



CHAPTER ENVIRONMENTAL CHEMISTRY - II WATER

15

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INTRODUCTION

SHORT QUESTIONS

Q.1 What is importance of water? (*Knowledge Base*)

Ans:

REASONS FOR IMPORTANCE OF WATER

Throughout history, importance and significance of water has been recognized by mankind. Its importance is because of following reasons.

- It is an essential and major component of each and every living cell. For example, human body consists of about 70% water.
- It provides an environment for animals and plants that live in water. So, all living organisms owe their life because of water.
- We use water in daily life for drinking, cooking and washing purposes. →

Q.2 How does ground water pollution occur? (*Knowledge Base*)

Ans:

GROUND WATER POLLUTION

Quality of drinking water has remained a major factor in determining human health and welfare since ages.

- Since World War II, there has been a rapid production and use of synthetic chemicals.
- Many of these chemicals (fertilizers and pesticides run off from agriculture lands and industrial discharge from industrial units) have polluted water supplies.
- Besides this, there is also a threat to ground water from waste chemical dumps and landfills. Currently, waterborne toxic chemicals pose the greatest threat to the supplies of water especially in urban areas.

Q.3 Why it is necessary to understand the sources and effects of water pollution? (*Knowledge Base*)

Ans:

SOURCES AND EFFECTS OF WATER POLLUTION

Use of polluted water is causing water borne diseases. So, use of polluted water is a concern of every citizen. Therefore, understanding the sources and effects of water pollution is essential for controlling this alarming threat.

Q.4 What do you mean by ground water pollution? (*Knowledge Base*)

Ans:

GROUND WATER POLLUTION

"The contamination of ground water due to undesirable and harmful substances is called ground water pollution."

Disadvantage:

Use of this polluted water is causing water borne diseases.

Q.5 Write a note on occurrence of water. (*Knowledge Base*)

(SWL 2016 G-I)

Ans:

OCCURRENCE OF WATER

The occurrence of water is as follows:

- (i) The oceans contain about 97% of world water.
- (ii) The rest 3% of water is in the form of:
 - Glaciers and ice caps (2.1 %)
 - Ground water (0.6%)
 - Inland water (river, lakes, and streams) about 0.2%
 - Atmospheric water (water vapours) about 0.001%

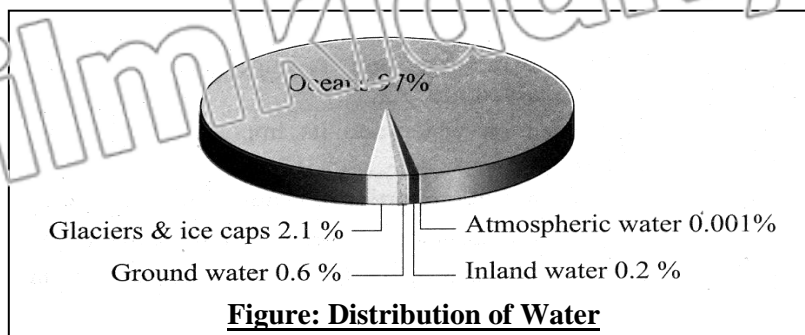


Figure: Distribution of Water

INTRODUCTION**MULTIPLE CHOICE QUESTIONS**

- Human body consists of _____ % water (*K.B*)
(A) 70 (B) 60
(C) 40 (D) 30
- The ocean contains about _____ % of world water: (*K.B*) (BWP 2017)
(A) 97 (B) 98
(C) 90 (D) 97.1
- Water is also present in the atmosphere in form of: (*K.B*)
(A) Rain drops (B) Dew
(C) Water vapors (D) Rivers
- Only _____ % of the total water on the earth is potable: (*K.B*) (LHR 2013)
(A) 0.6 (B) 0.9
(C) 0.2 (D) 2
- The amount of ground water is: (*K.B*)
(A) 0.6 % (B) 0.9 %
(C) 0.2 % (D) 2 %

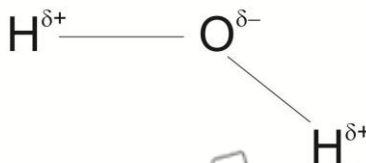
15.1 PROPERTIES OF WATER**15.2 WATER AS A SOLVENT****LONG QUESTIONS**

- Q.1 Write a detailed note on properties of water: (*Knowledge+Understanding Base*)
(LHR 2015, GRW 2016, SWL 2017, FSD 2016 G-I&II, MTN 2016 G-I & II)

Ans:

PROPERTIES OF WATER**Structure of Water Molecules:**

Water is composed of two elements: oxygen and hydrogen. One atom of oxygen combines with two atoms of hydrogen to form one molecule of water.

**Properties:**

The properties of water are as follows.

- Pure water is a **clear, colourless, odourless and tasteless liquid**.
- It is **neutral** to litmus. (i.e. pH = 7)
- Its **freezing point** is **0°C** and **boiling point** is **100°C** at sea level.
- Its maximum density is **1 gcm⁻³ at 4°C**.
- It is an **excellent solvent** for ionic as well as molecular compounds i.e. polar compounds.
- It has usually high that of **heat capacity about 4.2 Jg⁻¹K⁻¹**, which is about **six times greater than that of rocks**. This specific property of water is responsible for keeping the Earth's temperature within limits. Otherwise, day time

temperature would have been too high to bear and night time temperature would have been too low to freeze everything.

- It has **high surface tension**. This unique property of water is responsible for its high capillary action.

Capillary Action:

“Capillary action is the process by which water rises up from the roots of plants to leaves”.

Significance:

This process is vital for the survival of the land plants.

Q.2 Why water is called universal solvent? (Knowledge+Understanding Base)

(GRW 2014, SGD 2016 G-II)

OR

How polarity of water molecule plays its role to dissolve the substances?

OR

Explain the reasons, water is considered a universal solvent.

Ans:

WATER AS A UNIVERSAL SOLVENT

Water is the universal solvent because it can dissolve almost all the minerals. Its ability to dissolve substances is because of two unique properties of water:

- Polarity of water molecule.
- Exceptional hydrogen bonding ability.

(i) Polar Nature of Water (Dissolution by Hydration):

(GRW 2014)

Water molecule has a polar structure, i.e. **one end of the molecule is partially positive while the other end is partially negative because of electronegativity difference between oxygen and hydrogen atoms.**

Solubility of Polar Substances in Water:

(DGK 2017)

All other polar substances are soluble in water, because the **positive end** of the **substance** is attracted by the **negative end ($O^{\delta-}$)** of the water and **negative end** of the **substance** is attracted by the **positive end ($H^{\delta+}$)** of the water. The **electrostatic attraction among the ions** is overcome by the **ion-dipole** forces of attraction between ion and water molecules. In this way, positive and negative ions of the compounds are pulled apart. Ultimately, these oppositely charged ions are surrounded by water molecules, thus separated and kept in solution.

Examples:

Most of the salts are soluble in water like:

- NaCl
- KCl
- Na_2SO_4 , etc.

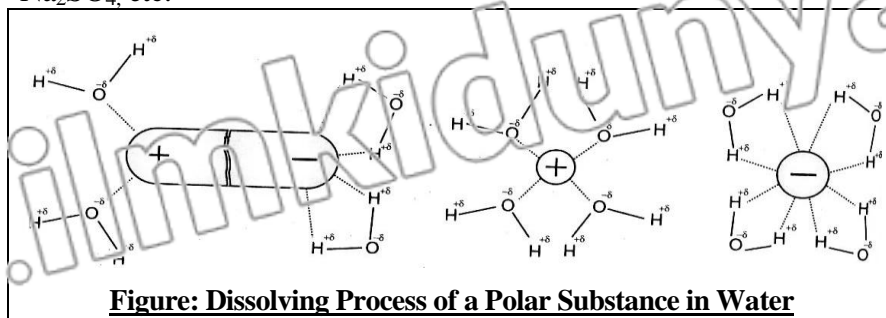


Figure: Dissolving Process of a Polar Substance in Water

Insolubility of Non Polar Substances in Water:

(FSD 2017)

Many covalent substances which **do not have polar ends** or bonds are not attracted by water molecule. Therefore, non-polar compounds do not dissolve in water.

Exmaples:

- Benzene
- Ether
- Octane etc.

(ii) Extensive Hydrogen Bonding Ability:

"The attractive force present between partial positive hydrogen end of one molecule and partial negative end of more electronegative atom of other molecule is called Hydrogen bonding".

Mechanism of Dissolution:

Water molecule is composed of oxygen and hydrogen atoms. Because of **two O-H bonds and two lone pairs**, one H₂O molecule can develop hydrogen bonding with four other H₂O molecules, which are arranged like tetrahedral around the water (H₂O) molecule.

This unique behavior of water enables it to dissolve many polar non-ionic compounds having hydroxyl group (-OH).

Examples:

- Alcohols
- Organic acids
- Glucose
- Sugar etc.

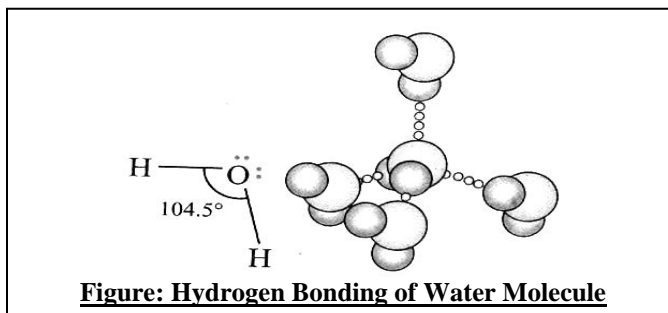


Figure: Hydrogen Bonding of Water Molecule

15.1 PROPERTIES OF WATER

15.2 WATER AS A SOLVENT

SHORT QUESTIONS

Q.1 What is the significance of heat capacity of water? (*Knowledge+Understanding Base*)

Ans:

HEAT CAPACITY OF WATER

Water has unusually high heat capacity about $4.2 \text{ Jg}^{-1}\text{K}^{-1}$, which is about six times greater than that of rocks.

