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Prodigy CHEMISTRY

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- Activities
- Recapitulation
- Experiential Learning Based Questions
- Value & Life Skills
- Intext Questions
- Multi-Disciplinary Based Questions
- Application Based Questions
- Stem Projects

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8

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CHEMISTRY -8

ANSWER KEY

ICSE Chemistry-8

Chapter-1

Matter

Exercise Corner

A. MCQs

1. (a) Vaccum
2. (c) Sand
3. (a) Melting
4. (d) All of these
5. (c) Freezing point

B. Fill in the Blanks

1. The change of state from solid to liquid is called **melting**.
2. Solid is very difficult to **compress**.
3. **Gases** have no definite shape.
4. The change of liquid to gas is called **vaporization**.
5. The process in which solid directly changes into gas is called **sublimation**.

C. True Or False

1. **True**. LPG stands for liquefied petroleum gas.
2. **False**. Solid changing into liquid is called melting, not fusion. Fusion typically refers to the process of combining nuclei in nuclear physics.
3. **False**. In the gaseous state, the interparticle spaces are relatively large compared to the solid and liquid states.
4. **False**. The zig-zag motion of gas particles is called random motion or Brownian motion, not spreading motion.
5. **True**. Matter can indeed change from one form to another when temperature and pressure are changed, as seen in phase changes such as melting, boiling, and condensation.

D. Very short answer type questions

1. A gas exerts pressure on the walls of the container due to the constant collisions of gas molecules with the walls, resulting in the transfer of momentum.

2. Melting point is the temperature at which a solid substance changes into a liquid state.

3. Solid state of matter has the least kinetic energy.

4. Solidification is the process of changing a substance from a liquid state to a solid state by cooling.

5. Brownian motion is the random motion of particles suspended in a fluid (liquid or gas) due to collisions with the surrounding molecules of the fluid.

E. Short answer type questions

1. Three characteristics of solids are:

1. **Definite shape:** Solids have a definite shape, meaning they maintain a fixed volume and shape under normal conditions.
2. **Definite volume:** Solids have a definite volume, meaning they occupy a specific amount of space that is constant.
3. **Strong intermolecular forces:** Solids have strong intermolecular forces of attraction between their particles, which hold them in a fixed position relative to each other.

2. Brownian motion is the random motion of microscopic particles suspended in a fluid (liquid or gas) due to the constant collisions with the surrounding molecules of the fluid. This motion was first observed by the botanist Robert Brown in 1827 while studying pollen grains suspended in water. The random movement of particles is a result of the thermal energy of the fluid molecules, which causes them to collide with the suspended particles and transfer momentum. Brownian motion is evidence of the kinetic theory of matter and is significant in various fields, including physics, chemistry, and biology.

3. The kinetic theory of matter states that:

1. All matter is composed of particles: Matter, regardless of its state (solid, liquid, gas), is made up of tiny particles such as atoms, molecules, or ions.
2. Particles are in constant motion: The particles of matter are in continuous random motion due to their kinetic energy. This motion increases with an increase in temperature and decreases with a decrease in temperature.
3. Particles have negligible volume: The volume occupied by the particles themselves is negligible compared to the total volume of the matter.
4. Particles exert attractive forces: There are attractive forces between particles, which vary in strength depending on the type of particles and the distance between them.
5. Temperature reflects the average kinetic energy: The temperature of a substance is a measure of the average kinetic energy of its particles. Higher temperature corresponds to higher average kinetic energy, and vice versa.

6. Pressure arises from particle collisions: The pressure exerted by a gas is a result of the collisions of its particles with the walls of the container. The force exerted by each collision contributes to the overall pressure exerted by the gas.

4.

No, matter is defined as anything that has mass and occupies space. If a substance has no mass, it cannot be considered matter according to the traditional definition.

5. Naphthalene balls disappear with time without leaving any solid because of the process of sublimation. Naphthalene, the primary component of naphthalene balls, has a relatively high vapor pressure at room temperature. This means that naphthalene molecules can transition directly from the solid phase to the gas phase without passing through the liquid phase. As a result, over time, naphthalene balls gradually sublimate, turning into vapor and dissipating into the surrounding air without leaving behind any solid residue.

F. Long answer type questions

1. Here are three key differences between the solid, liquid, and gaseous states of matter:

1. **Arrangement of particles:**
    - Solid: In a solid, particles are tightly packed in a regular arrangement, forming a rigid structure with strong intermolecular forces of attraction. The particles vibrate in fixed positions, maintaining the shape and volume of the solid.
    - Liquid: In a liquid, particles are loosely packed and have more freedom of movement compared to solids. They are arranged randomly but still have strong enough intermolecular forces to maintain a definite volume. Liquids can flow and take the shape of their container.
    - Gas: In a gas, particles are widely spaced apart and have very weak intermolecular forces of attraction. They move freely and randomly, filling the entire volume of their container and exerting pressure on its walls.
2. **Shape and volume:**
    - Solid: Solids have a definite shape and volume, meaning they maintain a fixed shape and occupy a specific amount of space.
    - Liquid: Liquids have a definite volume but take the shape of their container. They do not have a fixed shape.
    - Gas: Gases do not have a definite shape or volume. They expand to fill the entire volume of their container, taking its shape.
3. **Compressibility and density:**
    - Solid: Solids are generally not compressible and have a high density due to the close packing of particles.
    - Liquid: Liquids are slightly compressible and have a moderate density compared to solids and gases.
    - Gas: Gases are highly compressible and have a much lower density compared to solids and liquids.

2. The kinetic theory of matter is a fundamental concept in physics and chemistry that describes the behavior of particles in matter. It provides insights into how particles move and interact at the microscopic level, explaining various macroscopic properties of solids, liquids, and gases. Here is an explanation of the kinetic theory of matter:

1. **Particle Nature of Matter:** The kinetic theory of matter proposes that all matter is composed of tiny particles, such as atoms, molecules, or ions. These particles are in constant motion and possess kinetic energy, which is the energy of motion. The behavior of matter at the macroscopic level arises from the collective motion and interactions of these particles.
2. **Particle Motion:** According to the kinetic theory, particles in matter are in continuous random motion. The motion of particles is attributed to their kinetic energy, which is influenced by factors such as temperature and pressure. At higher temperatures, particles have higher kinetic energy and move faster, while at lower temperatures, they move more slowly.
3. **Interparticle Forces:** Particles in matter interact with each other through intermolecular forces, which can be attractive or repulsive depending on the type of particles and their distance apart. These interparticle forces determine the behavior and properties of matter, such as its state (solid, liquid, or gas), viscosity, and compressibility.
4. **Volume and Density:** The kinetic theory explains the differences in volume and density among the three states of matter:
    - In solids, particles are closely packed in a regular arrangement, resulting in a fixed volume and high density.
    - In liquids, particles are less densely packed and have more freedom of movement, leading to a definite volume but lower density compared to solids.
    - In gases, particles are widely spaced apart and move freely, filling the entire volume of their container and having a much lower density compared to solids and liquids.
5. **Temperature and Pressure:** Temperature is a measure of the average kinetic energy of particles in matter. According to the kinetic theory, an increase in temperature leads to an increase in the kinetic energy and speed of particles, while a decrease in temperature results in slower particle motion. Pressure arises from the collisions of gas particles with the walls of their container. The force exerted by each collision contributes to the overall pressure exerted by the gas.
6. **Macroscopic Observations:** The kinetic theory provides explanations for various macroscopic observations and phenomena, such as diffusion, thermal expansion, phase changes (melting, freezing, boiling), and the behavior of ideal gases. It also helps understand the relationship between microscopic particle behavior and macroscopic properties of matter.

3.

The change of state refers to the process by which matter transitions from one physical state (solid, liquid, or gas) to another due to changes in temperature or pressure. Each state of matter represents a distinct arrangement and motion of particles, and transitions between states involve the absorption or release of energy.

Here's a flowchart showing the complete cycle of change of state:

1. **Solid to Liquid:**
    - Melting: Solid → Liquid
    - Heat is added to solid, increasing the kinetic energy of particles.
    - Particles overcome the attractive forces holding them in place, allowing them to move more freely.
    - Result: Solid melts into a liquid.
2. **Liquid to Solid:**
    - Freezing: Liquid → Solid
    - Heat is removed from the liquid, reducing the kinetic energy of particles.
    - Particles lose energy and slow down, forming orderly arrangements and solidifying.
    - Result: Liquid freezes into a solid.
3. **Liquid to Gas:**
    - Evaporation: Liquid → Gas
    - Heat is added to the liquid, increasing the kinetic energy of particles.
    - Some particles at the surface gain enough energy to overcome intermolecular forces and escape into the gas phase.
    - Result: Liquid evaporates into a gas.
4. **Gas to Liquid:**
    - Condensation: Gas → Liquid
    - Heat is removed from the gas, reducing the kinetic energy of particles.
    - Gas particles lose energy and slow down, coming closer together and forming a liquid.
    - Result: Gas condenses into a liquid.
5. **Solid to Gas:**
    - Sublimation: Solid → Gas
    - Heat is added to the solid, increasing the kinetic energy of particles.
    - Some particles gain enough energy to break free from the solid phase and enter the gas phase directly.
    - Result: Solid sublimes into a gas.
6. **Gas to Solid:**
    - Deposition: Gas → Solid
    - Heat is removed from the gas, reducing the kinetic energy of particles.
    - Gas particles lose energy and slow down, coming closer together and forming a solid without passing through the liquid phase.
    - Result: Gas deposits into a solid.

$$solid \underset{cool}{\overset{Heat}{\rightleftarrows}} liquid \underset{cool}{\overset{Heat}{\rightleftarrows}} Gas$$

4. To demonstrate that a substance absorbs heat during melting without a change in its temperature, we can conduct a simple experiment using a calorimeter. Here's how the experiment can be performed:

Materials Needed:

1. Calorimeter (insulated container)
2. Thermometer
3. Ice
4. Heat source (e.g., Bunsen burner or hot plate)
5. Stopwatch
6. Stopwatch

Procedure:

1. Set up the calorimeter by placing the ice inside and allowing it to reach thermal equilibrium with the surroundings. This ensures that the calorimeter is at the same temperature as the ice (0°C).
2. Measure and record the initial temperature of the ice using the thermometer.
3. Heat the ice in the calorimeter using the heat source (e.g., Bunsen burner or hot plate). Continuously stir the ice-water mixture to ensure uniform heating.
4. As the ice starts to melt, continue to monitor the temperature using the thermometer. Note any changes in temperature.
5. Once all the ice has melted and the temperature remains constant, stop heating and record the final temperature.
6. Calculate the amount of heat absorbed by the ice during melting using the formula:
   $Q=m\times L$
   where:
   - Q is the heat absorbed (in joules)
   - m is the mass of the melted ice (in grams)
   - L is the latent heat of fusion of the substance (in joules per gram)

Observations:

1. Initially, the temperature of the ice remains constant at 0°C as it absorbs heat from the surroundings during the melting process.
2. As the ice melts, there is no change in temperature until all the ice has melted.
3. Once all the ice has melted, the temperature of the water in the calorimeter remains constant at 0°C until all the ice has melted.

Analysis:

1. The constant temperature observed during melting indicates that the heat added to the ice is being used to break the intermolecular bonds between the ice particles, rather than increasing the temperature of the ice-water mixture.
2. The heat absorbed by the ice during melting is equal to the product of the mass of the melted ice and the latent heat of fusion of the substance.

3. This experiment demonstrates that substances absorb heat during melting without a change in temperature, illustrating the concept of latent heat of fusion.

G. Application based questions

1. Cotton is a solid material composed of cellulose fibers. Despite being a solid, cotton fibers have a relatively low density compared to water, which allows them to float on the surface of water. Several factors contribute to this phenomenon:

1. **Porosity:** Cotton fibers have a porous structure with many air pockets trapped within the fibers. This porosity reduces the overall density of cotton and increases its buoyancy, allowing it to float on water.
2. **Low Density:** The density of cotton fibers is lower than that of water. When placed on the surface of water, the upward buoyant force exerted by the water on the cotton is greater than the downward gravitational force acting on the cotton, causing it to float.
3. **Surface Tension:** The surface tension of water also plays a role in allowing cotton to float. Water molecules at the surface of the water experience cohesive forces, which create a 'skin' or surface layer with higher surface tension. This surface tension can support the weight of the cotton fibers, preventing them from sinking.
4. **Hydrophobicity:** Cotton fibers are hydrophilic, meaning they have an affinity for water and can absorb moisture. However, cotton fibers also have hydrophobic regions, which repel water to some extent. This combination of hydrophilic and hydrophobic properties may contribute to the ability of cotton to float on water.

Overall, the combination of porosity, low density, surface tension effects, and hydrophobicity allows cotton, despite being a solid material, to float on the surface of water.

2.
It is advisable to use a pressure cooker at high altitudes because the lower atmospheric pressure at higher altitudes affects the boiling point of water. At higher elevations, the atmospheric pressure is lower than at sea level. As a result, water boils at a lower temperature compared to at sea level.

Using a pressure cooker at high altitudes helps compensate for the lower boiling point of water by increasing the pressure inside the cooker. The increased pressure raises the boiling point of water, allowing it to reach higher temperatures than it would at atmospheric pressure. This higher temperature facilitates faster cooking times and ensures that food is cooked thoroughly.

In essence, using a pressure cooker at high altitudes helps maintain cooking efficiency and ensures that food is cooked safely and effectively despite the lower boiling point of water due to reduced atmospheric pressure.

Multi-Disciplinary Questions

1. When we place Potassium Permanganate crystals into the water, it's purple colour spreads throughout the water. This shows the diffusion property of particles of water and Potassium Permanganate, as due to this property only the dissolution and spreading of the colour of Potassium Permanganate takes place.
2. One kg sand is denser than 1kg cotton because density = mass/volume. The volume required by cotton is more than the sand and density and volume are inversely proportional.

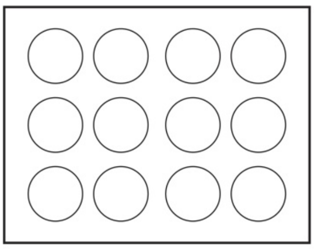
Play and Learn

Student do yourself

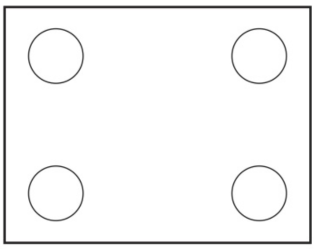
Stem Project

Student do yourself

Image based question



Position (x)
Liquid State



Position (y)
Gases State

Values and Life Skills

(a) Roma keep wet cloth surrounding the earthen pot because, the wet cloth gave the cooling effect to the pot, as the water in the cloth evaporated and evaporation causes cooling effect.

(b) By sprinkling some water on the lawn/veranda of the house can keep the house cool. Sita showed the value of responsible behavior.

(c) Roma showed the value of a responsible citizen.

ICSE Chemistry-8

Chapter-2

Physical and Chemical Changes

Exercise Corner

A. MCQs

1. (b) Wet clothes to dry clothes
2. (c) Wax vapour burns into flame
3. (c) natural process
4. (d) All of these
5. (a) Physical changes

B. Fill in the Blanks

1. Changes in which the formation of new substances takes place are called **chemical changes**.
2. Melting of ice is a **physical** change.
3. Burning of wood is a **chemical** change.
4. Revolution of the Earth around the Sun is a **periodical** change.
5. A small plant changing into a tree is a **natural** change.

C. True Or False

1. False- Cooking of rice is a chemical change.
2. False - Breaking of a china dish is a physical change.
3. False - Cutting of wood into pieces is a physical change.
4. True - Rusting of iron is an irreversible change.
5. False - Eruption of a volcano is an irreversible change.

