THE CAMBRIDGE SCHOOL

A PROJECT OF AZAM ACADEMY

CHEMISTRY

FOR CLASS – 10^{th}

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UNIT- 9

CHEMICAL EQUILIBRIUM

SELF ASSETSSMENT EXERCISES

Self Assessment Exercise 9.1

Write both forward and reverse reactions and describe macroscopic characteristic of each:

(i) $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$

Forward reaction	Reverse Reaction
$N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$	$2NH_{3(g)} \rightarrow N_{2(g)} + 3H_{2(g)}$
It is written from left to right.	It is written from right to left.
Reactants (N_2 and H_2) produce product (NH_3).	Product (NH_3) produces reactants (N_2 and H_2).
Rate is fastest in the beginning and gradually slows down.	Rate is zero in the beginning and gradually speeds up.

(ii) $H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$

Forward reaction	Reverse Reaction
$H_{2(g)} + I_{2(g)} \rightarrow 2HI_{(g)}$	$2HI_{(g)} \rightarrow H_{2(g)} + I_{2(g)}$
It is written from left to right.	It is written from right to left.
Reactants (H_2 and I_2) produce product (HI).	Product (HI) produces reactants (H_2 and I_2).
Rate is fastest in the beginning and gradually slows down.	Rate is zero in the beginning and gradually speeds up.

Self Assessment Exercise 9.2

Q.1. **Following reaction can occur during lightning storms.**

$3O_{2(g)} \rightleftharpoons 2O_{3(g)}$

Derive equilibrium constant expression for this reaction

Ans: **Forward reaction:** $3O_{2(g)} \rightarrow 2O_{3(g)}$

Reverse reaction: $2O_{3(g)} \rightarrow 3O_{2(g)}$

According to law of mass action:

Rate of forward reaction α $[O_2]^3$

Rate of forward reaction = $K_f[O_2]^3$

Rate of reverse reaction α $[O_3]^2$

Rate of reverse reaction = $K_r[O_3]^2$

At equilibrium:

Rate of forward reaction = Rate of reverse reaction

$$K_f[O_2]^3 = K_r[O_3]^2$$

$$\frac{K_f}{K_r} = \frac{[O_3]^2}{[O_2]^3}$$

Here $K_c = K_f / K_r$

$$K_c = \frac{[O_3]^2}{[O_2]^3}$$

This is the equilibrium constant (K_c) expression for the above mentioned reaction.

Q.2. Write equilibrium constant expression for the following reactions.

a. $4HCl_{(g)} + O_{2(g)} \rightleftharpoons 2H_2O_{(g)} + 2Cl_{2(g)}$

$$K_c = \frac{[H_2O]^2\,[Cl_2]^2}{[HCl]^4\,[O_2]}$$

b. $CH_3COOH_{(l)} + C_2H_5OH_{(l)} \rightleftharpoons CH_3COOC_2H_{5(l)} + H_2O_{(l)}$

$$K_c = \frac{[CH_3COOC_2H_5]\,[H_2O]}{[CH_3COOH]\,[C_2H_5OH]}$$

c. $2HF_{(g)} \rightleftharpoons H_{2(g)} + F_{2(g)}$

$$K_c = \frac{[H_2]\,[F_2]}{[HF]^2}$$

d. $2NO_{2(g)} \rightleftharpoons N_2O_{4(g)}$

$$K_c = \frac{[N_2O_4]}{[NO_2]^2}$$

Self Assessment Exercise 9.3

Determine the units of equilibrium constants for the following reactions.

1. $N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO_{(g)}$

$$K_c = \frac{[NO]^2}{[N_2]\,[O_2]}$$

$$K_c = \frac{[mol\,dm^{-3}]^2}{[mol\,dm^{-3}]\,[mol\,dm^{-3}]}$$

$$\mathbf{K_c = No\ unit}$$

2. $H_{2(g)} + CO_{2(g)} \rightleftharpoons H_2O_{(g)} + CO_{(g)}$

$$K_c = \frac{[H_2]\,[CO_2]}{[H_2O]\,[CO]}$$

$$K_c = \frac{[mol\,dm^{-3}]\,[mol\,dm^{-3}]}{[mol\,dm^{-3}]\,[mol\,dm^{-3}]}$$

$$\mathbf{K_c = No\ unit}$$

3. $PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$

$$K_c = \frac{[PCl_3]\,[Cl_2]}{[PCl_5]}$$

$$K_c = \frac{[mol\,dm^{-3}]\,[mol\,dm^{-3}]}{[mol\,dm^{-3}]}$$

$$\mathbf{K_c = mol\,dm^{-3}}$$

4. $CO_{(g)} + 2H_{2(g)} \rightleftharpoons CH_3OH_{(g)}$

$$K_c = \frac{[CH_3OH]}{[CO]\,[H_2]^2}$$

$$K_c = \frac{[mol\,dm^{-3}]}{[mol\,dm^{-3}]\,[mol\,dm^{-3}]^2}$$

$$K_c = \frac{1}{[mol\,dm^{-3}]^2}$$

$$K_c = \frac{1}{mol^2\,dm^{-6}}$$

$$K_c = mol^{-2}\,dm^{6}$$

$$\mathbf{K_c = dm^6\,mol^{-2}}$$

REVIEW EXERCISE

Q.1. Encircle the correct answer.

(i) Which is true about the equilibrium state?

(a) The forward reaction stops.
(b) The reverse reaction stops.
(c) Both the forward and reverse reactions stop.
(d) Both the forward and reverse reactions continue at the same rate.

Answer: (d)
Explanation: Chemical equilibrium is a state at which rate of both forward and reverse reactions become equal.

(ii) When a mixture of H_2 and I_2 is sealed in a flask and temperature is kept at 25°C, following equilibrium is established.

$$H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$$

Which substance or substances will be present in the equilibrium mixture?

(a) H_2 and I_2
(b) HI only
(c) H_2 only
(d) H_2 , I_2 and HI

Answer: (d)
Explanation: At equilibrium both reactants and products are present.

(iii) What are units for

$$N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO_{2(g)}$$

(a) mol dm^{-3}
(b) mol^2 dm^{-6}
(c) dm^3 mol^{-1}
(d) No units

Answer: (c)
Explanation: First of all balance the equation, i will be as follows:

$$N_{2(g)} + 2O_{2(g)} \leftrightarrow 2NO_{2(g)}$$

$$K_c = \frac{[NO_2]^2}{[N_2]\,[O_2]^2}$$

$$Kc = \frac{[\text{mol dm}^{-3}]^2}{[\text{mol dm}^{-3}]\,[\text{mol dm}^{-3}]^2}$$

$$K_c = \frac{1}{[\text{mol dm}^{-3}]}$$

$$K_c = \text{mol}^{-1}\,\text{dm}^3$$

$$\mathbf{K_c = dm^3\ mol^{-1}}$$

(iv) Which of the reactions will not have any units for K_c?

(a) $H_{2(g)} + CO_{2(g)} \rightleftharpoons H_2O_{(g)} + CO_{(g)}$
(b) $N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO_{(g)}$
(c) $2A_{(g)} + B_{(g} \rightleftharpoons 3AC_{(g)}$
(d) All of these

Answer: (d)
Explanation: In all of these reactions number of moles of products and reactants is same hence K_c has no units.

(v) Concentration of reactants and products at equilibrium remains unchanged if

(a) Concentration of any reactant or product is not changed.
(b) Temperature of the reaction is not changed.
(c) Pressure or volume of the system is not changed.
(d) All of the above are observed.

Answer: (d)
Explanation: Because a, b and c are conditions for equilibrium. If these conditions are fulfilled equilibrium will establish and concentration of reactants and products will not change.

(vi) Which of the following does not happen, when a system is at equilibrium state?

(a) Forward and reverse reactions stop.
(b) Forward and reverse rates become equal.
(c) Concentration of reactants and products stop changing.
(d) Reaction continues to occur in both the directions.

Answer: (a)
Explanation: Chemical equilibrium is dynamic equilibrium. Forward and reverse reaction both continue with equal rate, when a system is at equilibrium.

(vii) For which reaction, K_c has units of mol dm^{-3}.

(a) $2NO_{2(g)} \rightleftharpoons N_2O_{4(g)}$
(b) $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$
(c) $PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$
(d) $2ICl_{(g)} \rightleftharpoons I_{2(g)} + Cl_{2(g)}$

Answer: (c)
Explanation: For K_c to have units of mol dm^{-3}, product should have 1 more moles than reactant. Which in this case only option (c) has.

$$K_c = \frac{[PCl_3][Cl_2]}{[PCl_5]}$$

$$K_c = \frac{[\text{mol dm}^{-3}][\text{mol dm}^{-3}]}{[\text{mol dm}^{-3}]}$$

$$\mathbf{K_c = mol\ dm^{-3}}$$

(viii) In an irreversible reaction equilibrium is

(a) established quickly
(b) established slowly
(c) never established
(d) Established when reaction stops

Answer: (c)
Explanation: An irreversible reaction occurs only in one direction, i.e., forward direction thus equilibrium can never establish.

(ix) Active mass means

(a) Total mass of reactants
(b) Total mass of products

Answer: (d)
Explanation: Actually

(c) Total mass of reactant and products **(d)** Mass of substance in moles per dm^3 in a dilute solution	active mass refers to concentration and moles per dm^3 is unit of concentration.

(x) For reversible reaction

$$K_c = \frac{[C]^2}{[A][B]}$$

Which substance is product of the reaction

(a) A
(b) B
(c) Both A and B
(d) C

Answer: (d)

Explanation: As K_c is actually defined as the *ratio of the product of concentration of products to the product of concentration of reactants each raised to the power equal to the coefficient in the balance chemical equation*.

$$K_c = \frac{[Product]^{coefficient}}{[Reactant]^{coefficient}}$$

So the product is C

Q.2. Give short answers.

(i) Differentiate between forward and reverse reactions.

Ans:

	FORWARD REACTION	REVERSE REACTION
1.	It is written from left to right.	It is written from right to left.
2.	Reactants produce products.	Products produce reactants.
3.	Rate is fastest in the beginning and gradually slows down.	Rate is zero in the beginning and gradually speeds up.

(ii) What is chemical equilibrium?

Ans: A state of chemical reaction in which forward and reverse reactions take place at the same rate is called chemical equilibrium. Chemical equilibrium is a dynamic equilibrium. This is because reactions do not stop, however reactant and product interconvert into each other at same rate. Both reactants and products are present at equilibrium sate, however their concentration is constant.

Example:

$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$

In the above reaction when rate of formation of ammonia (NH_3) becomes equal to rate of decomposition of ammonia, equilibrium is established.

(iii) State the law of mass action.

Ans: Two chemists C.M.Guldberg and P.Waage in 1864 proposed the law of mass action to describe the equilibrium state. It states that
"The rate at which a substance reacts is directly proportional to its active mass and the rate at which the reaction proceeds is directly proportional to the product of the active masses of the reactants"
The term active mass refers to the molar concentrations of reactants and products.

(iv) State conditions for equilibrium.

Ans: Following conditions must be observed for equilibrium:

1. Concentration of none of the reactants and products should be changed.
2. Temperature of the reaction should be kept constant.
3. Pressure or volume of the system should be kept constant.

(v) What is the importance of equilibrium constant for a chemical reaction?

Ans: Equilibrium constant for a reaction can be used to predict many important features of a chemical reaction. It can be used to

1. determine the equilibrium concentration of equilibrium mixture knowing the initial concentration of reactants.
2. predict the direction of a chemical reaction.
3. predict the extent of a chemical reaction.
4. predict the effect of change in conditions of the chemical reaction on the equilibrium state.

Q.3. Following reaction can occur during lightning storms

$$3O_{2(g)} \rightleftharpoons 2O_{3(g)}$$

For this reaction write

(a) Equilibrium constant expression.

Ans: $K_c = \dfrac{[O_3]^2}{[O_2]^3}$

(b) Determine the units of equilibrium constant.

Ans: $K_c = \dfrac{[O_3]^2}{[O_2]^3}$

$$Kc = \frac{[\text{mol dm}^{-3}]^2}{[\text{mol dm}^{-3}]^3}$$

$$K_c = \frac{1}{[\text{mol dm}^{-3}]}$$

$$K_c = \text{mol}^{-1}\ \text{dm}^3$$

$$\mathbf{K_c = dm^3\ mol^{-1}}$$

(c) Forward and revers reactio s.

Ans: **Forward reaction:** $3O_{2(g)} \rightarrow 2O_{3(g)}$

Reverse reaction: $2O_{3(g)} \rightarrow 3O_{2(g)}$

Q.4. Coal reacts with hot steam to form CO and H_2. These substances react further in the presence of a catalyst to give methane and water vapour.

$$CO_{(g)} + 3H_{2(g)} \rightleftharpoons CH_{4(g)} + H_2O_{(g)}$$

(a) Write forward and reverse reactions for it.

Ans: **Forward reaction:** $CO_{(g)} + 3H_{2(g)} \rightarrow CH_{4(g)} + H_2O_{(g)}$

Reverse reaction: $CH_{4(g)} + H_2O_{(g)} \rightarrow CO_{(g)} + 3H_{2(g)}$

(b) Derive K_c expression for the reaction.

Ans: According to law of mass action:

Rate of forward reaction α $[CO]\,[H_2]^3$

Rate of forward reaction $= K_f[CO]\,[H_2]^3$

Rate of reverse reaction α $[CH_4]\,[H_2O]$

Rate of reverse reaction $= K_r[CH_4]\,[H_2O]$

At equilibrium:
Rate of forward reaction = Rate of reverse reaction

$$K_f[CO][H_2]^3 = K_r[CH_4][H_2O]$$

$$\frac{K_f}{K_r} = \frac{[CH_4][H_2O]}{[CO][H_2]^3}$$

Here $K_c = K_f / K_r$

$$K_c = \frac{[CH_4][H_2O]}{[CO][H_2]^3}$$

This is the equilibrium constant (K_c) expression for the above mentioned reaction.

(c) Determine the units of equilibrium constant.

Ans:

$$K_c = \frac{[CH_4][H_2O]}{[CO][H_2]^3}$$

$$K_c = \frac{[mol\ dm^{-3}][mol\ dm^{-3}]}{[mol\ dm^{-3}][mol\ dm^{-3}]^3}$$

$$K_c = \frac{1}{[mol\ dm^{-3}]^2}$$

$$K_c = \frac{1}{mol^2\ dm^{-6}}$$

$$K_c = mol^{-2}\ dm^6$$

$$\mathbf{K_c = dm^6\ mol^{-2}}$$

Q.5. Write equilibrium constant expression for each of the following reactions.

(a) $H_2O_{(g)} \rightleftharpoons H_{2(g)} + 1/2O_{2(g)}$

$$K_c = \frac{[H_2][O_2]^{1/2}}{[H_2O]}$$

(b) $CO_{(g)} + 2H_{2(g)} \rightleftharpoons CH_3OH_{(g)}$

$$K_c = \frac{[CH_3OH]}{[CO][H_2]^2}$$

(c) $COCl_{2(g)} \rightleftharpoons CO_{(g)} + Cl_{2(g)}$

$$K_c = \frac{[CO][Cl_2]}{[COCl_2]}$$

(d) $4HCl_{(g)} + O_{2(g)} \rightleftharpoons 2Cl_{2(g)} + 2H_2O_{(g)}$

$$K_c = \frac{[Cl_2]^2[H_2O]^2}{[HCl]^4[O_2]}$$

Q.6. Determine the units of equilibrium constant for the following reactions.

(a) $COCl_{2(g)} \rightleftharpoons CO_{(g)} + Cl_{2(g)}$

$$K_c = \frac{[CO][Cl_2]}{[COCl_2]}$$

$$K_c = \frac{[mol\ dm^{-3}][mol\ dm^{-3}]}{[mol\ dm^{-3}]}$$

$$\mathbf{K_c = mol\ dm^{-3}}$$

(b) $H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$

$$K_c = \frac{[HI]^2}{[H_2][I_2]}$$

$$K_c = \frac{[mol\ dm^{-3}]^2}{[mol\ dm^{-3}][mol\ dm^{-3}]}$$

$$\mathbf{K_c = No\ unit}$$

(c) $2H_{2(g)} + O_{2(g)} \rightleftharpoons 2H_2O_{(g)}$

$$K_c = \frac{[H_2O]^2}{[H_2]^2[O_2]}$$

$$Kc = \frac{[mol\ dm^{-3}]^2}{[mol\ dm^{-3}]^2[mol\ dm^{-3}]}$$

$$K_c = \frac{1}{[mol\ dm^{-3}]}$$

$$K_c = mol^{-1}\ dm^{3}$$

$$\mathbf{K_c = dm^3\ mol^{-1}}$$

(d) $N_{2(g)} + 2O_{2(g)} \rightleftharpoons 2NO_{2(g)}$

$$K_c = \frac{[NO_2]^2}{[N_2][O_2]^2}$$

$$Kc = \frac{[mol\ dm^{-3}]^2}{[mol\ dm^{-3}][mol\ dm^{-3}]^2}$$

$$K_c = \frac{1}{[mol\ dm^{-3}]}$$

$$K_c = mol^{-1}\ dm^{3}$$

$$\mathbf{K_c = dm^3\ mol^{-1}}$$

Q.7. State the ways that equilibrium can be recognized.

Ans: Equilibrium state of a chemical reaction can be determined by determining concentration of reactants and products at regular intervals. When constant concentration of products and reactants are observed, the reaction is at equilibrium. This can be done by both physical methods as well as chemical methods.
Physical methods: Spectroscopy, etc.
Chemical methods: Titration, etc.

Q.8. Describe the macroscopic characteristics of an equilibrium reaction.

Ans:

	FORWARD REACTION	REVERSE REACTION
1.	It is written from left to right.	It is written from right to left.
2.	Reactants produce products.	Products produce reactants.
3.	Rate is fastest in the beginning and gradually slows down.	Rate is zero in the beginning and gradually speeds up.

THINK TANK

Q.9. Bromine chloride (BrCl) decomposes to form chlorine and bromine. For this reaction write:

(a) Chemical equation

Ans: $$2BrCl_{(g)} \rightleftharpoons Br_{2(g)} + Cl_{2(g)}$$

(b) K_c expression

Ans: $$K_c = \frac{[Br_2][Cl_2]}{[BrCl]^2}$$

(c) Units of K_c

Ans: $$K_c = \frac{[Br_2][Cl_2]}{[BrCl]^2}$$

$$K_c = \frac{[mol\ dm^{-3}][mol\ dm^{-3}]}{[mol\ dm^{-3}]^2}$$

$$\mathbf{K_c = No\ unit}$$

Q.10. K_c expression for a reaction is given below

$$K_c = \frac{[NO_2]^2}{[N_2O_4]}$$

Write chemical equation and derive the units for K_c.