Importance:

This specific property of water is responsible for keeping the Earth's temperature within limits. Otherwise, day time temperature would have been too high to bear and night time temperature would have been too low to freeze everything.

Q.2 What happens if a lump of cesium is dropped to water? (*Knowledge Base*)

(Interesting Information Pg. # 140)

Ans:

REACTION OF CESIUM WITH WATER

If you add a lump of cesium to water in a glass trough, the reaction is so vigorous that the trough will shatter into small pieces.

Q.3 Why water is considered to be a universal solvent? (Knowledge Base)

(GRW 2014, FSD 2014, DGE 2017)

Ans:**WATER AS UNIVERSAL SOLVENT**

Water is a universal solvent because it can dissolve almost all the minerals. Its ability to dissolve substances is due to two unique properties of water:

- (i) Polarity of water molecules
- (ii) Exceptional hydrogen bonding ability

Q.4 Explain why non polar compounds are insoluble in water? (Understanding Base)

(FSD 2016 G-I,17)

Ans:**INSOLUBILITY OF NON POLAR COMPOUNDS**

Many covalent substances which do not have polar ends or bonds are not attracted by water molecule. Therefore, non-polar compounds do not dissolve in water.

Exmaples:

- Benzene
- Ether
- Octane etc.

15.1 PROPERTIES OF WATER**15.2 WATER AS A SOLVENT****MULTIPLE CHOICE QUESTIONS****1. Water is composed of: (K.B)**

- (A) Oxygen, hydrogen
- (B) Nitrogen, Hydrogen
- (C) Nitrogen, Oxygen
- (D) Oxygen, Hydrogen, Carbon

2. The freezing point of water at sea level is: (K.B)

(SWL 2017)

- (A) 0°C
- (B) 20°C
- (C) 100°C
- (D) 1°C

3. The boiling point of water at sea level is: (K.B)

- (A) 100 °C
- (B) 0 °C
- (C) 50 °C
- (D) 101

4. The maximum density of water at 4°C is: (K.B)

(MTN 2017, FSD 2016 G-II)

- (A) 3 g/cm³
- (B) 1 gm³
- (C) 1 g/cm²
- (D) 1 gcm⁻³

5. Water is excellent solvent for: (K.B)

- (A) Ionic compounds
- (B) Polar compounds
- (C) Both A and B
- (D) None of these

6. Surface tension of water is: (K.B)

- (A) High
- (B) Low
- (C) Moderate
- (D) Comparable

7. The bond angle between H-O-H in water is: (K.B)

(GRW 2016, BWP 2016 G-II)

- (A) 104.5°
- (B) 104.6°
- (C) 104.7°
- (D) 104.8°

8. Water is a universal: (K.B)

- (A) Solvent
- (B) Solute
- (C) Both A and B
- (D) Donor

9. **Structure of water molecule is: (K.B)** (DGK 2016 G-II)
 (A) Polar (B) Non-polar
 (C) Both A and B (D) Diatomic
10. **Water dissolves non-ionic compounds by: (U.B)**
 (A) Ion-ion forces (E) Ion-dipole forces
 (C) Hydrogen bonding (D) Covalent bonds
11. **Conductivity of pure water is: (K.B)**
 (A) High (B) Very low
 (C) Very high (D) None of these

15.1 TEST YOURSELF

- i. **What is capillary action? (Knowledge Base)** (GRW 2017, FSD 2016 G-I, RWP 2016 G-II, MTN 2016 G-II)

Ans:

CAPILLARY ACTION

Definition:

“Capillary action is the process by which water rises up from the roots of plants to leaves”.

Importance:

This process is vital for the survival of land plants.

- ii. **Point out two properties of water that make it an excellent solvent.**

(Knowledge Base)

Ans:

WATER AS EXCELLENT SOLVENT

The two properties of water that make it an excellent solvent are:

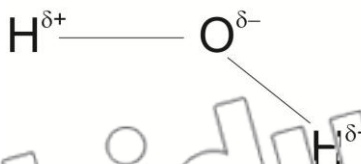
- (i) Polarity of water molecules
- (ii) Exceptional hydrogen bonding ability

- iii. **Why the water molecule is polar? (Understanding Base)**

Ans:

POLAR NATURE OF WATER MOLECULE

Water molecule has a polar structure i.e., one end of the molecule is partially positive while the other end is partially negative because of electro negativity difference between oxygen and hydrogen atoms.



- iv. **Explain why non-ionic polar compounds are soluble in water? (Understanding Base)**

(FSD 2017)

Ans:

SOLUBILITY OF NON-IONIC POLAR COMPOUNDS IN WATER

Non-ionic polar compounds are soluble in water due to hydrogen bonding. This hydrogen bonding is due to hydroxyl group i.e. OH^- , which is responsible for solubility

Example:

- Glucose
- Sugar

15.3 SOFT AND HARD WATER**LONG QUESTIONS**

Q.1 What is soft and hard water? Write down the causes of hardness. (*Knowledge + Understanding Base*)

OR

How is hardness caused in water?

(GRV 2014, 15, SGD 2014, MTN 2017, SWL 2016 G-II, BWP 2016 G-I)

Ans:

SOFT WATER AND HARD WATER

Soft Water:

“Soft water is that which *produces good lather with soap.*”

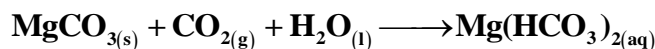
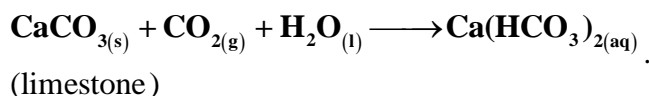
Hard Water:

“Hard water is that which *does not produce lather with soap.*”

CAUSES OF HARDNESS IN WATER

The rain water while coming down absorbs **carbon dioxide** from the atmosphere. The water mixed with carbon dioxide, when passes through the beds of the soil, converts insoluble carbonates of calcium and magnesium into soluble bicarbonates. It may also dissolve chlorides and sulphates of calcium and magnesium.

These salts make the water hard.

**Ions/Salts Present in Rain Water:**

The rain water dissolves many salts of divalent cations like Mg^{2+} , Ca^{2+} , and anions like Cl^{-} , SO_4^{2-} , HCO_3^{-} and CO_3^{2-} .

Important Salts:

- Gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$)
- Limestone (CaCO_3)

Gypsum is sparingly soluble in water, while limestone is insoluble in water. However, in the presence of carbon dioxide small quantity of limestone is soluble in water according to the above chemical reaction. These salts make the water hard.

Q.2 What are the types of hardness of water? Explain the methods for the removal of hardness in water. (*Knowledge + Understanding + Application Base*)

(LFR 2015, 15, 17, LGK 2016 G-II, SWL 2016 G-I)

OR

Explain the methods of removing permanent hardness of water.

Ans:

TYPES OF HARDNESS OF WATER

Hardness of water is of two types:

(i) **Temporary Hardness:**

“It is because of presence of *bicarbonates of calcium and magnesium.*”

(ii) **Permanent Hardness:**

“It is because of presence of *sulphates and chlorides of calcium and magnesium.*”

METHODS OF REMOVING HARDNESS

The removal of Mg^{2+} and Ca^{2+} ions which are responsible for the hardness is called **water softening**.

(i) Removal of Temporary Hardness:

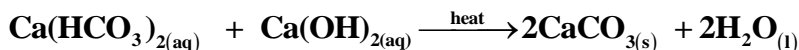
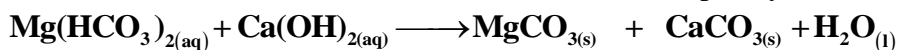
(CGK 2017, FSD 2017)

(a) By Boiling:

Temporary hardness of water is easily removed by boiling water. On boiling, calcium bicarbonate $\text{Ca}(\text{HCO}_3)_2$ decomposes to produce **insoluble calcium carbonate**, which precipitates out of the solution.

**(b) Clark's Method:**

A **chemical method** to remove temporary hardness is by the **addition of slaked lime** $\text{Ca}(\text{OH})_2$. A calculated amount of lime water is added to temporary hard water.



Thus, once the magnesium and calcium ions precipitate out water becomes soft.

(ii) Removal of Permanent Hardness:

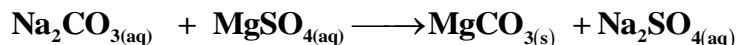
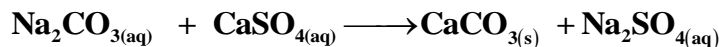
(Ex.Q.2)(GRW 2013, LHR 2013, MTN 2017, RWP 2017)

Permanent hardness can only be removed by using chemicals. Calcium ions (Ca^{2+}) and magnesium ions (Mg^{2+}) are removed as insoluble salts by adding **washing soda** (Na_2CO_3) or **Na_2 -zeolite**.

(a) By Using Washing Soda (Na_2CO_3):

(SWL 2016 G-I, BWP 2016 G-I)

The addition of washing soda removes the calcium and magnesium ions as the insoluble calcium and magnesium carbonates respectively.

