
Basic Essentials Of
CHEMISTRY
CBC
AQUA-SPRAY
FIRE EXTINGUISHER
SENIOR 1
Solomon Adilu
+256783237027

How to Use This Book

Welcome to your Chemistry Journey!

This textbook is designed to make your learning experience engaging and informative. Here are some tips on how to make the most of it:

Read Actively:

Skim: Quickly go through the chapter headings, subheadings, and visuals to get an overview.

Read Carefully: Pay attention to key concepts, definitions, and examples.

Highlight and Annotate: Mark important points, ask questions, and write down your thoughts.

Engage with the Text:

Solve Problems: Practice the exercises and problems to solidify your understanding.

Conduct Experiments: Perform the suggested experiments to observe chemical phenomena firsthand.

Discuss with Peers: Share your ideas and ask questions to deepen your knowledge.

Use the Visuals:

Diagrams and Graphs: Analyze the visual aids to understand complex concepts.

Tables and Charts: Use these to organize information and identify patterns.

Photographs: Observe real-world applications of chemistry.

Review Regularly:

Summarize: Write brief summaries of each chapter to reinforce key points.

Create Mind Maps: Visualize the connections between concepts.

Quiz Yourself: Test your knowledge with practice questions and quizzes.

Seek Help When Needed:

Consult Your Teacher: Ask questions and seek clarification.

Study Groups: Collaborate with classmates to discuss and solve problems.

Online Resources: Explore additional resources like educational websites and videos.
By following these tips, you can enhance your learning experience and achieve academic success.

Happy learning!

Introduction to Chemistry

Chemistry: The Science of Change

Chemistry is the science that explores the composition, structure, properties, and interactions of matter. It is the study of substances, atoms, molecules, and how they combine to form everything around us. From the air we breathe to the food we eat, chemistry plays a vital role in our daily lives.

Why Study Chemistry?

Understanding chemistry helps us:

Make Informed Decisions: By understanding the properties and effects of chemicals, we can make informed choices about the products we use.

Solve Real-World Problems: Chemists develop new materials, medicines, and technologies to address global challenges.

Appreciate the Natural World: Chemistry explains the beauty and complexity of the natural world, from the smallest atom to the largest galaxy.

Key Concepts in Chemistry

Matter and Its Properties: Learn about the different states of matter, their properties, and how they change.

Atoms and Elements: Explore the building blocks of matter, atoms, and how they combine to form elements.

Chemical Reactions: Discover the fascinating world of chemical reactions, how substances change, and the energy involved.

The Periodic Table: Understand the organization of elements and their periodic trends.

Acids and Bases: Learn about the properties of acids and bases and their applications.

Organic Chemistry: Explore the chemistry of carbon compounds, the basis of life.

As you delve into the world of chemistry, you will develop essential skills such as critical thinking, problem-solving, and experimental design. You will also gain a deeper appreciation for the interconnectedness of science and society.

Let's embark on this exciting journey of discovery together!

Solomonadilu5@gmail.com WhatsApp+256783237027/call+256783734986/+256705133397

Preface

Welcome to the World of Chemistry!

This textbook is designed to introduce you to the fascinating world of chemistry, a science that explores the composition, structure, properties, and interactions of matter. As you journey through these pages, you will discover how chemistry is essential to our daily lives, from the food we eat to the technology we use.

This book is aligned with the New Lower Secondary Curriculum, providing you with a solid foundation in key chemical concepts. Through engaging explanations, practical examples, and stimulating activities, you will develop a deep understanding of chemistry and its applications.

Key Features of This Book

Clear and Concise Explanations: Complex topics are broken down into simple, easy-to-understand concepts.

Real-World Applications: Numerous examples illustrate how chemistry is relevant to everyday life.

Engaging Activities: Hands-on experiments and projects encourage active learning and critical thinking.

Stunning Visuals: Colorful diagrams and photographs enhance understanding and make learning enjoyable.

Review Questions and Practice Problems: Reinforce learning and prepare for assessments.