Ans: Chemical equation

$$N_2O_{4(g)} \rightleftharpoons 2NO_{2(g)}$$

Units of K_c

$$K_c = \frac{[NO_2]^2}{[N_2O_4]}$$

$$K_c = \frac{[\text{mol dm}^{-3}]^2}{[\text{mol dm}^{-3}]}$$

$$\mathbf{K_c = mol\ dm^{-3}}$$

Q.11. For which of the following reactions are both reactants and products likely to be found when the reaction appears to be complete. Explain.

(i) $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$

(ii) $2HF_{(g)} \rightleftharpoons H_{2(g)} + F_{2(g)}$

Ans: $2HF_{(g)} \rightleftharpoons H_{2(g)} + F_{2(g)}$

In reaction (ii) both reactant and products are present when the reaction the reaction appears to be stopped.

Explanation:

Reaction (i) is an irreversible reaction and only proceed in forward direction, so when the reaction is completed only product i.e., CO_2 is present.

Reaction (ii) is a reversible reaction and proceeds both in forward as well as reverse direction. After some time equilibrium is established and reaction appears to be stopped. Actually the reaction does not stop though it occurs in both directions at the same rate although there is no net change in concentration of reactants and products. At equilibrium state both reactant (i.e. HF) and products (H_2 and F_2) are present.

Q.12. Cobalt chloride forms pink crystals ($CoCl_3.6H_2O$). When they are heated water is evolved and they turn blue ($CoCl_3$). Explain how you could use cobalt chloride as a test for water.

$$\mathbf{CoCl_3.6H_2O \rightleftharpoons CoCl_3 + 6H_2O}$$

Ans: In the reaction

$$CoCl_3.6H_2O \rightleftharpoons CoCl_3 + 6H_2O$$

Cobalt chloride hexahydrate $\rightleftharpoons$ Anhydrous Cobalt chloride + water

(pink) $\rightleftharpoons$ (blue)

When we want to test some place for presence of water, we take blue coloured anhydrous cobalt chloride ($CoCl_3$) there. If water is present the colour changes to pink ($CoCl_3.6H_2O$). If colour remains unchanged, it shows that water is absent. Actually equilibrium exists between cobalt chloride hexahydrate ($CoCl_3.6H_2O$) and Anhydrous cobalt chloride ($CoCl_3$). If water is present anhydrous $CoCl_3$ absorbs it and converts to pink clouored hydrated form, thus confirming the presence of water.

INFO BOXES

Info Box No. 1.

Q. How equilibrium is involved in fizzy or carbonated drinks.

Ans: When fizzy drinks are made, CO_2 is dissolved in the liquid drink under pressure and sealed.

$$CO_{2(g)} \rightarrow CO_{2(aq)} \quad \text{(during manufacturing)}$$

When the lid of the bottle is removed, bubbles of CO_2 suddenly appear.

$$CO_{2(aq)} \rightarrow CO_{2(g)} \quad \text{(during opening)}$$

When the lid is put back on the bottle, the bubbles stop. This is due to the following equilibrium.

$$CO_{2(g)} \rightleftharpoons CO_{2(aq)}$$

The forward reaction happens during manufacturing and reverse reaction happens on opening. Equilibrium is established when the bottle is closed.

Info Box No. 2.

Q. Define a catalyst? Can a catalyst disturb the equilibrium position?

Ans: A catalyst is a substance which increases the rate of an equilibrium reaction, but they have no effect on the position of equilibrium once this is reached. They do not favour forward or reverse reaction.

Example: V_2O_5 is used as a catalyst in following reversible reactionchemical reaction. Catalysts reduce the time taken to reach.

$$2SO_{2(g)} + O_{2(g)} \underset{450^oC,\ 200\ atm}{\overset{V_2O_5}{\rightleftharpoons}} 2SO_{3(g)}$$

Info Box No. 3.

Q. Why sulphuric acid is added to water but water in never added to concentrated sulphuric acid during dilution?

Ans: The addition of water to the concentrated sulphuric acid produces a vigorous reaction, which often causes acid droplets to spew in all directions. For this reason this must be avoided. Always acid should be added to water while diluting it.

Info Box No. 4.

Q. Define Le-Chatellier's principle. What are its applications?

Ans: Le-Chatellier"s principle is very useful about chemical equilibrium. It states:

"If you impose a change in concentration, temperature or pressure on a chemical system at equilibrium, the system responds in a way that opposes the change".

Applications:
It can be employed for the following reactions:

$$2SO_{2(g)} + O_{2(g)} \underset{450^{o}C,\ 200\ atm}{\overset{V_2O_5}{\rightleftharpoons}} 2SO_{3(g)} \quad \textbf{(Contact Process)}$$

$$N_{2(g)} + 3H_{2(g)} \underset{450^{o}C,\ 200\ atm}{\overset{Fe\ or\ Fe_2O_3}{\rightleftharpoons}} 2NH_{3(g)} \quad \textbf{(Haber Process)}$$

Under normal conditions, these reactions are not economic. In both the above mentioned reactions by applying Le-Chatellier"s principle, maximum yield (98 %) of SO_3 and NH_3 is obtained. This is done by

- First establishing the equilibrium in minimum time by using catalysts.
- Then the equilibrium is shifted to right (i.e. forward direction) by
  - Increasing pressure
  - Decreasing temperature
  - Continuously removing the product.

PREVIOUS BOARD QUESTIONS

Multiple Choice Questions

2014

Active mass means

(a) Total mass of reactants
(b) Total mass of products
(c) Total mass of reactant and products
(d) Mass of substance in mole / dm^3 in a dilute solution

Answer: (d)
Explanation: Actually active mass refers to concentration and moles per dm^3 is unit of concentration.

2014

Which of the following catalyst is used to form NH_3 gas from nitrogen and hydrogen gas?

(a) Fe_2O_3
(b) FeO
(c) Fe
(d) Pt

Answer: (c)
Explanation: Fe is used as catalyst in Haber"s process for formation of NH_3.

2015

Sulphur trioxide is prepared according to the following reaction:

$2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$ The condition of this reaction is

(a) V_2O_5 / 450 ^oC, 200 atm
(b) Fe / 400 ^oC, 200 atm
(c) Electric spark
(d) Ni / 450 ^oC, 200 atm

Answer: (a)
Explanation: these conditions are used in Contact process for formation of SO_3.

2015

For a reversible reaction, $K_c = \frac{[C]^2}{[A][B]}$

Which substance is product of the reaction?

(a) A
(b) B
(c) Both A and B
(d) C

Answer: (d)

Explanation: As K_c is actually defined as the *ratio of the product of concentration of products to the product of concentration of reactants each raised to the power equal to the coefficient in the balance chemical equation*.

$$K_c = \frac{[Product]^{coefficient}}{[Reactant]^{coefficient}}$$

So the product is C

2015

Nitrogen dioxide is synthesized according to the given equilibrium.

$$2NO_{(g)} + O_{2(g)} \rightleftharpoons 2NO_{2(g)}$$

The units of K_c for this reaction are

(a) mol dm^{-3}
(b) mol^2 dm^{-6}
(c) dm^3 mol^{-1}
(d) No units

Answer: (c)

Explanation:

$$K_c = \frac{[NO_2]^2}{[NO]^2[O_2]}$$

$$Kc = \frac{[mol\ dm^{-3}]^2}{[mol\ dm^{-3}]^2[mol\ dm^{-3}]}$$

$$K_c = \frac{1}{[mol\ dm^{-3}]}$$

$$K_c = mol^{-1}\ dm^3$$

$$\mathbf{K_c = dm^3\ mol^{-1}}$$

2016

Which of the reactions will not have any units for K_c?

(a) $H_{2(g)} + CO_{2(g)} \rightleftharpoons H_2O_{(g)} + CO_{(g)}$
(b) $N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO_{(g)}$
(c) $2A_{(g)} + B_{(g)} \rightleftharpoons 3AC_{(g)}$
(d) All of these

Answer: (d)

Explanation: In all of these reactions number of moles of products and reactants is same hence K_c has no units.

2016

Which of the following is not a characteristic of forward reaction?

(a) It is written from left to right.
(b) Reactants produce products.
(c) Rate is fastest in the beginning and gradually slows down.
(d) Products produce reactants.

Answer: (d)

Explanation: In reverse reaction products produce reactants, so this is not a characteristic of forward reaction.

Short Questions

2014	**Bromine chloride (BrCl) decomposes to form chlorine and bromine. For this reaction write: a) Chemical equation, b) K_c expression, c) Units of K_c** **Ans:** Same as Think tank Q.No.9.

2014	**Briefly write about Le Chatellier's principle. Give its application.** **Ans:** Same as Info box No. 4.

2014	**Write down macroscopic characteristics of forward and reverse reaction.** **Ans:** Same as Q.8 of Review Exercise.

2014	**The given reaction can occurs during lightning storms.** $3O_{2(g)} \rightleftharpoons 2O_{3(g)}$ **Derive the equilibrium constant expression for this reaction** **Ans:** Same as Q.1. of Self assessment exercise 9.2

2014

Differentiate between reversible reactions and dynamic equilibrium. Give examples.

	Reversible Reaction	Dynamic Equilibrium
1.	A reaction which proceeds in forward as well as reverse direction under same set of conditions is called reversible reaction.	A state of a reversible chemical reaction in which forward and reverse reactions take place at the same rate is called chemical dynamic equilibrium.
2.	It is a physical or chemical **reaction**.	It is a **state** of a reversible reaction. It is called dynamic because at equilibrium there is no net change and overall the concentration of reactants and products remain constant. This happens because reactants and products interconvert into each other at same rate.

3. Examples:

$$2SO_{2(g)} + O_{2(g)} \underset{450^{\circ}C,\ 200\ atm}{\overset{V_2O_5}{\rightleftharpoons}} 2SO_{3(g)}$$

$$N_{2(g)} + 3H_{2(g)} \underset{450^{\circ}C,\ 200\ atm}{\overset{Fe}{\rightleftharpoons}} 2NH_{3(g)}$$

Examples:

$$2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$$

For the above reaction equilibrium is achieved when rate of formation of Sulphur trioxide becomes equal to rate of its decomposition.

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$$

For the above reaction equilibrium is achieved when rate of formation of ammonia becomes equal to rate of its decomposition.

2014

Cobalt chloride forms pink crystals ($CoCl_3.6H_2O$). When it is heated water is evolved and it turns blue ($CoCl_3$). Explain how you could use cobalt chloride as a test for water.

$$CoCl_3.6H_2O \rightleftharpoons CoCl_3 + 6H_2O$$

Ans: Same as Q.12. of Think tank

2015

State Le-Chatellier's principle.

Ans: Le-Chatellier"s principle is very useful about chemical equilibrium. It states:

"If you impose a change in concentration, temperature or pressure on a chemical system at equilibrium, the system responds in a way that opposes the change".

Applications:

It can be employed for the industrial preparations involving equilibrium reactions.

2015

What is the unit of K_c in the following chemical equilibrium

$$K_c = \frac{[HI]^2}{[H_2]\,[I_2]}$$

Ans:

$$K_c = \frac{[HI]^2}{[H_2]\,[I_2]}$$

$$K_c = \frac{[mol\ dm^{-3}]^2}{[mol\ dm^{-3}]\,[mol\ dm^{-3}]}$$

$$K_c = \text{No unit}$$

2015

Write three macroscopic characteristics of forward and reverse reaction.

Ans: Same as Q.8 of Review Exercise.

2015	**Define the following: a) chemical equilibrium b) Equilibrium constant** **<u>Ans:</u>** **Chemical equilibrium:** A state of a reversible chemical reaction in which forward and reverse reactions take place at the same rate is called chemical equilibrium. **Equilibrium constant:** Equilibrium constant (K_c) is defined as the ratio of the product of concentration of products to the concentration of reactants each raised to the power equal to the coefficient in the balanced chemical equation. K_c is independent of the initial concentrations of the reactants but depends upon temperature.

2016	**Following reaction can occur during lightning storms** $$3O_{2(g)} \rightleftharpoons 2O_{3(g)}$$ **For this reaction write** **(a) Equilibrium constant expression.** **(b) Determine the units of equilibrium constant.** **(c) Forward and reverse reactions.** **<u>Ans:</u>** Same as Q.3 of Review Exercise.

2016

State three uses of equilibrium constant.

Ans: **Equilibrium constant** for a chemical reaction can be used to predict many important features of a chemical reaction. it can be used to**:**

1. *determine the equilibrium concentration of equilibrium mixture knowing the initial concentration of reactants.*
2. *predict the direction of a chemical reaction.*
3. *predict the extent of a chemical reaction.*
4. *predict the effect of change in conditions of the chemical reaction on the equilibrium state.*

Long Questions

2014

Write equilibrium constant expression for the following reaction.

$$COCl_2 \rightleftharpoons CO + Cl_2$$

Ans:

$$K_c = \frac{[CO][Cl_2]}{[COCl_2]}$$

UNIT- 10

ACIDS BASES AND SALTS

SELF ASSETSSMENT EXERCISES

Self Assessment Exercise 10.1

Identify Bronsted acids and Bronsted bases in the following reactions.

1. $H_2SO_4 + H_2O \rightarrow HSO_4^- + H_3O^+$

Bronsted acid (Proton donor): H_2SO_4
Bronsted base (Proton acceptor): H_2O
Explanation:
H_2SO_4 (Sulphuric acid) is Bronsted acid because it donates a proton to form HSO_4^- (bisulphate ion) while water (H_2O) is a Bronsted base because it accepts a proton to form H_3O^+ (hydronium ion).

2. $CH_3COOH + H_2O \rightarrow CH_3COO^- + H_3O^+$

Bronsted acid (Proton donor): CH_3COOH
Bronsted base (Proton acceptor): H_2O
Explanation:
CH_3COOH (Acetic acid) is Bronsted acid because it donates a proton to form CH_3COO^- (acetate ion) while water (H_2O) is a Bronsted base because it accepts a proton to form H_3O^+ (hydronium ion).

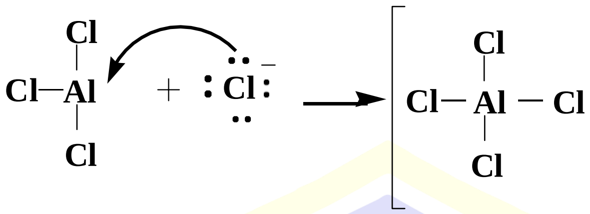
3. $H_2S + NH_3 \rightarrow NH_4^+ + HS^-$

Bronsted acid (Proton donor): H_2S
Bronsted base (Proton acceptor): NH_3
Explanation:
H_2S (hydrogen sulphide) is Bronsted acid because it donates a proton to form HS^- (bisulphide ion) while Ammonia (NH_3) is a Bronsted base because it accepts a proton to form NH_4^+ (Ammonium ion).

Self Assessment Exercise 10.2

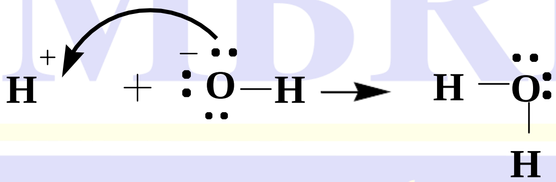
Identify Lewis acid and Lewis base in the following examples.

1. $Cl^- + AlCl_3 \rightarrow [AlCl_4]^-$



Lewis acid (electron pair acceptor): $AlCl_3$
Lewis base (electron pair donor): Cl^-
Explanation:
Al of $AlCl_3$ (aluminum chloride) is electron deficient. In $AlCl_3$ 6 electrons are present around Al but it still needs 2 electrons to complete its octet, which it accepts from Cl^- (chloride ion), thus acting as **Lewis acid**. Cl^- is electron rich. Chloride ion has 8 electrons, its octet is complete and it can donate one electron pair to form a coordinate covalent bond with Al thus acting as **Lewis base**.

2. $H^+ + OH^- \rightarrow H_2O$



Lewis acid (electron pair acceptor): H^+
Lewis base (electron pair donor): OH^-
Explanation:
H^+ (Hydrogen ion or proton) is electron deficient. It does not have any electrons in its outermost shell. It needs 2 electrons to complete its duplet, which it accepts from OH^- (hydroxyl ion), thus acting as **Lewis acid**. O of OH^- is electron rich, it has 8 electrons, its octet is complete and it can donate one electron pair to form a coordinate covalent bond with H^+ thus acting as **Lewis base**.

Self Assessment Exercise 10.3

1. A soft drink has $[H^+] = 3 \times 10^{-3}$ M. Is drink acidic, neutral or basic?

Ans: The drink is acidic
Explanation:
As $[H^+] = 3 \times 10^{-3}$ M $> 1.0 \times 10^{-7}$ M, the solution is acidic.

2. Ordinary vinegar is approximately 1 M CH_3COOH. Concentration of H^+ in it is 4.2×10^{-3} M. Is vinegar acidic, basic or neutral?

Ans: vinegar is acidic.
Explanation:
As $[H^+] = 4.2 \times 10^{-3}$ M $> 1.0 \times 10^{-7}$ M, the solution is acidic.

3. A student determines the $[OH^-]$ of milk of magnesium hydroxide in its saturated solution and obtains a value of 4.2×10^{-3} M. Is the solution acidic, basic or neutral?

Ans: The solution is basic.

Explanation:

$[OH^-] = 4.2 \times 10^{-3}$ M

$[H^+][OH^-] = K_w$

$[H^+][OH^-] = 1.0 \times 10^{-14}$

$$[H^+] = \frac{1.0 \times 10^{-14}}{[OH^-]} = \frac{1.0 \times 10^{-14}}{4.2 \times 10^{-3}} = 2.38 \times 10^{-12} \text{ M}$$

As $[H^+] = 2.38 \times 10^{-12}$ M $< 1.0 \times 10^{-7}$ M, the solution is basic.

Self Assessment Exercise 10.4

1. Write names of three acid base indicators.

Ans:

Indicator	pH at which colour changes	Colour in acidic solution	Colour in basic solution
Methyl red	5.5	Red	Yellow
Bromothymol blue	7	Yellow	Blue
Phenolphthalein	9	Colourless	Pink

2. What is the colour of methyl red in solution of (i) pH 4 (ii) pH 9 ?

Ans: (i) pH = 4

The colour of methyl red in solution of pH 4 (i.e. acidic solution) is red.

(i) pH = 9

The colour of methyl red in solution of pH 9 (i.e. basic solution) is yellow.

3. Bromothymol blue added to a solution imparts blue colour, what is the pH of this solution? pH 5 or 9.

Ans: When Bromothymol blue is added to a solution, it imparts blue colour. As bromothymol blue imparts blue colour in basic solution so pH of the solution is 9.

Self Assessment Exercise 10.5

1. Hydroxides such as $Mg(OH)_2$ called milk of magnesia is used as antacid. It neutralizes excess stomach acid (HCl). Write complete and balanced chemical equation for this neutralization reaction?