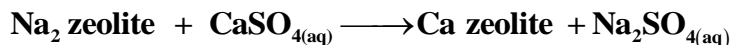
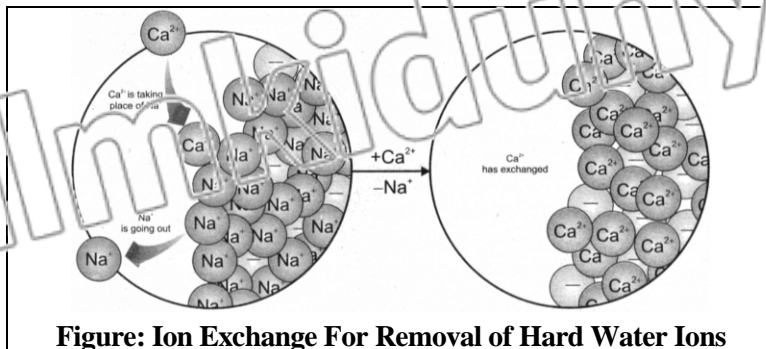
**(b) Using Sodium Zeolite (An Ion Exchanger):**

(BWP 2016 G-II)

Sodium zeolite is naturally occurring resin of **sodium aluminum silicate** $\text{NaAl}(\text{SiO}_3)_2$ which can also be prepared artificially.

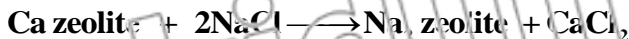
Uses of Sodium Zeolite:

It is used for softening of water at domestic as well as on industrial scale. When water is passed through resin, sodium ions of the resin are exchanged with the unwanted calcium and magnesium ions of the hard water.



Regeneration of Sodium Zeolite:

When resin is fully used up it can be regenerated by flushing it with **concentrated solution of NaCl**. The reverse process takes place because of **high concentration of sodium ions**.



Q.3 What are the disadvantages of hardness of water? (Knowledge Base)

(GRW 2013, 14, SGD 2014, BWP 2016 G-I, DGK 2016 G-II, 2017, MTN 2016 G-II)

OR

Give some disadvantages of hardness of water?

Ans:

DISADVANTAGES OF HARD WATER

Following are the disadvantages of hard water:

Consumption of More Soap:

Hard water **consumes large amount of soap** in washing purposes.

Stomach Disorders:

Drinking hard water causes **stomach disorders**.

Scales Formation:

Hard water is unfit for use in steam engines, boilers and turbines because insoluble calcium and magnesium salts are deposited inside which is called **scales**. They are bad conductors of heat and hence more fuel is used.

Insoluble calcium and magnesium sulphates not only **reduce the efficiency of the engine but also cause the boiler to burst**.

15.3 SOFT AND HARD WATER

SHORT QUESTIONS

Q.1 Define soap? (Knowledge Base)

(Science, Technology and Society Pg. # 144)

Ans:

SOAP

Soap is the **sodium salt** of a long chain **carboxylic acid** (fatty acid).

Q.2 What is scum? (Knowledge Base)

(DGK 2016 G-I, SGD 2017)

Ans:

SCUM

Hard water contains salts of magnesium and calcium. These ions react with the soap molecules to form an **insoluble precipitates of calcium and magnesium salts of fatty acids** called **scum**.

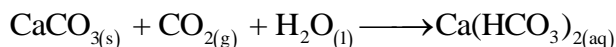
Q.3 How limestone dissolves in water? (Knowledge Base)

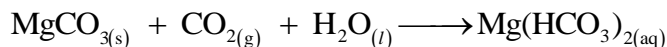
(MTN 2017)

Ans:

DISSOLUTION OF LIMESTONE

The rain water while coming down absorbs carbon dioxide from the atmosphere. The water mixed with carbon dioxide, when passes through the beds of the soil, converts insoluble carbonates of calcium and magnesium into soluble bicarbonates. It may also dissolve chlorides and sulphates of calcium and magnesium. These salts make the water hard.





Q.4 Explain chemistry of removing hardness of water by Clark's method.

(Knowledge Base)

Ans: Answer given on page # 300

Q.5 Discuss briefly two types of hardness of water. (Knowledge Base)

(BWP 2016 G-II)

OR

Differentiate between temporary and permanent hardness.

(SGD 2016 G-II)

Ans: Answer given on page # 300

MULTIPLE CHOICE QUESTIONS

1. Soft water produces lather with soap: (K.B)

- (A) Good (B) Bad
(C) Rough (D) Fine

2. $\text{CaCO}_3 + \text{CO}_2 + \text{H}_2\text{O} \longrightarrow$: (K.B)

- (A) $\text{Ca}(\text{HCO}_3)_2$ (B) $\text{Mg}(\text{HCO}_3)_2$
(C) $\text{Ca}_2(\text{HCO}_3)_2$ (D) Ca_2CO_3

3. $\text{MgCO}_3 + \text{CO}_2 + \text{H}_2\text{O} \longrightarrow$: (K.B)

- (A) $\text{Mg}(\text{HCO}_3)_2$ (B) $\text{Mg}(\text{HCO})_2$
(C) $\text{Mg}(\text{HCO}_3)$ (D) MgCl

4. In water gypsum is sparingly: (K.B)

- (A) Soluble (B) Insoluble
(C) None of these (D) Both A and B

5. HCO_3 makes the water: (K.B)

- (A) Hard (B) Soft
(C) Clean (D) Waxy

6. Temporary hardness is because of presence of bicarbonates of magnesium and: (K.B)

- (A) Calcium (B) Potassium
(C) Gypsum (D) Copper

7. The removal of which ions is responsible for the hardness of water: (K.B)

- (A) Mg^{2+} (B) K
(C) Na^{1+} (D) Cu^{2+}

8. In washing purposes hard water consumes large amount of: (K.B)

- (A) Soap (B) Power
(C) Slaked lime (D) Detergents

9. Drinking hard water causes disorders: (K.B)

- (A) Blood (B) Heart
(C) Stomach (D) Kidney

10. It is sodium salt of a long chain carboxylic acid: (K.B)

- (A) Acid (B) Soap
(C) Lime (D) Sodium chloride

11. Hard water contains salts of: (K.B)

- (A) Magnesium, calcium (B) Magnesium, potassium

- (C) Calcium, potassium (D) Ca, Cu
12. A large number of soap is wasted in formation of: (K.B)
 (A) Scum (B) Detergents
 (C) Soda (D) None of these
13. Hardness is of how many types? (K.B) (GRW 2017)
 (A) Four (B) Two
 (C) Three (D) Five
14. Permanent hardness because of Mg^{2+} and Ca^{2+} : (K.B)
 (A) SO_4^{2-} (B) Cl^-
 (C) Both A and B (D) Phosphates
15. Sodium zeolite is resin of: (K.B) (LHR 2014)
 (A) $NaAl(SiO_3)_2$ (B) $KAl(SiO_3)_2$
 (C) $LiAl(SiO_3)_2$ (D) $RbAl(SiO_3)_2$

15.2 TEST YOURSELF

- i. Which salts are responsible for hardness of water? (Knowledge Base) (GRW 2015)

Ans: SALTS RESPONSIBLE FOR HARDNESS

Calcium and magnesium salts like bicarbonates, sulphates and chlorides present in water cause hardness in water.

Examples:

- Gypsum ($CaSO_4 \cdot 2H_2O$)
- Limestone ($CaCO_3$)

- ii. Explain the chemistry of removing the temporary hardness by boiling water. (Knowledge Base)

Ans: REMOVAL OF TEMPORARY HARDNESS

On boiling, calcium and magnesium bicarbonates present in temporary hard water decompose to produce insoluble carbonates, which are precipitated out of the solution.



- iii. What is the principle of removing permanent hardness of water? (Knowledge Base)

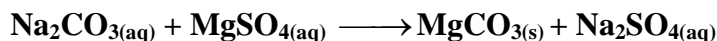
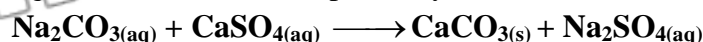
Ans: PRINCIPLE TO REMOVE PERMANENT HARDNESS

The permanent hardness can only be removed by using chemicals. Calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions are removed as “insoluble salts” by adding washing soda (Na_2CO_3) or sodium zeolite.

- iv. How addition of Na_2CO_3 removes permanent hardness of water? (Knowledge Base) (SGD 2016 G-II)

Ans: USES OF Na_2CO_3

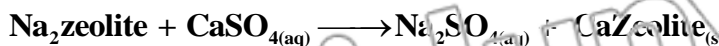
The addition of washing soda removes the calcium and magnesium ions as the insoluble calcium and magnesium carbonates respectively.



- v. How sodium zeolite softens water? (Understanding+Application Base)

Ans: WATER SOFTENING PROCESS

When hard water is passed through sodium zeolite, sodium ions of the resin are exchanged with the unwanted calcium and magnesium ions of the hard water to form insoluble calcium zeolite.



- vi. What do you mean by boilers scale? How are they removed?
(*Understanding+Application Base*)

(GRW 2014, LHR 2015, FSD 2016 G-II, SGD 2016 G-II, RWP 2016 G-I)

Ans: **BOILERS SCALE**

The hard layer of carbonates of calcium and magnesium salts deposited in industrial boilers is called boiler scales. They can be removed by washing the boilers with washing soda, slaked lime or sodium zeolite.

15.4 WATER POLLUTION

LONG QUESTIONS

- Q.1 What is water pollution? Describe the effects of using polluted water.
(*Knowledge+Understanding+Application Base*)

(GRW 2017, BWP 2017, SWL 2017, SGD 2017, FSD 2016 G-II, 2017, DGK 2016 G-I) (Ex-Q.8)

Ans: **WATER POLLUTION**

Definition:

“Water pollution is a contamination of water bodies (e.g. lakes, rivers, oceans and ground water)”.

Reason:

Water pollution occurs when pollutants are discharged directly or indirectly into water bodies without adequate treatment to remove harmful compounds.

EFFECTS OF WATER POLLUTION

The effects of water pollution are as follows:

- (i) It is **hazardous to human health**. Drinking polluted water can cause cholera, typhoid and diarrhea.
- (ii) The use of polluted water is not only devastating for people but also for **animals and birds**.
- (iii) It causes **rapid growth of algae**. Death and decomposition of algae causes deficiency of oxygen in water that affects other organism living in water.
- (iv) It is damaging aquatic life, thus breaking a link in **food chain**.
- (v) It reduces the **aesthetic quality** of lakes and rivers.
- (vi) It is **unfit for cleaning** or washing purposes.