D. Very short answer type questions

1. Slow changes refer to gradual alterations or transformations that occur over an extended period of time. These changes often involve processes that unfold slowly and may not be immediately noticeable.

2.

1. Melting of ice
2. Boiling of water
3. Crushing a can

3. The tearing of paper demonstrates a physical change.

4. Melting of ice.

5. A chemical change is a process in which one or more substances undergo a chemical reaction, resulting in the formation of new substances with different chemical properties.

E. Short answer type questions

1. One instance where water undergoes a physical change is when it changes from solid ice to liquid water through melting.

One instance where water undergoes a chemical change is when it reacts with sodium metal to form hydrogen gas and sodium hydroxide, a process known as the sodium-water reaction.

2. The setting of curd is a chemical change because it involves a biochemical process called fermentation. During fermentation, bacteria such as Lactobacillus convert lactose (a sugar present in milk) into lactic acid through enzymatic action. This process changes the chemical composition of the milk, resulting in the formation of curd. Additionally, the transformation of milk into curd is irreversible, indicating a chemical change rather than a physical change.

3.
Burning wood and cutting something into small pieces are considered two different types of changes because they involve different mechanisms and result in different outcomes:

1. **Burning Wood (Chemical Change):** When wood is burned, it undergoes a chemical change known as combustion. During combustion, the wood reacts with oxygen in the air to produce heat, light, carbon dioxide, water vapor, and ash. This process involves the breaking of chemical bonds within the wood molecules and the formation of new substances, such as carbon dioxide and water vapor. Burning wood is irreversible, as the original wood is transformed into different chemical compounds.
2. **Cutting into Small Pieces (Physical Change):** Cutting something into small pieces, such as cutting wood into smaller chunks, is a physical change. This process involves only the physical alteration of the material's shape and size, without changing its chemical composition. The cutting action severs the bonds between adjacent particles, but the chemical structure of the material remains unchanged. Cutting is a reversible

process because the pieces can theoretically be rejoined to form the original material without altering its chemical properties.

4. The three characteristics of physical changes are:

1. No new substances are formed: Physical changes do not involve the formation of new substances. The original substances retain their chemical identity throughout the change.
2. Reversibility: Physical changes are often reversible, meaning the altered material can return to its original state without undergoing any chemical transformation.
3. No change in chemical composition: Physical changes only affect the physical properties of a substance, such as its shape, size, or state of matter. The chemical composition of the substance remains unchanged before and after the change.

5. The three characteristics of chemical changes are:

1. Formation of new substances: Chemical changes involve the formation of one or more new substances with different chemical properties from the original substances.
2. Irreversibility: Chemical changes are often irreversible, meaning it is difficult or impossible to reverse the process and return to the original substances once the change has occurred.
3. Change in chemical composition: Chemical changes result in a change in the chemical composition of the substances involved. Bonds between atoms are broken and new bonds are formed, leading to the creation of different molecules with unique properties.

F. Long answer type questions

1. When a candle burns, both physical and chemical changes occur:

I. **Physical Change:** The physical change that occurs during the burning of a candle is the melting of the solid wax. As the flame of the candle heats the wax, it melts and forms a pool of liquid wax around the wick. This change is physical because it only involves a change in the state of the substance from solid to liquid, without altering the chemical composition of the wax.

II. **Chemical Change:** The chemical change that occurs during the burning of a candle is the combustion of the wax vapor. As the liquid wax near the wick heats up, it vaporizes and reacts with oxygen from the air in a combustion reaction. This combustion reaction releases heat and light energy, producing carbon dioxide gas (CO_2) and water vapour (H_2O). This change is chemical because it involves the breaking and formation of chemical bonds, resulting in the conversion of the wax molecules into new substances.

Another example of a familiar process in which both physical and chemical changes take place is cooking an egg:

i. **Physical Change:** When an egg is heated in a pan, the egg white and yolk undergo a physical change as they change from a liquid to a solid state. This change is physical because it only involves a change in the state of the substances, without altering their chemical composition.
ii. **Chemical Change:** At the same time, chemical changes also occur during the cooking of an egg. The proteins in the egg white denature and coagulate as they are exposed to heat, resulting in the formation of new chemical structures. Additionally, Maillard reactions occur between the proteins and sugars present in the egg, leading to the development of flavour and browning on the surface of the cooked egg. These changes are chemical because they involve the rearrangement of atoms and the formation of new chemical compounds.

2. Difference between physical and chemical changes

1. **Nature of Change:**
   - Physical Change: In a physical change, the substance undergoes a change in its physical state or appearance without altering its chemical composition. The molecules remain the same, and no new substances are formed.
   - Chemical Change: In a chemical change, the substance undergoes a change in its chemical composition, resulting in the formation of one or more new substances with different chemical properties.
2. **Reversibility:**
   - Physical Change: Physical changes are often reversible, meaning the altered material can return to its original state without undergoing any chemical transformation. For example, melting ice can refreeze into solid ice.
   - Chemical Change: Chemical changes are typically irreversible. Once a chemical change has occurred, it is difficult or impossible to reverse the process and return to the original substances.
3. **Energy Changes:**
   - Physical Change: Physical changes generally do not involve the absorption or release of significant amounts of energy. The changes in energy are usually minimal and may involve changes in temperature or phase transitions.
   - Chemical Change: Chemical changes often involve the absorption or release of energy in the form of heat, light, or sound. These changes in energy are often indicative of a chemical reaction taking place.
4. **Observability:**
   - Physical Change: Physical changes are often observable through changes in the appearance, shape, or state of the substance. However,

the identity and chemical composition of the substance remain unchanged.

- Chemical Change: Chemical changes may be observed through changes in color, odor, or the formation of precipitates or gas bubbles. These changes indicate the formation of new substances with different chemical properties.

3. When magnesium oxide MgO) is dissolved in water H_2O), it undergoes a chemical change known as hydrolysis. In this process, magnesium oxide reacts with water to form magnesium hydroxide $Mg(OH)_2$).

The word equation for this process is:

$$\text{Magnesium oxide}(MgO)+\text{Water}(H_2O)\rightarrow\text{Magnesium hydroxide}(Mg(OH)_2)$$

The type of change that takes place is a chemical change, as it involves the formation of a new substance $Mg(OH)_2$) with different chemical properties compared to the reactants MgO and H_2O).

G. Application based questions

1.
The change that occurs during the use of LPG (liquefied petroleum gas) is a physical change.

When LPG is stored in a cylinder, it exists in a liquid state due to high pressure. However, when it is burned on the stove, it is released from the cylinder and undergoes vaporization, transitioning into a gaseous state. This change in state from liquid to gas is a physical change because it only involves a change in the physical state or phase of the substance, without altering its chemical composition. The molecules of LPG remain the same before and after the change; only their arrangement and behavior change as they transition from a liquid to a gas.

2. Iron rusts when exposed to moisture and oxygen in the air, forming iron oxide (rust) on its surface. This rusting process weakens the structure of iron and eventually leads to its degradation or corrosion.

Stainless steel, on the other hand, contains iron but also incorporates other alloying elements such as chromium, nickel, and molybdenum. These alloying elements form a protective layer on the surface of stainless steel, known as a passive film or chromium oxide layer. This passive film acts as a barrier, preventing the underlying iron from coming into contact with moisture and oxygen, thereby inhibiting rust formation. As a result, stainless steel resists rusting and corrosion, making it more durable and suitable for various applications where iron alone would not be as effective.

Experiential Learning Questions

1. Change which can happen backward, that is, can be reversed is called a reversible change. If you keep water in the freezer for some time, it transforms into ice. But as soon as you take it out of the freezer, it turns into water again. This is a reversible change.
2. **Examples of chemical changes** would be burning, cooking, rusting, and rotting **Examples of physical changes** could be boiling, melting, freezing, and shredding.

Multi-disciplinary Questions

1. A bottle containing a perfume is by mistake left open. After a few days, its volume was found to have reduced to half. This is because perfume contains alcohol. It is a volatile liquid. When it is kept open, it vaporizes and diffuses into the gaseous molecule. Hence, the volume of perfume is reduced.

2. Yes, the quality of air and water do affect the rusting process. In dry air and oxygen-free water iron does not rust. The rate of rusting also increases with an increase in acidic gases like sulphur dioxide, nitric dioxide and carbon dioxide in the air and in water.

Play and Learn

Student do yourself

Stem Project

Student do yourself

Image Based Question:

(i) Physical change
(ii) Chemical change
(iii) Chemical change
(iv) Chemical change

Value and Life Skills

(i) By oiling, greasing or painting

(ii) The presence of air (oxygen) and moisture (water) are the essential condition for rusting to occur.

(iii) The rusting of iron can be controlled by limiting the amount of oxygen and water surrounding the metal. There for we can increases the national economy.

ICSE Chemistry-8

Chapter-3

Elements and Compounds

Exercise Corner

A. MCQs

1. (a) Filtration
2. (a) Adsorption
3. (c) Sieving
4. (b) Evaporation
5. (c) Loading

B. Fill in the Blanks

1. Symbol of gold is **Au**.
2. Compounds have **fixed** melting points.
3. Sugarcane juice is a mixture of **sugar**, water, and many other substances.
4. Separation of components is done to obtain a **pure** substance.
5. Boiling point of pure water is **higher** than that of impure water.

C. True Or False

1. True - A pure substance typically has a fixed melting and boiling point.
2. True - Compounds are indeed pure substances, as they consist of molecules made up of two or more different elements chemically bonded together in fixed proportions.
3. True - Separation of components of a mixture is indeed a useful process to isolate individual substances for various purposes.
4. True - Nitrogen molecules are indeed formed by the mutual sharing of electrons between nitrogen atoms, resulting in a covalent bond.
5. False - Tap water and pond water may have different compositions and characteristics depending on various factors such as source, treatment, and contamination.

D. Very short answer type questions

1. Alum

2. Sieving

3. Screening

4. Evaporation

5. The process used to recover salt from sea water is called **evaporation**.

E. Short answer type questions

1. Alum is used in loading to help settle suspended clay particles in muddy water by forming larger flocs, which can then be easily separated by filtration or sedimentation.

2. The use of decantation is to separate a mixture of liquids or a liquid-solid mixture by pouring off the liquid phase while leaving the solid phase behind in the container.

3. To separate a mixture of sand and salt, you can use the following steps:

1. Dissolve the mixture in water to dissolve the salt, leaving the sand particles undissolved.
2. Filter the mixture to separate the sand particles, which will remain on the filter paper, from the salt solution, which will pass through as the filtrate.
3. Evaporate the water from the salt solution to recover the salt, leaving behind the sand particles.

4. (i) **Distillation:** Distillation is a method used to separate a mixture of liquids with different boiling points. The process involves heating the mixture to its boiling point and collecting the vapor, which is then condensed back into liquid form. Since different substances have different boiling points, they will vaporize and condense at different temperatures, allowing for the separation of components based on their boiling points. Distillation is commonly used in industries for the purification of liquids, such as water purification, and in the production of alcoholic beverages and essential oils.

(ii) **Sieving:** Sieving is a method used to separate particles of different sizes. It involves passing a mixture of particles through a sieve or mesh screen with uniform-sized holes. The smaller particles pass through the sieve, while the larger particles are retained on top of the sieve. Sieving is commonly used in various industries and everyday applications, such as in the preparation of flour, the separation of gravel and sand in construction, and the filtration of solid particles from liquids.

(iii) **Sublimation:** Sublimation is a phase transition process in which a solid substance directly converts into a vapor without passing through the liquid phase. This occurs when the vapor pressure of the solid exceeds the atmospheric pressure at a specific temperature. Sublimation is observed in certain substances with high vapor pressures, such as dry ice (solid carbon dioxide) and camphor. In practical applications, sublimation is utilized for purification purposes, such as in the sublimation purification of iodine, the production of freeze-dried foods, and the deposition of thin films in the semiconductor industry.

5. Diffusion is the spontaneous movement of particles (atoms, ions, or molecules) from an area of higher concentration to an area of lower concentration, resulting in the uniform distribution of particles. This process occurs due to the random motion of particles, driven by the tendency to minimize concentration gradients and achieve equilibrium.

In simpler terms, diffusion is the process by which particles naturally spread out and mix with one another until they are evenly distributed. It is a fundamental process observed in various natural phenomena, such as the dispersion of fragrance in the air, the movement of gases in the atmosphere, and the exchange of substances across cell membranes in biological systems.

F. Long answer type questions

1. Fractional distillation is a process used to separate a mixture of liquids with different boiling points. It is a more precise and efficient version of simple distillation, particularly useful when the boiling points of the components in the mixture are close to each other.

Here's how fractional distillation works, along with an example:

1. **Setup**: The mixture is heated in a fractional distillation apparatus, typically consisting of a fractionating column packed with glass beads or metal trays. The mixture is heated in a flask, and the vapors rise through the fractionating column.
2. **Vaporization**: As the mixture is heated, the component with the lowest boiling point vaporizes first. The vapor rises through the fractionating column, where it comes into contact with the beads or trays. These surfaces provide numerous sites for condensation and re-evaporation, promoting repeated vapor-liquid equilibrium.
3. **Condensation**: As the rising vapor reaches cooler regions of the fractionating column, it condenses back into liquid form. However, the condensed liquid isn't entirely separated from the vapor phase. Instead, it trickles back down the column, undergoing further vaporization and condensation as it ascends and descends.
4. **Separation**: The repeated vaporization and condensation cycles in the fractionating column gradually enrich the vapor in the component with the lower boiling point. At the top of the column, the vapor is collected and condensed into a liquid, while the higher boiling point component remains behind in the flask.
5. **Collection**: The condensed liquid, enriched in the lower boiling point component, is collected as the distillate. This distillate contains a higher concentration of the lower boiling point component than the original mixture.

Example: Separation of crude oil

Fractional distillation is commonly used in the petroleum industry to separate crude oil into its various components, such as gasoline, diesel, kerosene, and lubricants. Crude oil is a complex mixture of hydrocarbons with different boiling points. During fractional distillation, crude oil is heated in a fractionating column. The vapor rises through the column, where it undergoes repeated vaporization and condensation cycles. The lighter hydrocarbons with lower boiling points vaporize first and are collected at the top of the column, while the heavier fractions with higher boiling points remain in the bottom. This process allows for the separation and collection of various petroleum products according to their boiling points, resulting in the production of different fuels and industrial chemicals.

2. Filtration is a separation technique used to separate a solid-liquid mixture by passing it through a porous barrier, such as filter paper or a filter bed, which allows the liquid component to pass through while retaining the solid component.

Here's how filtration works, along with an example:

1. **Setup**: The solid-liquid mixture is poured onto a filtration apparatus, which typically consists of a funnel with a piece of filter paper or a porous barrier placed at the base. The funnel is supported by a flask or container to collect the filtrate.
2. **Filtration**: The mixture is poured into the funnel, and gravity or vacuum pressure is applied to facilitate the filtration process. As the mixture passes through the filter paper or porous barrier, the liquid component, known as the filtrate, passes through the pores, while the solid component, known as the residue, is retained on the surface of the filter paper or within the filter bed.
3. **Separation**: The solid residue collected on the filter paper or within the filter bed is separated from the liquid filtrate. The filtrate collects in the flask or container placed beneath the funnel.
4. **Washing**: In some cases, the solid residue may be washed with a solvent to remove any adhering impurities or traces of the liquid component. This ensures the purity of the separated solid.
5. **Drying**: After filtration, the solid residue may be dried to remove any residual moisture before further analysis or use.

Example: Separation of sand and water

Suppose you have a mixture of sand and water. To separate the two components using filtration, you can follow these steps:

1. Set up a filtration apparatus with a funnel and filter paper, supported by a flask to collect the filtrate.
2. Pour the sand-water mixture into the funnel.
3. The water, being a liquid, passes through the pores of the filter paper and collects in the flask as the filtrate.
4. The sand particles, being solids, are retained on the surface of the filter paper as the residue.
5. Once all the water has passed through the filter paper, carefully remove the filter paper with the sand residue.
6. Allow the sand residue to dry completely to remove any remaining moisture.