Ans: Magnesium hydroxide + Hydrochloric acid → Magnesium chloride + Water

$Mg(OH)_2 + 2HCl \rightarrow MgCl_2 + 2H_2O$

2. Hydrochloric acid (HCl) and Potassium hydroxide (KOH) react and produce potassium chloride. Write complete and balanced chemical equation for this neutralization reaction?

Ans: Potassium hydroxide + Hydrochloric acid → Potassium chloride + Water

$KOH + HCl \rightarrow KCl + H_2O$

3. Balance following neutralization reactions

(i) $\mathbf{H_2SO_{4(aq)} + NaOH_{(aq)} \rightarrow Na_2SO_{4(aq)} + H_2O_{(l)}}$

Ans: $H_2SO_{4(aq)} + 2NaOH_{(aq)} \rightarrow Na_2SO_{4(aq)} + 2H_2O_{(l)}$

(ii) $\mathbf{H_3PO_{4(aq)} + NaOH_{(aq)} \rightarrow Na_3PO_{4(aq)} + H_2O_{(l)}}$

Ans: $H_3PO_{4(aq)} + 3NaOH_{(aq)} \rightarrow Na_3PO_{4(aq)} + 3H_2O_{(l)}$

Self Assessment Exercise 10.6

Classify following salts as normal or acid salt.

(a) $\mathbf{NaHSO_4}$

Ans: $NaHSO_4$ is acidic salt because it contains replaceable H-atom.

(b) $\mathbf{Na_2SO_4}$

Ans: Na_2SO_4 is normal salt because it does not contain replaceable H-atom or OH^- group.

(c) $\mathbf{KHSO_4}$

Ans: $KHSO_4$ is acidic salt because it contains replaceable H-atom.

(d) $\mathbf{K_2CO_3}$

Ans: K_2CO_3 is normal salt because it does not contain replaceable H-atom or OH^- group.

REVIEW EXERCISE

Q.1. Encircle the correct answer.

(i) Which of the following cannot be classified as Arrhenius acid?

(a) HNO_3
(b) H_2CO_3
(c) CO_2
(d) H_2SO_4

Answer: (c)
Explanation: An Arrhenius acid ionizes in water to produce H^+ ions. As CO_2 does not have any H ion to release in the solution, so it cannot be an Arrhenius acid.

(ii) NH_3 cannot be classified as a base by

(a) Lewis theory
(b) Bronsted-Lowery theory
(c) Arrhenius theory
(d) All of these theories

Answer: (c)
Explanation: An Arrhenius base ionizes in water to produce OH^- ions. As NH_3 does not have any OH^- ion to release in the solution, so it cannot be an Arrhenius base.

(iii) Which of the following is a Lewis base?

(a) BF_3
(b) HCl
(c) $AlCl_3$
(d) F^-

Answer: (d)
Explanation: In all the options, only F^- is electron rich. Fluoride ion has 8 electrons, its octet is complete and it can donate one electron pair to form a coordinate covalent bond, thus acting as **Lewis base**.

(iv) Choose Lewis acid.

(a) CN^-
(b) NH_3
(c) H_2O
(d) H^+

Answer: (d)
Explanation: H^+ (Hydrogen ion or proton) is electron deficient. It does not have any electrons in its outermost shell. It needs 2 electrons to complete its duplet, which it accepts to form a coordinate covalent bond thus acting as **Lewis acid**. All other options are electron rich and can act as Lewis base.

(v) A drain cleaner solution contains 1.0×10^{-8} M, OH^- concentration. This solution is

(a) Acidic
(b) Basic
(c) Neutral
(d) Cannot be predicted

Answer: (a)
1st Explanation: The solution is acidic because
$[OH^-] = 1.0 \times 10^{-8}$ M $< 1.0 \times 10^{-7}$ M

2nd Explanation:
$[OH^-] = 1.0 \times 10^{-8}$ M
$[H^+][OH^-] = K_w$
$[H^+][OH^-] = 1.0 \times 10^{-14}$
$$[H^+] = \frac{1.0 \times 10^{-14}}{[OH^-]} = \frac{1.0 \times 10^{-14}}{1.0 \times 10^{-8}} = 1.0 \times 10^{-6} \text{ M}$$

As $[H^+] = 1.0 \times 10^{-6}$M $> 1.0 \times 10^{-7}$ M, the solution is acidic.

(vi) Milk of magnesia contains $Mg(OH)_2$. It is used as antacid. It neutralizes excess stomach acid. Which salt is formed in this reaction?

(a) $MgSO_4$
(b) $MgCO_3$
(c) $MgCl_2$
(d) MgO

Answer: (c)
Explanation:
The reaction of $Mg(OH)_2$ and HCl is as follows:
$Mg(OH)_2 + 2HCl \rightarrow MgCl_2 + 2H_2O$

(vii) Ammonia is a base because it

(a) Ionizes in water to give OH^- ions
(b) Contains OH group
(c) Can accept an electron pair
(d) Can accept proton

Answer: (d)
Explanation:
Ammonia accepts a proton, thus acting as Bronsted-Lowery base.
$NH_3 + H^+ \rightarrow NH_4^+$

(viii) Consider the following reaction?
$\mathbf{H_2O + HCl \rightarrow H_3O^+ + Cl^-}$
Which species is an electron pair acceptor in this reaction?

(a) H_2O
(b) HCl
(c) H_3O^+
(d) None

Answer: (b)
Explanation: HCl acts as a electron pair acceptor because H^+ of HCl accepts an electron pair from water to form H_3O^+ thus HCl acts as Lewis acid.

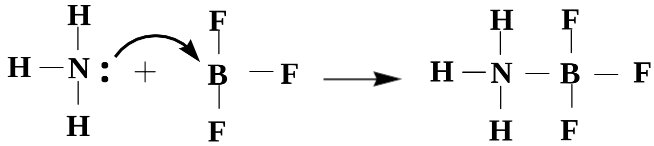
(ix) In the following reaction which species is donating an electron pair?
$$:NH_3 + BF_3 \rightarrow H_3N - BF_3$$

(a) H
(b) B
(c) N

Answer: (c)
Explanation: In all the options, only N is electron rich. N has 5 electrons, it shares 3

(d) BF_3

with hydrogen so now it has 8 electrons, its octet is complete and it has one lone pair which it can donate to form a coordinate covalent bond, thus acting as **Lewis base**.



(x) An aqueous solution of NaOH is used as a drain cleaner. If the concentration of OH^- ions in the solution is 1.0×10^{-5} M, the concentration of H^+ ions in it would be?

(a) 1.0×10^{-5} M
(b) 1.0×10^{-7} M
(c) 1.0×10^{-9} M
(d) 1.0×10^{-14} M

<u>Answer:</u> (c)

<u>Explanation:</u>

$[OH^-] = 1.0 \times 10^{-5}$ M

$[H^+][OH^-] = K_w$

$[H^+][OH^-] = 1.0 \times 10^{-14}$

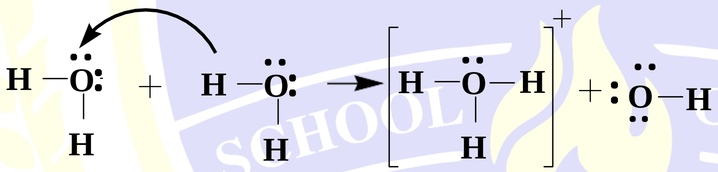
$$[H^+] = \frac{1.0 \times 10^{-14}}{[OH^-]} = \frac{1.0 \times 10^{-14}}{1.0 \times 10^{-5}} = 1.0 \times 10^{-9}\ \text{M}$$

So $[H^+] = 1.0 \times 10^{-9}$ M

Q.2. Give short answers.

(i) Write the equation for the self ionization of water.

Ans: Equation for the self ionization of water.



$$2H_2O \rightarrow H_3O^+ + OH^-$$

For one molecule this equation becomes as follows:

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

(ii) Define and give examples of Arrhenius acids.

Ans: An Arrhenius acid ionizes in water to produce H^+ ions. Examples of Arrhenius acid are HCl, H_2SO_4, HNO_3, etc.

$$HCl \xrightleftharpoons{H_2O} H^+ + Cl^-$$

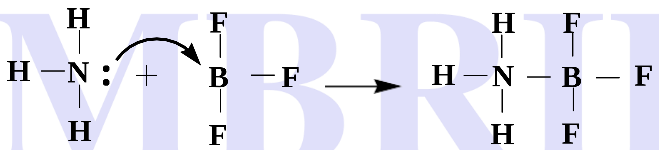
$$H_2SO_4 \xrightleftharpoons{H_2O} 2H^+ + SO_4^{2-}$$

$$HNO_3 \xrightleftharpoons{H_2O} H^+ + NO_3^-$$

(iii)	**Why H^+ ion act as a Lewis acid?**
Ans:	H^+ (Hydrogen ion or proton) is electron deficient. It does not have any electrons in its outermost shell. It needs 2 electrons to complete its duplet, which it accepts to form a coordinate covalent bond thus acting as **Lewis acid**. $\mathbf{H^+ \quad + \quad OH^- \quad \rightarrow \quad H_2O}$

(iv)	**Why NH_3 acts as Bronsted-Lowery base?**
Ans:	Ammonia (NH_3) is a Bronsted-Lowery base because it accepts a proton to form NH_4^+ (Ammonium ion). In the following reaction $\mathbf{NH_3 + H^+ \rightarrow NH_4^+}$ Ammonia accepts a proton, thus acting as Bronsted-Lowery base.

(v)	**Why BF_3 acts as a Lewis acid?**
Ans:	B of BF_3 is electron deficient. In BF_3 6 electrons are present around B but it still needs 2 electrons to complete its octet, which it accepts to form a coordinate covalent bond, thus acting as **Lewis acid**. $\mathbf{:NH_3 \quad + \quad BF_3 \quad \rightarrow \quad H_3N - BF_3}$



Q.3.	**Ammonium hydroxide and nitric acid react and produce ammonium nitrate and water. Write balanced equation for this neutralization reaction.**
Ans:	Ammonium hydroxide + nitric acid → ammonium nitrate + Water $NH_4OH + HNO_3 \rightarrow NH_4NO_3 + H_2O$

Q.4.	**Write balanced equations for the following neutralization reactions.**
i.	Sulphuric acid + Magnesium hydroxide → Magnesium sulphate + Water
Ans:	$\mathbf{H_2SO_4 + Mg(OH)_2 \rightarrow MgSO_4 + 2H_2O}$
ii.	Sulphuric acid + Sodium hydroxide → Sodium sulphate + Water
Ans:	$\mathbf{H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O}$
iii.	Hydrochloric acid + Calcium hydroxide → Calcium chloride + Water
Ans:	$\mathbf{2HCl + Ca(OH)_2 \rightarrow CaCl_2 + 2H_2O}$

Q.5.	**Identify Bronsted-Lowery acids or bases in the following reactions.**
i.	$\mathbf{HNO_3 + H_2O \rightarrow H_3O^+ + NO_3^-}$

Ans: Bronsted acid (Proton donor): HNO_3
Bronsted base (Proton acceptor): H_2O
Explanation:
HNO_3 (Nitric acid) is Bronsted acid because it donates a proton to form NO_3^- (nitrate ion) while water (H_2O) is a Bronsted base because it accepts a proton to form H_3O^+ (hydronium ion).

ii. $\mathbf{NH_3 + HNO_3 \rightarrow NH_4NO_3}$

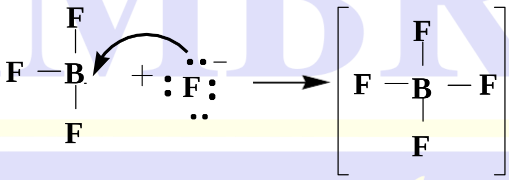
Ans: Actually in this reaction first ammonium ion and nitrate ion are produced which combine to form NH_4NO_3. Reaction can be written as:
$NH_3 + HNO_3 \rightarrow NH_4^+ + NO_3^- \rightarrow NH_4NO_3$

Bronsted acid (Proton donor): HNO_3
Bronsted base (Proton acceptor): NH_3
Explanation:
HNO_3 (Nitric acid) is Bronsted acid because it donates a proton to form NO_3^- (nitrate ion) while ammonia (NH_3) is a Bronsted base because it accepts a proton to form NH_4^+ (ammonium ion). Here ammonium ion and nitrate ion combine to form NH_4NO_3.

Q.6. Identify Lewis acid and Lewis base in the following reactions.

i. $\mathbf{F^- + BF_3 \rightarrow [BF_4]^-}$

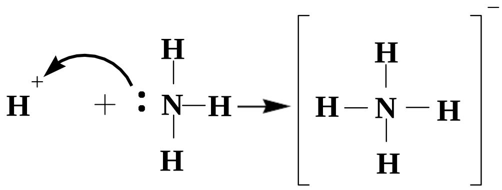
Ans:



Lewis acid (electron pair acceptor): BF_3
Lewis base (electron pair donor): F^-
Explanation:
B of BF_3 is electron deficient. In BF_3 6 electrons are present around B but it still needs 2 electrons to complete its octet, which it accepts to form a coordinate covalent bond, thus acting as **Lewis acid**. F^- is electron rich. Fluoride ion has 8 electrons, its octet is complete and it can donate one electron pair to form a coordinate covalent bond with B thus acting as **Lewis base**.

ii. $\mathbf{H^+ + NH_3 \rightarrow NH_4^+}$

Ans:



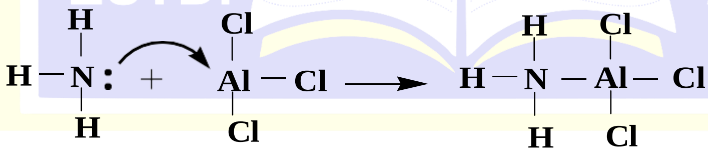
Lewis acid (electron pair acceptor): H^+
Lewis base (electron pair donor): NH_3

Explanation:

H^+ (Hydrogen ion or proton) is electron deficient. It does not have any electrons in its outermost shell. It needs 2 electrons to complete its duplet, which it accepts from NH_3 (Ammonia), thus acting as **Lewis acid**. N of NH_3 is electron rich. N has 5 electrons, it shares 3 with hydrogen so now it has 8 electrons, its octet is complete and it has one lone pair which it can donate to form a coordinate covalent bond, thus acting as **Lewis base**.

iii. $\mathbf{NH_3 + AlCl_3 \rightarrow [H_3N - AlCl_3]}$

Ans:



Lewis acid (electron pair acceptor): $AlCl_3$
Lewis base (electron pair donor): NH_3

Explanation:

Al of $AlCl_3$ (aluminum chloride) is electron deficient. In $AlCl_3$ 6 electrons are present around Al but it still needs 2 electrons to complete its octet, which it accepts from NH_3 (Ammonia), thus acting as **Lewis acid**. N of NH_3 is electron rich. N has 5 electrons, it shares 3 with hydrogen so now it has 8 electrons, its octet is complete and it has one lone pair which it can donate to form a coordinate covalent bond, thus acting as **Lewis base**.

Q.7. Classify the solutions as acidic, basic or neutral.

i. A solution that has hydrogen ion concentration $\mathbf{1.0 \times 10^{-3}}$ M.

Ans: As $[H^+] = 1.0 \times 10^{-3}$ M > 1.0×10^{-7} M, the solution is acidic.

ii. A solution that has hydrogen ion concentration $\mathbf{1.0 \times 10^{-10}}$ M.

Ans: As $[H^+] = 1.0 \times 10^{-10}$ M < 1.0×10^{-7} M, the solution is basic.

iii. A solution that has hydroxyl ion concentration $\mathbf{1.0 \times 10^{-3}}$ M.

Ans: $[OH^-] = 1.0 \times 10^{-3}$ M

$[H^+][OH^-] = K_w$

$[H^+][OH^-] = 1.0 \times 10^{-14}$

$$[H^+] = \frac{1.0 \times 10^{-14}}{[OH^-]} = \frac{1.0 \times 10^{-14}}{1.0 \times 10^{-3}} = 1.0 \times 10^{-11} \text{ M}$$

As $[H^+] = 1.0 \times 10^{-11}$ M < 1.0×10^{-7} M, the solution is basic.

iv. A solution that has hydroxyl ion concentration $\mathbf{1.0 \times 10^{-10}}$ M.

Ans: $[OH^-] = 1.0 \times 10^{-10}$ M

$[H^+][OH^-] = K_w$

$[H^+][OH^-] = 1.0 \times 10^{-14}$

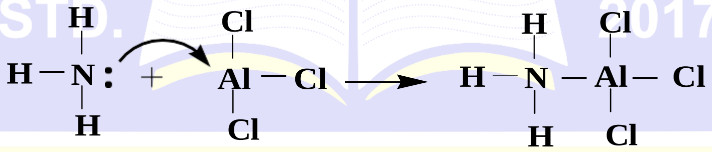
$$[H^+] = \frac{1.0 \times 10^{-14}}{[OH^-]} = \frac{1.0 \times 10^{-14}}{1.0 \times 10^{-10}} = 1.0 \times 10^{-4} \text{ M}$$

As $[H^+] = 1.0 \times 10^{-4}$ M > 1.0×10^{-7} M, the solution is acidic.

Q.8. Classify the following substances as Lewis acid and bases.

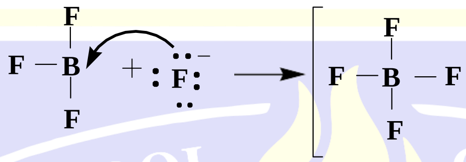
NH_3

N of NH_3 is electron rich. N has 5 electrons, it shares 3 with hydrogen so now it has 8 electrons, its octet is complete and it has one lone pair which it can donate to form a coordinate covalent bond, thus acting as **Lewis base**.



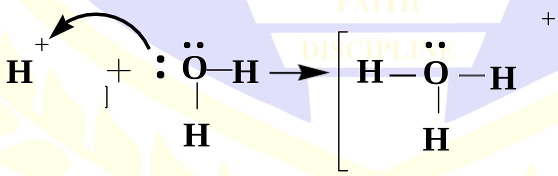
F^-

F^- is electron rich. Fluoride ion has 8 electrons, its octet is complete and it can donate one electron pair to form a coordinate covalent bond thus acting as **Lewis base**.



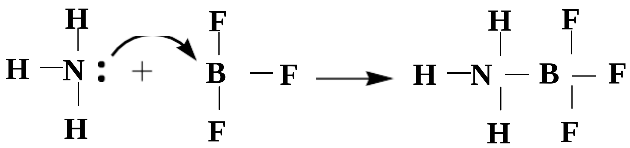
H_2O

O of H_2O is electron rich. O has 6 electrons, it shares 2 with hydrogen so now it has 8 electrons, its octet is complete and it has two lone pairs. O donates its one lone pair to form a coordinate covalent bond, thus acting as **Lewis base**.