- Q.2 Explain the water pollution because of industrial waste.

(*Knowledge+Application Base*) (Ex-Q.5)

Ans: **INDUSTRIAL EFFLUENTS**

“The waste water of industries is called industrial effluents”.

Purpose of Industries:

Industrial units are installed to produce the desired substances on commercial scale to meet the needs of the society.

Examples:

- Chemicals
- Cloth
- Leather goods

- Paper
- Plastic items
- Petrochemicals
- Rubber items

Disadvantages of industries:

Unfortunately all the industrial units discharge their wastes (chemicals and solid materials) either to open ground or to water channels. This is called industrial effluent.

Composition of Industrial Effluents:

The industrial effluents may be:

- Highly toxic organic chemicals
- Inorganic salts
- Heavy metals
- Mineral acids
- Oil
- Greases
- All kinds of toxic chemicals and detergents

Water used as cleaning agent in industries is directly discharged out. This water contains all kinds of toxic chemicals and detergents

Forms of Industrial Effluents:

When these effluents or used water enters lakes, streams, rivers or oceans, they are present in the following forms:

- Either get dissolved
- Float suspended in water
- Even they get deposited on the bed

Effects of Industrial Effluents on Water:**Results:**

The effects of industrial effluents on water are as follows:

(i) Quality of Water:

They **deteriorate** the quality of water.

(ii) Quantity of Dissolved Oxygen

They reduce the quantity of dissolved oxygen, ultimately affect **aquatic life and ecosystem**.

(iii) Human Health:

They can also seep down and affect the ground water deposits. They contaminate the water deposits. When this water is used by human beings, it **causes serious diseases like cancer and gastro**.

(iv) Damage to Soil and Living Organisms:

This polluted water damages soil, crops, plants and animals.

(v) Effects of Heavy Metals:

Heavy metals like cadmium, lead and mercury are toxic and health hazards for human beings.

- **Acute cadmium poisoning** causes **high blood pressure, kidney damage** and **destruction of red blood cells**.
- **Acute lead poisoning** causes **dysfunction of kidney, liver, brain, central nervous system and reproductive system**.
- **Mercury poisoning** causes **neurological damage**.

Q.3 Justify the statement: household water is the reason of water pollution.
(Knowledge+Understanding Base) (Ex-Q.4)

(GRW 2017, BWT 2017, DCEK 2017)

Ans:

DOMESTIC EFFLUENTS

Definition:

"The waste water of domestic sources is called domestic effluents" household water is also a domestic effluent.

Composition of Domestic Sewage:

(Ex-Q.4)

Domestic sewage contains a wide variety of dissolved and suspended impurities. They include:

- Detergents
- Food and vegetable waste
- Garbage
- Cans
- Bottles

All these substances add to water pollution.

Advantages of Detergents:

- **Use of detergents is increasing day by day** for cleaning purposes in houses and industries. **It is because; detergents have strong cleaning action** than that of soap even in hard water.
- They **can work even in acidic solutions.**

Disadvantages of Detergents:

- They have a major disadvantage over the soaps, as some of the detergents are **non-biodegradable** (cannot be decomposed by microorganisms like bacteria).
- The detergent remains in the water for a long time and makes the water unfit for aquatic life.
- Use of detergent affects **aquatic life**. When household water containing these detergents is discharged in streams, ponds, lakes and rivers, it causes water pollution.

Effect of Detergents on Aquatic Life:

The **phosphate salts** present in detergents **cause rapid growth of algae** in water bodies, which floats over the surface of water. These plants ultimately die and decay. Decaying plants **being biodegradable consume oxygen gas present in water**. Thus, depletion of oxygen gas results in death of aquatic life.

Q.4 Explain agricultural effluents are fatal for aquatic life.

Ans:

AGRICULTURAL EFFLUENTS

Definition:

"The waste water of agricultural sources is called agricultural effluents".

Major Pollutants:

Water pollution due to agricultural waste is because of use of **fertilizers and pesticides**.

Fertilizers:

Fertilizers are used to make up the **deficiency of nitrogen, phosphorus**, etc. of the soil because of **intensive cultivation of crops** in the recent years.

Pesticides:

The pesticides are used either directly to **kill or control the growth of pests**. Pests may

be weeds, herbs, insects, fungi, viruses, etc. They all damage crops and transmit diseases both to human beings and animals.

Effects of Agricultural Effluents on Water:

Agricultural effluents have dual effects:

(i) Ground Water Pollution:

Intensive cultivation of crops causes these chemicals from fertilizers and pesticides to **seep into the ground water** commonly called **leaching process**. The high nitrate contents in ground water is mainly because of irrigation run-off from agricultural fields.

(ii) Run-off Water:

Run-off from the agricultural land (where fertilizers and pesticides have been used) enters into ponds, streams or rivers. This water **contains nitrate (NO_3^-) and phosphate (PO_4^{3-}) salts**. These substances result in a **rapid growth of algae**, floating over the surface of water. They prevent the sunlight and air (oxygen) to reach upto aquatic life. **When algae dies, bacteria consume oxygen of the water for decomposition of algae. As a result oxygen depletes in the water.** Aquatic animals feel suffocation and ultimately die due to insufficient supply of oxygen.

15.4 WATER POLLUTION

SHORT QUESTIONS

Q.1 What is role of fluorine for protection of teeth?

(Knowledge+Understanding+Application Base)

(Interesting Information Pg. # 146)

OR

Why tooth pastes contain fluorine compounds?

Ans:

FLUORINE AND TEETH PROTECTION

In some parts of the world, the water supply contains small amounts of compounds of fluorine. It was found that, in these areas, people did not suffer much from tooth decay. This is because compounds of fluorine protect teeth from decay. This is why many tooth-pastes contain fluorine compounds.

Q.2 Which industrial effluents cause water pollution? *(Knowledge Base)*

Ans:

INDUSTRIAL EFFLUENTS

Industrial effluents are one of the main causes of water pollution.

Composition:

Industrial effluents include:

- High toxic organic chemicals
- Inorganic salts
- Heavy metals
- Mineral acids
- Oil and greases, etc.

Q.3 Explain agricultural effluents are fatal for aquatic life. *(Knowledge Base)* (GRW 2014)

Ans: Answer given on page # 307

Q.4 Define industrial effluents. (Knowledge Base)

(SGD 2016 G-II, SWL 2016 G-II)

Ans: Answer given on page # 305

What is meant by water pollution? (RWP 2016 G-II) (Knowledge Base)

Ans:

WATER POLLUTION

Definition:

“Water pollution is a contamination of water bodies (e.g. lakes, rivers, oceans and ground water)”.

Water pollution occurs when pollutants are discharged directly or indirectly into water bodies without adequate treatment to remove harmful compounds.

15.4 WATER POLLUTION

MULTIPLE CHOICE QUESTIONS

- Water pollution is contamination of water: (K.B)**
(A) Bodies (B) Molecules
(C) Compounds (D) Prices
- Water pollution causes rapid growth of: (K.B)**
(A) Bacteria (B) Algae
(C) Chemicals (D) Pollutants
- Water pollution is unfit for following purposes: (K.B)**
(A) Cleaning (B) Washing
(C) Both A and B (D) Drinking
- In some parts of the world, the water supply contains small amount of compounds of: (K.B)**
(A) Chlorine (B) Bromine
(C) Fluorine (D) Iodine
- Lack of proper sanitation facilities is the main cause of rapidly spreading _____ diseases. (K.B)**
(A) Water borne (B) Water pollution
(C) Hepatitis (D) Heart
- Water pollution due to agriculture waste is because of use of the: (K.B)**
(A) Fertilizers (B) Pesticide
(C) Both A and B (D) Insecticide
- Fertilizers are used to make up deficiency of: (K.B)**
(A) Nitrogen (B) Phosphorus
(C) Both A and B (D) Calcium
- Aquatic animals feel suffocation and ultimately die due to insufficient supply of: (K.B)**
(A) Oxygen (B) Hydrogen
(C) Carbon dioxide (D) None of these
- Heavy metals like Cadmium, Lead and Mercury are toxic and health hazards for: (K.B)**
(A) Humans (B) Animals
(C) Both A and B (D) Plants
- Use of detergents is increasing day by day for cleaning purposes in: (K.B)**
(A) Houses (B) Industries
(C) Both A and B (D) Classes

11. Detergents can work even in solutions: (K.B)
 (A) Acidic (B) Basic
 (C) Both A and B (D) Alkaline
12. Which salt present in detergents causes rapid growth of algae in water? (K.B)
 (A) Nitrate (B) Phosphate
 (C) Magnesium (D) Both A and B
13. Used water is called: (K.B)
 (A) Waste water (B) Sewage
 (C) Both A and B (D) None of these
14. Good quality water is colorless and: (K.B)
 (A) Odorless (B) Tasteless
 (C) Both A and B (D) Softly

15.3 TEST YOURSELF

- i. What is an industrial waste? (Knowledge Base) (LHR 2014, 2015)

Ans: INDUSTRIAL WASTE

Definition:

"The waste materials (particles) which are discharged by industrial units are called industrial waste".

Disadvantages:

- Water pollution deteriorate the quality of water.
- It reduce the quantity of dissolved oxygen, ultimately affect aquatic life and ecosystem.
- It causes serious diseases like cancer and gastro.
- This polluted water damages soil, crops, plants and animals.

Examples:

Inorganic salts, heavy metals, mineral acids, oil and grease etc.

- ii. How water used as a cleaning agent in industries causes pollution?