After filtration, you will have separated the sand (solid) from the water (liquid), obtaining two distinct components. This demonstrates the effectiveness of filtration as a separation technique for solid-liquid mixtures.

3. (a) To separate iron from sulfur, the most suitable technique is magnetic separation. Iron is a ferromagnetic material, which means it can be attracted by a magnet. On the other hand, sulfur is non-magnetic. By using a magnet, the iron particles can be easily separated from the sulfur particles. This method is efficient and selective because it exploits the magnetic properties of iron while leaving sulfur unaffected.

(b) To separate chalk powder from water, the most suitable technique is filtration. Filtration is effective for separating a solid-liquid mixture when the solid particles are insoluble in the liquid. Chalk powder is insoluble in water, so when the mixture is passed through a filter paper, the water (liquid) will pass through, leaving the chalk powder (solid) behind on the filter paper. This method is simple, quick, and does not require any chemical treatment.

G. Application based questions

1. Three characteristics of a pure substance are:

1. Uniform Composition: A pure substance has a consistent and uniform composition throughout, meaning it is made up of only one type of particle or molecule.
2. Fixed Melting and Boiling Points: A pure substance typically has fixed melting and boiling points at standard pressure, indicating its purity and uniformity.
3. Cannot be Separated by Physical Means: Pure substances cannot be separated into simpler substances by physical methods such as filtration, distillation, or evaporation.

Example of a pure substance from my home: Table salt (sodium chloride).

2. Two metals that cannot be kept in air or water without undergoing rapid corrosion are:

1. Sodium (Na): Sodium is a highly reactive metal that reacts vigorously with water to produce sodium hydroxide and hydrogen gas. It also reacts with oxygen in the air to form sodium oxide or sodium peroxide, leading to rapid corrosion.
2. Potassium (K): Potassium is another highly reactive metal that reacts violently with water, resulting in the formation of potassium hydroxide and hydrogen gas. It also reacts with oxygen in the air to form potassium oxide or potassium peroxide, leading to rapid corrosion.

3. Differences between Mixture and Compound:

1. **Composition**:
   - Mixture: A mixture is a combination of two or more substances that are physically combined and can be separated by physical means. The

substances in a mixture retain their individual properties and can exist in varying proportions.
- Compound: A compound is a substance composed of two or more elements chemically bonded together in fixed proportions. The elements in a compound lose their individual properties and form new chemical properties.

2. **Separation**:
   - Mixture: Components of a mixture can be separated by physical methods such as filtration, distillation, or evaporation, as they retain their original properties.
   - Compound: Components of a compound cannot be separated by physical methods; they can only be separated by chemical reactions.
3. **Properties**:
   - Mixture: The properties of a mixture are a combination of the properties of its individual components. Each component retains its original properties.
   - Compound: The properties of a compound are entirely different from those of its constituent elements. The compound has unique properties that are distinct from the properties of its elements.

Example:

1. **Mixture**: Air is a mixture of gases, primarily nitrogen, oxygen, carbon dioxide, and traces of other gases. It can be separated into its components by methods such as fractional distillation. Each gas in air retains its individual properties, and their proportions can vary.
2. **Compound**: Water (H2O) is a compound composed of hydrogen and oxygen chemically bonded together. It cannot be separated into hydrogen and oxygen by physical methods; it can only be decomposed into its elements through chemical reactions, such as electrolysis. Water has unique properties distinct from those of hydrogen and oxygen individually.

Multi-Disciplinary Question

When sulphur is heated in air it produce sulphur dioxide SO_2.

(a) (i) SO_2 gas is neutral in nature and thus there will be no change in colour of dry litmus paper.

(ii) SO_2 reacts with water to produce H2SO3 sulphurous acid that being acid turns blue moist litmus red.

(b) $S(s) + O_2(g) \rightarrow SO_2(g)$

$SO_2(g) + H_2O(aq) \rightarrow H_2SO_3(a)$

Play and Learn

Students do yourself

Stem Project

Students do yourself

Values and Life Skills

(a) Law of conservation of mass

(b) The mass in an isolated system can neither be created nor be destroyed but can be transformed from one form to another form.

ICSE Chemistry-8

Chapter-4

Atomic Structure

Exercise Corner

A. MCQs

1. (a) Number of protons in the nucleus of an atom
2. (b) Atoms consist of electrons
3. (a) Proton
4. (a) One
5. (b) an unionised helium atom

B. Fill in the Blanks

1. An ion which has a negative charge is called an **anion**.
2. The mass of a hydrogen atom is approximately **1.008 g**.
3. Isotopes of an element differ in the number of **neutrons** in their nucleus.
4. The outermost shell of an atom is known as the **valence shell**.
5. Neutrons are **neutral** particles having mass equal to that of protons.

C. True Or False

1. False

2. True

3. True

4. False

5. True

D. Very short answer type questions

1. Cathode rays are streams of electrons observed in vacuum tubes.

2. A neutron is approximately 1836 times heavier than an electron.

3. Rutherford's experiment is called the gold foil scattering of α-particles experiment, and his atomic model is called the nuclear atomic model.

4. The innermost shell (K shell) has the least energy.

5. Anode rays are positively charged particles (cations) observed in vacuum tubes.

E. Short answer type questions

1. The fundamental particles can be represented as follows:

1. Electrons: Symbolized as "e^{-1}", with a negative charge (-1) and negligible mass compared to protons and neutrons.
2. Protons: Symbolized as "p^{+}", with a positive charge (+1) and a mass approximately 1836 times greater than that of an electron.
3. Neutrons: Symbolized as "n^{0}", with no charge (neutral) and a mass approximately equal to that of a proton.

2. Thomson's atomic model was compared to a watermelon because it proposed that atoms consisted of a positively charged "soup" with negatively charged electrons scattered throughout, resembling the seeds of a watermelon within its positively charged pulp.

3. The comparative masses of the fundamental particles are as follows:

1. Electron: Negligible mass, approximately 1/1836 times the mass of a proton or neutron.
2. Proton: Relatively heavy compared to an electron, with a mass approximately 1836 times that of an electron.
3. Neutron: Similar in mass to a proton, with a mass approximately equal to that of a proton.

4. James Chadwick discovered the neutron through experiments involving the bombardment of beryllium with alpha particles. He observed an uncharged particle being emitted, which he identified as the neutron. This discovery occurred in 1932.

5. Atomic Number: The atomic number of an element represents the number of protons present in the nucleus of an atom. It is denoted by the symbol Z and determines the element's identity. For example, hydrogen has an atomic number of 1, indicating it has one proton in its nucleus.

Mass Number: The mass number of an atom represents the total number of protons and neutrons present in its nucleus. It is denoted by the symbol A and is used to differentiate between isotopes of an element. For example, carbon-12 has a mass number of 12, indicating it has 6 protons and 6 neutrons in its nucleus.

F. Long answer type questions

1. Bohr's atomic model, proposed by Danish physicist Niels Bohr in 1913, was a significant advancement in the understanding of atomic structure, particularly the structure of hydrogen and hydrogen-like atoms. Here's an explanation of Bohr's atomic model:

1. **Postulates**: Bohr's model was based on a few key postulates:
   a. Electrons orbit the nucleus in circular paths, or orbits, without radiating energy. These orbits are called "stationary orbits" or "allowed orbits".
   b. Electrons can only occupy certain specific orbits, each corresponding to a specific energy level. These orbits are quantized, meaning they have fixed energies.
   c. Electrons can jump from one orbit to another by absorbing or emitting energy in discrete packets, or quanta. When an electron jumps to a lower energy orbit, it emits energy, usually in the form of light, and when it jumps to a higher energy orbit, it absorbs energy.
2. **Quantization of Energy**: According to Bohr's model, electrons can only exist in certain energy levels or orbits around the nucleus. These energy levels are quantized, meaning they can only have specific discrete values. The energy of an electron in a particular orbit is inversely proportional to the radius of the orbit. Electrons in orbits closer to the nucleus have lower energy levels, while those in orbits farther from the nucleus have higher energy levels.
3. **Energy Transitions**: When an electron transitions from a higher energy orbit to a lower energy orbit, it emits energy in the form of electromagnetic radiation, such as light. This emitted radiation corresponds to specific frequencies or wavelengths determined by the energy difference between the initial and final orbits. Conversely, when an electron absorbs energy, it transitions to a higher energy orbit.
4. **Application to Hydrogen Atom**: Bohr's model was particularly successful in explaining the hydrogen atom's spectrum, particularly the Balmer series of spectral lines. The model predicted the wavelengths of the spectral lines emitted by hydrogen, which matched the experimental observations.
5. **Limitations**: While Bohr's model successfully explained some features of the hydrogen atom's spectrum, it had limitations. It could not explain the spectra of atoms with more than one electron, nor could it fully account for the fine details of the hydrogen spectrum. Additionally, it violated the principles of classical mechanics, particularly the laws of motion and electromagnetism.

2. Rutherford's atomic model, also known as the nuclear model or Rutherford model, was proposed by physicist Ernest Rutherford in 1911. It marked a significant advancement in the understanding of atomic structure. Here's an explanation of Rutherford's model and the observations and conclusions drawn from his famous alpha-ray scattering experiment:

Rutherford's Atomic Model:

1. **Structure of the Atom**: Rutherford's model proposed that atoms consist of a tiny, dense, positively charged nucleus at the centre, surrounded by negatively charged electrons orbiting the nucleus. This concept was a departure from the previously proposed Thomson's "plum pudding" model, which suggested that atoms were uniform spheres of positive charge with embedded electrons.
2. **Nucleus**: The nucleus, according to Rutherford, contains most of the atom's mass and all of its positive charge. It is extremely small compared to the overall size of the atom. The electrons orbit the nucleus in empty space, much like planets orbiting the sun.
3. **Observations from Alpha-Particle Scattering Experiment**:
   Rutherford and his colleagues conducted an experiment where they bombarded a thin gold foil with alpha particles (helium nuclei) emitted by a radioactive source. They observed the paths of these alpha particles after they passed through the foil.
   - Most alpha particles passed straight through the foil without deflection, indicating that most of the atom is empty space.
   - Some alpha particles were deflected at small angles, suggesting that they encountered a positively charged center within the atom.
   - A few alpha particles were deflected back at large angles, even bouncing back toward the source, indicating a strong repulsive force from a concentrated positive charge.

Conclusion from Alpha-Particle Scattering Experiment:

1. **Most of the Atom is Empty Space**: The fact that most alpha particles passed straight through the foil without deflection indicated that atoms are mostly empty space. This observation contradicted the earlier Thomson model, which proposed that electrons were embedded in a positively charged "pudding."
2. **Concentration of Positive Charge**: The deflection of some alpha particles at small angles suggested the presence of a concentrated positive charge within the atom. This positive charge, according to Rutherford, must be located in a small, dense nucleus at the center of the atom.
3. **Small Size of the Nucleus**: The few alpha particles that were deflected back at large angles indicated that the positive charge within the atom occupies a very small volume compared to the overall size of the atom. This observation led to the conclusion that most of the atom's mass is concentrated in a tiny nucleus.

In summary, Rutherford's model of the atom proposed a dense, positively charged nucleus at the center, with electrons orbiting around it. This model was based on the observations from the alpha-particle scattering experiment, which revealed the structure of the atom and led to a new understanding of atomic structure.

3. Comparison of Rutherford's and Bohr's Model of the Atom:

1. **Nucleus:**
   - Rutherford's Model: Rutherford's model proposed the existence of a dense, positively charged nucleus at the centre of the atom, where most of the atom's mass is concentrated.

- Bohr's Model: Bohr's model also included a nucleus at the atom's center, but it introduced the idea of quantized energy levels for electrons orbiting the nucleus.

2. **Electron Orbits:**
    - Rutherford's Model: Rutherford's model did not specify the arrangement of electrons around the nucleus. It assumed that electrons orbited the nucleus in a manner similar to planets orbiting the sun but did not address the stability or quantization of these orbits.
    - Bohr's Model: Bohr's model introduced the concept of quantized electron orbits, where electrons could only occupy specific, discrete energy levels around the nucleus. These orbits were stable and did not radiate energy.
3. **Energy Levels:**
    - Rutherford's Model: Rutherford's model did not address the quantization of energy levels for electrons.
    - Bohr's Model: Bohr's model proposed that electrons could only exist in certain energy levels, or "shells," around the nucleus. These energy levels were quantized, meaning they had specific, fixed energies.

G. Applications based questions

1. The particle discovered by Chadwick is called a neutron. Neutrons are subatomic particles with no charge and a mass nearly equal to that of a proton.

In an atom, neutrons are located within the nucleus along with protons. They contribute to the mass of the nucleus but do not carry any electric charge. Neutrons play a crucial role in stabilizing the nucleus by counteracting the repulsive forces between positively charged protons.

2. Here are the symbols and valencies of the given elements:

(a) Sodium

- Symbol: Na
- Valency: +1

(b) Nitrogen

- Symbol: N
- Valency: -3

(c) Aluminium

- Symbol: Al
- Valency: +3

Multi-Disciplinary-Questions

1.

(i) Cobalt-60 is used as a radiation source for medical radiotherapy where it is used in cancer treatment to control or kill malignant cells.
(ii) Iodide salts area used in pharmaceuticals and disinfectants, printing inks and dyes, catalysts, animals feed supplements and photographic chemical
(iii) U-235 used as fuel for nuclear power plants and the nuclear reactors that run naval ships and submarines. It also can be used in nuclear weapons.

2. A thin foil of lighter atoms will not give the same results as given with the foil of heavier atoms. Lighter atoms would be able to carry very little positive charge. Hence, they will not cause enough deflection of α-particles (positively charged).

Play and Learn:

1. Students do yourself
2. Students do yourself

Stem Project

Students do yourself

Values and Life Skills

(a) First disk according to arrangement of electrons orbital lowest energy shows high stability.
(b) The distribution of electrons in different orbitals of an atom is called electronic configuration.

ICSE Chemistry-8

Chapter-5

Language of Chemistry

Exercise Corner

A. MCQs

1. (c) N_2
2. (b) K
3. (a) H
4. (c) Valency
5. (c) Cu^{2+}

B. Fill in the Blanks

1. A chemical equation provides information on the **identity** of the substances and the reaction condition.
2. The symbol "aq" in a chemical equation represents the physical state of the substance as **aqueous** (dissolved in water).
3. Reaction in which heat is absorbed is represented by **positive** sign.
4. An unbalanced equation is known as **an incomplete equation**.
5. In a chemical reaction, the sum of the masses of the reactants and products remains unchanged. This is called the **law of conservation of mass**.

C. True Or False

1. True
2. False
3. True
4. False
5. False

D. Very short answer type questions

1. The symbol of an element is a one or two-letter abbreviation used to represent the element.

2. A chemical equation is a symbolic representation of a chemical reaction, showing the reactants and products involved, as well as their respective stoichiometric coefficients.

3. Combustion of methane (CH_4) is an example of an exothermic reaction.

4.

The molecular formula of a compound represents the actual number of atoms of each element present in a molecule of the compound.

5. Atomic mass is the mass of an atom of a chemical element, typically expressed in atomic mass units (amu).

E. Short answer type questions

1. Characteristics of a chemical equation include:

1. **Reactants and Products**: It shows the chemical substances (reactants) that are undergoing a reaction and the substances produced (products) by the reaction.
2. **Stoichiometric Coefficients**: It includes coefficients indicating the relative amounts of reactants and products involved in the reaction.
3. **Chemical Formulas**: It uses chemical symbols and formulas to represent the reactants and products accurately.
4. **Physical States**: It may include the physical states of the substances involved (solid, liquid, gas, aqueous).
5. **Directionality**: It is written from left to right, with reactants on the left side of the arrow and products on the right side.
6. **Law of Conservation of Mass**: It adheres to the principle that the total mass of the reactants equals the total mass of the products, ensuring mass conservation.