We hope that this book inspires you to explore the wonders of chemistry and fosters a lifelong love of learning.

Scenario:

You're a curious scientist interested in understanding the properties of everyday substances like salty water. You've decided to investigate the boiling point of salty water.

Task:

Carry out an experiment to determine whether salty water is a pure liquid or not.

Expected Response

Aim: To determine the boiling point of salty water.

Hypothesis: The boiling point of salty water is 100°C.

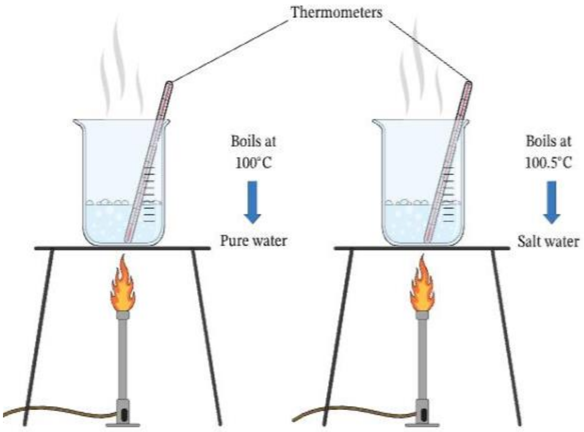
Materials:

- Salty water
- Distilled water
- Beaker(250 mL)
- Bunsen burner
- Tripod stand
- Wire gauze
- Thermometer
- Safety goggles
- Stopwatch

Risks and Mitigation

- Burns from the Bunsen burner:- Keep a safe distance from the flame, and use the wire gauze to distribute the heat evenly.
- Scalds from hot liquids:- Handle the beakers with care, and use tongs or heat-resistant gloves if necessary.
- Eye damage:- Wear safety goggles to protect your eyes from splashes or broken glassware.

Procedure



- Set up the tripod stand, wire gauze, and Bunsen burner.
- Measure 100 mL of salty water into a beaker and 100 mL of distilled water into another beaker.
- Attach the thermometer to the side of each beaker, making sure the bulb is submerged in the liquid.
- Light the Bunsen burner and adjust the flame to a medium size.
- Place the beaker with salty water on the wire gauze and heat it until boiling.
- Record the temperature of the salty water at regular intervals (e.g., every 2 minutes) until it reaches boiling point.
- Repeat steps 2-3 with the distilled water.
- Once both liquids have reached boiling point, turn off the Bunsen burner.

Results and Observations

Time (Mins)	0	2	4	6	8	10
Temperature (°C) For distilled water	20	40	60	80	100	100
Temperature (°C) For salty water (10% NaCl solution)	20	40	65	85	105	107

- Water gradually heats up, forming small bubbles initially. Vigorous bubbling occurs at the boiling point.

- The distilled water boiled at 100°C, as expected.

- The salty water solution boiled at higher temperatures than the distilled water, with the 10% NaCl solution boiling at 107°C.

- The boiling point of the salty water solutions increased with increasing concentration of NaCl.

The boiling point of salty water is higher than that of distilled water due to the dissolved salt. This experiment demonstrates the effect of dissolved substances on the boiling point of a liquid.

The boiling point of a liquid is the temperature at which the vapor pressure equals the atmospheric pressure.

Dissolved salt in the water increases the boiling point by:

- Increasing the vapor pressure of the solution.
- Reducing the rate of evaporation.
- Requiring more energy to vaporize the solution.

Determining and comparing melting points of pure and impure solid naphthalene

Aim: To investigate the effect of impurities on the melting point of naphthalene.

Hypothesis

- Pure naphthalene will have a sharp and distinct melting point around 80°C.
- Impure naphthalene will have a lower and broader melting point range.