(Knowledge Base)

Ans: POLLUTION DUE TO WATER AS CLEANING AGENT

Water used as cleaning agent in industries is directly discharged out. This water contains all kinds of toxic chemicals and detergents. When these effluents or used water enter lakes, streams, rivers or oceans, they either get dissolved or float suspended in water. Even they get deposited on the bed. This results in the pollution of water.

- iii. Why use of detergents is increasing day by day? (Knowledge Base)

Ans: INCREASING USE OF DETERGENTS

The use of detergents is increasing day by day in houses and industries because of following reasons:

- Detergents have strong cleaning action than that of soap even in hard water.
- They work in acidic solution as well.

- iv. How decaying plants consume oxygen? (Knowledge Base)

Ans: DECAYING PLANTS CONSUME OXYGEN

Decaying plants consume oxygen present in water thus depletion of oxygen results in death of aquatic life for the biodegradation.

- v. What is function of fertilizers? (Knowledge Base)

(LHR 2014)

Ans: FUNCTION OF FERTILIZERS

Fertilizers are used to make up the deficiency of nitrogen, phosphorous etc. of the soil because of intensive cultivation of crops in the recent years.

vi. **How pesticides cause water pollution? (Knowledge Base)** (GIW 2013)

Ans: **WATER POLLUTION BY PESTICIDES**

Pesticides are used to kill or control the pests. Pesticides cause water pollution by adding poisonous chemicals in it.

15.5 WATERBORNE INFECTIOUS DISEASES

LONG QUESTIONS

Q.1 Write a detailed note on water borne diseases. (Knowledge+Understanding Base)

(Ex-Q.6)

OR

What are water borne infectious diseases? Explain five important water borne diseases. How can they be prevented? (GRW 2013, BWP 2017)

Ans: **WATER BORNE DISEASES**

Definition:

“Diseases that spread because of drinking polluted water or eating food prepared with polluted water are called waterborne infectious diseases”.

Causes of Water Pollution:

Water pollution may be due to toxins or microorganisms.

(i) Toxins:

Toxins are arsenic, mercury, lead and many organic chemicals.

(ii) Microorganisms:

Microorganisms are viruses, bacteria, protozoa and worms.

Main Cause of Waterborne Infectious Diseases:

Lack of proper sanitation facilities is the main cause of rapidly spreading waterborne diseases.

WATER BORNE DISEASES

A few common diseases are mentioned here:

(i) Diarrheal Diseases:

Intestinal diseases, such as cholera, that may cause dangerous dehydration.

Causative Organisms:

- Viruses
- Bacteria
- Parasites

(ii) Dysentery:

Dysentery is an **intestinal disease**. It is characterized by **severe diarrhea** that may be accompanied by blood or mucus.

Causative Organisms:

It is typically caused by certain bacteria or parasites.

(iii) Cholera:

(SGD 2016 G-I)

Cholera is an **acute infection**. It causes severe diarrhea and can be fatal.

Causative Organisms:

It is caused by the bacteria *Vibrios cholerae* which may be found in **water contaminated**

by human faeces.

(iv) Cryptosporidiosis:

(DGK 2016 C-1)

Waterborne disease that causes **gastrointestinal effects** including diarrhea and vomiting.

Causative Organisms:

- **Protozoa**

These tiny pathogens are found in surface water sources like reservoirs, lakes and rivers.

(v) Fluorosis:

Fluorosis is a disease caused by the **consumption of excess fluoride**. Fluorosis can cause bones and teeth damage.

(vi) Hepatitis:

It is **liver inflammation**.

Causative Organisms:

It is commonly caused by one of five viruses called hepatitis A, B, C, D, and E. Hepatitis **A and E can be transmitted by contaminated water**.

(vii) Hookworm:

Effects:

Hookworm is a **parasitic worm** that infects the **small intestine**. Severe cases can result in anemia and stunted growth in children.

Transmission:

Hookworm larvae enter the body through the skin, often via the feet. Spread by poor sanitary conditions, hookworms infect about one billion people worldwide per annum.

(viii) Jaundice:

(RWP 2017)

Jaundice is caused by an **excess of bile pigments** in the blood. **Liver ceases to function** and eyes turn yellow. Patient feels weakness and fatigue.

(ix) Typhoid:

A dangerous bacterial disease often spread by contaminated water or by food prepared with contaminated water.

Causative Organisms:

- Bacteria

Q.2 What are the remedial parameters to avoid water borne diseases? (Knowledge Base)
(Ex-Q.6)

Ans:

PREVENTION OF WATER BORNE DISEASES

Waterborne diseases can be prevented by taking the following measures:

(i) Provision of Safe Water:

Drinking water must be properly treated and purified.

(ii) Disposal of Sewage:

There must be adequate sanitary disposal of sewage, any type of waste must not be thrown or discharged directly in water supplies or reservoirs.

(iii) Control of Toxic Chemicals:

Chemical contamination can cause acute illness, but often toxic contaminants are slow poisons and carcinogens. There must be a strict control over the use of pesticides and other chemicals.

15.5 WATERBORNE INFECTIOUS DISEASES

SHORT QUESTIONS

Q.1 What are waterborne infectious diseases? (Knowledge Base)

(DGK 2017)

Ans: Answer given on Page # 311

Q.2 How jaundice is caused? Write its symptoms. (Knowledge Base)

(RWP 2017)

Ans: Answer given on Page # 312

MULTIPLE CHOICE QUESTIONS

1. ***Vibrios cholerae* may be found in water contaminated by: (K.B)**
(A) Human faeces (B) Animal faeces
(C) Both A and B (D) Human urine
2. **Fluorosis is a disease caused by the consumption of excess: (K.B) (LHR 2014, SWL 2017)**
(A) Chlorine (B) Bromine
(C) Fluoride (D) Astatine
3. **Which of the following disease causes liver inflammation? (K.B)**
(A) Typhoid (B) Cholera
(C) Hepatitis (D) Jaundice
4. **Hepatitis _____ and _____ can be transmitted by contaminated water. (K.B)**
(A) B, C (B) A, E
(C) A, D (D) B, A
5. **Hookworm infects the: (K.B)**
(A) Small intestine (B) Large intestine
(C) Stomach (D) Liver
6. **Hookworm infects about how many billion people worldwide per annum? (K.B)**
(A) 1 (B) 2
(C) 4 (D) 5
7. **Diarrhea may be caused by viruses: (K.B)**
(A) Bacteria (B) Parasites
(C) Both a and b (D) Fungal infections
8. **Dysentery is a disease of: (K.B)**
(A) Intestine (B) Stomach
(C) Heart (D) Liver
9. **Cholera is an acute infection caused by bacteria: (K.B)**
(A) *Cholerae* (B) *Vibrious cholerae*
(C) Both a and b (D) None of these
10. **Water borne diseases: (K.B)**
(A) Dysentery (B) Cholera
(C) Both A and B (D) Pneumonia
11. **Jaundice is caused by an excess of _____ in blood. (K.B)**
(A) Bile pigments (B) RBC's
(C) WBC's (D) Thrombocytes
12. **Patient feels weakness and fatigue in: (K.B)**
(A) Jaundice (B) Hepatitis
(C) Cryptosporidiosis (D) Cholera
13. **Typhoid is a dangerous disease: (K.B)**
(A) Intestinal (B) Bacterial
(C) Infections (D) Fungal
14. **Chlorine kills: (K.B)**
(A) Bacteria (B) Micro-organisms
(C) Both A and B (D) Germs

15. Swimming pools are cleaned by: (K.B)
 (A) Chlorination (B) Fluorination
 (C) Bromination (D) Both B and C
16. A disease that causes bone and tooth damage: (K.B) (IHR 2015, GRW 2017)
 (A) Jaundice (B) Fluorosis
 (C) Hepatitis (D) Asthma
17. Which gas is used to destroy harmful bacteria in water? (K.B) (GRW 2015, MTN 2017, DGK 2017)
 (A) Iodine (B) Chlorine
 (C) Fluorine (D) Bromine

15.4 TEST YOURSELF

- i. Define water borne diseases. (Knowledge Base)

Ans:

WATER BORNE DISEASES

Definition:

"Diseases that spread because of drinking polluted water or eating food prepared with polluted water are called water borne diseases".

Examples:

- Cholera
- Dysentery
- Hepatitis

These diseases spread because of lack of sanitation arrangements.

- ii. What is dysentery? (Knowledge Base)

Ans:

DYSENTERY

Definition:

"Dysentery is an intestinal disease which is typically caused by certain bacteria or parasites".

Symptoms:

It is characterized by severe diarrhea that may be accompanied by blood or mucous.

- iii. Which of the bacteria causes the cholera? (Knowledge Base)

Ans:

BACTERIA CAUSING CHOLERA

Cholera is an acute infection caused by the bacteria "*Vibrio cholerae*".

- iv. What do you mean by fluorosis? (Knowledge Base)

(RWP 2017)

Ans:

FLUOROSIS

Definition:

"Fluorosis is a disease caused by the consumption of excess fluoride".

Symptoms:

Fluorosis can cause bones and teeth damage.

- v. What is hepatitis? (Knowledge Base)

(SWL 2017)

Ans:

HEPATITIS

Definition:

"It is liver inflammation commonly caused by one of five viruses called hepatitis A, B, C, D and E".

Transmission:

Hepatitis A and E can be transmitted by contaminated water.

SKILLS**Quality of Water:**

Good quality water is colourless, odourless and tasteless. Hardness of water can be checked by washing. Soft water produces lather with water. Pure water has least conductivity.