2. (i) **Reactant**: A reactant is a substance that undergoes a chemical change in a chemical reaction. Reactants are consumed during the reaction, and they are written on the left side of a chemical equation.

(ii) **Balanced Chemical Equation**: A balanced chemical equation is a representation of a chemical reaction where the number of atoms of each element is the same on both sides of the equation. This ensures that the law of conservation of mass is obeyed, meaning the total mass of the reactants equals the total mass of the products.

3. (i) **Balanced Equation**: $3H_2+N_2 \longrightarrow 2NH_3$

(ii) **Balanced Equation**: $4MnO_2+16HCl \rightarrow 4MnCl_2+8Cl_2+4H_2O$

4. (i) **Precipitate**: Precipitates are often represented by the symbol "↓" (downward arrow) placed next to the chemical formula of the precipitate in a chemical equation.

(ii) **Gas**: Gases are represented by the symbol "↑" (upward arrow) placed next to the chemical formula of the gas in a chemical equation.

(iii) **Liquid**: Liquids are typically not indicated explicitly in chemical equations since they are the most common state of matter and do not undergo significant changes in chemical reactions. However, if necessary, a liquid can be indicated simply by writing its chemical formula without any additional notation.

5.
In chemistry, the term "radical" refers to a group of atoms that behaves as a single unit in chemical reactions. These groups are often formed from molecules by the removal of one or more atoms, leaving behind unpaired electrons, making them highly reactive. Radicals play significant roles in various chemical processes, including combustion, polymerization, and atmospheric chemistry.

F. Long answer type questions

1. The modern concept of valency is based on the electron configuration of atoms and their tendency to achieve a stable electron configuration by gaining, losing, or sharing electrons. Here's an explanation of the modern concept of valency:

1. **Electron Configuration**: According to the modern atomic theory, atoms consist of a nucleus containing protons and neutrons, surrounded by electrons arranged in energy levels or shells. Each shell can hold a specific number of electrons, with the innermost shell having a lower energy level than outer shells.
2. **Octet Rule**: The octet rule states that atoms tend to gain, lose, or share electrons to achieve a stable electron configuration with eight electrons in their outermost shell (except for hydrogen and helium, which are stable with two electrons in their outermost shell, known as the duet rule). This stable configuration is similar to the noble gas configuration, which is highly stable due to its full outer shell.

3. **Valence Electrons**: Valency is determined by the number of electrons an atom can gain, lose, or share to achieve a stable electron configuration. The electrons in the outermost shell, known as valence electrons, are primarily responsible for determining the atom's chemical properties and its ability to form bonds with other atoms.
4. **Determining Valency**: The valency of an element is typically determined by the number of valence electrons it possesses. For main group elements (groups 1, 2, 13-18), the valency often corresponds to the number of electrons needed to achieve a stable octet configuration:
    - Group 1 elements have a valency of +1, as they tend to lose one electron to achieve a stable configuration.
    - Group 2 elements have a valency of +2, as they tend to lose two electrons to achieve a stable configuration.
    - Group 17 elements (halogens) have a valency of -1, as they tend to gain one electron to achieve a stable configuration.
    - Group 18 elements (noble gases) have a valency of 0, as they already have a stable configuration and do not readily form bonds.
5. **Variable Valency**: Some transition metals and post-transition metals exhibit variable valency, meaning they can form ions with different charges by losing different numbers of electrons. This variability arises from the presence of partially filled d or f orbitals, which allow for multiple oxidation states.

2.

Copper (Cu) exhibits variable valency due to the presence of incompletely filled orbitals in its electronic configuration. Let's delve into the reasons and then identify the compounds CuCl and $CuCl_2$:

Reason for Variable Valency in Copper (Cu):

1. **Electronic Configuration**: The electronic configuration of copper is 2, 8, 18, 1. This configuration shows that copper has a filled 3d subshell with 10 electrons, which is one electron short of a fully filled d subshell (which would be achieved with 18 electrons).
2. **Partially Filled d Orbitals**: The partially filled d orbitals in copper allow it to exhibit variable oxidation states by losing different numbers of electrons from the 4s and 3d orbitals.
3. **Variable Valency**: Copper can exhibit two common oxidation states: +1 and +2. In the +1 oxidation state, copper loses one electron from the 4s orbital, resulting in the electronic configuration 2, 8, 18. In the +2 oxidation state, copper loses two electrons, one from the 4s orbital and one from the 3d orbital, resulting in the electronic configuration 2, 8, 17.

Now, let's identify the compounds CuCl and CuCl2:

1. **CuCl (Copper(I) Chloride)**:

- In this compound, copper exhibits an oxidation state of +1.
- The formula indicates that there is one copper atom for every chlorine atom.
- Since copper is in the +1 oxidation state, the compound is named copper(I) chloride.

2. **$CuCl_2$ (Copper(II) Chloride)**:
   - In this compound, copper exhibits an oxidation state of +2.
   - The formula indicates that there are two chlorine atoms for every copper atom.
   - Since copper is in the +2 oxidation state, the compound is named copper(II) chloride.

3. Information provided by a chemical equation:

A chemical equation provides valuable information about a chemical reaction, including:

1. **Reactants and Products**: It identifies the chemical substances (reactants) that are consumed during the reaction and the substances produced (products) by the reaction.
2. **Stoichiometry**: It indicates the relative quantities of reactants and products involved in the reaction through stoichiometric coefficients.
3. **Physical States**: It may include information about the physical states of reactants and products (solid, liquid, gas, aqueous) to indicate the conditions under which the reaction occurs.
4. **Energy Changes**: Some chemical equations may indicate whether the reaction is exothermic (releasing heat) or endothermic (absorbing heat).
5. **Directionality**: It shows the direction of the reaction, with reactants on the left side of the equation and products on the right side.

Limitations of a chemical equation:

Despite the valuable information provided by chemical equations, they suffer from several limitations:

1. **Simplicity**: Chemical equations provide a simplified representation of chemical reactions and may not capture all the complexities and nuances of real-world reactions.
2. **No Mechanistic Information**: Chemical equations do not provide any information about the mechanism or pathway by which the reaction occurs. They only show the starting materials and final products.
3. **Reaction Conditions**: Chemical equations often do not specify the reaction conditions, such as temperature, pressure, or catalysts, which can significantly affect the rate and outcome of the reaction.
4. **Rate of Reaction**: Chemical equations do not provide information about the rate at which the reaction occurs or the kinetics of the reaction.
5. **Side Reactions**: Chemical equations may not account for side reactions or competing reactions that may occur simultaneously with the main reaction, leading to the formation of additional products or intermediates.
6. **Validity of Stoichiometry**: Chemical equations assume that reactions proceed to completion and that stoichiometry accurately reflects the ratio of reactants and products. In reality, reactions may not always proceed to completion, and the actual yield of products may differ from theoretical predictions.

7. **Isomeric Products**: Chemical equations may not distinguish between different isomeric forms of products, leading to ambiguity in the interpretation of the reaction.

G. Application based questions

1.
When white silver chloride (AgCl) is exposed to sunlight, it undergoes a photochemical reaction and turns violet or purple in color. This color change is due to the decomposition of silver chloride into elemental silver and chlorine gas under the influence of ultraviolet (UV) light.

The balanced chemical equation for this reaction is:

$$2AgCl \text{ sunlight} 2Ag + Cl_2$$

This equation represents the decomposition of silver chloride (AgCl) into silver (Ag) and chlorine gas (Cl_2) under the influence of sunlight, specifically UV light.

2. (i) The substance used for whitewashing is calcium oxide, also known as quicklime. Its chemical formula is CaO.

(ii) When calcium oxide CaO) reacts with water (H_2O), it forms calcium hydroxide ($2Ca(OH)_2$). The chemical equation for this reaction is:

$$2CaO + H_2O \longrightarrow Ca(OH)_2$$

This reaction is highly exothermic and is used in various applications, including in the preparation of whitewash.

Multi-disciplinary Question

Name of element in quick lime (cao) are calcium (ca) and oxygen (o)

Chemical reaction

CaO	+ $H2O$	$\longrightarrow Ca(OH)_2 + Heat$	
Calcium oxide	*Water*	*calcium hydroxide*	

Play and Learn

Students do yourself

Stem Project

Students do yourself

Image Based Question

Students do yourself

Values and Life Skills

1. Content of moisture in air is high in rainy season whereas air is almost dry in summer season. For rusting, the presence of both oxygen and water is essential. Rusting becomes faster, if the content of moisture in air is high. Hence, rusting of iron objects is faster in rainy season than in summer season.
2. Silver articles, when exposed to air become black after sometime. This is because the silver metal reacts with sulphur present in the atmosphere and forms silver sulphide.
3. Corrosion is a process by which an oxide layer is formed on a metal surface due to oxidation, when the metal is exposed to moist air. The corrosion of iron is called rusting. Silver on exposure to moist air develops black coating and copper on exposure to moist air develops greenish coating.

Damages caused by corrosion are:

(i) It reduces the strength of the metal.
(ii) It eats up the metal.

ICSE Chemistry-8

Chapter-6

Chemical Reactions

Exercise Corner

A. MCQs

1. (a) MgO
2. (c) CaO
3. (c) Displacement reaction
4. (c) Distillation
5. (c) Al_2O_s

B. Fill in the Blanks

1. Magnesium ribbon burns in the air on heating with the formation of a white powder called **magnesium oxide**.
2. The substances which undergo chemical change are called **reactants**.
3. (Sodium nitrate)$AgNO_3 + NaCl \rightarrow AgCl +$(Sodium nitrate).
4. Decomposition of potassium chlorate on heating in the presence of manganese dioxide is called **catalytic decomposition**.
5. Unbalanced reaction is also known as **incomplete reaction**.

C. True Or False

1. True
2. True
3. False
4. False
5. True

D. Very short answer type questions

1. Neutralization is a chemical reaction between an acid and a base, resulting in the formation of water and a salt.

2. The metal reactivity series is a list of metals arranged in order of their reactivity, with the most reactive metal at the top and the least reactive at the bottom.

3. Oxides are chemical compounds composed of oxygen and another element (or elements). They can be either acidic, basic, or amphoteric depending on their chemical properties.

4. A catalyst is a substance that increases the rate of a chemical reaction without being consumed in the process.

5.
Two examples of enzymes are:

1. Catalase
2. Amylase

E. Short answer type questions

1. Precipitation refers to the formation of a solid substance (precipitate) from a solution during a chemical reaction. An example of precipitation is the reaction between silver nitrate ($AgNO_3$) and sodium chloride (NaCl) solutions, which forms a white precipitate of silver chloride (AgCl) when mixed.

2. (i) **Addition reaction**:

- Definition: An addition reaction is a type of chemical reaction in which two or more reactants combine to form a single product without the formation of any byproducts.
- Example: The hydrogenation of alkenes is an example of an addition reaction. For instance, when hydrogen gas (H_2) reacts with ethene (C_2H_4) in the presence of a catalyst like platinum (Pt), it forms ethane (C_2H_6).

$$H_2 + C_2 + H_4 \xrightarrow{pt} C_2H_6$$

(ii) **Decomposition reaction**:

- Definition: A decomposition reaction is a type of chemical reaction in which a compound breaks down into two or more simpler substances.
- Example: The decomposition of hydrogen peroxide (H_2O_2) into water (H_2O) and oxygen (O_2) is an example of a decomposition reaction. $22H_2O_2 \rightarrow 2H_2O + O_2$

(iii) **Displacement reaction**:

- Definition: A displacement reaction is a type of chemical reaction in which a more reactive element displaces a less reactive element from its compound.
- Example: The reaction between zinc (Zn) metal and hydrochloric acid (HCl) to form zinc chloride ($ZnCl_2$) and hydrogen gas (H_2) is an example of a displacement reaction. $2Zn + 2HCl \rightarrow ZnCl_2 + H_2$

(iv) **Double displacement reaction**:

- Definition: A double displacement reaction is a type of chemical reaction in which the cations and anions of two different compounds switch places, resulting in the formation of two new compounds.

Example: The reaction between silver nitrate $AgNO_3$) and sodium chloride ($NaCl$) to form silver chloride ($AgCl$) and sodium nitrate ($NaNO_3$) is an example of a double displacement reaction. $3AgNO_3+NaCl \longrightarrow AgCl+NaNO_3$

3. The metal reactivity series is important for several reasons:

1. **Predicting Reactivity**: It helps predict the reactivity of metals in various chemical reactions. Metals higher in the reactivity series are more likely to undergo reactions, such as displacement reactions, with compounds containing metals lower in the series.
2. **Understanding Redox Reactions**: It provides insight into redox (reduction-oxidation) reactions, where metals lose or gain electrons. Metals higher in the reactivity series are more likely to be oxidized (lose electrons) and act as reducing agents, while metals lower in the series are more likely to be reduced (gain electrons) and act as oxidizing agents.
3. **Extraction of Metals**: It assists in the extraction of metals from their ores. Metals higher in the reactivity series are typically extracted using methods like electrolysis or reduction with carbon, while metals lower in the series can often be found in their elemental form in nature.
4. **Corrosion Resistance**: It helps determine the susceptibility of metals to corrosion. Metals higher in the reactivity series, such as alkali metals and alkaline earth metals, are more reactive and prone to corrosion, while metals lower in the series, such as noble metals like gold and platinum, are more resistant to corrosion.
5. **Selection of Materials**: It guides the selection of materials for various applications based on their reactivity. For example, metals lower in the reactivity series, like copper and aluminum, are often used in electrical wiring and construction due to their resistance to corrosion, while more reactive metals, like sodium and potassium, are used in chemical synthesis and pharmaceuticals.

4.
(i) **Acidic oxide**:

- Definition: An acidic oxide is a type of oxide that reacts with water to form an acid. These oxides typically contain nonmetals and are acidic because they produce acidic solutions when dissolved in water.
- Example: Carbon dioxide (CO_2) is an acidic oxide. When dissolved in water, it forms carbonic acid (H_2CO_3):$CO_2+H_2O \longrightarrow H_2CO_3$

(ii) **Basic oxide**:

- Definition: A basic oxide is a type of oxide that reacts with water to form a base. These oxides typically contain metals and are basic because they produce basic solutions when dissolved in water.
- Example: Sodium oxide (Na_2O) is a basic oxide. When dissolved in water, it forms sodium hydroxide ($NaOH$): $Na_2O+H_2O \rightarrow 2NaOH$

(iii) **Amphoteric oxide**:

- Definition: An amphoteric oxide is a type of oxide that can act as both an acid and a base. These oxides typically contain elements that can exhibit variable oxidation states and can react with both acids and bases.
- Example: Aluminum oxide (Al_2O_3) is an amphoteric oxide. It can react with acids to form aluminum salts and with bases to form aluminates:

$Al_2O_3+6HCl \longrightarrow 2AlCl_3+3H_2O$

(iv) **Neutral oxide**:

- Definition: A neutral oxide is a type of oxide that does not react with water to form either an acid or a base. These oxides typically consist of nonmetals and are neither acidic nor basic.
- Example: Nitrogen monoxide (NO) is a neutral oxide. It does not react with water to form either an acid or a base: $NO+H_2O \longrightarrow \text{No reaction}$

5. An exothermic reaction is a chemical reaction that releases energy in the form of heat to the surroundings. In exothermic reactions, the total energy of the products is lower than the total energy of the reactants, resulting in a net release of energy.

Example: The combustion of methane ($4CH_4$) is an exothermic reaction. When methane gas reacts with oxygen gas (O_2) in the presence of a spark or heat, it produces carbon dioxide (CO_2) and water (H_2O) along with the release of heat energy:

$CH_4+2O_2 \longrightarrow CO_2+2H_2O+\text{heat}$

In this reaction, the bonds formed in the products are stronger than the bonds broken in the reactants, leading to a net release of energy in the form of heat.