Materials

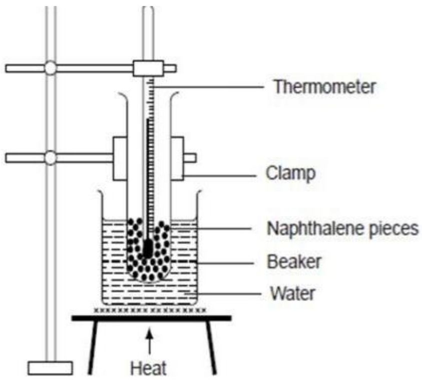
- Pure naphthalene crystals
- Naphthalene crystals mixed with a small amount of sand (or another suitable impurity)
- Boiling tube
- Thermometer
- Bunsen burner
- Glass Beaker
- Tongs
- Retort stand
- Stirring rod

Risks and Mitigation

- Burns from the Bunsen burner:- Keep a safe distance from the flame, and use tongs to handle the crucible.
- Scalds from hot liquids:- Handle the crucible with care, and use tongs to avoid direct contact.
- Inhalation of naphthalene vapors:- Avoid inhaling the vapors, as they can be harmful.

Procedure

- Carefully pack a small amount of pure naphthalene crystals into a boiling tube.
- Place the boiling tube containing the pure naphthalene into the a glass Beaker of water. Set up the apparatus as shown in the figure.



- Heat the water in the beaker using a Bunsen burner while stirring gently.
- Observe carefully as the temperature rises. Record the temperature at which the naphthalene begins to melt (start of melting). Stir the naphthalene using a thermometer when it starts melting.
- Read and record the steady temperature at which it is completely melted (end of melting), this is referred to as the melting point of naphthalene.
- Repeat the procedure using impure naphthalene.
- Record Observations, Note any differences in the appearance of the substances during melting (e.g., clarity, bubbling).

Expected Results

Pure Naphthalene

Sharp melting point: The naphthalene should melt within a narrow temperature range, typically around 80°C.

Example: Starting melting point: 79°C, End of melting point: 81°C

Impure Naphthalene

Lower and broader melting point: The naphthalene will likely begin to melt at a slightly lower temperature than the pure sample.

The melting process will occur over a wider temperature range.

Example: Starting melting point: 75°C, End of melting point: 85°C

The melting point of impure naphthalene is lower than that of pure naphthalene.

The presence of impurities in the impure naphthalene disrupts the crystal lattice structure, making it easier for the substance to melt. The pure naphthalene has a higher melting point due to its uniform crystal lattice structure.

The investigation confirms that the melting point of a substance can be affected by the presence of impurities. The impure naphthalene had a lower melting point than the pure naphthalene, demonstrating the importance of purity in determining the physical properties of a substance.
The principle behind this method of separation is based on the difference in melting points between the pure substance (naphthalene) and the impurities.

This method relies on the **principle/fact** that a pure substance has a sharp, well-defined melting point, whereas an impure substance has a lower and more variable melting point.
When the impure naphthalene is heated, the impurities melt first, since they have a lower melting point. As the temperature continues to rise, the pure naphthalene melts, releasing the impurities.

Purifying mixtures

Purification of Impure Salt (sand + salt) using Dissolving, Filtration, and Crystallization

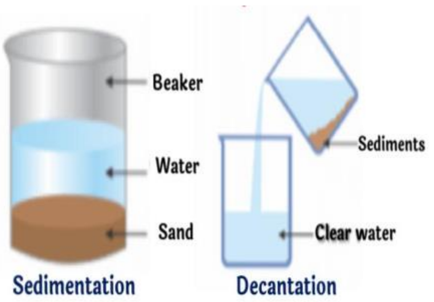
Aim: To purify impure salt using dissolving, filtration, and crystallization techniques.

Hypothesis: The impurities in the impure salt can be removed using dissolving, filtration, and crystallization techniques, resulting in pure salt.