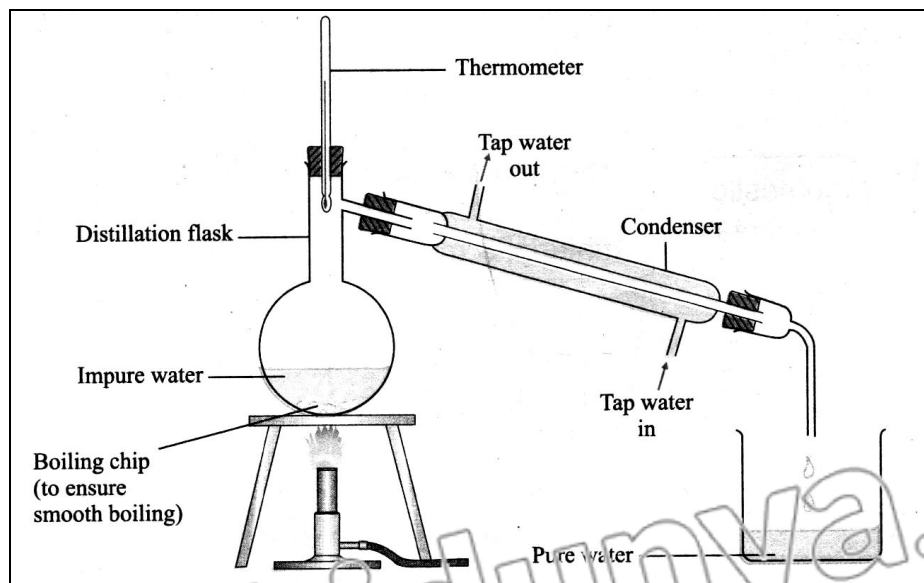
Boiling point of water:

Water boils at 100°C .

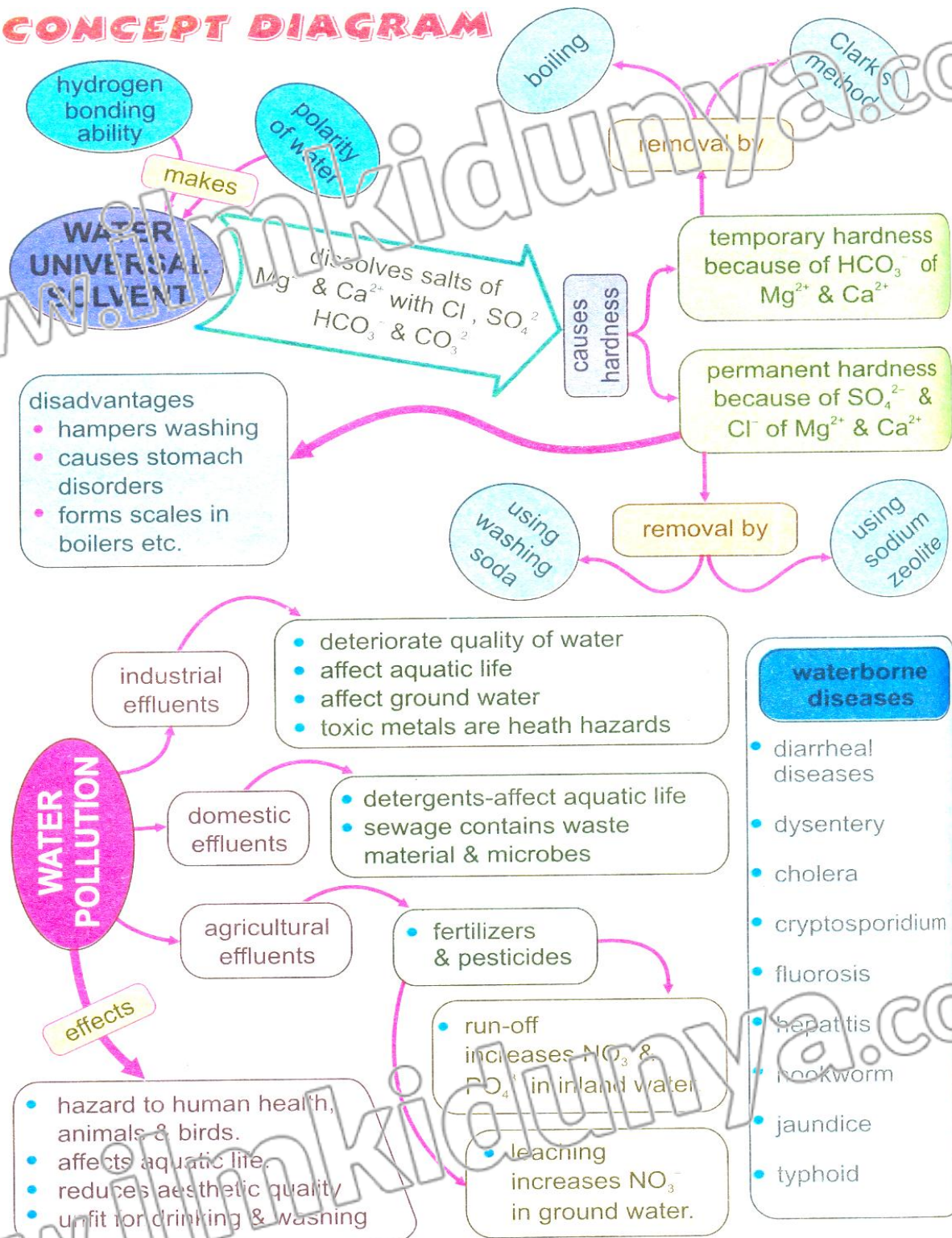
Distillation of Impure water:

Impure water can be purified by simple distillation apparatus as shown in figure.

Distillation process involves boiling of a liquid and then condensing the vapours.



Impure water is taken in a distillation flask. It is boiled. Water vapours rise and enter the condenser. The vapours condense while passing through condenser. Thus, they are changed back into pure water, which is called distillate (distilled water). The distillate is collected in a beaker. The impurities remain behind in the distillation flask.

CONCEPT DIAGRAM

ANSWER KEY**MULTIPLE CHOICE QUESTIONS****INTRODUCTION**

1	A
2	A
3	C
4	C
5	A

15.1 PROPERTIES OF WATER**15.2 WATER AS SOLVENT**

1	A	6	A	11	B
2	A	7	A		
3	A	8	A		
4	D	9	A		
5	C	10	C		

15.3 SOFT AND HARD WATER

1	A	6	A	11	A
2	A	7	A	12	A
3	A	8	A	13	B
4	A	9	C	14	C
5	A	10	B	15	A

15.4 WATER POLLUTION

1	A	6	C	11	A
2	B	7	C	12	B
3	D	8	A	13	C
4	C	9	A	14	C
5	A	10	C		

15.5 WATER BORNE INFECTIOUS DISEASES

1	A	6	A	11	A	16	B
2	C	7	C	12	A	17	B
3	C	8	A	13	B		
4	B	9	B	14	C		
5	A	10	C	15	A		

EXERCISE SOLUTION**MULTIPLE CHOICE QUESTIONS**

1. Which one of the following properties of water is responsible for rising of water in plants? (K.B) (LHR 2015, DGK 2016 G-II, SGD 2017)
- (a) Specific heat capacity (b) Surface tension
(c) Excellent solvent action (d) Capillary action
2. Specific heat capacity of water is: (K.B) (GRW 2014,17 SGD 2014, RWP 2016 G-II, LHR 2017, BWP 2017, SWL 2017, MTN 2017)
- (a) $4.2 \text{ kJg}^{-1} \text{K}^{-1}$ (b) $4.2 \text{ Jg}^{-1} \text{K}^{-1}$
(c) $2.4 \text{ kJg}^{-1} \text{K}^{-1}$ (d) $2.4 \text{ Jg}^{-1} \text{K}^{-1}$
3. Water dissolves non-ionic compound by: (K.B) (GRW 2014, SWL 2017)
- (a) Ion-ion forces (b) Ion-dipole forces
(c) Dipole-dipole forces (d) Hydrogen bonding
4. Temporary hardness is because of: (K.B) (GRW 2013,14,17, LHR 2015, BWP 2016 G-II, FSD 2016 G-I, SGD 2016 G-II, RWP 2016 G-II, SWL 2016 G-I, DGK 2017)
- (a) $\text{Ca}(\text{HCO}_3)_2$ (b) CaCO_3
(c) MgCO_3 (d) MgSO_4
5. Temporary hardness is removed by adding: (K.B) (SGD 2016 G-I, GRW 2015, MTN 2017)
- (a) Quick lime (b) Slaked lime
(c) Limestone (d) Lime water
6. Permanent hardness is removed by adding: (K.B) (GRW 2014, DGK 2016 G-I, BWP 2017)
- (a) Na_2 zeolite (b) Soda lime
(c) Lime water (d) Quick lime
7. Which one of the following salts makes the water permanently hard? (K.B) (LHR 2014, 15, GRW 2014, 15, 16, SWL 2016 G-II, MTN 2016 G-I, RWP 2016 G-I, 17)
- (a) Na_2CO_3 (b) NaHCO_3
(c) $\text{Ca}(\text{HCO}_3)_2$ (d) CaSO_4
8. Rapid growth of algae in water bodies is because of detergent having: (K.B) (DGK 2017)
- (a) Carbonate salts (b) Sulphonic acid salts
(c) Sulphate salts (d) Phosphate salts
9. Depletion of O_2 from water is not because of: (K.B)
- (a) Decaying of aquatic plants (b) Biodegradation of aquatic plants
(c) Rapid growth of aquatic plants (d) Decomposition of aquatic plants