F. Long answer type questions

1. (i) When phenolphthalein is added to NaOH solution, the solution turns pink or magenta in color. Phenolphthalein is a pH indicator that changes color in the presence of bases. In acidic solutions, phenolphthalein remains colorless, but when added to a basic solution like NaOH, it undergoes a chemical change and turns pink due to the formation of the phenolphthalein ion.

(ii) When red litmus paper is dipped in NaOH solution, the red litmus paper turns blue. Litmus is a pH indicator that changes color in the presence of acids and bases. Red litmus paper remains red in acidic solutions but turns blue in basic solutions. This color change occurs because the red litmus paper reacts with the hydroxide ions (OH^-) present in the NaOH solution, resulting in the conversion of the red litmus dye to its blue form.

2. (i) $CaCO_3$ (s) → CaO (s) + CO_2 (g)

Balanced equation:

$$2CaCO_3 \longrightarrow CaO + CO_2$$

(ii) Zn (s) + H_2SO4 (aq) → $ZnSO_4$ (aq) + H_2 (g)

Balanced equation:

$$2Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$$

3.
(i) Burning a paper is a chemical change because it involves the transformation of the paper's chemical composition. When paper burns, it undergoes combustion, reacting with oxygen in the air to produce new substances such as carbon dioxide, water vapor, and ash. The chemical bonds within the paper molecules are broken and new bonds are formed with oxygen atoms from the air, resulting in the release of heat and light energy. The change is irreversible, and the resulting ash has different chemical properties than the original paper.

(ii) Freezing of water to ice and evaporation of water are physical changes because they only involve a change in the physical state of water without altering its chemical composition. When water freezes, it undergoes a phase transition from a liquid to a solid state, forming ice. Similarly, when water evaporates, it undergoes a phase transition from a liquid to a gaseous state, forming water vapor. In both processes, the molecules of water remain unchanged, and no new substances are formed. These changes are reversible, and the properties of the water molecules remain the same regardless of whether they are in the liquid, solid, or gaseous state.

G. Application based questions

1. Respiration is considered as an exothermic reaction because it releases energy in the form of heat to the surroundings. During respiration, organic molecules such as glucose are oxidized in cells to produce carbon dioxide, water, and energy in the form of adenosine triphosphate (ATP). The overall process can be summarized by the following equation:

$$C_6H_{12}O_6+6O_2 \longrightarrow 6CO_2+6H_2O+\text{energy (ATP)}$$

In this reaction, glucose ($C_6H_{12}O_6$) is oxidized by oxygen (O_2) to form carbon dioxide (CO_2) and water (H_2O). This oxidation process releases energy in the form of ATP molecules, which are used by cells as a source of energy for various cellular activities.

The breakdown of glucose molecules during respiration involves the breaking of chemical bonds within the glucose molecule and the formation of new chemical bonds in the products (carbon dioxide and water). The energy released from these bond-breaking and bond-forming processes is greater than the energy required to initiate the reaction. Therefore, the overall reaction releases excess energy in the form of heat, making respiration an exothermic reaction.

This released energy is essential for maintaining the body's metabolic processes, providing energy for muscle contraction, maintaining body temperature, and carrying out various physiological functions. Thus, respiration is not only vital for the survival of organisms but also serves as a major source of energy for cellular activities.

2.

Grapes hanging on the plant do not ferment because they are still intact and the fermentation process requires the presence of yeast and enzymes, which are often found on the grape skins. However, once the grapes are plucked from the plant and damaged (e.g., by bruising or breaking the skin), the yeast and enzymes can come into contact with the sugars present in the grape juice, initiating the fermentation process.

Fermentation of grapes occurs under specific conditions:

1. **Presence of Yeast**: Yeast is a microorganism that converts sugars into alcohol and carbon dioxide through fermentation. Yeast cells are naturally present on the skins of grapes and can also be introduced during winemaking.
2. **Anaerobic Environment**: Fermentation of grapes typically occurs in an anaerobic (oxygen-free) environment. When grapes are crushed and placed in a fermentation vessel, the oxygen is usually excluded, creating conditions suitable for fermentation.
3. **Optimal Temperature**: Fermentation proceeds most efficiently at moderate temperatures, typically between 20-30°C (68-86°F), depending on the strain of yeast used.
4. **Presence of Sugar**: Grapes contain natural sugars, primarily glucose and fructose, which serve as the substrate for fermentation. Yeast metabolizes these sugars to produce alcohol (ethanol) and carbon dioxide.

The process of fermentation is a chemical change because it involves the conversion of one set of chemical substances (sugars) into another set of chemical substances (alcohol and carbon dioxide) through the action of microorganisms (yeast) and enzymes. This chemical transformation results in the formation of new compounds with different properties from the original substances. Therefore, the fermentation of grapes is considered a chemical change.

Experiential Learning Questions

1. A chemical reaction where two or more reactants combine to form a single product is called an addition reaction in organic chemistry, addition reaction is commonly seen for unsaturated compounds.

Chemical reaction

(i) Hydrogenation reaction, where an unsaturated alkene/alkyne is converted to a saturated alkane, using the catalyst Ni/Pd/Pt

$$Ch_2 = Ch_2 \longrightarrow Ch_3 - Ch_3 \ Ethane$$

$Ethene$

(ii) Hydrogen gas react with oxygen gas produce water.

$$2H_2 + O_2 \longrightarrow 2H_2O$$

2. To investigate the chemical reaction of an iron nail with an aqueous copper sulphate solution.

Materials required:

There iron nails, two test tubes Measuring cylinder (50 mL), Copper sulphate, Water, Dilute sulphuric acid, Sandpaper, Thread, Stand with clamp, Test tube stand and, Single bored cork

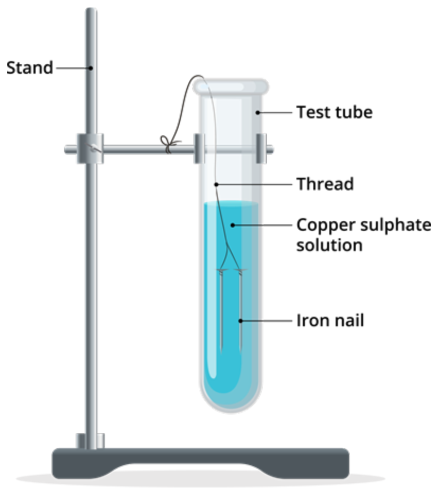
Experimental Procedure:

Step 1: Take two iron iron nails and clean them by rubbing them with sandpaper.

Step 2: Take 20 mL of distilled water in a clean test tube and dissolve 1.0 g of copper sulphate in it. Add 2 or 3 drops of dilute sulphuric acid to it to check the hydrolysis of $CuSO_4$ in water. Label this test tube as A.

Step 3: Transfer 10 mL of the copper sulphate solution from test tube A to a clean test tube. This test tube will be labeled as B.

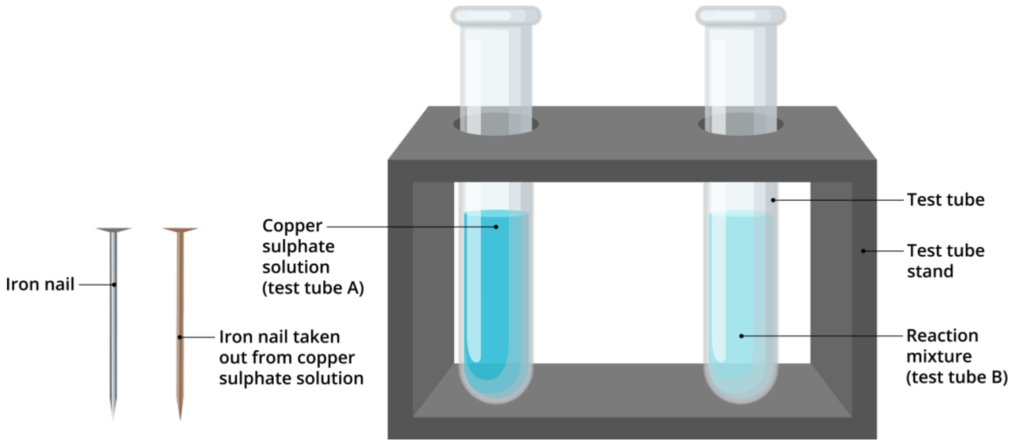
Step 4: Tie one iron nail with a thread and dip it carefully in copper sulphate solution in test tube B through a boring cork [as shown in the below figure] for about 15 minutes. Keep the other iron nail separately for comparison.



Iron copper displacement reaction

Step 5: Take the iron nail from the copper sulphate solution after 15 minutes.

Step 6: Compare the intensity of the blue colour of copper sulphate solution in tubes A and B before and after the experiment, as well as the colour of an iron nail dipped in copper sulphate solution versus one kept separately. Record your observations.



Result of iron copper displacement reaction

Observation:

- The colour of the iron nails immersed in the copper sulphate solution in test tube B became brownish.
- In test tube B, the colour of the copper sulphate solution has faded.
- Before the experiment, the colour of the copper sulphate solution was blue, after the experiment, it turns to light green.
- Similarly, the colour of the iron nail before the experiment, was grey, after the experiment it turns into red-brown.

Result:

We know that a highly active iron (Fe) element displaces a less active copper (Cu) element in a displacement reaction. So, iron displaces copper from its salt solution copper sulphate because of the displacement reaction.

Displacement reaction:

$$\mathrm{Fe}(s) + \mathrm{CuSo_4(aq)} \rightarrow \mathrm{FeSO_4(aq)} + \mathrm{Cu(s)}$$

Iron (Copper sulphate) → (*Iron Sulphate*) *Copper*

Conclusion:

In this activity, iron has displaced or replaced another element, copper, from the copper sulphate solution. This reaction is called the displacement reaction. Here, copper gets displaced from copper sulphate solution, which you can see on the iron nails. The brownish colour is deposited on the iron nails. Iron took the place of copper in copper sulphate solution in test tube B. The faded solution is iron sulphate.

Multi-Disciplinary Question

Single displacement reaction are defined as the reactions in which more reactive metal displaces the less reactive metal from its chemical reaction. The reactivity of metal is given by a series known as reactivity series. In this series, the metals lying above are more reactive than the metals which lie below.

General equation for these reactions follows:

- $\boldsymbol{A + BC \rightarrow AC + B}$

A is more reactive metal than B.

According to the question:

We are given 10 mL of freshly prepared iron sulphate solution taken in 4 different test tubes and in each test tube a strip of Copper, Iron, Zinc and Aluminium are put.

Test tubes having aluminium and zinc metal strip will obtain a black residue of iron because these two metals are more reactive than iron and will easily displace iron from its chemical reaction.

Equations for the reaction follows:

$3FeSO_4(aq). + 2Al(s) \rightarrow Al_2(SO_4)(aq). + 3Fe(s)$

$FeSO_4(aq). + Zn(s) \rightarrow ZnSO_4(aq). + Fe(s)$

$FeSO_4(aq). + Fe(s) \rightarrow$ No reaction

$FeSO_4(aq). + Cu(s) \rightarrow$ No reaction

Play and Learn

Students do youself

Stem Project

Students do youself

Values and Skills

1. Aluminium forms white colour oxide on exposure to the atmosphere. This white colour oxide prevents it from further corrosion whereas iron reacts with air to form hydrated oxide called rust.

That is why iron undergoes corrosion to greater extent.

2. Iron and its alloys are widely used in the construction of many structures and in many machines and objects. Therefore, the prevention of the corrosion of iron is very important

ICSE Chemistry-8

Chapter-7

Water

Exercise Corner

A. MCQs

1. (c) Rainwater

2. (a) Water cycle

3. (c) 70
4. (b) Boiling
5. (d) Transpiration

B. Fill in the Blanks

1. Large part of the Earth's surface is covered by **water**.
2. Water has maximum density at **4°C** temperature.
3. Waste water is treated in **wastewater** treatment plant.
4. Boiling removes the **temporary** hardness of water.
5. Water can exist in **three** states.

C. True Or False

1. False
2. False
3. False
4. True
5. False

D. Very short answer type questions

1. The freezing point of water is 0°C Celsius or 32°F (Fahrenheit).

2. Approximately 90% of human blood is water.

3. The four main sources of water are:

1. Rivers
2. Lakes
3. Groundwater
4. Oceans

4. Surface water refers to water found on the Earth's surface in sources such as rivers, lakes, and ponds.

5. Water exists in three main states: solid, liquid, and gas.

Solid state: Water freezes into ice at temperatures below 0°C (Celsius) 32°F Fahrenheit).

Liquid state: Water exists as a liquid at temperatures between 0°C Celsius (32°F Fahrenheit) and 100°C Celsius (212°C Fahrenheit).

Gas state: Water vaporizes into steam at temperatures above 100°C Celsius (212°F Fahrenheit).

6.

Water is considered a universal solvent because it has the ability to dissolve a wide variety of solutes due to its polarity and ability to form hydrogen bonds with other substances.

E. Short answer type questions

1.

1. **Hydration**: Water is essential for maintaining proper hydration in the body, which is vital for overall health and functioning.
2. **Temperature Regulation**: Water helps regulate body temperature through processes such as sweating and evaporation.
3. **Nutrient Transportation**: Water serves as a medium for transporting nutrients and oxygen to cells and removing waste products from the body.
4. **Joint Lubrication**: Water acts as a lubricant for joints, aiding in smooth movement and reducing friction.
5. **Digestive Function**: Water is necessary for proper digestion, facilitating the breakdown of food and absorption of nutrients in the gastrointestinal tract.

2. Water is very precious for all living beings because:

1. **Essential for Life**: Water is vital for the survival of all living organisms. It is a fundamental requirement for cellular processes, metabolic reactions, and maintaining physiological functions.
2. **Hydration**: Water is crucial for maintaining proper hydration in the body. Adequate water intake is necessary to regulate body temperature, transport nutrients and oxygen to cells, and remove waste products from the body.
3. **Habitat**: Water plays a key role in providing habitats for various aquatic organisms. It sustains ecosystems such as rivers, lakes, oceans, and wetlands, supporting a diverse array of plant and animal life.
4. **Economic Importance**: Water is essential for agriculture, industry, and commerce. It is used for irrigation in agriculture, as a coolant and solvent in industrial processes, and for transportation of goods via waterways.
5. **Environmental Balance**: Water is crucial for maintaining environmental balance and ecological stability. It regulates climate patterns, supports biodiversity, and contributes to the functioning of natural ecosystems.

3.

H_2O is a compound composed of two hydrogen atoms (H) covalently bonded to one oxygen atom (O). In a water molecule, each hydrogen atom forms a single covalent bond with the oxygen atom. The resulting molecule has a bent shape due to the arrangement of the atoms and the lone pairs of electrons on the oxygen atom. Water is a polar molecule because the oxygen atom is more electronegative than the hydrogen atoms, causing a partial negative charge (δ-) on the oxygen atom and partial positive charges (δ+) on the hydrogen atoms. This polarity allows water molecules to form hydrogen bonds with each other, resulting in unique properties such as high surface tension, cohesion, and adhesion.

4.

The anomalous expansion of water refers to the fact that water expands as it freezes, contrary to most substances which contract when they solidify. This property has significant implications for aquatic plants and animals.