Materials

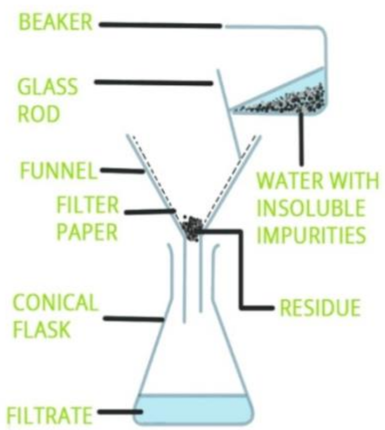
- 20g Impure salt (salt + sand)
- 200 cm^3 of distilled water
- Measuring cylinders
- Filter funnel
- Filter paper
- Beakers
- Bunsen burner
- Tripod stand
- Evaporating basin

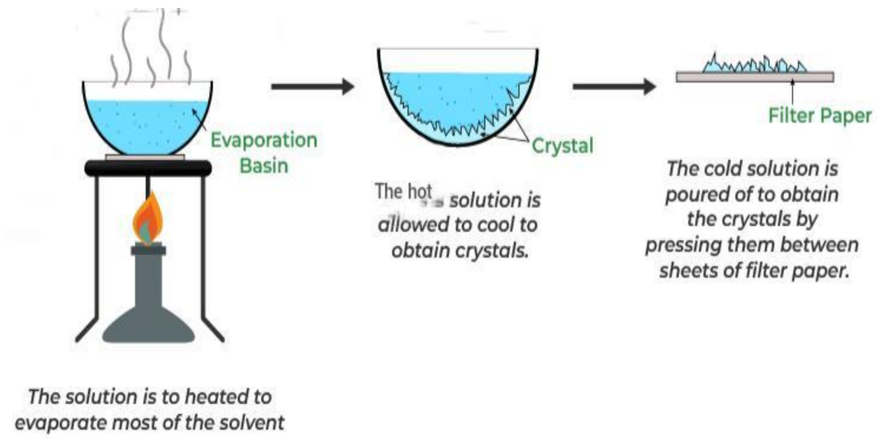
Procedure



- Weigh 20g of impure salt using a balance and mix it with 50cm^3 of distilled water in a measuring cylinder.
- Stir until the salt dissolves.
- Allow the mixture to settle for 10-15 minutes. Observe and record the changes.
- Carefully pour the supernatant water (containing dissolved salt) into another measuring cylinder, leaving the sand behind. This is called **decantation**.

- Use a filter funnel and filter paper to separate any remaining sand from the water.
- Collect the filtrate in another beaker.
- Heat the filtrate gently in an evaporating dish using a Bunsen burner until the water evaporates, leaving behind crystals of salt.





Observations

Learners give their observations and later a teacher harmonizes with the discussion as below.

Discussion

The impure salt appears as a mixture of white and brown particles, indicating the presence of sand and other impurities.

On dissolving, the salt dissolves completely in the distilled water, The initial mixture of Impure salt and water appeared cloudy and murky, with the sand particles visibly suspended in the water.

After allowing the mixture to settle, the sand particles had settled to the bottom of the measuring cylinder, leaving a clear layer of salty water on top. The water was still slightly cloudy, indicating some remaining suspended particles.

After carefully pouring the supernatant water into another measuring cylinder, the water appeared clearer, with most of the sand particles left behind. Some fine sand particles still remained suspended in the water.

After using a filter funnel to separate any remaining sand from the water, the water appeared crystal clear, with all visible sand particles removed. The filter paper removes the sand and other impurities from the solution, leaving behind a clear filtrate which contains salt.

When the filtrate is heated, as the water evaporates, crystals of salt begin to form at the bottom of the beaker. The crystals appear as white, transparent, and cubic in shape. This is called **Crystallization**.

Note:

This method of separation relies on the density difference between sand and water, as well as the size and shape of the particles. The settling and decantation steps separate the larger sand particles, while the filtration step removes the finer particles.

Impure salt, also known as rock salt, contains impurities such as sand, dirt, and other minerals. These impurities can affect the quality and texture of the salt, making it unsuitable for consumption or industrial use.

The technique of purifying impure substances using dissolving, filtration, and crystallization can be applied in various areas, including:

- Laboratory Settings during preparation of Standard Solutions
- Water Purification to purify contaminated water by removing impurities and pollutants.