BF_3

B of BF_3 is electron deficient. In BF_3 6 electrons are present around B but it still needs 2 electrons to complete its octet, which it accepts to form a coordinate covalent bond, thus acting as **Lewis acid**.



Q.9. Give the Bronsted-Lowery definition of an acid. Write an equation that illustrates the definition.

Ans: A **Bronsted-Lowery acid** is a substance that is proton donor. For example HCl, HNO_3, H_2SO_4, etc.

$HNO_3 + H_2O \rightarrow H_3O^+ + NO_3^-$

Bronsted acid (Proton donor): HNO_3

Bronsted base: H_2O

Explanation:

HNO_3 (Nitric acid) is Bronsted acid because it donates a proton to form NO_3^- (nitrate ion) while water (H_2O) is a Bronsted base because it accepts a proton to form H_3O^+ (hydronium ion).

Q.10. Give the Bronsted-Lowery definition of a base. Write an equation that illustrates the definition.

Ans: A **Bronsted-Lowery base** is a substance that is proton acceptor. For example OH^-, NH_3, etc.

Ammonia (NH_3) is a Bronsted base because it accepts a proton to form NH_4^+ (Ammonium ion). In the following reaction

$NH_3 + HCl \rightarrow NH_4^+ + Cl^-$

Ammonia accepts a proton, thus acting as Bronsted-Lowery base while HCl donates a proton by acting as a Bronsted-Lowery acid.

Q.11. Identify Bronsted acids and Bronsted bases in the following reactions.

i. $\mathbf{CH_3COOH + H_2O \rightarrow CH_3COO^- + H_3O^+}$

Ans: Bronsted acid (Proton donor): CH_3COOH

Bronsted base (Proton acceptor): H_2O

Explanation:

CH_3COOH (acetic acid) is Bronsted acid because it donates a proton to form CH_3COO^- (acetate ion) while water (H_2O) is a Bronsted base because it accepts a proton to form H_3O^+ (hydronium ion).

ii. $\mathbf{HCO_3^- + H_2O \rightarrow CO_3^{-2} + H_3O^+}$

Ans: Bronsted acid (Proton donor): HCO_3^-

Bronsted base (Proton acceptor): H_2O

Explanation:

HCO_3^- (bicarbonate ion) is Bronsted acid because it donates a proton to form CO_3^{-2} (carbonate ion) while water (H_2O) is a Bronsted base because it accepts a proton to form H_3O^+ (hydronium ion).

iii. $\mathbf{NH_3 + H_2O \rightarrow NH_4^+ + OH^-}$

Ans: Bronsted acid (Proton donor): H_2O

Bronsted base (Proton acceptor): NH_3

Explanation:

H_2O is Bronsted acid because it donates a proton to form OH^- (hydroxyl ion) while ammonia (NH_3) is a Bronsted base because it accepts a proton to form NH_4^+ (ammonium ion).

iv. $\mathbf{HCl + HCO_3^- \rightarrow Cl^- + H_2CO_3}$

Ans: Bronsted acid (Proton donor): HCl

Bronsted base (Proton acceptor): HCO_3^-

Explanation:

HCl (hydrochloric acid) is Bronsted acid because it donates a proton to form Cl^-(chloride ion) while HCO_3^- (bicarbonate ion) is a Bronsted base because it accepts a proton to form H_2CO_3 (carbonic acid).

v. $\mathbf{HS^- + H_2O \rightarrow S^{-2} + H_3O^+}$

Ans: Bronsted acid (Proton donor): HS^-

Bronsted base (Proton acceptor): H_2O

Explanation:

HS^- (bisulphide ion) is Bronsted acid because it donates a proton to form S^{-2} (sulphide ion) while water (H_2O) is a Bronsted base because it accepts a proton to form H_3O^+ (hydronium ion).

vi. $\mathbf{H_2S + NH_3 \rightarrow HS^- + NH_4^+}$

Ans: Bronsted acid (Proton donor): H_2S

Bronsted base (Proton acceptor): NH_3

Explanation:

H_2S (hydrogen sulphide) is Bronsted acid because it donates a proton to form HS^- (bisulphide ion) while ammonia (NH_3) is a Bronsted base because it accepts a proton to form NH_4^+ (ammonium ion).

Q.12. Identify the Lewis acids and the Lewis bases in the following reactions.

i. $\mathbf{Ag^+ + 2CN^- \rightarrow [Ag(CN)_2]^-}$

Ans: Lewis acid (electron pair acceptor): Ag^{+}

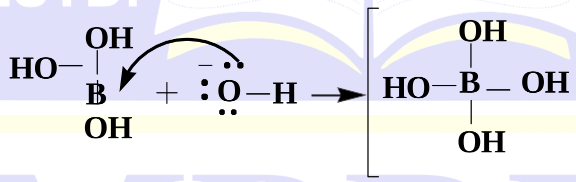
Lewis base (electron pair donor): CN^{-}

Explanation:

Ag^{+} is electron deficient, it accepts two electron pairs from two CN^{-} (cyanide ion) to form coordinate covalent bonds, thus acting as **Lewis acid**. Cyanide ion (CN^{-}) is electron rich and can donate one electron pair to form a coordinate covalent bond thus acting as **Lewis base**. $[Ag(CN)_2]^{-}$ complex is formed.

ii. $\mathbf{B(OH)_3 + OH^{-} \rightarrow [B(OH)_4]^{-}}$

Ans:



Lewis acid (electron pair acceptor): $B(OH)_3$

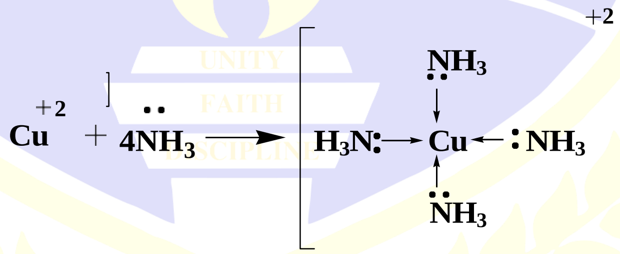
Lewis base (electron pair donor): OH^{-}

Explanation:

B of $B(OH)_3$ is electron deficient. In $B(OH)_3$ 6 electrons are present around B but it still needs 2 electrons to complete its octet, which it accepts to form a coordinate covalent bond, thus acting as **Lewis acid**. OH^{-} is electron rich and it can donate an electron pair to form a coordinate covalent bond with B thus acting as **Lewis base**. $[B(OH)_4]^{-}$ complex is formed.

iii. $\mathbf{Cu^{+2} + 4NH_3 \rightarrow [Cu(NH_3)_4]^{+2}}$

Ans:



Lewis acid (electron pair acceptor): Cu^{+2}

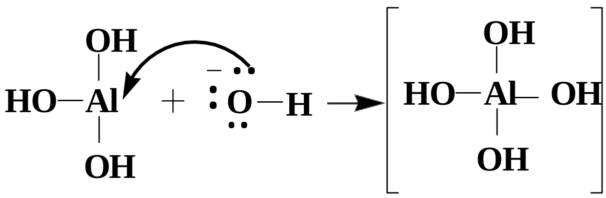
Lewis base (electron pair donor): NH_3

Explanation:

Cu^{+2} (copper ion) is electron deficient, thus it accepts an electron pair from NH_3 (Ammonia), thus acting as **Lewis acid**. N of NH_3 is electron rich. N has 5 electrons, it shares 3 with hydrogen so now it has 8 electrons, its octet is complete and it has one lone pair which it can donate to form a coordinate covalent bond, thus acting as **Lewis base**. $[Cu(NH_3)_4]^{+2}$ complex is formed.

iv. $\mathbf{OH^{-} + Al(OH)_3 \rightarrow [Al(OH)_4]^{-}}$

Ans:



Lewis acid (electron pair acceptor): $Al(OH)_3$
Lewis base (electron pair donor): OH^-

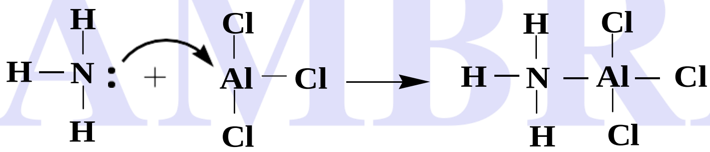
Explanation:

Al of $Al(OH)_3$ is electron deficient. In $Al(OH)_3$ 6 electrons are present around Al but it still needs 2 electrons to complete its octet, which it accepts to form a coordinate covalent bond, thus acting as **Lewis acid**. OH^- is electron rich and it can donate an electron pair to form a coordinate covalent bond with Al thus acting as **Lewis base**. $[Al(OH)_4]^-$ complex is formed.

Q.13. Identify Lewis acids and bases from the following substances.

$AlCl_3$

Al of $AlCl_3$ (aluminum chloride) is electron deficient. In $AlCl_3$ 6 electrons are present around Al but it still needs 2 electrons to complete its octet, which it accepts from thus acting as **Lewis acid**.



Ag^+

Lewis acid (electron pair acceptor): Ag^+

Explanation:

Ag^+ is electron deficient, it accepts two electron pairs to form coordinate covalent bonds, thus acting as **Lewis acid**. $[Ag(CN)_2]^-$ complex is formed when cyanide ion (CN^-) which is electron rich donates one electron pair to form a coordinate covalent bond.

$$\mathbf{Ag^+ + 2CN^- \rightarrow [Ag(CN)_2]^-}$$

CH_3OH

O of CH_3OH is electron rich. O has 6 electrons, it shares 1 with hydrogen and 1 with carbon, so now it has 8 electrons, its octet is complete and it has two lone pairs. O donates its one lone pair to form a coordinate covalent bond, thus CH_3OH acts as **Lewis base**.

$$\mathbf{CH_3 - OH + H^+ \rightarrow [CH_3 - OH_2]^+}$$

CH_3NH_2

N of CH_3NH_2 is electron rich. N has 5 electrons, it shares 2 with hydrogen and 1 with carbon, so now it has 8 electrons, its octet is complete and it has one lone pairs. N donates its lone pair to form a coordinate covalent bond, thus CH_3NH_2 acts as **Lewis base**.

$$\mathbf{CH_3 - NH_2 + H^+ \rightarrow [CH_3 - NH_3]^+}$$

CN^-

Lewis base (electron pair donor): CN^-

Explanation:

Cyanide ion (CN^-) is electron rich and can donate one electron pair to form a coordinate covalent bond thus acting as **Lewis base**. $[Ag(CN)_2]^-$ complex is formed when cyanide ion (CN^-) reacts with electron deficient Ag^+.

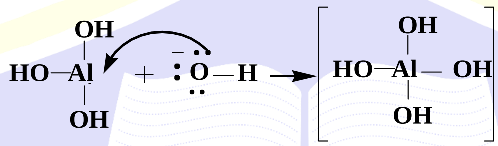
$$\mathbf{Ag^+ + 2CN^- \rightarrow [Ag(CN)_2]^-}$$

OH^-

Lewis base (electron pair donor): OH^-

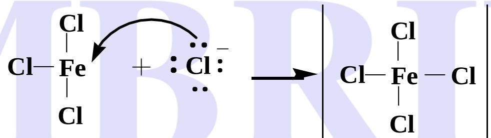
Explanation:

OH^- is electron rich and it can donate an electron pair to form a coordinate covalent bond, thus acting as **Lewis base**.



$FeCl_3$

Fe of $FeCl_3$ (aluminum chloride) is electron deficient thus it accepts electron pair, thus acting as **Lewis acid**.



Q.14. Classify water as proton donor or proton acceptor.

Ans: Water is amphoteric in nature. Water behaves like an acid as well as a base. When it reacts with a strong acid, it accepts a proton to act as a **Bronsted base.** For example with nitric acid it accepts a proton and forms H_3O^+ (hydronium ion).

$$\mathbf{HNO_3 + H_2O \rightarrow H_3O^+ + NO_3^-}$$

When water reacts with a strong base, it donates a proton to act as a **Bronsted acid.** For example with NH_3 it donates a proton and forms OH^- (hydroxyl ion).

$$\mathbf{NH_3 + H_2O \rightarrow NH_4^+ + OH^-}$$

Q.15. Write equations showing the ionization of following as Arrhenius acids.

Ans: **$HI_{(aq)}$**

$$\mathbf{HI_{(aq)} \xrightleftharpoons{H_2O} H^+_{(aq)} + I^-_{(aq)}}$$

$HNO_{2(aq)}$

$$\mathbf{HNO_{2(aq)} \xrightleftharpoons{H_2O} H^+_{(aq)} + NO_2^-{}_{(aq)}}$$

Q.16. Write equations showing the ionization of following as Bronsted-Lowery acids.

Ans: $HNO_{2(aq)}$

$$HNO_2 + H_2O \rightarrow NO_2^- + H_3O^+$$

$HCN_{(aq)}$

$$HCN + H_2O \rightarrow CN^- + H_3O^+$$

THINK TANK

Q.17. What is true about the relative concentrations of hydrogen ions and hydroxide ions in each kind of solutions.

Ans: **a) Acidic**

$[H^+] > [OH^-]$

b) Basic

$[H^+] < [OH^-]$

c) Neutral

$[H^+] = [OH^-]$

Q.18. Codeine, $C_{18}H_{21}NO_3$ is commonly prescribed pain killer, it dissolves in water by the following reaction

$$C_{18}H_{21}NO_3 + H_2O \rightleftharpoons [C_{18}H_{21}HNO_3]^+ + OH^-$$

Identify codeine as Bronsted-Lowery acid or base.

Ans: Codeine, $C_{18}H_{21}NO_3$ in reaction with water will accept a proton to form $[C_{18}H_{21}HNO_3]^+$ thus acting as **Bronsted-Lowery base.**

Q.19. Suggest some ways in which you might determine whether a particular water solution contains an acid or a base.

Ans: To determine whether a particular water solution contains an acid or a base, following tests can be performed.

1. Litmus paper indicates whether a solution is acidic, basic or neutral. An acid turns blue litmus paper red and a base turns red litmus paper blue.

2. pH paper or universal indicator paper is used to measure pH of a solution.

3. Acid-base indicators are intensely coloured organic compounds which estimate the pH of a solution.

Q.20. The table below shows the colour of two indicators in acidic and alkaline solutions.

Indicator	Colour in acidic solution	Colour in alkaline solution
A	Red	Blue
B	Colourless	Red

Ans: **a) What will be the colour of indicator A?**

i. in a solution of pH 3

The colour of the indicator A in a solution of pH 3 (i.e. acidic pH) will be red.

ii. in a solution of pH 10

The colour of indicator A in a solution of pH 10 (i.e. alkaline pH) will be blue.

b) What will be the colour of the indicator B in a solution of pH 5?

The indicator B in a solution of pH 5 (i.e. acidic pH) will be colourless.

c) When a few drops of indicator B are placed in a solution X, it turns red immediately. What can you deduce about the properties of solution X?

Solution X will be alkaline in nature because indicator B imparts red colour in alkaline solutions. Solution X will be bitter in taste, harmful to skin tissues, electrical conductor and will turn red litmus blue.

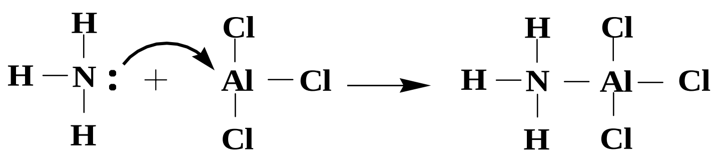
Q.21. Bacteria in our mouth feed on small particles of food stuck to our teeth and change it into acid. Explain how using toothpaste of pH 10 can help to prevent the acid from damaging our teeth?

Ans: The acid produced by decay of food may cause damage to teeth due to reaction of this acid with calcium of the teeth. Toothpaste of pH 10 contains a base. When we use this toothpaste, a neutralization reaction takes place between the base of toothpaste and acid resulted from decay of food, thus preventing the teeth from damage.

Q.22. Can a substance be a Lewis acid without being a Bronsted-Lowery acid?

Ans: Yes, a substance can be a Lewis acid without being a Bronsted-Lowery acid.

A Bronsted acid is a substance which has a proton to donate while a Lewis acid is an electron deficient specie, which accepts a pair of electron to complete its octet. Lewis acids like BF_3, $AlCl_3$, Cu^{+2}, Ag^{+}, etc., lack a proton are thus Lewis acids without being Bronsted-Lowery acid.



INFO BOXES

Info Box No. 1.

Q. What are side effects of acid rains?
OR
Why acid rain is an important environmental issue?

Ans: Acid rains can damage trees, kill huge areas of forest. It washes out aluminum ions from the soil. These aluminum ions run into rivers, lakes and ponds. Aluminum is very toxic to fish and other aquatic life. They can no longer survive in it and may be killed. Acid rain can also damage buildings and statues. The acid reacts with carbonates in lime stone. The lime stone dissolves and the statue gradually crumbles away. Thus acid rain is an important environmental issue.

Info Box No. 2.

Q. What are side effects of smoking?
OR
Which gases are produced by cigarette smoke and what are their side effects?

Ans: Sulphur dioxide and oxides of nitrogen are produced by the smoking of cigarettes. Smokers breathe in a lot of sulphur dioxide. Over long period of time, they have an increased risk of suffering from cold, bronchitis and asthma.

Info Box No. 3.

Q. What are the applications of pH measurements?

Ans: Applications of pH Measurements:
Analytical chemist measures pH of solutions. pH measurement has valuable applications. For instance, it helps analytical chemist to
i. To create soil conditions ideal for plant growth
ii. Medical diagnosis
iii. Maintaining the correct acid base balance in swimming pools
iv. Electroplating
v. Manufacture of medicine etc. tap water and waste water.

Info Box No. 4.

Q. What are the causes of acid rains?
OR
How fossil fuel is responsible for acid rains?

Ans: Fossil fuels contain small amounts of sulphur and nitrogen. They produce sulphur dioxide and oxides of nitrogen when the fuel is burned. Large amounts of these oxides are released from coal-burning factories and power stations. They react chemically with the water vapours in clouds and oxygen in the air, forming acids.

$$SO_{2(g)} + \frac{1}{2} O_{2(g)} + H_2O_{(l)} \rightarrow H_2SO_{4(aq)}$$

$$4NO_{2(g)} + O_{2(g)} + 2H_2O_{(l)} \rightarrow 4HNO_{3(aq)}$$

Theses acids mix up with rain drops and fall as acid rain or acid snow.

Info Box No. 5.

Q. At which pH range apple, broad bean, carrots, onions, potatoes and tomatoes grow?

Ans:

Plant	pH Range
Apple	5.5 – 7.0
Broad Bean	6.5 – 7.0
Carrots	6.0 – 7.5
Onions	6.5 – 7.5
Potatoes	5.5 – 6.5
Tomatoes	5.5 – 7.0

Info Box No. 6.