1. **Density Stratification**: When water freezes, it forms ice which is less dense than liquid water. As a result, ice floats on the surface of bodies of water. This layer of ice acts as insulation, preventing further heat loss from the water below and allowing aquatic life to survive in colder temperatures.
2. **Maintenance of Life Below Freezing**: The floating ice layer insulates the water beneath it, keeping it from freezing solid. This allows aquatic organisms to continue living in the liquid water underneath the ice, providing a habitat for fish, plants, and other organisms even during cold winter months.
3. **Protection from Extreme Temperatures**: The expansion of water upon freezing helps buffer aquatic ecosystems from rapid temperature changes. As water cools, it becomes denser until it reaches its maximum density at $4^\circ 4_\circ$ Celsius. Below this temperature, water becomes less dense as it approaches freezing, allowing it to float and form insulating ice layers, which protect aquatic life from extreme cold.

5. Ice floats on water because it is less dense than liquid water. When water freezes and forms ice, the water molecules arrange themselves in a crystalline lattice structure with relatively open spaces between the molecules. This arrangement causes ice to be less dense than the liquid water from which it formed. As a result, ice is buoyant and floats on the surface of liquid water. This property of ice floating is crucial for aquatic ecosystems, as it insulates the water below from further cooling, allowing aquatic life to survive in colder temperatures.

F. Long answer type questions

1.

1. **(i) Coke reacts with water at 100°C**: When coke (pure carbon) reacts with water at 100°C, the following reaction occurs: $C + H_2O \rightarrow CO + H_2$ In this reaction, carbon (C) from coke reacts with steam (H_2O) to produce carbon monoxide (CO) and hydrogen gas (H2). This reaction is known as the water-gas shift reaction and is often used industrially to produce hydrogen gas and carbon monoxide, which are important feedstocks for various chemical processes.
2. **(ii) Calcium oxide reacts with water**: When calcium oxide (CaO), also known as quicklime, reacts with water, it undergoes a highly exothermic reaction, producing calcium hydroxide $CaO + H_2O \rightarrow Ca(OH)_2$ This reaction is highly exothermic, releasing a large amount of heat. Calcium hydroxide is a strong base and is commonly used in various applications, including the production of cement, as a flocculant in water treatment, and in the manufacturing of paper and textiles.
3. **(iii) Nitrogen pentoxide reacts with water**: When nitrogen pentoxide (N_2O_5) reacts with water (H_2O), it forms nitric acid ($3HNO_3$): $N_2O_5 + H_2O \rightarrow 2HNO_3$ This reaction is highly exothermic and produces nitric acid, which is a strong acid commonly used in the production of fertilizers, explosives, and various organic compounds. Nitric acid is also a key reagent in laboratory experiments and industrial processes.

2. Suspension and colloidal solutions are both types of heterogeneous mixtures, but they differ in several key aspects. Here are the main differences between suspension and colloidal solutions:

1. **Particle Size**:
   - **Suspension**: In a suspension, the particles are relatively large and visible to the naked eye. They typically have sizes greater than 1000 nanometers (nm) and settle out over time due to gravity.
   - **Colloidal Solution**: In a colloidal solution, the particles are much smaller than those in a suspension, with sizes ranging from 1 to 1000

nm. These particles are not visible under a microscope and remain dispersed throughout the solution due to Brownian motion.

2. **Visibility**:
   - **Suspension**: The particles in a suspension are visible to the naked eye and can be seen as a cloudy or opaque mixture.
   - **Colloidal Solution**: The particles in a colloidal solution are not visible to the naked eye, and the solution appears transparent or translucent.
3. **Settling**:
   - **Suspension**: In a suspension, the particles tend to settle out over time due to gravity, forming a sediment at the bottom of the container.
   - **Colloidal Solution**: Colloidal particles remain dispersed throughout the solution and do not settle out due to Brownian motion, which prevents aggregation and settling.
4. **Tyndall Effect**:
   - **Suspension**: When a beam of light is passed through a suspension, it scatters the light, making the path of the light beam visible. This phenomenon is known as the Tyndall effect.
   - **Colloidal Solution**: Colloidal particles also scatter light, causing the solution to appear milky or hazy when viewed against a dark background. This is also known as the Tyndall effect.
5. **Filterability**:
   - **Suspension**: Suspensions can be separated from the liquid phase by filtration due to the large particle size.
   - **Colloidal Solution**: Colloidal solutions cannot be filtered using ordinary filter paper because the particles are too small to be retained by the filter.
6. **Stability**:
   - **Suspension**: Suspensions are often unstable and tend to settle out rapidly, requiring agitation or shaking to re-disperse the particles.
   - **Colloidal Solution**: Colloidal solutions are relatively stable and can remain dispersed for long periods without settling, especially if appropriate stabilizing agents are present.

3. Explanation of Terms:

(i) **Brownian Movement**:

Brownian movement, named after the British botanist Robert Brown who first observed it in 1827, refers to the random and continuous motion exhibited by microscopic particles suspended in a fluid medium (such as a gas or a liquid). This movement is caused by the collision of the fluid molecules with the suspended particles. Brownian motion is a consequence of thermal energy, as the particles in the fluid are in constant motion due to their kinetic energy.

Key features of Brownian movement include:

- **Random Motion**: The suspended particles exhibit erratic and unpredictable movements in all directions.
- **Continuous Motion**: Brownian motion is continuous, with particles constantly undergoing changes in direction and velocity.
- **Independent of Particle Size**: Brownian motion occurs regardless of the size or shape of the suspended particles, as long as they are small enough to be influenced by the thermal motions of the fluid molecules.
- **Evidence for Molecular Theory**: Brownian motion provided experimental evidence for the existence of atoms and molecules, supporting the molecular theory of matter.

(ii) **Tyndall Effect**:

The Tyndall effect is the phenomenon in which light is scattered or dispersed by colloidal particles or suspended particles in a transparent medium. It is named after the 19th-century physicist John Tyndall, who first explained the phenomenon. When a beam of light passes through a colloidal solution or a suspension, the light is scattered by the particles in the mixture, causing the path of the light beam to become visible. The extent of scattering depends on the size, shape, and concentration of the particles in the medium.

Key features of the Tyndall effect include:

- **Visible Light Scattering**: The scattering of light by colloidal or suspended particles makes the light beam visible, especially when viewed against a dark background.
- **Dependent on Particle Size**: The intensity of the Tyndall effect increases with decreasing particle size, as smaller particles scatter light more effectively than larger particles.
- **Differentiation from Solutions**: The Tyndall effect helps differentiate between true solutions (homogeneous mixtures) and colloidal solutions or suspensions (heterogeneous mixtures), as only the latter exhibit visible light scattering.

(iii) **Crystallization**:

Crystallization is the process by which a solid substance forms crystals with a specific and ordered arrangement of atoms, ions, or molecules in a repeating threedimensional pattern called a crystal lattice. It is a phase transition from a disordered state (solution or melt) to an ordered state (crystal).

Key features of crystallization include:

- **Nucleation**: Crystallization begins with the formation of tiny crystal nuclei, which act as seeds for the growth of larger crystals. Nucleation can occur spontaneously or be induced by external factors such as temperature, pressure, or the addition of a seed crystal.
- **Crystal Growth**: Once nuclei are formed, crystals grow by the addition of molecules, ions, or atoms onto the crystal surfaces. The growth rate and morphology of crystals depend on factors such as temperature, concentration, and the presence of impurities.
- **Purity and Order**: Crystallization often results in the formation of pure substances with well-defined crystal structures, making it an important technique for purifying solids and determining their crystal structures.
- **Applications**: Crystallization is widely used in various fields, including chemistry (for purifying and isolating compounds), materials science (for producing semiconductor crystals), and geology (for studying the formation of minerals).

4. Water pollution refers to the contamination or degradation of water bodies, such as rivers, lakes, oceans, and groundwater, by harmful substances or pollutants. These pollutants can originate from various sources, including industrial, agricultural, urban, and domestic activities. Water pollution poses significant risks to human health, aquatic ecosystems, and the environment as a whole.

Causes of Water Pollution:

1. **Industrial Discharges**: Industries discharge various pollutants into water bodies, including heavy metals, chemicals, solvents, and toxic substances. These pollutants can come from manufacturing processes, mining operations, and industrial waste disposal practices.
2. **Agricultural Runoff**: Agricultural activities contribute to water pollution through the runoff of pesticides, herbicides, fertilizers, and animal waste from farmland into nearby water bodies. These pollutants can lead to eutrophication, algal blooms, and contamination of drinking water sources.
3. **Urbanization and Urban Runoff**: Urban areas generate pollution through runoff from impervious surfaces, such as roads, parking lots, and rooftops, carrying pollutants like oil, grease, heavy metals, and litter into stormwater drains and water bodies. Urbanization also contributes to sewage pollution from inadequately treated wastewater and sewage overflows.

4. **Sewage and Wastewater**: Inadequate sewage treatment and disposal systems release untreated or partially treated wastewater into water bodies, contaminating them with pathogens, bacteria, viruses, and nutrients. Sewage pollution poses significant risks to public health, aquatic life, and recreational water use.
5. **Oil Spills and Marine Pollution**: Accidental spills of oil and other hazardous substances from ships, offshore drilling rigs, and pipelines can lead to marine pollution, harming marine ecosystems, wildlife, and coastal communities. These spills can have long-lasting environmental and economic consequences.
6. **Plastic Pollution**: Improper disposal of plastic waste, such as plastic bottles, bags, and packaging, contributes to plastic pollution in water bodies. Plastics can persist in the environment for hundreds of years, causing harm to marine life through ingestion, entanglement, and habitat destruction.
7. **Mining Activities**: Mining operations release pollutants such as heavy metals, sulfur compounds, and acidic drainage into water bodies, contaminating them and causing adverse effects on aquatic ecosystems, including reduced biodiversity and habitat degradation.
8. **Hazardous Waste Disposal**: Improper disposal of hazardous wastes, including toxic chemicals, industrial byproducts, and electronic waste, can result in contamination of groundwater and surface water, posing risks to human health and the environment.
9. **Atmospheric Deposition**: Airborne pollutants, such as heavy metals, acid rain, and airborne particulate matter, can deposit onto water bodies through precipitation, atmospheric deposition, and surface runoff, contributing to water pollution and ecosystem damage.

5. The water cycle, also known as the hydrological cycle, is the continuous process by which water moves through various stages in the environment, including the atmosphere, oceans, rivers, lakes, groundwater, and land surfaces. It involves the evaporation of water from the Earth's surface, the condensation of water vapor into clouds, precipitation in the form of rain or snow, and the runoff and infiltration of water into bodies of water and the ground. The water cycle plays a crucial role in regulating Earth's climate, distributing freshwater resources, and sustaining life on the planet.

Explanation of the Water Cycle:

1. **Evaporation**: The water cycle begins with the process of evaporation, in which liquid water on the Earth's surface, such as oceans, rivers, lakes, and soil, is heated by the sun and converted into water vapor. This water vapor rises into the atmosphere as warm air currents carry it upward.
2. **Condensation**: As water vapor rises into the atmosphere, it cools and condenses to form tiny water droplets or ice crystals, which cluster together to form clouds. This process is known as condensation. Clouds are formed when the air becomes saturated with water vapor and cannot hold any more moisture.

3. **Precipitation**: When the water droplets in clouds become large enough, they fall back to the Earth's surface as precipitation in the form of rain, snow, sleet, or hail. Precipitation is the primary mechanism by which water returns to the Earth's surface from the atmosphere.
4. **Runoff**: Once precipitation reaches the Earth's surface, it can flow overland as surface runoff, moving downhill along rivers, streams, and drainage channels. Surface runoff eventually collects in bodies of water such as rivers, lakes, and oceans. Some precipitation may also infiltrate into the soil and percolate downward to replenish groundwater reserves.
5. **Infiltration**: Infiltration is the process by which precipitation seeps into the soil and enters underground aquifers and water tables. Infiltrated water can be stored in the soil as soil moisture or replenish groundwater reservoirs. Some infiltrated water may eventually resurface as groundwater discharge through springs, seeps, or human-managed wells.
6. **Transpiration**: In addition to direct precipitation, water is also returned to the atmosphere through the process of transpiration, in which plants absorb water from the soil through their roots and release it into the atmosphere through small openings in their leaves called stomata. Transpiration accounts for a significant portion of water vapor input to the atmosphere.
7. **Evapotranspiration**: Evapotranspiration is the combined loss of water from the Earth's surface through evaporation and transpiration. It represents the total flux of water from the Earth's surface to the atmosphere and is influenced by factors such as temperature, humidity, wind speed, and vegetation cover.
8. **Return to the Ocean**: Ultimately, the water that evaporates from the Earth's surface and falls as precipitation eventually returns to the oceans, where the water cycle begins anew. This continuous process of evaporation, condensation, precipitation, runoff, infiltration, and transpiration maintains the balance of water on Earth and sustains life on the planet.

G. Application based questions

1.

One traditional way of storing water from ancient times is through the use of earthenware pots or clay vessels. Clay pots have been used for millennia across various cultures and civilizations for storing and transporting water. Here's how this traditional method works:

1. **Selection of Clay**: Clay pots are typically made from natural clay found in the local environment. The clay is selected based on its quality and suitability for pottery making.
2. **Pottery Making**: Skilled artisans shape the clay into pots of various sizes and shapes using traditional pottery techniques such as coiling, molding, or throwing on a wheel. The pots are then left to dry in the sun.
3. **Firing**: Once the pots are dry, they are fired in a kiln or traditional open-fire pottery kiln. Firing strengthens the pots and makes them durable and impermeable to water.

4. **Cooling and Glazing**: After firing, the pots are allowed to cool before being glazed with a natural glaze made from materials such as ash or plant extracts. Glazing helps to seal any pores in the clay and further waterproofs the pots.
5. **Storage**: Once glazed, the pots are ready for use. They can be filled with water from local sources such as wells, rivers, or rainwater harvesting systems. The water stored in the pots remains cool due to the evaporative cooling effect of the porous clay.
6. **Maintenance**: To ensure the longevity of the pots, they need to be cleaned regularly to prevent the buildup of algae or sediment. Additionally, minor cracks or chips in the pots can be repaired using traditional methods such as applying a clay paste or re-glazing.
7. **Cultural Significance**: In many cultures, clay pots have cultural and symbolic significance beyond their practical use. They are often decorated with intricate designs or patterns and may be used in traditional ceremonies or rituals.

Using clay pots for water storage is an environmentally friendly and sustainable method that has stood the test of time. It provides a reliable and cost-effective way to store and access water, particularly in regions where modern infrastructure may be limited or unreliable. Additionally, clay pots contribute to the preservation of traditional craftsmanship and cultural heritage.

2. The slogan "Jal Hai to Kal Hai" translates to "Water is essential for tomorrow" in English. This slogan emphasizes the critical importance of water conservation for the future. It conveys the message that ensuring the availability and sustainability of water resources today is essential for the well-being and survival of future generations. The slogan underscores the need for responsible water management practices and the preservation of water resources to meet the needs of both present and future populations.

Multi-Disciplinary Question

Water pollution can be defined as the contamination of water bodies. Water pollution is caused when water bodies such as rivers, lakes, oceans groundwater and aquifers get contaminated with industrial and agricultural effluents. When water gets polluted, it adversely affects all life forms that directly or indirectly depend on this source. The effects of water contamination can be felt for years to come.

Sources of Water Pollution

- Urbanization.
- Deforestation.
- Industrial effluents.
- Social and Religious Practices.
- Use of Detergents and Fertilizers.

- Agricultural run-offs-Use of insecticides and pesticides.

Prevent water pollution

1. Use the minimum amount of detergent and/or bleach when you are washing clothes or dishes.
2. Use only phosphate free soaps and detergents.
3. Minimize the use of pesticides, herbicides, fertilizers.
4. Do not dispose of these chemicals, motor oil, or other automotive fluids into the sanitary sewer or storm sewer systems.