Separation of Sulphur and Iron Fillings using Physical Separation Techniques

Magnetic Separation is a technique used to separate a mixture of substances based on their magnetic properties. This method is particularly effective for mixtures containing magnetic and non-magnetic components.

Principle:

Magnetic Attraction: Magnetic materials, such as iron, nickel, and cobalt, are attracted to magnets.

Non-Magnetic Materials: Substances like sand, salt, and wood are not attracted to magnets.

Experiment: Separating a Mixture of Iron Filings and Sulphur

Aim: To separate a mixture of iron filings and sand using the property of magnetism.

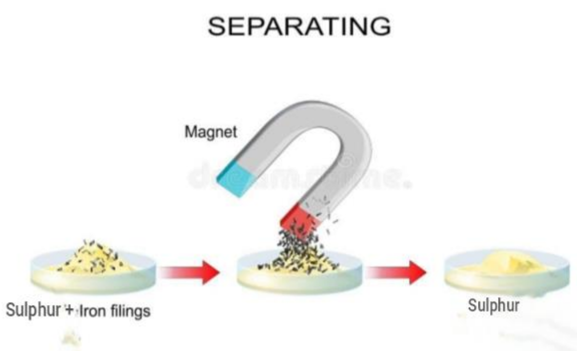
Hypothesis: Iron filings, being magnetic, can be separated from non-magnetic sand using a magnet.

Materials:

- Iron filings
- Sand
- Bar magnet
- Two Petri dishes
- Weighing scale

Procedure

- Weigh 5g of sulphur and 2g of iron fillings using a weighing scale and mix well in a Petri dish.
- Move the bar magnet across the mixture.
- Lift the magnet and tap it gently over the empty petri dish.



The experiment aims to separate a mixture of iron filings and sulphur using the property of magnetism. This is a classic example of magnetic separation, which is a widely used technique in various industries, including mining, recycling, and materials processing.

This is based on the principle that magnetic materials are attracted to magnets, while non-magnetic materials are not.

The bar magnet produces a magnetic field that attracts the iron filings. Iron is a ferromagnetic material, meaning it is capable of being magnetized and is attracted to magnets. When the magnet is moved across the mixture, the iron filings are attracted to it, allowing them to be separated from the non-magnetic sulphur.

The sulphur, being non-magnetic, is not attracted to the magnet and remains in the original Petri dish. This demonstrates the effectiveness of magnetic separation in separating magnetic materials from non-magnetic materials.

Distillation and Fractional Distillation

Fractional distillation is a laboratory technique that separates a mixture into pure components, or fractions, based on their boiling points. It's often used to purify miscible liquids that may contain dissolved impurities.

This technique uses a fractionating column which allows the component with the lowest-boiling-point to vaporizes first and rise into the condenser to condense and drip into the receiving flask.

Here are the steps of fractional distillation:

1. **Evaporation**: The substance is heated until it evaporates.
2. **Condensation**: The vapors rise through a fractionating column and condense as the temperature drops.
3. **Collection**: The fractions/components are collected.

Fractional Distillation of Fermented Liquor

Fermented liquor is a mixture of ethanol, water, and other impurities. Fractional distillation is used to separate fermented liquor into its component liquids, based on their boiling points:

- Ethanol (boiling point: 78.3°C)

- Water (boiling point: 100°C)

- Impurities (boiling point: >100°C)

Ethanol (alcohol) with the lower boiling point (78.4 °C) than water (100 °C) vaporizes first and is collected in the receiving flask as the first distillate. The process involves multiple vaporization and condensation cycles within a fractionating column, enriching the distillate in ethanol.

Activity

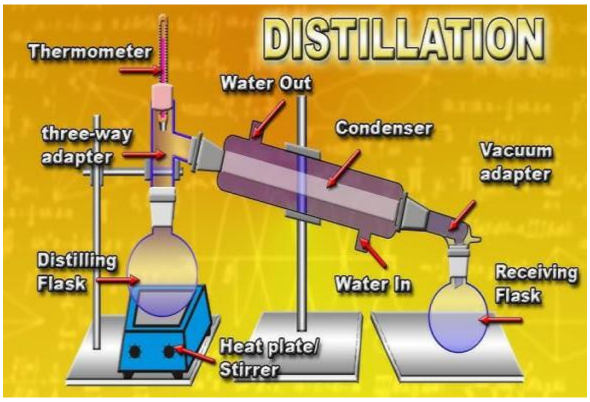
Aim: To increase the alcohol content of fermented liquor through fractional distillation.