10. Which one of the following diseases causes liver inflammation? (K.B)
(FSD 2016 G-II, 17, MTN 2016 G-I, SWL 2016 G-II, LHR 2014, 15, SGD 2017)
- (a) Typhoid (b) Jaundice
(c) Cholera (d) Hepatitis
11. Which one of the following diseases causes severe diarrhea and can be fatal? (K.B)
(SGD 2016 G-I, BWP 2017, RWP 2017)
- (a) Jaundice (b) Dysentery
(c) Cholera (d) Typhoid
12. Which one of the following gases is used to destroy harmful bacteria in water? (K.B)
(DGK 2017, SGD 2016 G-II, 17, MTN 2016 G-I)
- (a) Iodine (b) Chlorine
(c) Fluorine (d) Bromine
13. Which one of the following ions does not cause hardness in water? (K.B)
(LHR 2014, 16, MTN 2016, G-II, DGK 2016 G-I, SWL 2016 G-II, FSD 2017 G-I, RWP 2017, GRW 2017)
- (a) Ca^{2+} (b) Mg^{2+}
(c) SO_4^{2-} (d) Na^+
14. A disease that causes bone and tooth damage is: (K.B)
(GRW 2013, LHR 2013, 15, RWP 2016 G-II, 17, SGD, 2017)
- (a) Fluorosis (b) Hepatitis
(c) Cholera (d) Jaundice
15. Ionic compounds are soluble in water due to: (K.B) (RWP 2016 G-II)
- (a) Hydrogen bonding (b) Ion-dipole forces
(c) Dipole-dipole forces (d) Dipole-induced dipole forces
16. The chemicals used to kill or control pests are called pesticides. They are: (K.B)
- (a) Dangerous inorganic chemicals (b) Dangerous organic chemicals
(c) Beneficial inorganic chemicals (d) Beneficial organic chemicals

ANSWER KEY

1	D	6	a	11	c	16	b
2	B	7	d	12	b		
3	d	8	d	13	d		
4	a	9	c	14	a		
5	b	10	d	15	b		

EXERCISE SHORT QUESTIONS

1. How water rises in plants by capillary action? (*Knowledge Base*)

(RWP 2016 G-I, DGG 2016 G-I & II)

Ans: WATER RISE IN PLANTS

Water rises in plants by capillary action. Capillary action is the process by which water rises up from the roots of plants to leaves. This process is vital for the survival of land plants.

2. Which forces are responsible for dissolving polar substances in water?

(*Knowledge Base*)(GRW 2013, MTN 2016 G-I&II)

Ans: FORCES RESPONSIBLE FOR DISSOLUTION

Dipole forces (Dipole-dipole forces and H-bonding) are responsible for dissolving polar substances in water because positive end of polar substance is attracted by negative end of polar substance and vice versa.

3. Why non-polar compounds are insoluble in water?

(*Knowledge+Understanding Base*)(LHR 2013, SWL 2016 G-I&II)

Ans: INSOLUBILITY OF NON POLAR COMPOUNDS

The non-polar compounds do not have polar ends or bonds and are not attracted by water molecules. Therefore, non-polar compounds do not dissolve in water.

Examples:

- Benzene
- Ether
- Octane etc.

4. How water dissolves sugar and alcohols? (*Understanding Base*)

(LHR 2013)

Ans: DISSOLUTION OF SUGAR AND ALCOHOLS

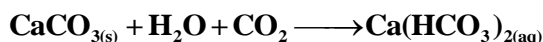
Water dissolves sugar and alcohols through H-bonding. Both sugar and alcohols contain hydroxyl groups (–OH) having polar ends which are attached by positive and negative ends of water molecules.

5. How limestone dissolves in water? (*Knowledge+Understanding Base*)

(GRW 2015)

Ans: DISSOLVING OF LIMESTONE

The water which has limestone is insoluble in water but carbon dioxide dissolved in it, convert the insoluble lime stone (calcium carbonate) into soluble calcium bicarbonate. In this way, lime stone dissolves in water.



6. Differentiate between soft and hard water. (*Knowledge Base*)

(GRW 2015, LHR 2013, BWP 2010 G-I, FSD 2016 G-I, DGG 20196 G-II, SWL 2017)

Ans: DIFFERENTIATION

The differences between soft water and hard water are as follows:

Soft Water	Hard Water
Definition	
• Soft water is that which produced good lather with soap.	• Hard water is that which does not produce lather with soap.
Importance	
• It does not affect the cleaning action of soap.	• It decreases the cleaning reaction of soap.
Scum formation	

- | | |
|-----------------------------------|----------------------------|
| • It does not form scum with soap | • It forms scum with soap. |
|-----------------------------------|----------------------------|

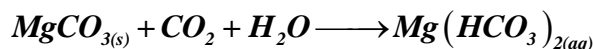
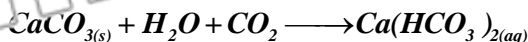
7. What are the causes of hardness in water? (*Knowledge+Understanding Base*)

(GRW 2015, LHR 2014, 15, BWP 2016 G-II, MTN 2016 G-II)

Ans:

CAUSES OF HARDNESS

The rain water while coming down absorbs carbon dioxide from the atmosphere. The water mixed with carbon dioxide, when passes through the beds of the soil, converts insoluble carbonates of calcium and magnesium into soluble bicarbonates. It may also dissolve chlorides and sulphates of calcium and magnesium.



8. What are the effects of temporary hardness in water? (*Knowledge Base*) (LHR 2013)

Ans:

EFFECTS OF TEMPORARY HARDNESS

Temporary hardness is because of presence of bicarbonates of calcium and magnesium.

Effects:

- Hard water consumes large amount of soap in washing purposes.
- Drinking hard water causes stomach disorders.
- Hard water is unfit for use in steam engines, boilers and turbines because insoluble calcium and magnesium salts are deposited inside, which is called scales. They are bad conductors of heat and hence more fuel is used. Insoluble calcium and magnesium sulphates not only reduce the efficiency of the engine but also cause the boiler to burst.

9. Mention the disadvantages of detergents. (*Knowledge Base*)

(GRW 2014, LHR 2015, SWL 2016 G-I, DGK 2016 G-I, BWP 2017, DGK 2017)

Ans:

DISADVANTAGES OF DETERGENTS

The disadvantages of detergents are as follows:

- Detergents have a major disadvantage over the soaps as some of the detergents are non-biodegradable (cannot be decomposed by micro-organisms like bacteria).
- Detergents cause water pollution.
- The detergents remain in the water for a long time and make the water unfit for aquatic life.
- The phosphate salts present in detergents cause rapid growth of algae.

10. What is difference between biodegradable and non-biodegradable substances? (*Knowledge Base*) (GRW 2014, MTN 2016 G-II, 17)

Ans:

DIFFERENTIATION

The differences between biodegradable substances and non-biodegradable substances are as follows:

Biodegradable Substances	Non-Biodegradable Substances
Definition	
<ul style="list-style-type: none"> • The substance which can be decomposed by microorganisms like bacteria are called bio-degradable substances. 	<ul style="list-style-type: none"> • The substances which cannot be decomposed by microorganism like bacteria are called non-biodegradable substances.
Examples	

- | | |
|---|--|
| <ul style="list-style-type: none"> Dead bodies of living organisms like plants and animals | <ul style="list-style-type: none"> Plastics Rubber |
|---|--|

11. How detergents make the water unfit for aquatic life? (*Understanding Base*)

(GR V 2015, RWP 2017, SGD 2017, FSD 2017)

Ans:

DETERGENTS AND AQUATIC LIFE

Detergents make the water unfit for aquatic life because:

(i) Non-biodegradable:

The detergents are non-biodegradable, so they remain in the water for a long time and make the water unfit for aquatic life.

(ii) Phosphate Salts:

The phosphate salts present in detergents cause rapid growth of algae in water bodies, which floats over the surface of water. These plants ultimately die and decay. Decaying plants being biodegradable consume O_2 present in water. Thus, depletion of O_2 results in death of aquatic life.

12. Why pesticides are used? (*Knowledge Base*)

(SWL 2016 G-II, MTN 2016 G-I)

Ans:

USE OF PESTICIDES

Pesticides are used either directly to kill or control the growth of pests. Pests may be weeds, herbs, insects, fungi, viruses, etc. they all damage crops and transmit diseases both to human beings and animals.

13. What is the reason of waterborne diseases? (*Knowledge Base*)

(GRW 2014, 2015, MTN 2016 G-I)

Ans:

CAUSE OF WATERBORNE DISEASES

The reason of waterborne diseases are as follows:

- “**Toxins**” like arsenic, mercury lead and many organic chemicals.
- “**Microorganisms**” like viruses, bacteria, protozoa and worms present in water.

The main cause of waterborne diseases is lack of proper sanitation facilities.

14. How waterborne diseases can be prevented? (*Application Base*)

(SGD 2016 G-I, DGK 2016 G-II)

Ans:

PREVENTION OF WATER BORNE DISEASES

The waterborne diseases can be prevented by the following methods:

- Provision of safe water
- Disposal of sewage
- Control of toxic chemicals
- Drinking water must be properly treated and purified
- There must be adequate sanitary disposal of waste.
- Chemical contamination can cause acute illness but often toxic contaminants are

slow poisons and carcinogens. There must be strict control over the use of pesticides and other chemicals.

EXERCISE LONG QUESTIONS

1. How polarity of water molecule plays its role to dissolve the substances?
Ans: See LQ. 2 (Topic 15.2)
2. Explain the methods of removing permanent hardness.
Ans: See LQ. 2 (Topic 15.3)
3. Explain the water pollution because of industrial waste.
Ans: See LQ. 2 (Topic 15.4)
4. Justify the statement: household water is the reason of water pollution.
Ans: See LQ.3 (Topic 15.4)
5. Explain agricultural effluents are fatal for aquatic life.
Ans: See LQ. 4 (Topic 15.4)
6. Explain five important waterborne diseases. How can these be prevented?
Ans: See LQ. 1 (Topic 15.5)
7. Give some disadvantages of hard water.
Ans: See LQ. 3 (Topic 15.3)
8. What is water pollution? Describe the effects of using polluted water.
Ans: See LQ. 1 (Topic 15.4)
9. Explain the reasons, water is considered a universal solvent.
Ans: See LQ. 2 (Topic 15.2)
10. Write a note on the treatment of sewage water.
(Understanding+Application Base)
Ans: SEWAGE TREATMENT

Definition:

"Sewage treatment is the process of removing contaminants from wastewater, primarily from household sewage".