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Play and Learn

Student do yourself

Stem Projects

Student do yourself

Value and life Skills

1. Electrocoagulation consists of pairs of metal sheets called electrodes, that are arranged in pairs of two – anodes and cathodes. Using the principles of electrochemistry, the cathode is oxidized (loses electrons), while the water is reduced (gains electrons), thereby making the wastewater better treated. This method will provide not only water for irrigation but also manure for the fields.
2. Water is used in the production of almost all goods. Water resources are critical for irrigated agriculture, mining, households, and many industries, all of which are substantial users. The largest amount of water use is for irrigated agriculture, producing food and fibres.

ICSE Chemistry-8
Chapter-8
Hydrogen

Exercise Corner

A. MCQs

1. (b) reducing agent
2. (c) Zn
3. (a) hydrogen chloride
4. (d) All of the above
5. (c) calcium

B. Fill in the Blanks

1. Hydrogen is the first and **lightest** element.
2. Hydrogen constitutes about **0.14%** per cent by weight of the Earth's crust.
3. Iron reacts with hydrochloric acid to produce **ferrous chloride** with hydrogen gas.
4. Water gas is a mixture of hydrogen and **carbon monoxide**.
5. Reduction is the addition of hydrogen or **another** element.

C. True Or False

1. **True**
2. **False**
3. **True**
4. **False**:

D. Very short answer type questions

1.

The three isotopes of hydrogen are:

1. Protium (symbol: $1H^1$)
2. Deuterium (symbol: $1H^2$)
3. Tritium (symbol: $1H^3$)

2. Oxidation is the loss of electrons by a substance during a chemical reaction.

3.
Two examples of non-electrolytes are:

1. Sugar (sucrose)
2. Ethanol (alcohol)

4. Hard water is water that contains high concentrations of dissolved minerals, primarily calcium and magnesium ions.

5.
When sodium reacts with sulfuric acid, hydrogen gas (H2) is produced.

E. Short answer type questions

1. When zinc reacts with sodium hydroxide (NaOH), it forms sodium zincate (Na_2ZnO_2) along with the liberation of hydrogen gas (H_2). The chemical equation for the reaction is:

$Zn + 2NaOH \rightarrow Na_2ZnO_2 + H_2$

2. (i) Hydrogen can be used as a fuel because it has a high energy content per unit mass and can undergo combustion reactions with oxygen to release energy in the form of heat. When hydrogen reacts with oxygen, it forms water vapor (H_2O) as the only by product, making it a clean and environmentally friendly fuel source.

(ii) Nitric acid is not used for the preparation of dihydrogen because it is a strong oxidizing agent and can react violently with reducing agents such as hydrogen gas. Instead, concentrated nitric acid is commonly used as an oxidizing agent in various chemical reactions, but it is not suitable for the direct preparation of dihydrogen due to safety concerns and the potential for uncontrolled reactions.

3. Three physical properties of dihydrogen (H2) are:

1. **Colorless and Odorless**: Dihydrogen gas is colorless and odorless in its pure form, making it difficult to detect by sight or smell.

2. **Highly Flammable**: Dihydrogen is highly flammable and can readily combust in the presence of oxygen, producing a clean flame. This property makes hydrogen a valuable fuel for various applications, including fuel cells and rocket propulsion.
3. **Low Density**: Dihydrogen gas has a low density, making it lighter than air. This property causes hydrogen to rise rapidly in the atmosphere, making it suitable for applications such as lifting balloons and airships.

4. (i) Two metals that give hydrogen with cold water are sodium (Na) and calcium (Ca).

(ii) The process in which oxygen is added or hydrogen removed is called oxidation.

F. Long answer type questions

1. The preparation of dihydrogen gas (H2) in the laboratory can be achieved through various methods, including the reaction of metals with acids or bases, the electrolysis of water, and the reaction of certain metal hydrides with water. One common method involves the reaction of a metal with an acid, such as hydrochloric acid (HCl) or sulfuric acid (H2SO4). Here's a description of the preparation of dihydrogen gas using zinc and hydrochloric acid:

Preparation of Dihydrogen Gas Using Zinc and Hydrochloric Acid:

1. **Setup**: In the laboratory, a conical flask is typically used to hold the reactants. A small piece of zinc metal (Zn) is added to the flask, and the flask is connected to a delivery tube leading to a collection vessel filled with water.
2. **Addition of Acid**: Dilute hydrochloric acid (HCl) is then added slowly to the flask containing the zinc metal. The reaction between zinc and hydrochloric acid proceeds as follows:
   $Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$
   The zinc metal reacts with hydrochloric acid to form zinc chloride ($ZnCl_2$) and hydrogen gas (H_2) as the products.
3. **Collection of Gas**: As the reaction proceeds, bubbles of hydrogen gas are evolved from the reaction mixture. The hydrogen gas is collected by displacement of water in the collection vessel. The delivery tube allows the hydrogen gas to escape from the flask and displace the water in the collection vessel, causing the gas to collect in the upper part of the vessel.
4. **Purification**: To purify the collected hydrogen gas, it can be passed through a drying agent, such as calcium chloride ($CaCl_2$), to remove any moisture or impurities.
5. **Storage**: Once purified, the dihydrogen gas can be collected in gas cylinders or used immediately for various laboratory experiments or applications.

This method demonstrates one of the laboratory techniques for the preparation of dihydrogen gas using zinc and hydrochloric acid. Other methods, such as the electrolysis of water or the reaction of metal hydrides with water, can also be used to produce dihydrogen gas in the laboratory. Each method offers advantages and may be chosen based on factors such as availability of reagents, safety considerations, and the desired purity of the dihydrogen gas.

2. The commercial preparation of dihydrogen gas (H_2) by the Bosch process is a significant industrial method used to produce large quantities of hydrogen gas for various applications, particularly in the production of ammonia (NH3) for fertilizers. The Bosch process, also known as the steam reforming process, involves the conversion of natural gas (methane, CH_4) into hydrogen gas and carbon dioxide (CO_2) through a series of chemical reactions. Here's a detailed explanation of the Bosch process:

Steps in the Bosch Process:

1. **Steam Reforming**: The first step in the Bosch process involves the steam reforming of natural gas (methane, CH_4). Natural gas is mixed with steam (H_2O) and passed over a nickel-based catalyst at high temperatures (700-1100°C) and moderate pressures (20-30 atmospheres). The steam reacts with methane in an endothermic reaction, producing carbon monoxide (CO) and hydrogen gas (H2) according to the following equation:

   $CH_4(g) + H_2O(g) \rightarrow CO(g) + 3H_2(g)$

   This reaction is known as steam reforming or steam methane reforming (SMR). The nickel catalyst enhances the reaction rate and facilitates the conversion of methane to hydrogen and carbon monoxide.
2. **Water-Gas Shift Reaction**: The carbon monoxide produced in the steam reforming step is then reacted with steam in the water-gas shift reaction to further increase the yield of hydrogen gas and convert carbon monoxide into carbon dioxide. The water-gas shift reaction is an exothermic reaction that proceeds as follows:

   $CO(g) + H_2O(g) \rightarrow CO_2(g) + H_2(g)$

   In this reaction, carbon monoxide reacts with steam to produce carbon dioxide and additional hydrogen gas. The shift reaction is typically carried out over a catalyst, such as iron oxide (Fe_2O_3) or chromium oxide (Cr_2O_3), at temperatures around 350-450°C.
3. **Carbon Dioxide Removal**: After the water-gas shift reaction, the product gas stream contains hydrogen gas, carbon dioxide, unreacted methane, and traces of other gases. The carbon dioxide is then removed from the gas mixture through a process called pressure swing adsorption (PSA) or amine scrubbing. This step helps to purify the hydrogen gas and improve its quality.
4. **Hydrogen Purification**: Finally, the purified hydrogen gas is collected and compressed for storage or transported to various industrial applications, such as the Haber-Bosch process for ammonia production, petroleum refining, and hydrogenation reactions in the chemical industry.

Advantages of the Bosch Process:

- High Yield: The Bosch process allows for the efficient conversion of natural gas into hydrogen gas with high yields.
- Scalability: The process can be scaled up to produce large quantities of hydrogen gas, making it suitable for commercial and industrial applications.
- Versatility: Hydrogen gas produced by the Bosch process can be used as a clean fuel source or as a feedstock for various chemical processes.

Limitations and Challenges:

- Carbon Dioxide Emissions: While the Bosch process produces hydrogen gas, it also generates carbon dioxide as a by product. Carbon dioxide emissions contribute to greenhouse gas emissions and climate change, highlighting the need for carbon capture and storage (CCS) technologies.
- Energy Intensive: The steam reforming process requires high temperatures and pressures, making it energy-intensive and reliant on fossil fuels. Efforts to develop alternative, renewable energy sources for hydrogen production are underway to reduce reliance on fossil fuels and mitigate environmental impacts.

Overall, the Bosch process plays a critical role in the industrial production of hydrogen gas, supporting various sectors such as agriculture, transportation, and manufacturing. Continued research and innovation in hydrogen production technologies are essential for advancing sustainable and environmentally friendly methods of hydrogen production in the future.

3. The electrolysis of water is a chemical process that involves the decomposition of water molecules (H_2O) into hydrogen gas (H_2) and oxygen gas (O_2) using an electric current. This process is commonly used to produce hydrogen gas for various industrial, commercial, and research applications. Here's a detailed explanation of the electrolysis of water:

Setup for Electrolysis of Water:

1. **Electrolysis Cell**: The electrolysis of water is typically carried out in an electrolysis cell, which consists of two electrodes (an anode and a cathode) submerged in an electrolyte solution of water. The electrodes are usually made of inert conductive materials such as platinum or graphite.
2. **Electrolyte**: Water serves as the electrolyte in the process. It is typically mixed with a small amount of an electrolyte, such as sulfuric acid (H2SO4) or potassium hydroxide (KOH), to enhance its conductivity and facilitate the flow of electric current.
3. **Power Source**: A direct current (DC) power source, such as a battery or a power supply, is connected to the electrodes. The positive terminal of the power source is connected to the anode, while the negative terminal is connected to the cathode.

Process of Electrolysis:

1. **Anode Reaction**: At the anode (positive electrode), oxidation occurs, leading to the generation of oxygen gas. The anode reaction involves the oxidation of water molecules to produce oxygen gas and positively charged hydrogen ions (protons). The overall reaction at the anode is:
   $2H_2O(l) \rightarrow O_2(g) + 4H^+(aq) + 4e^-$
   The oxygen gas (O_2) is evolved at the surface of the anode, while the hydrogen ions (H^+) remain in the electrolyte solution.
2. **Cathode Reaction**: At the cathode (negative electrode), reduction occurs, resulting in the generation of hydrogen gas. The cathode reaction involves the reduction of water molecules by gaining electrons from the cathode to produce hydrogen gas and hydroxide ions (OH^-). The overall reaction at the cathode is:
   $2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$
   The hydrogen gas (H_2) is evolved at the surface of the cathode, while hydroxide ions (OH^-) are left in the electrolyte solution.
3. **Overall Electrolysis Reaction**: The overall electrolysis reaction of water can be represented by the sum of the anode and cathode reactions:
   $2H_2O(l) \rightarrow 2H_2(g) + O_2(g)$
   This equation represents the decomposition of water into hydrogen gas and oxygen gas by the passage of electric current through the electrolyte solution.

5.
Hydrogen has numerous applications across various industries and technologies. Here are four common uses of hydrogen:

1. **Fuel Cells**: Hydrogen is utilized as a fuel in fuel cell technology. Fuel cells convert the chemical energy stored in hydrogen into electricity through electrochemical reactions with oxygen. This electricity can power electric vehicles, providing a clean and efficient alternative to traditional combustion engines.
2. **Ammonia Production**: Hydrogen is a crucial raw material in the production of ammonia (NH_3) through the Haber-Bosch process. Ammonia is a key component in the manufacturing of fertilizers, serving as a source of nitrogen for plant growth in agriculture.
3. **Hydrogenation Reactions**: Hydrogen is employed in various hydrogenation processes in the chemical industry. It is used to hydrogenate unsaturated compounds, such as vegetable oils, to produce saturated fats or oils. Hydrogenation is also utilized in the synthesis of chemicals and pharmaceuticals.
4. **Refining and Petrochemicals**: Hydrogen plays a vital role in petroleum refining processes, such as hydrocracking and hydrotreating, where it is used to remove impurities and improve the quality of petroleum products. Additionally, hydrogen is a feedstock in the production of various petrochemicals, including methanol, ammonia, and synthetic fuels.

G. Application based questions

1.
The property of hydrogen that makes it useful for transport and storage of energy in the form of liquid or gaseous hydrogen is its high energy density per unit mass. Hydrogen has one of

the highest energy densities of any fuel by mass, making it an attractive option for storing and transporting energy efficiently. Additionally, hydrogen can be stored in various forms, including compressed gas, liquid hydrogen, and hydrogen-rich compounds, providing flexibility in storage and transportation methods. This high energy density and versatile storage capability are fundamental principles of the hydrogen economy, enabling the utilization of hydrogen as a clean and sustainable energy carrier for various applications, including fuel cell vehicles, energy storage systems, and industrial processes.

2. In the manufacture of vegetable ghee, hydrogen plays a crucial role in the process known as hydrogenation. Vegetable ghee, also known as vegetable shortening or vegetable fat, is a semi-solid fat made from vegetable oils that have been subjected to hydrogenation. Here's the role of hydrogen in the manufacture of vegetable ghee:

1. **Hydrogenation of Vegetable Oils**: The primary step in the manufacture of vegetable ghee involves the hydrogenation of vegetable oils. Vegetable oils, which are liquid at room temperature, are hydrogenated to convert them into semi-solid fats with desired physical and chemical properties. Hydrogenation involves the addition of hydrogen gas (H2) to unsaturated fatty acids present in vegetable oils, leading to the saturation of double bonds and the formation of saturated fats.
2. **Improvement of Consistency and Texture**: Hydrogenation transforms the liquid vegetable oils into semi-solid fats, imparting a creamy and smooth consistency to the resulting vegetable ghee. This change in consistency makes vegetable ghee suitable for various culinary applications, including baking, frying, and cooking.
3. **Enhancement of Stability and Shelf Life**: Hydrogenation of vegetable oils increases the oxidative stability of the fats, thereby improving the shelf life of vegetable ghee. Saturated fats produced through hydrogenation are less prone to oxidation and rancidity compared to unsaturated fats, prolonging the freshness and quality of the vegetable ghee products.
4. **Customization of Melting Point**: The degree of hydrogenation can be adjusted to customize the melting point of the vegetable ghee according to specific requirements. By controlling the extent of hydrogenation, manufacturers can produce vegetable ghee with desired melting points suitable for different culinary and industrial applications.

Multi-Disciplinary Questions

1. Yes, but a limited one – given that it takes more energy to produce, store and transport hydrogen than it provides when converted into useful energy, so using anything but new renewable sources (true green hydrogen) will require burning more fossil fuels.

2. **Opportunities of hydrogen:** Hydrogen is essentially the key to our future as it will become a decisive factor for ensuring a steady energy supply. It can replace fossil fuels across the board, including energy-intensive

industries. Hydrogen is produced in electrolyzes. They use electricity to break down water into hydrogen and oxygen.

Challenges of Hydrogen

Hydrogen is a highly inflammable substance and explosive in nature; it cannot be easily transported from one place to another and it can be generated by the hydrolysis of water but it is a very expensive process.

Play and Learn:

Students do Yourself

Stem Projects:

Students do Yourself

Value and Life Skills

1. Fossil fuel is a generic term for non-renewable energy sources such as coal, coal products, natural gas, derived gas, crude oil, petroleum products and non-renewable wastes.
2. Fossils provide us with the knowledge of animals and plants that lived hundreds of years ago and now which are now extinct. It helps us to compare the animals that lived during prehistoric times with their present descendants. They provide the missing link in the study of evolution.