Materials:

- Fermented liquor (e.g., wine, beer)
- Fractional distillation apparatus (including a fractionating column, round-bottom flask, condenser, receiver flask)
- Heat source (e.g., Bunsen burner, hot plate)
- Thermometer
- Stand and clamps

Procedure:

- Assemble the fractional distillation apparatus carefully. Ensure all connections are tight to prevent leaks. Fill the round-bottom flask with the fermented liquor.
- Apply heat gradually to the round-bottom flask. The goal is to achieve a gentle, steady boil. Avoid rapid boiling, which can cause bumping and loss of product. As the liquor boils, ethanol vapor rises through the fractionating column. Within the column, the vapor encounters cooler surfaces. Components with higher boiling points (like water) tend to condense on these surfaces and return to the flask. The ethanol vapor, with its lower boiling point, continues to ascend through the column.



The ethanol-rich vapor reaches the condenser, where it cools and condenses back into a liquid. The condensed ethanol (distillate) is collected in the receiver flask.

Note:

Monitor the temperature throughout the process. Adjust the heating as needed to maintain a consistent distillation rate.

The temperature in the distillate collection flask should gradually increase as the ethanol concentration increases.

Depending on the desired alcohol content, you may collect different fractions of the distillate.

The first fractions will have a higher alcohol content, while later fractions will have lower alcohol content.

Fractional Distillation can be applied when separating Components of Crude Oil.

Crude oil is a complex mixture of hydrocarbons with different boiling points. Fractional distillation is used to separate crude oil into various fractions, including:

- Gasoline (boiling point: 38-204°C)
- Naphtha (boiling point: 150-250°C)
- Kerosene (boiling point: 250-300°C)
- Diesel oil (boiling point: 300-400°C)
- Fuel oil (boiling point: 400-500°C)
- Residuals (boiling point: >500°C)

Fractions with higher boiling points condense and are collected closer to the bottom of the column. Small chain hydrocarbon molecules are collected at the top because they have a lower boiling point and fewer intermolecular forces.

Fractional Distillation of Liquid Air

Liquid air is a mixture of gases, including nitrogen, oxygen, and argon. Fractional distillation is used to separate liquid air into its component gases, based on their boiling points:

- Nitrogen (boiling point: -195.8°C)
- Oxygen (boiling point: -182.96°C)
- Argon (boiling point: -185.85°C)

Conclusion

This technique is widely used in various industries, including petroleum, chemical, and pharmaceutical. By understanding the principles behind distillation and fractional distillation, we can apply these techniques to separate complex mixtures and obtain pure substances.

Chromatography: Used to separate components of a mixture based on their solubility in a solvent.

It's often used when dissolved substances are colored e.g inks, food colorings and plant dye. It works because some of the colored substances dissolve in the solvent used better than other so they travel further up the paper.

The principle involved in Chromatograph depends upon the different solubilities of the substances in the mixture in the solvent used – the most soluble solute will be carried quickly up the paper with the solvent while the least soluble solute will be left behind.

Experiment: Paper Chromatography of Common Inks

Aim: To separate and identify the components of common inks using paper chromatography.

Hypothesis: The different colored dyes in the ink will separate into distinct bands as they move up the filter paper due to differences in their solubility and interaction with the paper.

Materials

- Various types of ink (e.g., blue, black, red, green)
- Paper chromatography paper (e.g., Whatman No. 1)
- Scissors
- Pencil
- Ruler
- Water
- Solvent (e.g., ethanol, methanol)

Procedure

- Cut a strip of chromatography paper to the desired length.
- Draw a line along the center of the paper, about 1-2 cm from the bottom.