Q. What should be the optimum pH range of swimming pool and why?

Ans: The optimum pH range of a swimming pool is 7.2 to 7.6 because in human tears, when the pH is outside this range, an eye irritation can occur.

Info Box No. 7.

Q. How stomach acidity is caused? How it is cured.

Ans: The main component of digestive or gastric juice in the stomach is hydrochloric acid. Almost two litres of it is secreted each day by gastric glands. However, sometimes too much acid is secreted in the stomach which causes indigestion. This is called acidity of stomach. Acidity of stomach can be cured by using $Mg(OH)_2$ (milk of magnesia). This is a neutralization reaction.

Magnesium hydroxide +Hydrochloric acid →Magnesium chloride + Water

$$\mathbf{Mg(OH)_2 + 2HCl \rightarrow MgCl_2 + 2H_2O}$$

Info Box No. 8.

Q. Define etching, how it is done and how it can be used for ornamental purposes?

Ans: Etching is an art that uses acid to carve patterns into metal, glass and other materials. For this a piece of metal is covered with wax, and then a design is etched on to the plate through the wax. The plate is then dipped into a tank of acid. The acid eats away at the exposed portion, which leaves behind textured mark. The plate is then taken out of the acid and cleaned. Ink can be applied on etching to create colourful designs, which enhance the ornamental beauty of etched patterns.

<u>Info Box No. 9.</u>

Q. Why lemon juice is put on the fish?

Ans: We make use of chemistry when we put lemon juice on the fish. The unpleasant fishy order is due to amines. The citric acid present in the lemon converts amines to non-volatile salts, thus reducing the odour.

OR

Why vinegar is put on the fish?
We make use of chemistry when we put vinegar on the fish. The unpleasant fishy order is due to amines. The acetic acid of the vinegar converts amines to non-volatile salts, thus reducing the odour.

<u>Info Box No. 10.</u>

Q. What are the responsibilities of Food and Drug Administration Department?

Ans: Many people are allergic or sensitive to preservatives. Some preservatives are safe in small amount and toxic in larger amounts. Hence, Food and Drug Administration Department is given the responsibility for approving the safety and use of preservatives.

PREVIOUS BOARD QUESTIONS

Multiple Choice Questions

2014

Which substance is used as antacid and laxative

(a) NaOH
(b) $Ca(OH)_2$
(c) $Mg(OH)_2$
(d) KOH

Answer: (c)

Explanation: Antacid drugs cure acidity of stomach and laxatives cure constipation. $Mg(OH)_2$ (milk of magnesia) is used as antacid and laxative. Its neutralization reaction with HCl produced in stomach is as follows:

$$Mg(OH)_2 + 2HCl \rightarrow MgCl_2 + 2H_2O$$

2014

What is the particular pH range at which apple grows?

(a) 6.5 – 7.0
(b) 6.0 – 7.5
(c) 5.5 – 7.0
(d) 6.5 – 7.5

Answer: (c)

Explanation: Apple grows successfully at pH range of 5.5 – 7.0

2014 & 2015

Consider the given reaction

$$H_2O + HCl \rightarrow H_3O^+ + Cl^-$$

Which specie is an electron pair acceptor in the above reaction?

(a) H_2O
(b) H_3O^+
(c) HCl
(d) None of theses

Answer: (c)

Explanation: HCl acts as a electron pair acceptor because H^+ of HCl accepts an electron pair from water to form H_3O^+ thus HCl acts as Lewis acid.

2014

What is the concentration of H^+ ions in the milk of magnesia.

(a) 10^{-7}
(b) 10^{-8}
(c) 10^{-9}
(d) 10^{-10}

Answer: (d)

Explanation: Milk of magnesia i.e. $Mg(OH)_2$ is a base and thus can exist at a basic pH around 10. At this pH, $[H^+]$ is 10^{-10}.

2014

Green colour in fireworks is produced by the use of___________________.

(a) $Ba(NO_3)_2$
(b) $Ba(OH)_2$
(c) $BaCO_3$
(d) $BaSO_4$

Answer: (a)

Explanation: $Ba(NO_3)_2$ burns with a green colour and is thus used in fireworks.

2015

When $[H^+] < 10^{-7}$ M, then solution will be

(a) acidic
(b) Basic
(c) Neutral
(d) Amphoteric

Answer: (b)

Explanation: The solution will be basic because

For acidic solution: $[H^+] > 10^{-7}$ M
For basic solution: $[H^+] < 10^{-7}$ M
For neutral solution: $[H^+] = 10^{-7}$ M

2015

A drain cleaner solution contains 1×10^{-8} M, OH^- concentration. This solution is

(a) Neutral
(b) Basic
(c) Acidic
(d) Cannot be edicted

Answer: (c)

1st Explanation: The solution is acidic because
$[OH^-] = 1.0 \times 10^{-8}$ M$< 1.0 \times 10^{-7}$ M

2nd Explanation:

$[OH^-] = 1.0 \times 10^{-8}$ M

$[H^+][OH^-] = K_w$

$[H^+][OH^-] = 1.0 \times 10^{-14}$

$$[H^+] = \frac{1.0 \times 10^{-14}}{[OH^-]} = \frac{1.0 \times 10^{-14}}{1.0 \times 10^{-8}} = 1.0 \times 10^{-6} \text{ M}$$

As $[H^+] = 1.0 \times 10^{-6}$M $> 1.0 \times 10^{-7}$ M, the solution is acidic.

2016

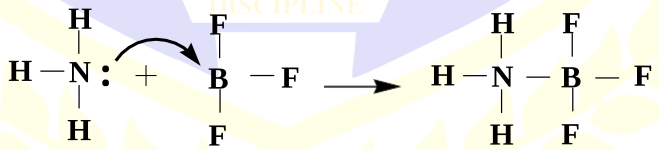
In the following reaction, which substance is donating an electron pair?

$$\mathbf{NH_3 + BF_3 \rightarrow BF_3 - NH_3}$$

(a) B
(b) H
(c) N
(d) BF_3

Answer: (c)

Explanation: In all the options, only N is electron rich. N has 5 electrons, it shares 3 with hydrogen so now it has 8 electrons, its octet is complete and it has one lone pair which it can donate to form a coordinate covalent bond, thus acting as **Lewis base**.



2016

What is the particular pH range at which potatoes grows?

(a) 5.5 – 6.5
(b) 5.5 – 7.0
(c) 6.5 – 7.5
(d) 6.0 – 7.5

Answer: (a)

Explanation: Apple grows successfully at pH range of 5.5 – 6.5

Short Questions

2014

What is pH? Write down its two valuable applications.

Ans: pH is defined as negative logarithm of the molar concentration of H^+ ions in aqueous solutions. Mathematically pH is defined as:
$pH = -\log [H^+]$

Applications of pH Measurements:
Analytical chemist measures pH of solutions. pH measurement has valuable applications. For instance, it helps analytical chemist to

i. To create soil conditions ideal for plant growth
ii. Medical diagnosis
iii. Maintaining the correct acid base balance in swimming pools
iv. Electroplating
v. Manufacture of medicine etc.

2014

Etching is an art. Explain the method to carve the pattern into metal or glass.

Ans: Same as info box no. 8.

2014

Complete and balance the following chemical reactions.

a. $H_2SO_4 + CuO \rightarrow$

$H_2SO_4 + CuO \rightarrow CuSO_4 + H_2O$

b. $HCl + CaCO_3 \rightarrow$

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

c. $AgNO_3 + NaCl \rightarrow$

$AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$

2015

Show that H_2O is Bronsted base, while HCl is Bronsted acid. Write chemical equation.

Ans: When H_2O reacts with a strong acid, it accepts a proton to act as a **Bronsted base.** For example with hydrochloric acid (HCl), it accepts a proton and forms H_3O^+ (hydronium ion). HCl loses a proton to act as a **Bronsted acid.** Chemical equation is as follows:

$$H_2O + HCl \rightarrow H_3O^+ + Cl^-$$

2015

Define neutralization reaction. Give an example.

Ans:

Neutralization is the reaction between H^+ ions of an acid and OH^- ions of a base.

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

It is also said to be a reaction between an acid and base which result in the formation of salt and water.

$$NaOH + HCl \rightarrow NaCl + H_2O$$

Write names of two acidic salts.

Ans:

Acidic salts are those salts which have replaceable H^+ ion. Examples are

Sodium bicarbonate ($NaHCO_3$)

Potassium bicarbonate ($KHCO_3$)

2015

a. What is pH? Write its mathematical form.

Ans:

pH is defined as negative logarithm of the molar concentration of H^+ ions in aqueous solutions. Mathematically pH is defined as:

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

b. What is the pH of pure water at 25°C?

Ans: Water is a weak electrolyte. The self ionization of water occurs to a very small extent. At 25°C the experimentally determined concentrations of H^+ ions and OH^- ions are as follows.

$[H^+] = [OH^-] = 1x10^{-7}$

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

$pH = -\log [1x10^{-7}]$

$pH = 7$

The pH of pure water at 25°C is 7.

2015

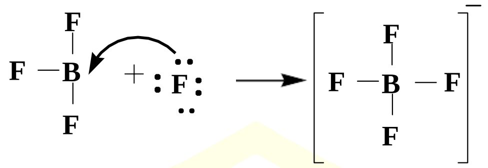
Differentiate between normal salt and acidic salts. Give an example of each.

Acidic Salt	Normal Salt
Acidic salt contains replaceable H^+.	A normal salt does not contain any replaceable H^+ or OH^-.
An acidic salt is resulted by partial neutralization of an acid.	A normal salt is resulted by complete neutralization of an acid.
Examples: Sodium bicarbonate ($NaHCO_3$) Potassium bicarbonate ($KHCO_3$) $\mathbf{NaOH+H_2CO_3 \rightarrow NaHCO_3+H_2O}$	**Examples:** Sodium carbonate (Na_2CO_3) Potassium carbonate (K_2CO_3) $\mathbf{2NaOH+H_2CO_3 \rightarrow Na_2CO_3+2H_2O}$

2016

Describe and give examples of Lewis acid.

Ans:
A **Lewis acid** is electron deficient and accepts an electron pair to form a coordinate covalent bond. Examples of Lewis acid are Ag^+, BF_3, $AlCl_3$, etc.



Here, B of BF_3 is electron deficient. In BF_3 6 electrons are present around B but it still needs 2 electrons to complete its octet, which it accepts, thus acting as **Lewis acid**.

2016

Briefly describe acidity of stomach.

Ans: Same as info box no. 7.

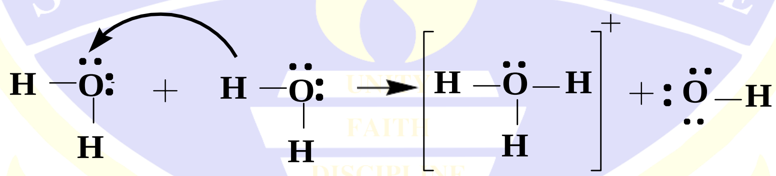
Long Questions

2014

Explain self ionization of water.

Ans: **Self Ionization of Water**

The reaction in which two water molecules react with themselves to produce ions is called as self ionization or auto-ionization of water.
Water molecules are highly polar. Occasionally the collisions between water molecules result in transfer of a proton from one water molecule to another.



A water molecule that donates or loses the proton becomes a negatively charged OH^- ion. The other water molecules which gain or accepts the proton becomes positively charged hyronium ion H_3O^+. This reaction can also be written as

$$2H_2O \rightarrow H_3O^+ + OH^-$$

For one molecule this equation becomes as follows:

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

Equilibrium constant expression for self ionization of water can be written as:

$$K_c = \frac{[H^+][OH^-]}{[H_2O]}$$

Water is a weak electrolyte, so concentration of water is constant.

$$K_c [H_2O] = [H^+][OH^-]$$
$$K_w = [H^+][OH^-]$$

Where, $K_w = K_c [H_2O]$ is called **ionization constant** or **ion product** for water.

Water is a weak electrolyte. The self ionization of water occurs to a very small extent. At 25^oC the experimentally determined concentrations of H^+ ions and OH^- ions are as follows.

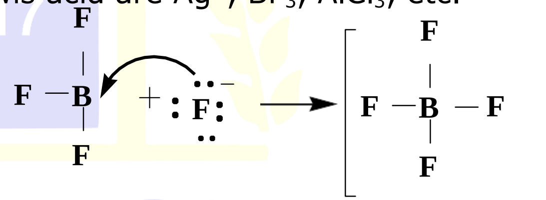
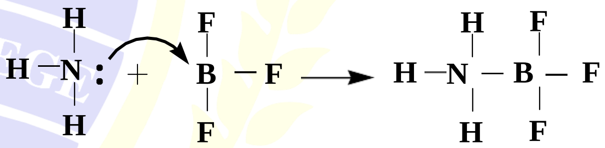
$$[H^+] = [OH^-] = 1x10^{-7}$$

So ion product for water becomes

$$K_w = (1x10^{-7})(1x10^{-7}) = 1x10^{-14} \text{ at } 25^oC$$

2014

Write a comparative note on the acid base concept of Arrhenius, Bronsted-Lowery and Lewis. Also give examples of each.

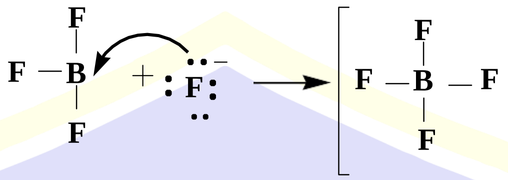
	Arrhenius	**Bronsted-Lowery**	**Lewis**
Acid	An **Arrhenius acid** ionizes in water to produce H^+ ions. Examples of Arrhenius acid are HCl, H_2SO_4, HNO_3, etc. $HCl \xrightleftharpoons{H_2O} H^+ + Cl^-$ $H_2SO_4 \xrightleftharpoons{H_2O} 2H^+ + SO_4^{2-}$	A **Bronsted-Lowery acid** donates a proton. Examples of Bronsted-Lowery acid are HCl, H_2SO_4, HNO_3, CH_3COOH etc. $CH_3COOH + H_2O \rightarrow CH_3COO^- + H_3O^+$ Bronsted acid: CH_3COOH Bronsted base: H_2O CH_3COOH (Acetic acid) is Bronsted acid because it donates a proton to form CH_3COO^- (acetate ion).	A **Lewis acid** is electron deficient and accepts an electron pair to form a coordinate covalent bond. Examples of Lewis acid are Ag^+, BF_3, $AlCl_3$, etc.  Here, B of BF_3 is electron deficient. In BF_3 6 electrons are present around B but it still needs 2 electrons to complete its octet, which it accepts, thus acting as **Lewis acid**.
Base	An **Arrhenius base** ionizes in water to produce OH^- ions. Examples of Arrhenius base are NaOH, $Mg(OH)_2$, KOH, etc. $KOH \xrightleftharpoons{H_2O} K^+ + OH^-$ $Mg(OH)_2 \xrightleftharpoons{H_2O} Mg^{+2} + 2OH^-$	A **Bronsted-Lowery base** accepts a proton. Examples of Bronsted-Lowery base are NH_3, OH-, etc. $H_2S + NH_3 \rightarrow NH_4^+ + HS^-$ Bronsted acid: H_2S Bronsted base: NH_3 Here Ammonia (NH_3) is a Bronsted base because it accepts a proton to form NH_4^+ (Ammonium ion).	A **Lewis base** is electron rich and donates an electron pair to form a coordinate covalent bond. Examples of Lewis base are OH^-, NH_3, F^-, etc.  N of NH_3 is electron rich. N has 5 electrons, it shares 3 with hydrogen so now it has 8 electrons, its octet is complete and it has one lone pair which it can donate thus acting as **Lewis base**.

2015

Define Lewis concept of acid and bases. Explain each with the help of an example. Name the bond formed in Lewis acid base reaction.

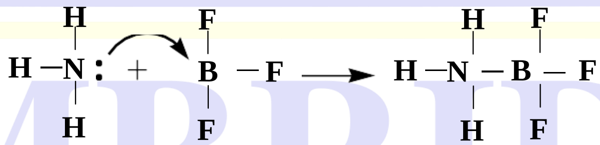
<u>Ans:</u>

A **Lewis acid** is electron deficient and accepts an electron pair to form a coordinate covalent bond. Examples of Lewis acid are Ag^+, BF_3, $AlCl_3$, etc.



Here, B of BF_3 is electron deficient. In BF_3 6 electrons are present around B but it still needs 2 electrons to complete its octet, which it accepts, thus acting as **Lewis acid**.

A **Lewis base** is electron rich and donates an electron pair to form a coordinate covalent bond. Examples of Lewis base are OH^-, NH_3, F^-, etc.



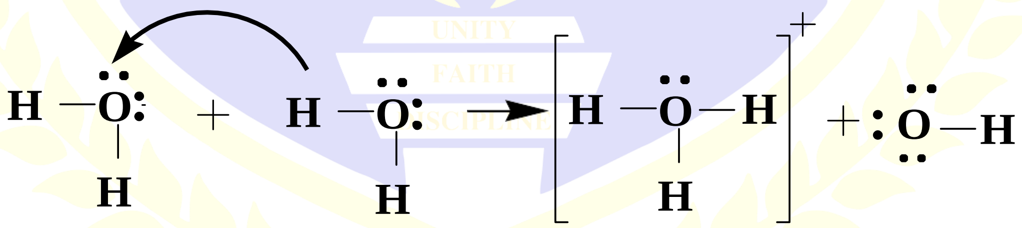
N of NH_3 is electron rich. N has 5 electrons, it shares 3 with hydrogen so now it has 8 electrons, its octet is complete and it has one lone pair which it can donate thus acting as **Lewis base**

The bond formed in Lewis acid base reaction is called **coordinate covalent bond**.

2015

Explain self ionization of water with the help of a chemical equation.

<u>Ans:</u> Equation for the self ionization of water.



$$\mathbf{2H_2O \rightarrow H_3O^+ + OH^-}$$

For one molecule this equation becomes as follows:

$$\mathbf{H_2O \rightarrow H^+ + OH^-}$$

2015

Write names of any two acid base indicators.

Indicator	pH at which colour changes	Colour in acidic solution	Colour in basic solution
Methyl red	5.5	Red	Yellow
Bromothymol blue	7	Yellow	Blue
Phenolphthalein	9	Colourless	Pink

2015 & 2016

Define salt. Explain different methods used for preparation of salt.

<u>Ans:</u> An acid contains replaceable hydrogen atoms. When these are completely or partially replaced by metal atoms, a compound called salt is formed.

$$\mathbf{HCl} \rightarrow \mathbf{NaCl}$$

Replaceable H atom   Metal atom has replaced H

Salt can also be defined as a compound resulted by the combination of positively charged radical from a base (basic radical) and negatively charged radical from an acid (acidic radical).

e.g.

