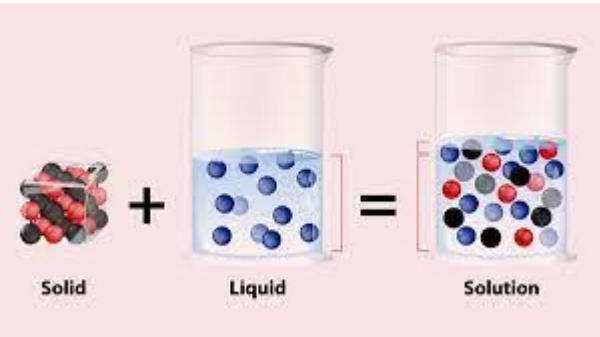
Factors Affecting Solubility:

- Temperature: Some substances dissolve better in hot water, while others prefer cold. For example, making hot cocoa, you need hot water to dissolve the cocoa powder.
- Stirring: Stirring a mixture helps the solute dissolve faster because it helps the solute particles come into contact with the solvent.
- Surface Area: Smaller particles have a larger surface area, which makes them dissolve faster. That's why powdered sugar dissolves faster than a big sugar cube.
- Type of Solute and Solvent: Some solutes dissolve better in specific solvents. For example, oil doesn't mix well with water because they have different properties.

Particle Arrangement:

To understand how mixtures work, think of the tiny particles that make up matter, like atoms and molecules, as dancers. They move around in the solute and solvent, doing a special dance.

When you add a solute to a solvent, these tiny particles start moving around faster. They bump into each other and form new bonds. It's like a dance party where new friendships are formed. The solute particles spread out and become evenly distributed in the solvent, creating a solution.



Independent practice

1. What is a mixture?
2. **Extended writing (paragraph required):** Explain the roles of solute and solvent in a mixture.
3. What's a solution, and how does it differ from a mixture?
4. Define solubility.
5. List four factors that affect solubility.
6. How does temperature affect the solubility of substances?
7. Why is stirring important in the process of dissolving?
8. How does the surface area of a solute affect its solubility?
9. Can any solute dissolve in any solvent? Why or why not?
10. Describe the particle arrangement in a mixture.
11. **Extended writing (paragraph required):** Why does adding a solute to a solvent cause the solute particles to spread out?
12. Give an example of a substance that dissolves better in hot water and one that dissolves better in cold water.
13. Why doesn't oil mix well with water?
14. Imagine you want to make a sweet lemonade. Would you use hot or cold water to dissolve the sugar? Why?

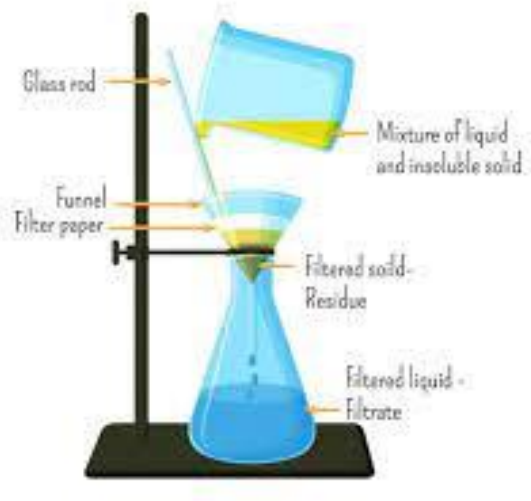
L5 Filtration - Separation technique

What Is Filtration?

Filtration is a separation technique used in science to separate mixtures based on the differences in particle size. It involves passing a mixture through a filter, which is a material with tiny pores that allow smaller particles, such as liquids, to pass through while trapping larger particles, like solids. Filtration is a method commonly employed to obtain a purified substance from a mixture, making it an essential process in various scientific and everyday applications.

How Does Filtration Work?