- Place a small dot of ink on the line, using a pencil to mark the spot.
- Repeat step 3 for each type of ink.
- Place the paper in a container with a lid, and add a small amount of solvent (e.g., ethanol, methanol)making sure the ink dots are above the solvent level.
- Cover the container and let it sit for 30-60 minutes, or until the solvent has risen to the top of the paper.
- Remove the paper from the container and let it dry.
- Observe the chromatogram and record the results.

Discussion question

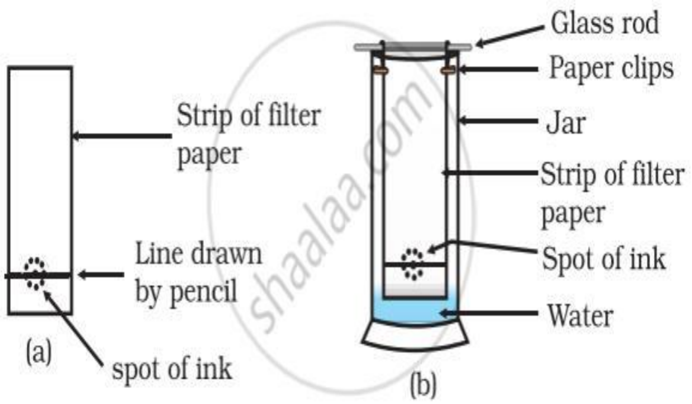
1. Why was a beaker covered with a watch glass?
2. Explain why the solvent level is below the line Marked.

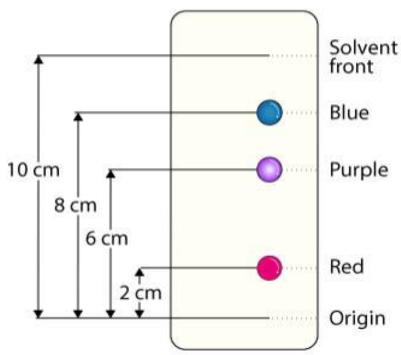
Expected Response and observations

1. To create a saturated environment.
2. To prevent line and the ink dots from washing off.

As the water rises up the filter paper, it carries the ink components with it. Different components of the ink will travel at different rates, separating into distinct bands. The solvent rises up the filter paper due to capillary action.

Different components of the ink have different solubilities in water. The more soluble components travel faster up the paper, separating from the less soluble components.





Interpretation of Chromatograms

The chromatograms show that each ink contains multiple components, which separate based on their affinities for the paper and the solvent.

The two or three components of each ink color may be due to the presence of different dyes or pigments.

Paper chromatography is a useful technique for separating and identifying the components of mixtures. In this experiment, we applied paper chromatography to separate the components of common inks. The results show that each ink contains multiple components, which separate based on their affinities for the paper and the solvent.

Sublimation: A purification Technique

Sublimation is a physical process where a solid substance directly transforms into a gas without passing through the liquid state. This property can be exploited to separate mixtures of solids where one component sublimes while the other remains solid.

How Sublimation Works

When the mixture is gently heated, the sublimable component absorbs heat and changes directly from a solid to a gas.

The gas is then cooled, causing it to condense back into a solid form.

Common Examples of Sublimation

- Separating Ammonium Chloride and Sodium Chloride.

Ammonium chloride sublimes when heated, leaving behind sodium chloride.

The sublimed ammonium chloride vapor is then cooled and collected.

- Purifying Naphthalene.

Naphthalene, a common moth repellent, can be purified by sublimation. Impurities remain behind, while pure naphthalene is collected.

In conclusion, sublimation is a valuable technique for separating mixtures based on the difference in their sublimation properties.

Substances that sublime when heated

- Ammonium chloride
- Iodine
- Naphthalene

- Dry ice (solid carbon dioxide)
- Anhydrous iron (III) chloride. Note that this one requires specific conditions like heating a mixture in a vacuum or controlled pressure.

Experiment: Separating Ammonium Chloride and Salt by Sublimation

Aim: To separate a mixture of ammonium chloride and sodium chloride using the technique of sublimation.