Base	Basic radical	Salt	Acidic radical	Acid
$NaOH$	Na^+	$\mathbf{NaCl}$	Cl^-	HCl
$Ca(OH)_2$	Ca^{+2}	$\mathbf{CaCl_2}$	Cl^-	HCl
KOH	K^+	$\mathbf{K_2SO_4}$	SO_4^{-2}	H_2SO_4

Methods for preparation of Salts:

1. Acid + Base → Salt + Water

$H_2CO_3 + 2NaOH \rightarrow Na_2CO_3 + 2H_2O$

$HCl + KOH \rightarrow KOH + H_2O$

2. Acid + Metal oxide → Salt + Water

$H_2SO_4 + CuO \rightarrow CuSO_4 + H_2O$

3. Acid + Metal → Salt + Hydrogen

$2HCl + Mg \rightarrow MgCl_2 + H_2$

4. Acid + Metal carbonate → Salt + Carbon dioxide + Water

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

5. $\mathbf{Salt_{(aq)}}$ + $\mathbf{Salt_{(aq)}}$ → $\mathbf{Salt_{(s)}}$ + $\mathbf{Salt_{(aq)}}$

$AgNO_{3(aq)} + NaCl_{(aq)} \rightarrow AgCl_{(s)} + NaNO_{3(aq)}$

2016

Write a note on uses of salts for food preservation.

Ans: Food preservation keeps food from spoiling and allows it to be stored for later use. Ancient methods for preserving include, drying fruits and vegetables, salting, boiling etc. Today, methods for preserving food also include the addition of preservatives. They are inhibitors of physical and chemical processes that cause food to spoil. Many foods are grown or produced in one location and then sent across the country or even overseas. Without preservatives, these foods would spoil long before they reach their destinations. Many salts such as sulphites and benzoates are being used as food preservatives for thousands of years.

UNIT- 11

ORGANIC CHEMISTRY

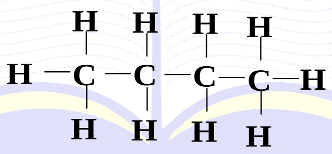
SELF ASSETSSMENT EXERCISES

Self Assessment Exercise 11.1

Give the molecular, structural and condensed structural formula

(a) Butane

Stem: **But** means four carbons
Suffix: **ane** means carbon to carbon single bond (alkane)
Molecular formula: $C_4H_{(2x4)+2}$ = C_4H_{10}
Structural formula:

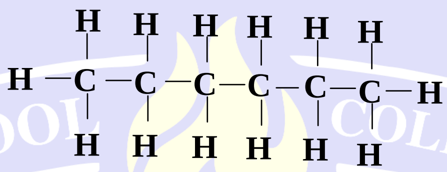


Condensed Structural formula:

$CH_3-CH_2-CH_2-CH_3$

(b) Hexane

Stem: **Hex** means six carbons
Suffix: **ane** means carbon to carbon single bond (alkane)
Molecular formula: $C_6H_{(2x6)+2}$ = C_6H_{14}
Structural formula:

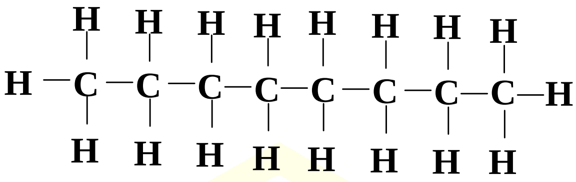


Condensed Structural formula:

$CH_3-CH_2-CH_2-CH_2-CH_2-CH_3$

(c) Octane

Stem: **Oct** means eight carbons
Suffix: **ane** means carbon to carbon single bond (alkane)
Molecular formula: $C_8H_{(2x8)+2} = C_8H_{18}$
Structural formula:



Condensed Structural formula:
$CH_3-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_3$

Self Assessment Exercise 11.2

Identify saturated and unsaturated compounds from the following.

(i) $CH_3-CH_2-CH_3$

Ans: Saturated compound (all carbon to carbon bonds are single)

(ii) $CH_3-C\equiv CH$

Ans: Unsaturated compound (one carbon to carbon triple bond)

(iii) $CH_3-CH=CH_2$

Ans: Unsaturated compound (one carbon to carbon double bond)

(iv) $CH_2=CH-CH=CH_2$

Ans: Unsaturated compound (two carbon to carbon double bonds)

Self Assessment Exercise 11.3

Write IUPAC names of the following alkanes

(i) $CH_3-CH_2-CH_2-CH_2-CH_2-CH_3$

Ans: No. of Carbon atoms = 6
Stem: Hex
Name: Hexane

(ii) $CH_3-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_3$

Ans: No. of Carbon atoms = 8
Stem: Oct
Name: Octane

(iii) $CH_3-CH_2-CH_2-CH_2-CH_2-CH_2-CH_3$

Ans: No. of Carbon atoms = 7
Stem: Hept
Name: Heptane

(iv) $CH_3-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_3$

Ans: No. of Carbon atoms = 10
Stem: Dec
Name: Decane

(v) $CH_3-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_3$

Ans: No. of Carbon atoms = 9
Stem: Non
Name: Nonane

Self Assessment Exercise 11.4

1. List the names of major sources of alkanes.

Ans: The major commercial sources of alkanes are coal, natural gas, petroleum and living organisms.

2. What is natural gas?

Ans: Natural gas is a mixture of low boiling hydrocarbons. Natural gas is mostly methane. It contains smaller amount of ethane, propane and butane.

3. Write some uses of acetylene.

Ans: Some uses of acetylene are as follows:

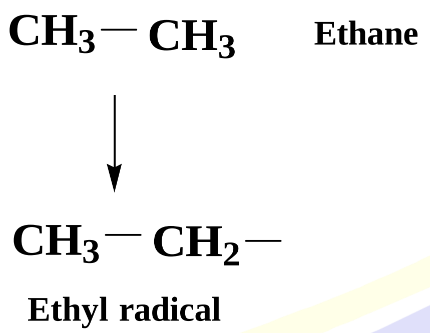
1. Acetylene is widely used in the oxy-acetylene welding and cutting metals.
2. Acetylene is also used in the preparation of polymers like PVC (polyvinyl chloride), polyvinyl acetate, synthetic rubber, nylon, etc.
3. Acetylene is also used for artificial ripening of fruits.

Self Assessment Exercise 11.5

Derive alkyl radicals from the following alkanes.

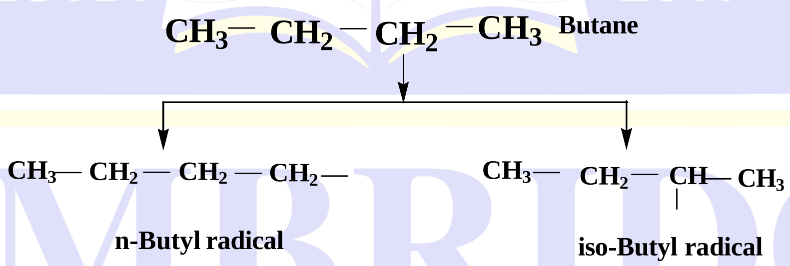
a. Ethane

Ans:



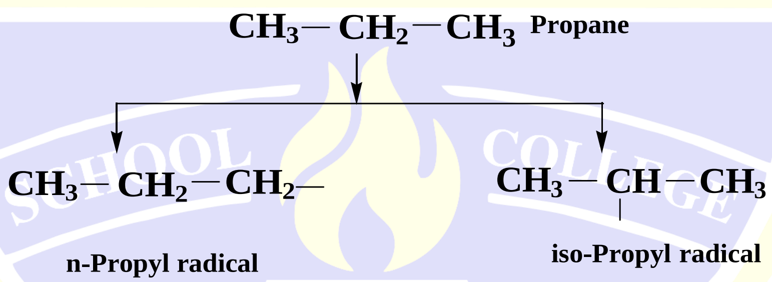
b. Butane

Ans:



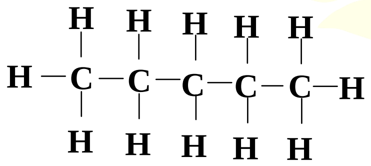
c. Propane

Ans:

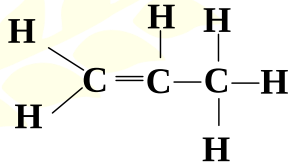


Self Assessment Exercise 11.6

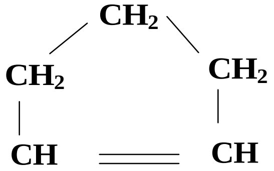
A to E are the structural formulas of some organic compounds.



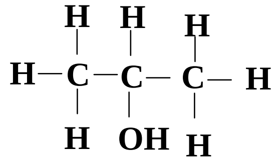
A



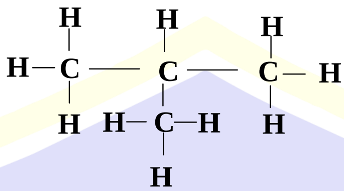
B



C



D



E

Give the letters which represents

(i) A branched chain compound.

Ans: E & D

(ii) A cyclic compound.

Ans: C

(iii) Two straight chain compounds

Ans: A & B

Self Assessment Exercise 11.7

Classify the following compounds as alcohol, ether or phenol.

(a) $CH_3CH_2OCH_2CH_3$

Ans: Diethyl ether (Ether)

(b) $CH_3CH_2CH_2OH$

Ans: Propanol (Alcohol)

(c) C_6H_5OH

Ans: Phenol

(d) C_2H_5OH

Ans: Ethanol (Alcohol)

Self Assessment Exercise 11.8

Identify the following compounds as an aldehyde, or a ketone or a carboxylic acid.

(a) $CH_3COCH_2CH_3$

Ans: Butanone (ketone)

(b)

$$CH_3-CH_2-CH_2-\overset{\overset{\large O}{\|}}{C}H$$

Ans: Butanal or Butyraldehyde (Aldehyde)

(c)

$$CH_3-CH_2-\overset{\overset{\large O}{\|}}{C}OH$$

Ans: Propanoic acid (carboxylic acid)

REVIEW EXERCISE

Q.1. Encircle the correct answer.

(i) Condensed structural formula for butane is

(a) $CH_3-CH_2-CH_3$

(b) $CH_3-CH_2-CH_2-CH_3$

(c) $CH_3-CH_2-CH_2-CH_2-CH_3$

(d) CH_3-CH_3

Answer: (b)

Explanation:
Stem: **But** means four carbons
Suffix: **ane** means carbon to carbon single bond (alkane)
Molecular formula:
$C_4H_{(2x4)+2} = C_4H_{10}$

(ii) $CH_3-CH_2-CH_3$ is the chemical formula for

(a) Ethane
(b) Propane
(c) Butane
(d) Pentane

Answer: (b)

Explanation:
No. of Carbon atoms = 3
Stem: Prop
Name: Propane

(iii) Which compound is not a saturated hydrocarbon?

(a) CH_3-CH_3
(b) CH_4
(c) $CH_3-CH=CH_2$
(d) $CH_3-CH_2-CH_3$

Answer: (c)

Explanation:
Propene is a unsaturated hydrocarbon with a double between two carbons.

(iv) Stem "But" stands for how many carbon atoms?

(a) 2
(b) 3
(c) 4
(d) 5

Answer: (c)

Explanation:
Stem: **But** means four carbons

(v) Pitch is produced by

(a) Coal
(b) Coal tar
(c) Coal gas
(d) Petroleum

Answer: (b)

Explanation: Coal tar results from destructive distillation of coal. Coal tar is a source of many organic compounds such as benzene and its derivates. These compounds can be separated by fractional distillation of coal tar. The residue left behind is called pitch and it is used to make roads and roofs.

(vi) The functional group $-\overset{\overset{\large O}{\|}}{C}-$ is found in

(a) Alcohols
(b) Ketones
(c) Carboxylic acid
(d) Esters

Answer: (b)

Explanation: $-\overset{\overset{\large O}{\|}}{C}-$ is found in ketones, e.g. Propanone

$$CH_3-\overset{\overset{\large O}{\|}}{C}-CH_3$$

(vii) In which of the following compounds, oxygen is attached to two alkyl carbon atoms?

(a) Alcohols
(b) Phenol
(c) Ether
(d) Ester

Answer: (c)

Explanation: In ether, oxygen is attached to two alkyl carbon atoms. e.g. Dimethyl ether

$$CH_3-O-CH_3$$

(viii) Which of the following is an alcohol?

(a) $CH_3-CH_2-O-CH_2-CH_3$
(b) CH_3-CH_2-COOH
(c) C_6H_5-OH
(d) CH_3-CH_2-OH

Answer: (d)

Explanation: In alcohols OH group is attached to an alkyl group, so ethanol with ethyl and OH group is an alcohol.

(ix) The functional group of amines is

(a) $-OH$
(b) $-COOH$
(c) $-NH_2$
(d) $-CHO$

Answer: (c)

Explanation: Amino group ($-NH_2$) is the functional group of amines.

(x) Formic acid contains functional group.

(a) $-OH$
(b) $-CO-$
(c) $-COOH$
(d) $-CHO$

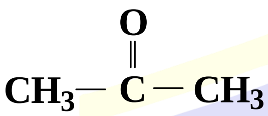
Answer: (c)

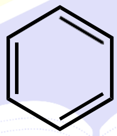
Explanation: $-COOH$ is carboxylic acid group. Formic acid is a carboxylic acid. Chemical formula of formic acid is ($H-COOH$).

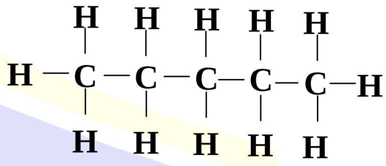
Q.2. Give short answers.

(i) What is catenation?

Ans: Carbon atoms have ability to bond to each other to form long chains and rings. This self-linking ability of carbon is called catenation. Catenation is a unique property and is responsible for a large number of diverse compounds. A few examples of compounds showing catenation is as follows:







(ii) Define isomerism.

Ans: The compounds that have same molecular formula but different arrangement of atoms in their molecules are called isomers and this phenomenon is called isomerism. For example two compounds have same molecular formula C_4H_{10} have following structures.

$CH_3-CH_2-CH_2-CH_3$

n-Butane

$CH_3-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_3$

iso-Butane

Similarly two compounds have same molecular formula C_2H_6O have following structures.

CH_3-CH_2-OH

Ethanol

CH_3-O-CH_3

Dimethyl ether

(iii) Give three examples of alkyl groups.

Ans: Alkyl groups are resulted by removal of one H atom from an alkane. Examples are as follows:

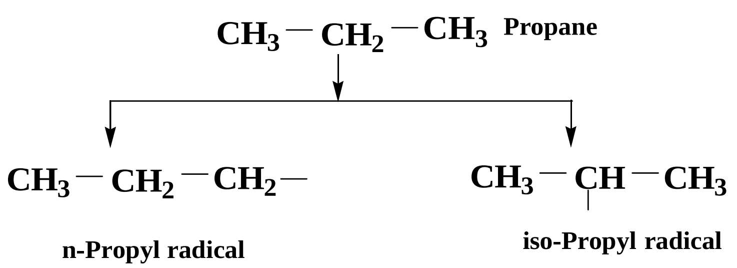
(Methane) CH_4 → CH_3- (Methyl)

CH_3-CH_3 **Ethane**

$\downarrow$

CH_3-CH_2-

Ethyl radical



(iv) Define functional group.

Ans: An atom or group of atoms that give a family of organic compounds its characteristic chemical and physical properties is called a **functional group**.

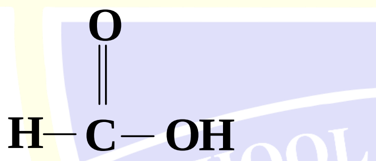
Examples:

Alcohols are characterized by the presence of the hydroxyl group (–OH) attached to a hydrocarbon chain. e.g.

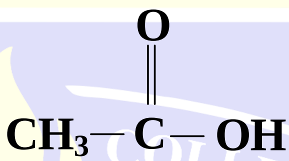
$CH_3 - CH_2 - OH$ — **Ethanol**

$CH_3 - OH$ — **Methanol**

Carboxylic acid are characterized by the presence of the carboxylic group (–COOH) attached to a hydrocarbon chain.



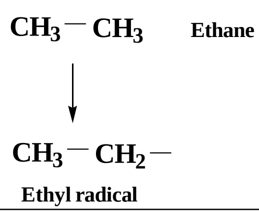
Formic acid



Acetic acid

(v) What is difference between an alkane and an alkyl radical?

Ans:

Alkane	Alkyl radical
Alkanes are hydrocarbons which contain carbon to carbon single bond only.	An alkyl radical is a group of atoms obtained by removing one hydrogen atom from an alkane. Alkyl radicals are represented by the symbol R.
General formula of alkanes is C_nH_{2n+2}.	General formula of alkyl radicals is C_nH_{2n+1}.
Examples: **CH_3 – CH_3 (Ethane)**	**Examples:** 

$CH_3-CH_2-CH_2-CH_3$

(Butane)

$CH_3-CH_2-CH_2-CH_2-CH_2-CH_3$

(Hexane)

$CH_3-CH_2-CH_3$ Propane

$\downarrow$

$CH_3-CH_2-CH_2-$ n-Propyl radical

$CH_3-\underset{|}{CH}-CH_3$ iso-Propyl radical

Q.3. What do you mean by the term destructive distillation?

Ans: When coal is heated without air, it does not burn but produces many by-products. A process by which organic substances such as coal are decomposed by heat in the absence of air and distilled to produce useful products such as coke, charcoal, coal tar and coal gas.

Q.4. List some general properties of organic compounds.

Ans: **General Characteristics of Organic compounds**

1. Occurrence

Most of them come from living things or from the things that were once living.

2. Covalent Nature:

Organic compounds are generally covalent in nature. They may have polar or non-polar bonds.

3. Composition:

Carbon is the main constituent of organic compounds. Hydrogen is also frequency present in organic compounds. Other element like oxygen, nitrogen, sulphur, phosphorus and halogens are present in many organic compounds.

4. Melting and boiling point:

Generally organic compounds are volatile. So they have low melting and boiling point.

5. Solubility:

Organic compounds are non-polar in nature; therefore mostly they are soluble in organic solvent such as ether, benzene, carbon disulphide etc. Polar organic compounds are soluble in alcohols such as methyl alcohol and ethyl alcohol.

6. Similarities in behaviors:

There exists a close relationship between different organic compounds. This similarity in behavior has made the study of millions of organic compounds easier. They can be classified into few families. A series of related compounds in which any two adjacent molecules differ by $-CH_2-$ group is called **homologous series.**

7. Reaction rates:

Organic compounds are generally less stable than inorganic compounds. Due to covalent bonding in them; their reaction rates are often slow.

Q.5. List major commercial sources of alkanes.

Ans: **Sources of organic compounds:**

The major commercial sources of alkanes are coal natural gas, petroleum and living organisms.