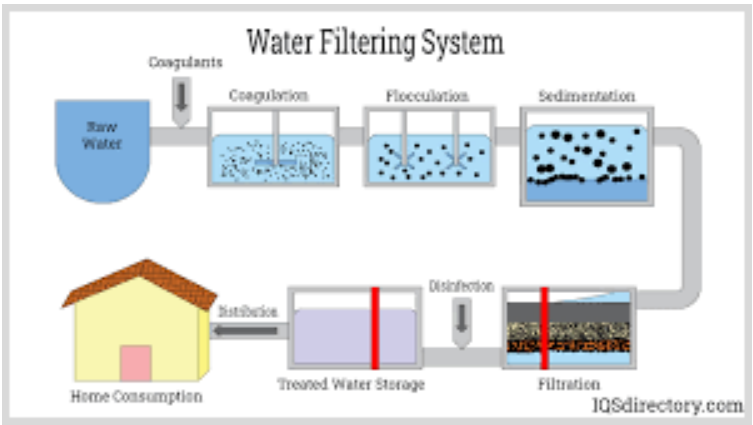
- To understand how filtration works, let's imagine a simple experiment.
- Take a glass of dirty water, like the one you might find in a muddy puddle after a rainstorm.
- Get a coffee filter or a piece of cloth (like a clean old sock) and stretch it over the mouth of another empty glass.
- Slowly pour the dirty water through the filter.
- What do you think will happen? Well, the dirty water will go into the filter, and the clean water will drip down into the empty glass. The filter traps the dirt and lets the water pass through. This is exactly how filtration works!



Factors Affecting Filtration

Things that can affect filtration:

- Particle Size: The size of the particles in the mixture matters. A very fine filter can catch tiny particles, while bigger particles might pass through.
- Filter Material: Different materials can be used for filters, like paper, cloth, or even special filters made of tiny holes. The type of material can impact how well the filtration works.
- Filter Pores: Some filters have tiny holes, called pores. The size of these pores can determine what gets caught and what goes through. A filter with small pores can catch smaller particles.
- Gravity: Filtration often relies on gravity to make the mixture flow through the filter. The force of gravity helps pull the liquid through the filter, leaving the solid behind.



Independent practice

1. What is filtration, and why is it important in science?
2. Can you give an example of a mixture that you might want to separate using filtration?
3. **Extended writing (paragraph required):** How does filtration work, in simple terms?
4. What does a filter do in the filtration process?
5. Imagine you have a mixture of sand and water. Which one will be left behind, and which will flow through the filter?
6. What can affect filtration when it comes to particle size?
7. What is the role of the filter material in the filtration process?
8. How do filter pores influence the effectiveness of filtration?
9. Why is gravity an important factor in filtration?
10. **Extended writing (paragraph required):** Have you ever seen filtration being used in your daily life? What was being filtered, and why?
11. What would happen if you tried to filter very tiny particles with a filter that had large pores?
12. Is it possible to filter a liquid with no solid particles in it? Why or why not?
13. Can you think of a situation where you'd want to use a filter with very tiny pores?
14. What other methods of separation do you know, and how do they differ from filtration?

L6 Evaporation – Separating technique

What is Evaporation?

Evaporation is a process that happens when a liquid, like water, turns into a gas. You've probably seen this happen when a puddle of water dries up under the sun. When the water absorbs the sun's heat, it gradually changes into tiny water vapor particles that rise into the air. This transformation from a liquid to a gas is what we call "evaporation."

How Does Evaporation Work as a Separation Technique?

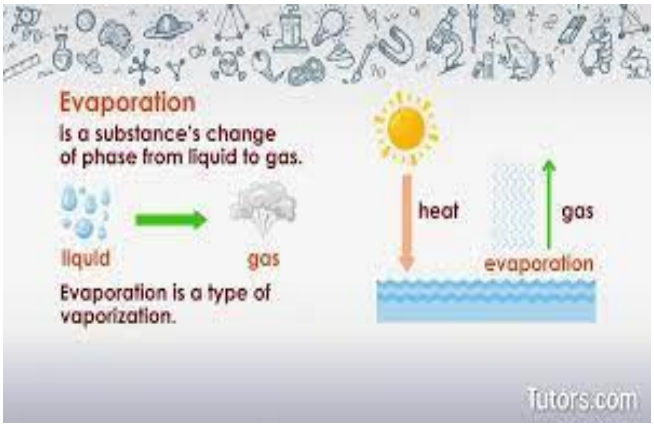
Imagine you have a mixture of two substances dissolved in water, like salt and water. You can use evaporation to separate them. Here's how:

- Step 1: Pour your salty water mixture into a shallow container, like a plate.
- Step 2: Leave the plate in a warm place, like in the sun or near a heater.
- Step 3: As the water evaporates, it leaves the salt behind. After some time, you'll see tiny salt crystals forming on the plate.
- Step 4: Carefully scrape off the salt crystals, and there you have it - separated salt from the water!

How is Evaporation Different from Filtration?

Filtration and evaporation are both used to separate mixtures, but they work differently.