Methods:

It includes physical, chemical, and biological processes to remove these contaminants and produce environmentally safe treated wastewater (or treated effluent).

STEPS INVOLVED

Sewage treatment generally involves three stages, called primary, secondary and tertiary treatment.

1. Primary Treatment:

"It consists of temporarily holding the sewage in a quiescent basin where heavy solids can settle to the bottom while oil, grease and lighter solids float to the surface. The settled and floating materials are removed and the remaining liquid may be discharged or subjected to secondary treatment".

Some sewage treatment plants that are connected to a combined sewage system have a bypass arrangement after the primary treatment unit. This means that during very heavy rainfall events, the secondary and tertiary treatment systems can be bypassed to protect them from hydraulic overloading, and the mixture of sewage and storm water only receives primary treatment.

2. Secondary Treatment:

“Secondary treatment removes dissolved and suspended biological matter. Secondary treatment is typically performed by indigenous, water-borne micro-organisms in a managed habitat”.

Secondary treatment may require a separation process to remove the micro-organisms from the treated water prior to discharge or tertiary treatment.

3. Tertiary Treatment:

“Tertiary treatment is sometimes defined as anything more than primary and secondary treatment in order to allow rejection into a highly sensitive or fragile ecosystem (estuaries, low-flow rivers, coral reefs)”.

Treated water is sometimes disinfected chemically or physically (for example, by lagoons and microfiltration) prior to discharge into a stream, river, bay, lagoon or wetland, or it can be used for the irrigation of a golf course, green way or park. If it is sufficiently cleaned, it can also be used for groundwater recharge or agricultural purposes.

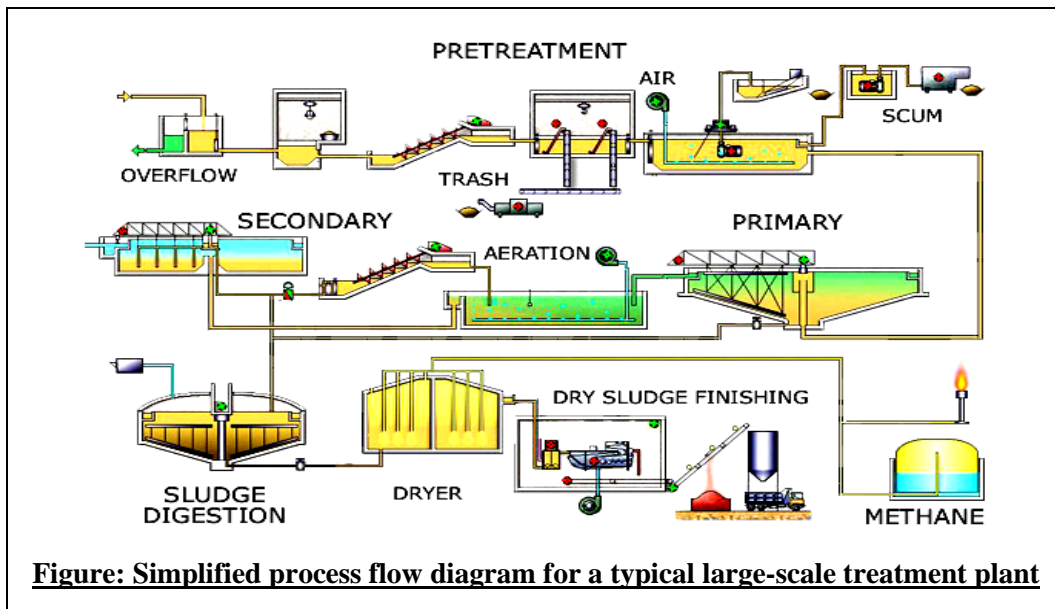


Figure: Simplified process flow diagram for a typical large-scale treatment plant

ADDITIONAL CONCEPTUAL QUESTIONS

Q.1 What is chlorination process of water?

(Science, Technology and Society Pg. # 148)

Ans:

CHLORINATION OF WATER

Definition:

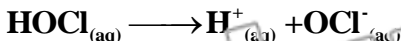
“The process of passing of chlorine through water to kill bacteria and other micro-organisms is called chlorination”.

Mechanism of Chlorination of Water:

Swimming pools are cleaned by **chlorination process**. It is the addition of chlorine solution in swimming' pools. Chlorine kills bacteria and other micro-organisms. Cl_2 itself does not kill rather it dissociates in water to form **hypochlorous acid (HOCl)** and hydrochloric acid.



HOCl further ionizes to produce **hypochlorite** and proton.



Both the products HOCl and OCl⁻ kill bacteria and micro-organisms.

Q.2 What is difference between hepatitis and jaundice?

(LHR 2015)

Ans:

DIFFERENTIATION

Hepatitis	Jaundice
Effects	
<ul style="list-style-type: none"> It is liver inflammation. 	<ul style="list-style-type: none"> In this disease, liver ceases to function and eyes turn yellow. Patient feels weakness and fatigue.
Cause	
<ul style="list-style-type: none"> It is caused by one of five viruses called hepatitis A, B, C, D and E. 	<ul style="list-style-type: none"> It is caused by an excess of bile pigments in the blood.

Q.3 Differentiate between temporary hardness and permanent hardness.

Ans:

DIFFERENTIATION

Temporary Hardness	Permanent Hardness
Definition	
<ul style="list-style-type: none"> It is because of presence of bicarbonates of calcium and magnesium. 	<ul style="list-style-type: none"> It is because of presence of sulphates and chlorides of calcium and magnesium.
Removal	
<ul style="list-style-type: none"> It can be removed by physical as well as chemical method. 	<ul style="list-style-type: none"> It can only be removed by chemical method.

Q.4 Why sea water is unfit for drinking and agricultural purposes? (Knowledge Base)

Ans:

SEA WATER IS UNFIT

Sea water is unfit for drinking and agricultural purposes due to high percentage of dissolved salts. **Only 0.2% of the total water on the Earth is potable, i.e. fit for drinking purposes.**

Q.5 What is meant by heat capacity of water?

Ans:

Heat capacity is defined as, "The amount of heat required to raise the temperature of one gram of water by 1 °C". Water has a high heat capacity meaning it takes more energy to increase the temperature of water compared to other substances.

TERMS TO KNOW

Terms	Definitions
Ground Water Pollution	The contamination of ground water due to undesirable and harmful substances is called ground water pollution.
Capillary Action	Capillary action is the process by which water rises up from the roots of plants to leaves. This process is vital for the survival of the land plants.

Hydrogen Bonding	The attractive force present between partial positive hydrogen end of one molecule and partial negative end of more electronegative atom of other molecule is called Hydrogen bonding.
Soft Water	Soft water is that which produces good lather with soap.
Hard Water	Hard water is that which does not produce lather with soap.
Temporary Hardness	It is because of presence of bicarbonates of calcium and magnesium.
Permanent Hardness	It is because of presence of sulphates and chlorides of calcium and magnesium.
Water Pollution	Water pollution is a contamination of water bodies (e.g. lakes, rivers, oceans and ground water).
Agricultural Effluents	The waste water of agricultural sources is called agricultural effluents.
Industrial Effluents	The waste materials (particles) which are discharged by industrial units are called industrial waste or industrial effluents.
Waterborne Infectious Diseases	Diseases that spread because of drinking polluted water or eating food prepared with polluted water are called waterborne infectious diseases.
Chlorination	The process of passing of chlorine through water to kill bacteria and other micro-organisms is called chlorination.
Dysentery	Dysentery is an intestinal disease which is typically caused by certain bacteria or parasites. It is characterized by severe diarrhea that may be accompanied by blood or mucus.
Fluorosis	Fluorosis is a disease caused by the consumption of excess fluoride. Fluorosis can cause bones and teeth damage.
Hepatitis	It is liver inflammation commonly caused by one of five viruses called hepatitis A, B, C, D and E.
Bio-degradable Substances	The substance which can be decomposed by micro-organisms like bacteria are called bio-degradable substances.



CUT HERE

SELF TEST**Time: 35 Minutes****Marks: 15****Q.1 Four possible answers (A), (B), (C) and (D) to each question are given, mark the correct answer. (6×1=6)**

1. **The %age of drinkable water on earth is:**
(A) 2.0% (B) 0.02%
(C) 0.2% (D) 5%
2. **The heat capacity of water is:**
(A) 4.3 K/gK (B) 4.2 Jg⁻¹K⁻¹
(C) 4.4 Jg⁻¹k⁻¹ (D) 4.1 Jg⁻¹K⁻¹
3. **Water molecule has a structure:**
(A) Polar (B) Non-polar
(C) Both (D) None of these
4. **It is sparingly soluble in water:**
(A) Limestone (B) Benzene
(C) Ether (D) Gypsum
5. **The disease that causes bones and teeth damage:**
(A) Fluorosis (B) Hepatitis
(C) Cholera (D) Jaundice
6. **Temporary hardness is removed by adding:**
(A) Quick lime (B) Slaked lime
(C) Limestone (D) Lime water

Q.2 Give short answers to the following questions.**(5×2=10)**

- (i) What is the distribution of water?
- (ii) Differentiate between soft and hard water?
- (iii) Write two disadvantages of hard water?
- (iv) What is the function of fertilizer?
- (v) What do you mean by fluorosis?

Q.3 Answer the following questions in detail.**(5+4=9)**

- (i) Explain water pollution because of industrial wastes? **(5)**
- (ii) Write two methods used for removal of permanent hardness of water. **(4)**

NOTE: Parents or guardians can conduct this test in their supervision in order to check the skill of students.