Coal:

Coal is source of many organic compounds. When coal is heated in the absence of air at high temperature, it is converted into coal gas, coal tar, coke. This process is called destructive distillation. Coal is also used as solid fuel.

Coal gas contains methane, hydrogen and carbon monoxide gases. It is mainly used as fuel in industry. Coal tar is a source of many organic compounds such as benzene and its derivatives. These compounds can be separated by fractional distillation. These are very useful substances in synthetic organic chemistry. These are used to synthesize plastic dyes, fibers, drugs paints varnishes etc. The residue left behind called pitch is used to metal roads and roofs.

Natural gas:

Natural gas is a mixture of low boiling hydrocarbons. Natural gas is mostly methane. It contains smaller amounts of ethane, propane and butane.

Petroleum:

Petroleum contains a wide variety of alkanes including those having very long chains. On fractional distillation petroleum separates into various hydrocarbons components; known as fractions. Each fraction is not a pure compound but a mixture of different compounds that boil in a certain range of temperature.

Living organism:

Many important organic compounds such as proteins, fats, carbohydrates vitamins drugs and medicine are obtained from plants and animals.

Q.6. Identify the following compounds on the basis of functional groups they contain and encircle the functional group.

➢ $CH_3 - CH = CH_2$

Ans: Functional group: **Alkene** (one carbon to carbon double bond)
No. of Carbon atoms = 3
Stem: Prop
Suffix: ene
Name: **Propene**

$$CH_3 - CH = CH_2$$

➢ $CH_3 - C \equiv CH$

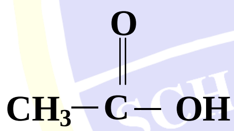
Ans: Functional group: **Alkyne** (one carbon to carbon triple bond)
No. of Carbon atoms = 3
Stem: Prop
Suffix: yne
Name: **Propyne**

$$CH_3 - C \equiv CH$$

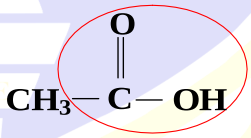
➢ $CH_3 - CH_2 - COOH$

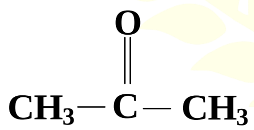
Ans: Functional group: **carboxylic acid** (contains –COOH group)
No. of Carbon atoms = 3
Stem: Prop
Name: **Propanoic acid**

$$CH_3 - CH_2 - COOH$$

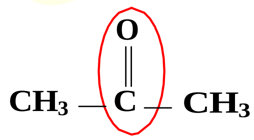
➢ 

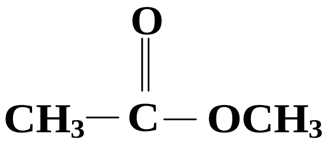
Ans: Functional group: **carboxylic acid** (contains –COOH group)
No. of Carbon atoms = 2
Stem: Eth
Name: **Ethanoic acid (Acetic acid)**



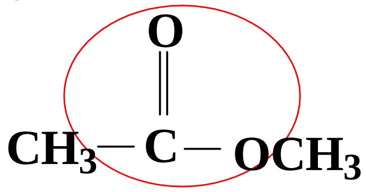
➢ 

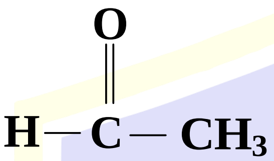
Ans: Functional group: **ketone** (contains carbonyl i.e. –CO – group)
No. of Carbon atoms = 3
Stem: Prop
Name: **Propanone (Acetone)**



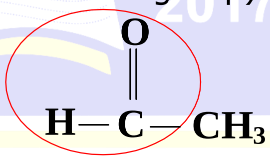
- 

Ans: Functional group: **Ester** (contains R–COOR group)
No. of Carbon atoms = 2 & 1
Name: **Methyl ethanoate (Methyl acetate)**



- 

Ans: Functional group: **Aldehyde** (contains –CHO group)
No. of Carbon atoms = 2
Stem: Eth
Name: **Ethanal (Acetaldehyde)**



Q.7. What is the name of alkane having seven carbon atoms in the chain?

Ans: No. of Carbon atoms = 7
Stem: Hept
Name: Heptane

$$CH_3-CH_2-CH_2-CH_2-CH_2-CH_2-CH_3$$

Q.8. What is the name of the alkyl group obtained by removing an end hydrogen atom from

(i) Propane **(ii) Ethane**

Ans:

$CH_3-CH_2-CH_3$ **Propane**

$\downarrow$

$CH_3-CH_2-CH_2-$

n-Propyl radical

CH_3-CH_3 **Ethane**

$\downarrow$

CH_3-CH_2-

Ethyl radical

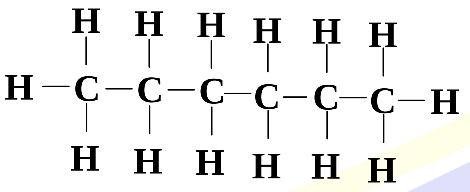
Q.9. Give the structural formula of two simple alkanes and one alkyne.

Ans: Alkanes:

Hexane

Molecular formula: $C_6H_{(2x6)+2} = C_6H_{14}$

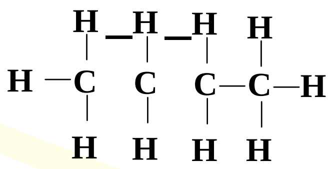
Structural formula:



Butane

Molecular formula: $C_4H_{(2x4)+2} = C_4H_{10}$

Structural formula:



Alkyne:

Propyne

Molecular formula: $C_3H_{(2x3)-2} = C_3H_4$

Structural formula:

$$CH_3 - C \equiv CH$$

Q.10. What is meant by the term functional group?

Ans: An atom or group of atoms that give a family of organic compounds its characteristic chemical and physical properties is called a **functional group**.

Examples:

Alcohols are characterized by the presence of the hydroxyl group (–OH) attached to a hydrocarbon chain. e.g.

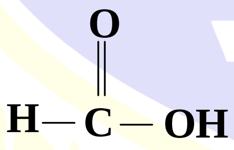
$$CH_3 - CH_2 - OH$$

Ethanol

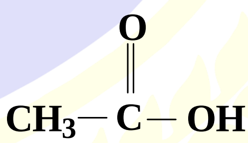
$$CH_3 - OH$$

Methanol

Carboxylic acid are characterized by the presence of the carboxylic group (–COOH) attached to a hydrocarbon chain.



Formic acid

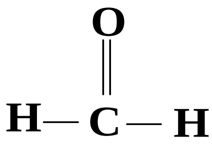


Acetic acid

Q.11. Identify the type of following compounds as an alcohol, aldehyde or ketone:

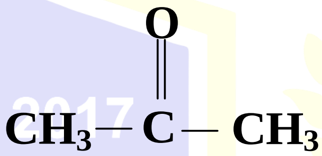
(a) HCHO, which is used to manufacture polymers, such as urotropine which is used to treat urinary tract infection.

Ans: Functional group: **Aldehyde** (contains –CHO group)
No. of Carbon atoms = 1
Stem: Meth
Name: **Methanal (Formaldehyde)**



(b) CH_3COCH_3, which is used in nail polish remover.

Ans: Functional group: **Ketone** (contains –CO– group)
No. of Carbon atoms = 3
Stem: Prop
Name: **Propanone (Acetone)**



(c) CH_3CH_2OH, which is used in the preparation of many organic substances such as plastics, cosmetics, tinctures, etc.

Ans: Functional group: **Alcohol** (contains – OH group)
No. of Carbon atoms = 2
Stem: Eth
Name: **Ethanol (Ethyl alcohol)**

$$CH_3-CH_2-OH$$

THINK TANK

Q.12. Given a molecular formula of a compound containing C, H and O and single bonds. List all the possible functional groups this compound can have.

Ans Alcohol and ether are two functional groups which contain C, H, O and single bonds.

Alcohols are characterized by the presence of the hydroxyl group (–OH) attached to a hydrocarbon chain. e.g.

$$CH_3-CH_2-OH$$

Ethanol

$$CH_3-OH$$

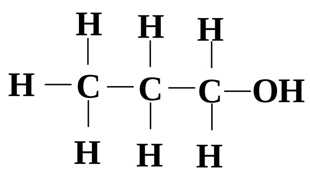
Methanol

Ethers are characterized by the presence of the oxygen attached to two alkyl groups; its general formula is (R– O – R).

$$CH_3-O-CH_3 \qquad CH_3-CH_2-O-CH_3$$

Q.13. Give the condensed structural formulas of the following compounds and classify each on the basis of functional group.

(a)

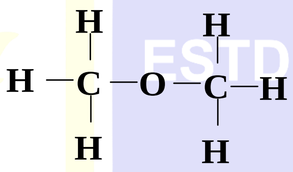


Functional group: **Alcohol** (contains – OH group)
No. of Carbon atoms = 3
Stem: Prop
Name: **1-Propanol (n-propyl alcohol)**

$$CH_3 - CH_2 - CH_2 - OH$$

Condensed structural formula of 1-Propanol

(b)

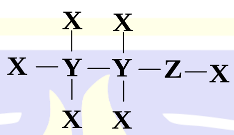


Functional group: **Ether** (contains $R - O - R'$ group)
No. of Carbon atoms = ($R = 1$ & $R' = 1$)
Name: **Dimethyl ether (Methoxy methane)**

$$CH_3 - O - CH_3$$

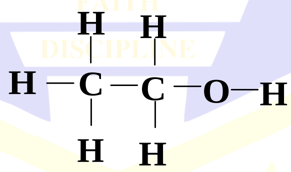
Condensed structural formula of Dimethyl ether

Q.14. The diagram represents an organic compound that contains three different elements.

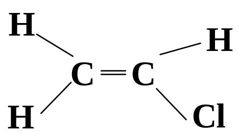


What could be the compound?
a) Ethanoic acid b) Propene c) Ethanol d) Propane

Ans Correct answer is ethanol because if ethanol has the same structures as our given compound. By considering X = H, Y = C and Z = O, the structure of ethanol is as follows:



Q.15. Polyvinyl chloride (PVC) is a polymer. It is used for making vinyl sheets, drainage pipes, wire insulation etc. It is obtained from vinyl chloride.



Classify vinyl chloride as saturated or unsaturated compound.

Ans	As there is a double bond between two carbon atoms, so vinyl chloride is an unsaturated compound.

Q.16. For each of the following, draw the structural formula of a two carbon compound containing the indicated functional group.

(a) Alcohol

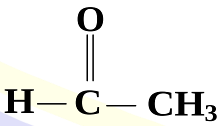
Ans

CH_3-CH_2-OH

Ethanol

(b) Aldehyde

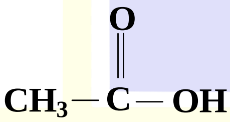
Ans



Ethanal
(Acetaldehyde)

(c) Carboxylic acid

Ans



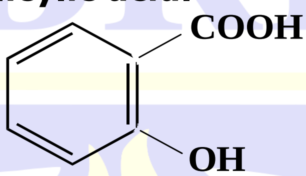
Acetic acid

(d) Alkene

Ans $CH_2=CH_2$

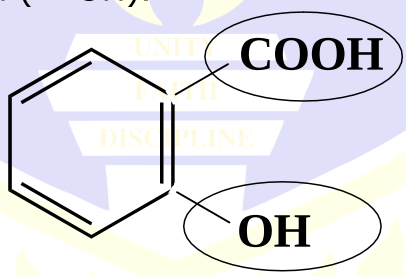
Ethene

Q.17. Aspirin is a mild pain killer and fever reducer. It is manufactured from salicylic acid.



Identify the functional groups present in it and encircle them.

Ans The functional groups present in salicylic acid are carboxylic acid (– COOH) and hydroxyl (– OH).



Q.18. General formula for alkane is C_nH_{2n+2}. What will be the general formula for alkyl radical?

Ans An alkyl radical is a group of atoms obtained by removing one hydrogen atom from an alkane. General formula of alkyl radicals is C_nH_{2n+1}.

$$CH_3-CH_3 \quad \text{Ethane}$$
$$\downarrow$$
$$CH_3-CH_2-$$
Ethyl radical

Q.19. Water adds to ethene according to the following reaction:

$$CH_2=CH_2 + H_2O \longrightarrow CH_3-CH_2-OH$$

Identify functional groups in the reactant and product molecules.

Ans **Reactant** is an **alkene** (carbon to carbon double bond).
Product is an **alcohol** and contains hydroxyl (– OH) group.

$$\underbrace{CH_2=CH_2}_{\text{Ethene (an alkene)}} + H_2O \longrightarrow \underbrace{CH_3-CH_2-OH}_{\text{Ethanol (an alcohol)}}$$

INFO BOXES

Info Box No. 1.

Q. How pharmaceutical drugs are synthesized?

Ans: To develop a synthesis scheme for a particular substance produced by plants and animals or new effective drug, pharmaceutical chemists first analyze the target molecule. They look for a suitable starting material. The synthesis involves two steps.

- Changing in the cabon skeleton
- Inter conversion of functional groups.

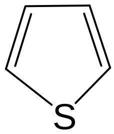
So, pharmaceutical chemists determine whether the reaction changes the carbon skeleton or inter converts the functional groups. If both the molecules have same number of carbon atom, then they can accomplish the synthesis by one or more functional groups inter-conversion. If they are different sizes, then they modify the carbon skeleton. For this they look for the molecule that allows them to make a possible carbon containing skeleton to obtain the product. Then they look for ways to obtain the functional groups of the target molecule.

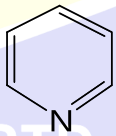
PREVIOUS BOARD QUESTIONS

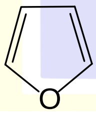
Multiple Choice Questions

2014

What is structural formula of pyridine?

(a) 

(b) 

(c) 

(d) None of these

Answer: (b)

Explanation: Option (b) is six membered aromatic ring with a nitrogen in the ring, so it is pyridine. Option (a) is thiophene, thio is the word used when S is present in the compound. Five membered aromatic compounds with an oxygen in the ring is called furan (option c).

2014

The functional group of amines is

(a) – OH
(b) –COOH
(c) – NH_2
(d) – CHO

Answer: (c)

Explanation: Amines contain amino (–NH_2) group. e.g. Formula of Methyl amine is $CH_3 - NH_2$.

2014

The general formula for amines is

(a) R – NH_2
(b) R – NH
(c) R – NH_3
(d) R – NH_4

Answer: (a)

Explanation: The general formula for amines is R – NH_2. Amines contain amino (– NH_2) group. e.g. Formula of Methyl amine is $CH_3 - NH_2$.

2014

Which coloured solution is produced when ketones are mixed with alkaline sodium nitro-prusside solution?

(a) Red
(b) Green
(c) Blue
(d) Orange

Answer: (a)

Explanation: Ketones give red colour with alkaline sodium nitro-prusside solution due to their carbonyl group (-CO-).

2015

The general formula of alkynes

(a) C_nH_{2n+2}
(b) C_nH_{2n}
(c) C_nH_{2n-2}
(d) C_nH_{2n-1}

Answer: (c)

Explanation: Alkynes with one triple bond have formula C_nH_{2n-2}. Example is acetylene with two carbon compound and formula $C_2H_{(2x2)-2} = C_2H_2$.

2015

Which of the following is an ether?

(a) $CH_3 - CH_2 - O - CH_2 - CH_3$
(b) $CH_3 - CH_2 - COOH$
(c) $C_6H_5 - OH$
(d) $CH_3 - CH_2 - OH$

Answer: (a)

Explanation: Ethers have general formula

$$R - O - R'$$

Compound (a) is diethyl ether.

2015

Which of the following is general formula of ether?

(a) $R - O - R'$

(b) $R - \overset{\overset{\displaystyle O}{\|}}{C} - R'$

(c) $R - \overset{\overset{\displaystyle O}{\|}}{C} - OR'$

(d) $R - OH$

Answer: (a)

Explanation: Ethers have general formula

$$R - O - R'$$

Two same or different alkyl groups are attached on either side of oxygen atom.

2015

Which of the following is functional group of amine?

(a) $R-COOH$
(b) $R-CHO$
(c) $R-OH$
(d) $R-NH_2$

Answer: (d)

Explanation: The general formula for amines is $R - NH_2$. R refers to an alkyl group. Amines contain amino $(-NH_2)$ group. e.g. Formula of Methyl amine is $CH_3 - NH_2$.

2016

Formic acid contain functional group

(a) $- OH$
(b) $- CO -$
(c) $- COOH$
(d) $- CHO$

Answer: (c)

Explanation: Formic acid is a carboxylic acid with functional group $- COOH$. Formula of formic acid is $H- COOH$.

2016

Stem “But” stands for how many carbon atoms

(a) 2
(b) 3
(c) 4
(d) 7

Answer: (c)

Explanation: Stem “But” stands for four carbon atoms. Example is butane with 4 carbon atoms.

CH_3– CH_2– CH_2– CH_3

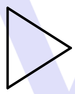
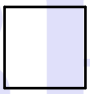
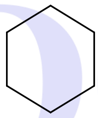
Short Questions

2014

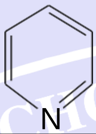
What are cyclic compounds?

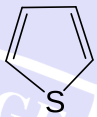
Ans: Organic compounds which contain rings of atoms are called closed chain or cyclic compound.
Cyclic compounds are of two types.

- **Homocyclic or carbocyclic compounds:**
  The compounds which contain only carbon atoms in the ring are called homocyclic or carbocyclic compounds. For example cyclopropane and cyclobutane.

- **Heterocyclic compounds:**
  The compounds which contain one or more atoms other than carbon atoms in the ring are called heterocyclic compounds. For example pyridine, furan, etc.





2014

Give the molecular, structural and condensed structural formula for a) butane b) Hexane c) Octane

Ans: Same as self assessment 11.1

2014

Write about any two major commercial sources of alkanes.

Ans: Same as Q.5. of Review exercise.

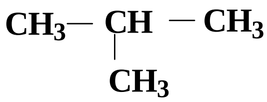
2015

What is isomerism? Draw the structure of isomers of butane.

The compounds that have same molecular formula but different arrangement of atoms in their molecules are called **isomers** and this phenomenon is called **isomerism.** For example two compounds have same molecular formula C_4H_{10} have following structures.

$$CH_3-CH_2-CH_2-CH_3$$

n-Butane



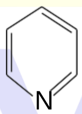
iso-Butane

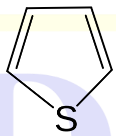
2015

Define heterocyclic compounds. Draw the structures of pyridine and thiophene.

<u>Ans:</u> Heterocyclic compounds:

The compounds which contain one or more atoms other than carbon atoms in the ring are called heterocyclic compounds. For example pyridine, furan, etc.