- Filtration is used when you want to separate solids from liquids. Imagine you have a mixture of sand and water. You can use a filter, like a sieve or a piece of cloth, to separate the sand from the water. The solid (sand) is trapped by the filter, while the liquid (water) passes through.
- Evaporation, on the other hand, is used to separate a dissolved solid from a liquid. It's like a magic trick where the liquid disappears, leaving the solid behind. So, if you have salt dissolved in water, you can use evaporation to get the salt back, but filtration wouldn't work because the salt is dissolved in the water and too small to be caught by a filter.



Independent practice

1. What is evaporation, and how does it happen?
2. Can you give an example of evaporation in your daily life?
3. When you leave a glass of water in the sun, what happens to the water?
4. **Extended writing (paragraph required):** How can you separate salt from water using evaporation?
5. Explain the steps involved in using evaporation to separate a saltwater mixture.
6. How is evaporation different from filtration?
7. When would you use filtration as a separation technique?
8. What's the main difference between separating sand from water using filtration and separating salt from water using evaporation?
9. Can you think of a mixture that you can separate using filtration, but not with evaporation?
10. What happens to the liquid in the process of evaporation?
11. What's left behind when you use evaporation to separate substances?
12. Why do you need to place a mixture in a warm place for evaporation to work?
13. Can you name some other substances that can be separated using evaporation?
14. **Extended writing (paragraph required):** Imagine you have a mixture of sugar and water. Which separation technique would you use, and why?

L7 Distillation – Separating technique

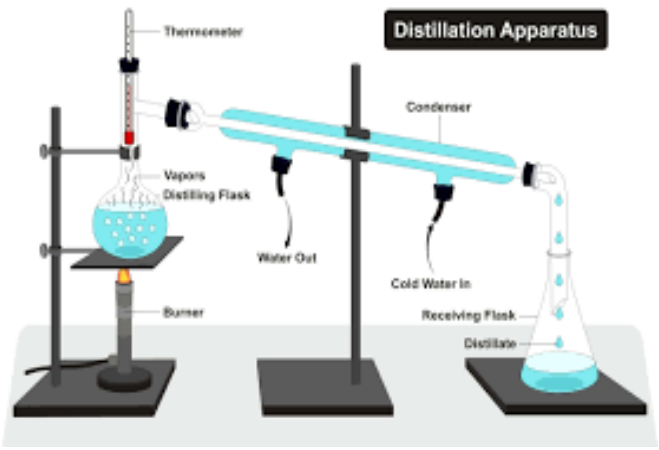
What is Distillation?

Distillation is a fantastic method used to separate different parts of a mixture based on their boiling points. But what's a boiling point? Well, it's the temperature at which a substance changes from a liquid to a gas. Think of it as the point where a liquid gets so hot that it turns into vapor or steam.

How Does Distillation Work?

Imagine you have a mixture of two liquids that have different boiling points, like water and alcohol. Here's how distillation helps us separate them:

- Step 1: You heat the mixture, and the liquid with the lower boiling point (in this case, alcohol) turns into vapor first. It rises into a tube.
- Step 2: The vapor travels through the tube and enters a special container called a condenser, where it cools down.
- Step 3: When it cools, the vapor changes back into a liquid, and you collect it in a different container. This is your separated liquid, the alcohol.
- Step 4: The liquid with the higher boiling point (in this case, water) is left behind in the original container.



Why is Distillation Important?

Distillation is important for a few reasons:

- Purification: It helps purify substances by removing impurities and getting the pure liquid. For example, distillation can turn saltwater into fresh drinking water by separating the salt from the water.
- Separation: It's used in the production of many things like alcoholic beverages, perfumes, and even the gasoline that powers cars! Distillation is the key to separating the different components that make up these products.
- Chemistry: In the world of chemistry, distillation is a powerful tool for separating and purifying chemicals. It's essential for scientists working on experiments and inventing new materials.

What's the Difference Between Distillation and Evaporation?

Distillation and evaporation both involve heating a mixture, but they are used for different purposes.

- Distillation is used to separate different liquids in a mixture, based on their boiling points. It's like a special kind of evaporation that allows us to collect the vapor and turn it back into a liquid.
- Evaporation, as we learned earlier, is the process of turning a liquid into a gas. It's used to separate dissolved solids from liquids or to get rid of a liquid to leave behind a solid.
- Distillation is an exciting method that helps separate different liquids in a mixture by heating them and collecting the vapor. It's used to purify substances, separate components for products we use every day, and is a crucial tool in the world of chemistry.