Hypothesis:

Ammonium chloride, a substance that sublimes, can be separated from sodium chloride, which does not, by heating the mixture.

Materials:

- Mixture of ammonium chloride and salt
- China dish
- Funnel
- Cotton wool
- Tripod stand
- Bunsen burner
- Wire gauze

Variables:

Independent Variable- The heating temperature and time

Dependent Variable- The amount of ammonium chloride recovered, The purity of the separated substances.

Controlled Variables-The mass of the initial mixture, The size of the apparatus.

Risks and Mitigation:

Burns: The Bunsen burner flame can cause burns.

Mitigation: Use heat-resistant gloves and avoid touching hot surfaces.

Chemical Fumes: Heating ammonium chloride can produce fumes.

Mitigation: Conduct the experiment in a well-ventilated area.

Safety Precautions:

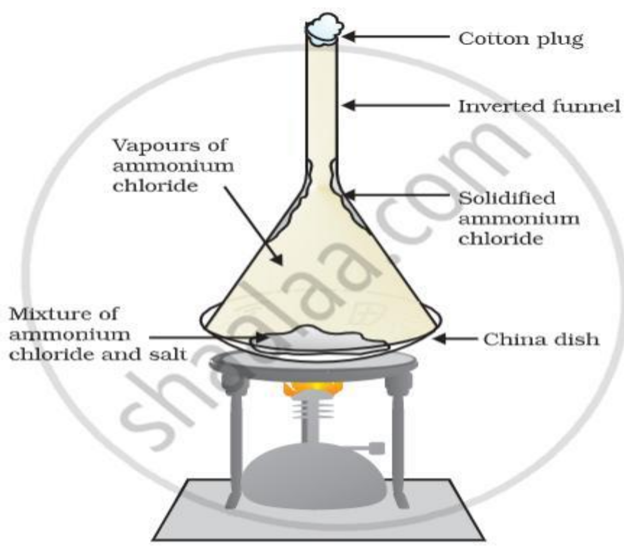
Wear safety goggles and gloves to protect your eyes and hands.

Handle the Bunsen burner carefully and avoid direct contact with the flame.

Be cautious when handling hot glassware.

Procedure:

- Measure 10g of ammonium chloride and 5g of sodium chloride using a weighing scale and mix.
- Place the mixture of ammonium chloride and salt in a China dish.
- Invert a glass funnel over the China dish and plug the stem with cotton wool.
- Place the setup on a tripod stand over a wire gauze.
- Heat the mixture gently using a Bunsen burner.



Discussion questions

Discuss what is observed during the experiment.

Observe Sublimation:

As the mixture is heated, the ammonium chloride will sublime, turning directly from a solid to a gas.

The ammonium chloride vapor will rise and condense on the cooler surface of the funnel, forming white crystals.

The salt will remain in the China dish.

Ammonium chloride has the property of sublimation, meaning it can directly change from a solid to a gas state without passing through the liquid state.

The ammonium chloride vapor, upon coming in contact with the cooler surface of the funnel, loses heat and condenses back into solid form.

This process effectively separates the ammonium chloride from the salt, leaving the salt behind in the China dish.

1.1. End of chapter Scenarios

Item 3

A group of students is conducting an experiment in the science laboratory. One student, eager to finish the experiment quickly, decides to skip a few safety procedures. They rush through the steps, not paying attention to the instructions or the safety guidelines.

Task;

a. Discuss the potential consequences of the student's unsafe behavior?
b. How could this behavior impact the student's own safety and the safety of others in the lab?

Item 4

A high school student wants to conduct a simple experiment at home to investigate the effect of different cleaning agents on the removal of stains from fabrics.

Task;

a. What common household items could be used as laboratory apparatus for this experiment?
b. What safety precautions should the student take while conducting this experiment at home?

All the best from Tr.solomon

For your own personal copies

Call: +256783734986

WhatsApp: +256783237027

Email: solomonadilu5@gmail.com

Thanks