ICSE Chemistry-8
Chapter-9
Carbon and its Compounds

Exercise Corner

A. MCQs

1. (a) Graphite
2. (c) Carbon dioxide
3. (d) all of the above
4. (b) Carbon

B. Fill in the Blanks

1. Diamond and graphite are **crystalline** forms of carbon.
2. Lamp black, charcoal, and coal are examples of **amorphous** allotropic forms of carbon.
3. Lack of oxygen and excess of carbon dioxide in the blood causes **asphyxiation**.
4. In Buckminsterfullerene, carbon atoms are held together by **covalent** bonds.
5. All carbonates upon reaction with dilute acids give **carbon dioxide**.

C. True Or False

1. **True**: Graphite is indeed a crystalline form of carbon, consisting of layers of carbon atoms arranged in a hexagonal lattice structure.
2. **True**: Carbon is the fourth most abundant element in the universe by mass, after hydrogen, helium, and oxygen.
3. **True**: Allotropes of the same element can have different physical properties, such as structure, density, and appearance, while retaining the same chemical properties due to the identical arrangement of atoms.
4. **False**: Water gas is actually a mixture of carbon monoxide (CO) and hydrogen (H_2).
5. **False**: Activated charcoal is not a good conductor of heat and electricity. It is known for its high surface area and adsorption properties rather than its conductivity.

D. Very short answer type questions

1. Catenation is the ability of an element, especially carbon, to form long chains or rings of atoms linked by covalent bonds.

2. Diamond

3. Destructive distillation is a process where a material is heated strongly in the absence of air to produce useful products, such as gases, liquids, and solids, by breaking down complex organic compounds into simpler substances.

4. Lamp black is used as a pigment in inks, paints, and dyes, as well as in the manufacture of carbon brushes for electric motors and batteries.

5. Carbonization is the process of converting organic materials into carbon or carbon-rich residue through heating in the absence of oxygen.

6.
Carbon dioxide (CO_2) is used in various industrial applications, including:

1. Carbonation of beverages: CO_2 is used to carbonate soft drinks, beer, and sparkling water.
2. Fire extinguishers: CO_2 is used as a fire suppressant in fire extinguishers due to its ability to displace oxygen.
3. Food processing: CO_2 is used in food processing and packaging to maintain freshness and extend shelf life.
4. Welding: CO_2 is used as a shielding gas in welding processes, such as MIG welding, to protect the weld from atmospheric contamination.
5. Oil recovery: CO_2 is injected into oil wells to enhance oil recovery through techniques such as enhanced oil recovery (EOR) and carbon dioxide flooding.

7. Carbon monoxide (CO) is considered poisonous because it binds strongly to hemoglobin in red blood cells, reducing the blood's ability to carry oxygen to vital organs and tissues.

E. Short answer type questions

1. Fullerenes are a class of carbon allotropes consisting of molecules composed entirely of carbon, typically in the form of hollow spheres, ellipsoids, or tubes. These molecules are made up of carbon atoms arranged in hexagonal and pentagonal rings, similar to the structure of graphite and graphene. The most well-known fullerene is Buckminsterfullerene (C60), which has a spherical shape resembling a soccer ball and is commonly referred to as a buckyball. Fullerenes have unique physical and chemical properties, making them useful in various applications, including nanotechnology, materials science, and medicine.

2. Four physical properties of graphite are:

1. **Layered Structure**: Graphite has a layered structure, with carbon atoms arranged in hexagonal rings stacked on top of each other. These layers are held together by weak van der Waals forces, allowing them to slide over each other easily.

2. **Soft and Lubricious**: Graphite is soft and lubricious due to its layered structure, which allows the layers to slide past each other with minimal friction. This property makes graphite an excellent lubricant in applications such as pencils and industrial machinery.
3. **Conductivity**: Graphite exhibits electrical conductivity along the planes of its layered structure. This conductivity arises from the delocalized π electrons within the hexagonal rings of carbon atoms, allowing graphite to conduct electricity.
4. **High Melting Point**: Graphite has a high melting point of around 3,600°C (6,500°F) due to the strong covalent bonds within its layers. This high melting point makes graphite suitable for use in high-temperature applications, such as crucibles and electrodes in metallurgy.

3. Wood charcoal is typically made through a process called carbonization, which involves heating wood in the absence of oxygen. Here's how wood charcoal is made:

1. **Selection of Wood**: Hardwoods such as oak, maple, or birch are commonly used for making charcoal due to their dense and compact nature, which results in higher-quality charcoal.
2. **Stacking and Covering**: Wood logs or branches are stacked in a pile or kiln, with spaces left between them to allow for airflow. The pile is then covered with a layer of soil, sand, or metal sheets to prevent the entry of oxygen and control the rate of burning.
3. **Heating**: The stacked wood is then heated slowly in a kiln or pit furnace. The absence of oxygen prevents the wood from combusting completely and instead undergoes pyrolysis, where volatile compounds are driven off, leaving behind carbon-rich charcoal.
4. **Carbonization**: As the wood heats up, volatile gases such as water vapor, methane, and tar are driven off, leaving behind carbonaceous residue. This residue undergoes further decomposition and carbonization, resulting in the formation of charcoal.
5. **Cooling and Collection**: Once the carbonization process is complete, the charcoal is allowed to cool gradually. The cooled charcoal is then removed from the kiln or pit furnace and sorted for use.

4. Carbon monoxide (CO) is poisonous because it binds strongly to hemoglobin in red blood cells, forming carboxyhemoglobin. This reduces the blood's ability to carry oxygen to vital organs and tissues, leading to oxygen deprivation or asphyxiation. Even at low concentrations, carbon monoxide exposure can cause symptoms such as headache, dizziness, nausea, confusion, and eventually death if levels are high enough.

F. Long answer type questions

1. (a) Reaction with water (H_2O)3$CO_2 + H_2O \rightarrow H_2CO_3$

(b) Reaction with calcium hydroxide ($Ca(OH)_2$), also known as lime water: $CO_2 + Ca(OH)_2 \rightarrow CaCO_3 + H_2O$

(c) Reaction with magnesium (Mg): $CO_2 + Mg \rightarrow MgCO_3$

(d) Reaction with potassium hydroxide (KOH): $CO_2 + 2KOH \rightarrow K_2CO_3 + H_2O$

(e) Reaction with sodium hydroxide (NaOH): $CO_2 + 2NaOH \rightarrow Na_2CO_3 + H_2O$

These equations represent different chemical reactions where carbon dioxide reacts with various substances to form different products.

2. Two methods used for preparing carbon dioxide (CO_2) are:

1. **Combustion**: Carbon dioxide is produced as a by product of combustion reactions involving carbon-containing compounds. For example, when hydrocarbons like methane (CH_4) or coal are burned in the presence of oxygen, carbon dioxide is formed along with water vapor.
2. **Reaction of Acid with Carbonate/Bicarbonate**: Carbon dioxide can be generated by the reaction of an acid with a carbonate or bicarbonate salt. For instance, when hydrochloric acid (HCl) reacts with calcium carbonate ($CaCO_3$), carbon dioxide gas is liberated:

$2HCl + CaCO_3 \rightarrow CaCl_2 + H_2O + CO_2$

Two uses of carbon dioxide are:

1. **Carbonation of Beverages**: Carbon dioxide is used to carbonate soft drinks, beer, and sparkling water. When dissolved in water under pressure, it produces the characteristic effervescence and bubbles in these beverages.
2. **Fire Suppression**: Carbon dioxide is used as a fire suppressant in fire extinguishers. When released, carbon dioxide displaces oxygen in the vicinity of the fire, effectively smothering it and extinguishing the flames.

3. (a) Diamond:

- Jewelry: Diamond is prized for its brilliance and hardness, making it a popular gemstone for use in jewelry.
- Cutting and Polishing Tools: Due to its exceptional hardness, diamond is used as an abrasive for cutting, grinding, and polishing materials such as gemstones, metals, and ceramics.
- Industrial Applications: Diamond has industrial applications in cutting tools for machining, drilling, and mining operations, as well as in precision optics and electronics.

(b) Lamp black:

- Pigment: Lamp black is used as a pigment in inks, paints, and dyes due to its deep black color and fine particle size.
- Printing: Lamp black is used in printing inks for newspapers, magazines, and packaging materials.
- Coatings: Lamp black is added to coatings and sealants to enhance their color, opacity, and UV resistance.

(c) Charcoal:

- Cooking: Charcoal is commonly used as a fuel for cooking and grilling due to its high heat output and low smoke emission.
- Water Filtration: Activated charcoal is used in water filtration systems to remove impurities and contaminants from drinking water.
- Art: Charcoal is used as a drawing medium in art due to its dark and rich black color, as well as its ability to be easily manipulated for shading and blending.

(d) Graphite:

- Writing and Drawing: Graphite is used in pencils for writing and drawing due to its ability to leave marks on paper.
- Lubrication: Graphite is used as a dry lubricant in applications where conventional lubricants cannot be used, such as in high-temperature environments or in the presence of chemicals.
- Electrodes: Graphite electrodes are used in various industrial processes, including electrolysis, electroplating, and electric arc furnaces for steelmaking.

(e) Soot:

- Ink: Soot is used as a pigment in traditional Chinese and Japanese ink painting, known as sumi-e, to create shades of black and gray.
- Carbon Black: Soot is processed to produce carbon black, which is used as a reinforcing filler in tires, rubber products, and plastics, as well as in inks and coatings for its color and UV-resistant properties.
- Conductive Ink: Soot can be used to make conductive ink for printing electronic circuits and sensors.

4. The formation of coal begins with the accumulation of organic matter in swampy environments such as marshes or peatlands. Over time, the organic material undergoes burial and compaction under the weight of sediment layers, leading to the gradual transformation into coal through a process known as coalification. This process involves the gradual alteration of plant remains by microbial activity, heat, and pressure over millions of years.

The four main types of coal are:

1. **Peat**: Peat is the earliest stage of coal formation and is composed of partially decomposed plant matter. It has a high moisture content and low carbon content, making it a low-grade fuel. Peat is often used as a fuel source in some regions, particularly in Ireland and Scotland.
2. **Lignite**: Lignite, also known as brown coal, is the next stage of coalification. It has a higher carbon content than peat but is still relatively soft and contains significant amounts of moisture. Lignite is primarily used for electricity generation in power plants, particularly in regions where it is abundant.
3. **Sub-bituminous coal**: Sub-bituminous coal has a higher carbon content than lignite and is darker in color. It has lower moisture and sulfur content compared to lignite, making it a more efficient fuel for electricity generation. Sub-bituminous coal is commonly used in power plants due to its relatively low cost and abundance.
4. **Bituminous coal**: Bituminous coal is the most common type of coal and is widely used in various industrial applications. It has a higher carbon content and energy density compared to sub-bituminous coal, making it a preferred fuel for steelmaking, heating, and electricity generation. Bituminous coal can be further classified into low-volatile and high-volatile varieties based on its volatile matter content.
5. **Anthracite**: Anthracite is the highest grade of coal and has the highest carbon content and energy density. It is hard, shiny, and black in color, with low moisture and volatile matter content. Anthracite burns cleanly and efficiently, making it a valuable fuel for heating and industrial processes such as metal smelting.

G. Application based questions

1. It is advisable not to use an angithi (traditional charcoal or wood-burning stove) in a closed room at home due to several reasons:

1. **Carbon Monoxide Poisoning**: Angithis emit carbon monoxide (CO) gas as a byproduct of incomplete combustion. When used in a closed room with poor ventilation, the concentration of carbon monoxide can build up to dangerous levels. Carbon monoxide is odorless and colorless, making it difficult to detect, but it can cause symptoms such as headaches, dizziness, nausea, and even death if inhaled in high concentrations.
2. **Fire Hazard**: Angithis produce open flames and hot coals, which pose a fire hazard, especially in confined spaces where combustible materials are nearby. Accidental ignition of flammable materials such as curtains, furniture, or clothing can lead to rapid spread of fire and endanger the occupants of the room.

3. **Smoke and Indoor Air Pollution**: Burning charcoal or wood in an angithi generates smoke and particulate matter, which can degrade indoor air quality. Prolonged exposure to indoor air pollution from angithi smoke can lead to respiratory problems, particularly in individuals with pre-existing conditions such as asthma or bronchitis.
4. **Heat and Overheating**: Angithis produce a significant amount of heat, which can cause overheating in a closed room, especially during hot weather. Overheating can lead to discomfort, dehydration, and heat-related illnesses, particularly in vulnerable individuals such as the elderly, infants, or those with certain medical conditions.

Overall, using an angithi in a closed room without proper ventilation increases the risk of carbon monoxide poisoning, fire hazards, indoor air pollution, and heat-related health problems. It is safer to use angithis in well-ventilated areas or outdoors to minimize these risks.

2.

(i) Lamp black: Lamp black, a form of carbon black produced from the incomplete combustion of hydrocarbons, finds various uses in daily life:

1. **Pigment**: Lamp black is utilized as a pigment in inks, paints, and dyes due to its intense black color and fine particle size. It is commonly used in calligraphy, ink drawing, and painting.
2. **Printing**: Lamp black is employed in printing inks for newspapers, magazines, packaging materials, and labels. It contributes to the formulation of high-quality printing inks with good color intensity and ink flow properties.
3. **Coatings**: Lamp black is added to coatings and sealants to enhance their color, opacity, and UV resistance. It provides black pigmentation to products such as rubber coatings, sealants, varnishes, and adhesives.

(ii) Graphite: Graphite, a form of carbon consisting of layered sheets of carbon atoms arranged in a hexagonal lattice, is widely used in daily life for various purposes:

1. **Writing and Drawing**: Graphite is the primary component of pencil lead, allowing for smooth and precise writing and drawing on paper. It is preferred for its dark mark, erasability, and ability to create fine lines and shading in artwork and sketches.
2. **Lubrication**: Graphite serves as a dry lubricant due to its low friction and high lubricity properties. It is commonly used as a lubricant in applications where conventional lubricants may be unsuitable, such as in high-temperature environments, vacuum systems, or in the presence of chemicals.
3. **Industrial Applications**: Graphite finds numerous industrial applications, including as electrodes in electric arc furnaces for steelmaking, as a refractory material in crucibles and molds for metal casting, as a heat-resistant material in brake linings and clutch facings, and as a component in lubricants, coatings, and composite materials.
4. **Battery Technology**: Graphite is a key component of lithium-ion batteries, serving as the anode material. It provides a stable and conductive matrix for the storage and

release of lithium ions during battery charging and discharging cycles, enabling the efficient and long-lasting performance of rechargeable batteries used in electronic devices, electric vehicles, and renewable energy storage systems.

Multi-disciplinary Questions

1. When coal burns in a closed room carbon monoxide is produced. This poisonous gas has the affinity to mix with the haemoglobin present in our blood and forms carboxyhaemoglobin. This carboxyhaemoglobin decreases the oxygen carrying capacity of blood in our body. Thus the brain gets deprived of oxygen. This leads to suffocation and eventually leads to death. So it is advised not to sleep in a closed room with coal burning inside it.
2. Pradhan Mantri Ujjwala Yojana (PMUY) is the Scheme for providing LPG connections to the women belonging to the Below Poverty Line (BPL) families. The scheme was launched on 1st May 2016 in Ballia, Uttar Pradesh by Hon'ble Prime Minister of India, Shri. Narendra Modi. The scheme has been implemented by the Ministry of Petroleum and Natural Gas. The aims of the Pradhan Mantri Ujjwala Yojana to empower women and protect their health. To minimize health issues arising from the use of unclean fossil fuel and other fuel while cooking. To control indoor pollution from the use of fossil fuel which causes respiratory issues.

Play and Learn

Students do yourself

Stem Project

Students do yourself

Value and Life Skills

1. Yellow flames occur generally for two reasons. Gas burners usually blaze with blue flame if the ratio of the air is correct. Yellow gas indicates that the burner is not getting proper air for combustion.
2. Carbon monoxide (Co)
3. She is so possessive about the safety of people , so that she advised kareena to clean it.