Independent practice

1. What is distillation, and how does it work?
2. **Extended writing (paragraph required):** Can you explain the concept of boiling point?
3. Give an example of two liquids that can be separated using distillation.
4. Describe the steps involved in distillation.
5. Why is distillation important in the purification of substances?
6. How is distillation different from evaporation?
7. What is the main goal of distillation?
8. Can you name some everyday products that are made using distillation?
9. If you wanted to separate sand and water, would you use distillation? Why or why not?
10. What happens to the vapor in a distillation process when it enters the condenser?
11. **Extended writing (paragraph required):** Why is it important for scientists in chemistry to know about distillation?
12. Imagine you have a mixture of oil and water. Which separation technique would you use, and why?
13. In distillation, which part of the mixture turns into vapor first, the one with the lower boiling point or the higher boiling point?
14. What does distillation help us achieve in the production of alcoholic beverages?

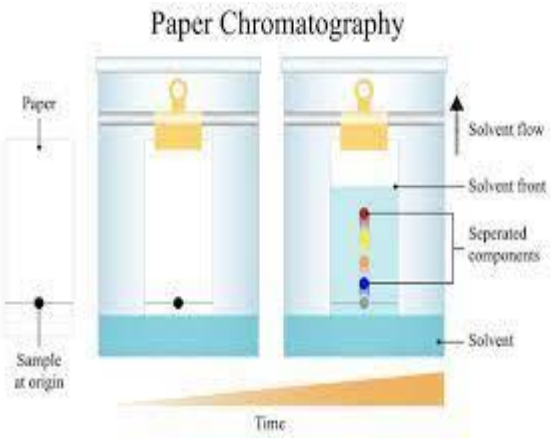
L8 Chromatography – Separating technique

Chromatography is a special technique that helps us separate mixtures, like different colours in ink or components in a liquid. The word "chromatography" comes from the Greek words "chroma," which means colour, and "grapho," which means to write. So, chromatography is like writing with colours!

How Does Chromatography Work?

Imagine you have a mixture of different colours in ink, like a marker or a pen. Chromatography can help us see all the colours that make up that ink. Here's how it works:

- Step 1: You take a strip of special paper called chromatography paper and make a small dot of the ink mixture at the bottom of the paper.
- Step 2: You place the paper in a container with a little bit of a special liquid, like water or rubbing alcohol. This liquid is called the "solvent."
- Step 3: The solvent begins to travel up the paper. As it moves, it carries the different colours in the ink mixture along with it.
- Step 4: As the solvent travels up the paper, it separates the ink into its different colours. You can see the colours spreading out in pretty patterns on the paper.



Chromatography is important for several reasons:

- Forensic Science: In crime-solving, chromatography is used to analyse ink samples, helping detectives match inks from different sources. It can also help identify substances like drugs and chemicals found at crime scenes.
- Pharmaceuticals: In the world of medicine, chromatography helps scientists develop and test new drugs. It's vital for making sure medicines are safe and effective.
- Environmental Science: Environmental scientists use chromatography to study pollution and identify harmful chemicals in the environment.
- Art Conservation: Museums and art restorers use chromatography to analyse pigments in paintings and artifacts, helping preserve cultural treasures.

Chromatography is different from other separation techniques like distillation or filtration.

- Chromatography is all about separating different substances based on their ability to move through the chromatography paper with a solvent. It's like showing the individual colours in ink or the components in a mixture.
- Distillation separates substances based on their boiling points. It's often used for separating liquids with different boiling points, like water and alcohol.
- Filtration separates solids from liquids by using a filter, like a sieve or a piece of cloth, to trap the solid while the liquid passes through.

Chromatography is a fantastic technique used to separate colours or components in mixtures. It works by using a special paper and a solvent to make colours spread out, showing us what's in the mixture. It's essential in many areas of science, from crime-solving to medicine and art.

Independent practice

1. What is chromatography, and what does the word "chromatography" mean?
2. **Extended writing (paragraph required):** Can you explain the purpose of chromatography paper and the solvent in the chromatography process?
3. Give an example of a mixture that can be separated using chromatography.
4. What are the steps involved in performing chromatography?
5. Why is chromatography important in forensic science?
6. How is chromatography different from distillation and filtration?
7. What are some real-world applications of chromatography in science?
8. If you wanted to separate sand from water, would you use chromatography? Why or why not?
9. What does chromatography help us discover about a mixture of colours?
10. What happens when the solvent moves up the chromatography paper in the process of chromatography?
11. How is chromatography used in the field of pharmaceuticals?
12. **Extended writing (paragraph required):** Imagine you have a mixture of sugar and salt. Which separation technique would you use, and why?
13. In chromatography, what does it mean when colours or substances spread out on the paper?
14. How does chromatography help in art conservation?