2015

Classify the following as an aldehyde, ketone or carboxylic acid.

a. **$CH_3COCH_2CH_3$**

Ans: Butanone (ketone)

b.

$$CH_3-CH_2-CH_2-\overset{\overset{\displaystyle O}{\|}}{C}H$$

Ans: Butanal or Butyraldehyde (Aldehyde)

c.

$$CH_3-CH_2-\overset{\overset{\displaystyle O}{\|}}{C}OH$$

Ans: Propanoic acid (carboxylic acid)

2

Write the condensed formula of the following:

a. **Butane**

Ans: Stem: **But** means four carbons
Suffix: **ane** means carbon to carbon single bond (alkane)
Molecular formula: $C_4H_{(2x4)+2}$ = C_4H_{10}
Condensed Structural formula:
$CH_3-CH_2-CH_2-CH_3$

b. **Pentane**

Ans: Stem: **Pent** means five carbon atoms
Suffix: **ane** means carbon to carbon single bond (alkane)
Molecular formula: $C_5H_{(2x5)+2}$ = C_5H_{12}
Condensed Structural formula:
$CH_3-CH_2-CH_2-CH_2-CH_3$

c. **Octane**

Ans: Stem: **Oct** means eight carbons
Suffix: **ane** means carbon to carbon single bond (alkane)
Molecular formula: $C_8H_{(2x8)+2}$ = C_8H_{18}
Condensed Structural formula:
$CH_3-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_3$

2016

What is condensed structural formula? Write the condensed formula of the following:

Ans: A **condensed structural formula** is a system of writing organic structures in a line of text. It shows all atoms, but omits the vertical bonds and most or all the horizontal single bonds.

a. **Hexane**

Ans: Stem: **Hex** means six carbons
Suffix: **ane** means carbon to carbon single bond (alkane)
Molecular formula: $C_6H_{(2x6)+2}$ = C_6H_{14}
Condensed Structural formula:
$CH_3-CH_2-CH_2-CH_2-CH_2-CH_3$

b. **Nonane**

Ans: Stem: **Non** means nine carbons
Suffix: **ane** means carbon to carbon single bond (alkane)
Molecular formula: $C_9H_{(2x9)+2}$ = C_9H_{20}
Condensed Structural formula:
$CH_3-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_3$

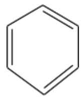
2 **What are the reasons for the formation of millions of organic compounds?**

Ans: The diversity of organic compounds is due to carbon"s special property of catenation, and to form multiple bonds and they also show the phenomenon of isomerism. Due to these reasons carbon forms almost infinite number of molecules of various sizes, shapes and structures.

Catenation:

Carbon has ability to bond to each other to form long chains and rings. This self-linking ability of carbon is called catenation.

$CH_3-CH_2-CH_2-CH_2-CH_2-CH_3$



Multiple bonds:

Carbon can also form stable single and multiple bonds with other atoms like oxygen, nitrogen and sulphur. Carbon can also form multiple bonds to itself.

$CH_2=CH_2$

Ethene

$H-\overset{\overset{\displaystyle O}{\|}}{C}-CH_3$

Ethanal (Acetaldehyde)

Isomerism:

The compounds that have same molecular formula but different arrangement of atoms in their molecules are called isomers and this phenomenon is called isomerism. For example two compounds have same molecular formula C_4H_{10} have following structures.

$CH_3-CH_2-CH_2-CH_3$

n-Butane

$CH_3-\underset{\underset{\displaystyle CH_3}{|}}{CH}-CH_3$

iso-Butane

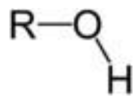
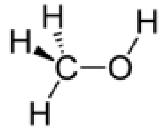
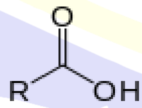
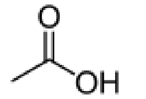
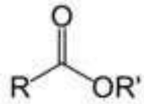
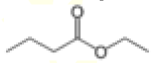
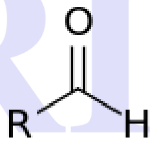
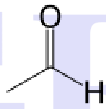
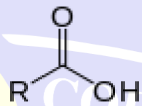
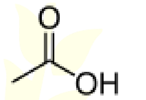
Long Questions

2014

Classify the organic compounds on the basis of functional groups? Give examples.

Ans: An atom or group of atoms that give a family of organic compounds its characteristic chemical and physical properties is called a **functional group**. Following are various groups.

Chemical class	Group	Formula	Structural Formula	Suffix	Example
Alkane	C-C single bond	R-H	R-H	**ane**	CH_3-CH_3 Ethane
Alkene	C-C double bond	R-CH=CH_2	R-CH=CH_2	**ene**	$CH_2=CH_2$ Ethene
alkyne	C-C triple bond	R-C≡CH	R-C≡C-H	**yne**	CH ≡ CH Ethyne

Alcohol	Hydroxyl	ROH		**-ol**	 Methanol
Amines	Amino	RNH_2	$R - NH_2$	**amine**	$CH_3 - NH_2$ Methyl amine
Carboxylic acid	Carboxyl	RCOOH		-oic **acid**	 Acetic acid *(Ethanoic acid)*
Ester	Ester	RCOOR'		alkyl alkan**oate**	 Ethyl butyrate *(Ethyl butanoate)*
Aldehyde	Aldehyde	RCHO		**-al**	 Acetaldehyde *(Ethanal)*
Carboxylic acid	Carboxyl	RCOOH		-oic **acid**	 Acetic acid *(Ethanoic acid)*
Ether	Ether	ROR'		alkyl **ether**	 Diethyl ether *(Ethoxyethane)*

2015

Classify the following compounds as ether or a phenol.

a. $\mathbf{CH_3 - CH_2 - O - CH_2 - CH_3}$

Ans: Diethyl ether (Ethoxy ethane)

b. $\mathbf{C_6H_5 - OH}$

Ans: Phenol

2015

Write the chemical formula of ethyl amine.

Ans: $\mathbf{CH_3 - CH_2 - NH_2}$

Chemical formula: C_2H_7N

UNIT- 12

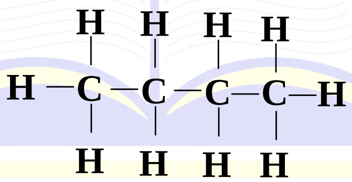
HYDROCARBONS

SELF ASSETSSMENT EXERCISES

Self Assessment Exercise 12.1

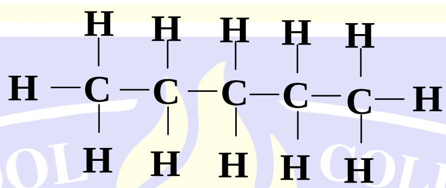
Write structural formula for
(a) Butane

Ans: Stem: **But** means four carbons
Suffix: **ane** means carbon to carbon single bond (alkane)
Molecular formula: $C_4H_{(2x4)+2}$ = C_4H_{10}
Structural formula:



(b) Pentane

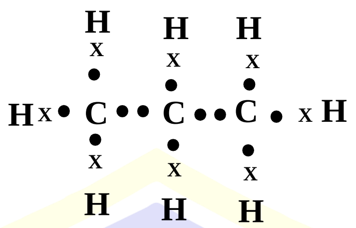
Ans: Stem: **Pent** means five carbons
Suffix: **ane** means carbon to carbon single bond (alkane)
Molecular formula: $C_5H_{(2x5)+2}$ = C_5H_{12}
Structural formula:



Self Assessment Exercise 12.2

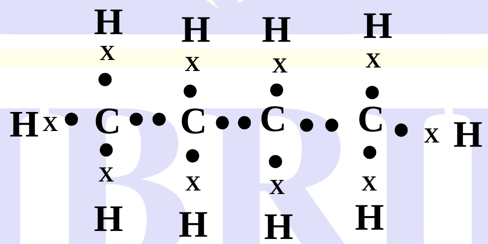
Draw electron dot and cross structures for the following.
(a) Propane

Ans: Stem: **Prop** means three carbons
Suffix: **ane** means carbon to carbon single bond (alkane)
Molecular formula: $C_3H_{(2x3)+2} = C_3H_8$
Electron dot & cross structure:



(b) Butane

Ans: Stem: **But** means four carbons
Suffix: **ane** means carbon to carbon single bond (alkane)
Molecular formula: $C_4H_{(2x4)+2} = C_4H_{10}$
Electron dot & cross structure:



Self Assessment Exercise 12.3

Complete the following reactions

- $$CH_3-CH=CH_2 + H_2 \xrightarrow[200\text{-}300\ ^oC]{Ni}$$

Ans: $$\underset{\text{Propene}}{CH_3-CH=CH_2} + H_2 \xrightarrow[200\text{-}300\ ^oC]{Ni} \underset{\text{Propane}}{CH_3-CH_2-CH_3}$$

- $$CH_3-C\equiv CH + 2H_2 \xrightarrow[200\text{-}300\ ^oC]{Ni}$$

Ans: $$\underset{\text{Propyne}}{CH_3-C\equiv CH} + H_2 \xrightarrow[200\text{-}300\ ^oC]{Ni} \underset{\text{Propene}}{CH_3-CH=CH_2} \xrightarrow[200\text{-}300\ ^oC]{H_2/Ni} \underset{\text{Propane}}{CH_3-CH_2-CH_3}$$

Self Assessment Exercise 12.4

Complete the following reactions

- $CH_3-CH_2(Cl) + 2[H] \xrightarrow[HCl_{(aq)}]{Zn}$

Ans: $CH_3-CH_2(Cl) + 2[H] \xrightarrow[HCl_{(aq)}]{Zn} CH_3-CH_3 + HCl$

Chloro ethane — Ethane

- $CH_3-CH(Cl)-CH_3 + 2[H] \xrightarrow[HCl_{(aq)}]{Zn}$

Ans: $CH_3-CH(Cl)-CH_3 + 2[H] \xrightarrow[HCl_{(aq)}]{Zn} CH_3-CH_2-CH_3 + HCl$

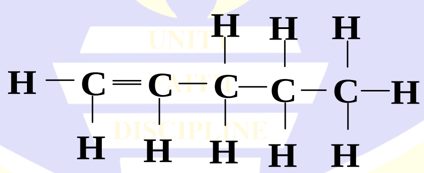
2-chloro propane — Propane

Self Assessment Exercise 12.5

Draw structural formulas for the following compounds

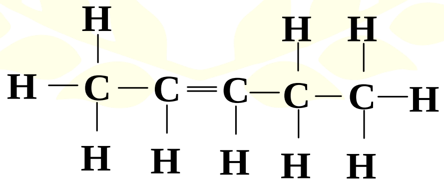
(a) 1 – Pentene

Ans:



(b) 2 – Pentene

Ans:



Self Assessment Exercise 12.6

Complete the following reactions

(a) $$CH_3-CH_2-\underset{\displaystyle OH}{\underset{|}{CH_2}} \xrightarrow[170\ ^\circ C]{Conc.\ H_2SO_4}$$

Ans: $$\underset{\text{1-Propanol}}{CH_3-CH_2-\underset{\displaystyle OH}{\underset{|}{CH_2}}} \xrightarrow[170\ ^\circ C]{Conc.\ H_2SO_4} \underset{\text{Propene}}{CH_3-CH=CH_2} + H_2O$$

(b) $$CH_3-CH_2-\underset{\displaystyle Br}{\underset{|}{CH_2}} + KOH \xrightarrow{Alcohol}$$

Ans: $$\underset{\text{1-Bromo propane}}{CH_3-CH_2-\underset{\displaystyle Br}{\underset{|}{CH_2}}} + KOH \xrightarrow{Alcohol} \underset{\text{Propene}}{CH_3-CH=CH_2} + KBr + H_2O$$

Self Assessment Exercise 12.7

Complete the following reactions

1. $$CH_3-CH=CH_2 + Br_2 \longrightarrow$$

Ans: $$\underset{\text{Propene}}{CH_3-CH=CH_2} + Br-Br \longrightarrow \underset{\text{1,2-Dibromo propane}}{CH_3-\underset{\displaystyle Br}{\underset{|}{CH}}-\underset{\displaystyle Br}{\underset{|}{CH_2}}}$$

2. $$CH_3-CH=CH_2 + KMnO_4 + H_2O \longrightarrow$$

Ans: $$3\underset{\text{Propene}}{CH_3-CH=CH_2} + 2KMnO_4 + 4H_2O \longrightarrow 3\underset{\text{Propylene glycol}}{CH_3-\underset{\displaystyle OH}{\underset{|}{CH}}-\underset{\displaystyle OH}{\underset{|}{CH_2}}} + 2MnO_2 + 2KOH$$

3. $$CH_3-CH=CH_2 + Cl_2 \longrightarrow$$

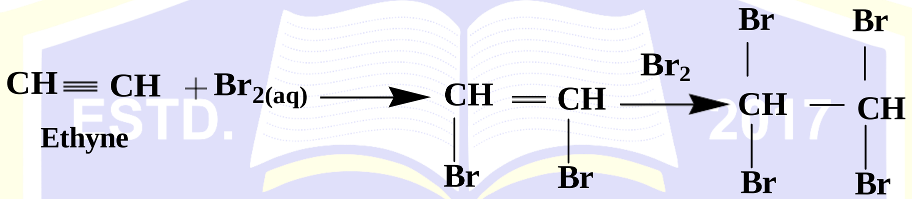
Ans: $$\underset{\text{Propene}}{CH_3-CH=CH_2} + Cl-Cl \longrightarrow \underset{\text{1,2-Dichloro propane}}{CH_3-\underset{\displaystyle Cl}{\underset{|}{CH}}-\underset{\displaystyle Cl}{\underset{|}{CH_2}}}$$

Self Assessment Exercise 12.8

Write chemical reaction of ethyne and bromine. Why this reaction is used to identify the unsaturation in a molecule?

$$CH \equiv CH + Br_{2(aq)} \longrightarrow A \xrightarrow{Br_2} B$$

Ans: Bromine is a reddish brown liquid but the product formed by its reaction with alkenes or alkynes is colourless. When bromine water is added to an alkene or alkyne, the reddish brown colour disappears. The decolorization of bromine solution is used as a simple test for **presence of unsaturation.**



1,2-Dibromo ethene   1,1,2,2-Tetrabromo ethane

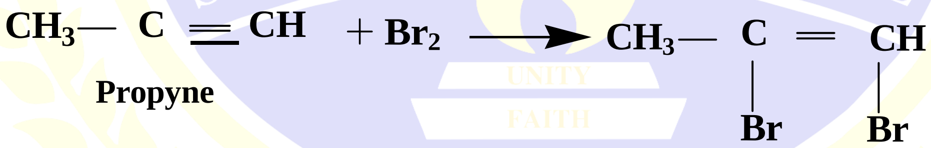
Explanation: When bromine (Br_2) reacts with alkenes or alkynes, it adds to double bond. One bromine atom attaches to one doubly bonded carbon and second bromine atom attaches to other doubly bonded carbon. This type of reaction is called **addition reaction.**

Self Assessment Exercise 12.9

Complete the following reactions

1. $CH_3-C \equiv CH + Br_2 \longrightarrow$

Ans:

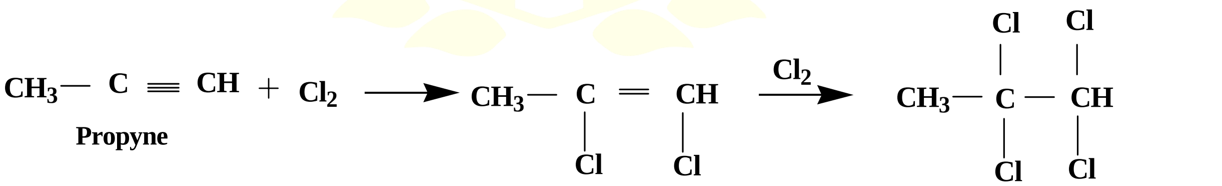


1,2-Dibromo propene

2. $CH_3-C \equiv CH + 2Cl_2 \longrightarrow$

Propyne

Ans:



1,2-Dichloro propene   1,1,2,2-tetrachloro propane

REVIEW EXERCISE

Q.1. Encircle the correct answer.

(i) Which molecule contains a carbon –carbon double bond?

(a) Ethane
(b) Ethene
(c) Ethyne
(d) Ethyl alcohol

Answer: (b)
Explanation: Ethene is an alkene. An alkene has carbon –carbon double bond. Structure of ethene is
$CH_2 = CH_2$

(ii) Which product is obtained when chloromethane (or methyl chloride) is reduced?

(a) Ethane
(b) Ethene
(c) Methane
(d) Ethyne

Answer: (c)
Explanation: Reduction means addition of hydrogen. So when one carbon compound CH_3Cl (chloromethane) is reduced it converts to another one carbon compound CH_4 (methane).

(iii) Which reacts explosively with methane?

(a) F_2
(b) Cl_2
(c) Br_2
(d) I_2

Answer: (a)
Explanation: F_2 is highest electronegative element and thus in most cases reacts violently. It reacts explosively with methane and form a mixture of alkyl fluorides.

(iv) By dehydration we mean, the removal of

(a) Hydrogen
(b) Water
(c) Halogen
(d) Hydrogen halide

Answer: (b)
Explanation: „Hydra" is the word for water and „de" is used for removal of something, so dehydration means the removal of water. Dehydration is the term used when two hydrogen and one oxygen is removed from a compound and water is formed.

(v) Ethene and ethyne can be differentiated by

(a) Hydrogenation
(b) Bromine water
(c) Dilute alkaline aqueous solution of $KMnO_4$

Answer: (c)
Explanation: When ethene reacts with dilute alkaline aqueous solution of $KMnO_4$, it forms ethylene glycol.

(d) Hydrohalogenation

Ethyne does not react with this reagent. This test is used to differentiate between an alkene and alkyne. All other options show presence of unsaturation and are thus exhibited both by alkenes and alkynes.

(vi) Which is used for dehydrohalogenation?

(a) Br_2 water
(b) Conc, H_2SO_4
(c) Al_2O_3
(d) Alcoholic KOH

Answer: (d)
Explanation: Dehydrohalogenation means removal of hydrogen as well as a halogen from a compound. Dehydrohalogenation of alkyl halides result in the formation of alkenes.

$$\underset{\text{Bromoethane (Ethyl bromide)}}{CH_3-\underset{\displaystyle Br}{\underset{|}{CH_2}}} + KOH \xrightarrow{\text{Alcohol}} \underset{\text{Ethene}}{CH_2=CH_2} + KBr + H_2O$$

(vii) Which substance reacts with $KMnO_4$ to produce oxalic acid?

(a) Ethane
(b) Ethene
(c) Ethyne
(d) Ethyl alcohol

Answer: (c)
Explanation: Ethyne like other alkynes do not react with dilute alkaline $KMnO_4$ aqueous solution, however in strong alkaline solution of $KMnO_4$, it is oxidized to oxalic acid.

(viii) The reduction of alkyl halides takes place in the presence of

(a) Al_2O_3 at 350 ^oC
(b) Conc. H_2SO_4 at 170 ^oC
(c) Zn dust
(d) Zn + HCl

Answer: (d)
Explanation: Zn reacts with aqueous acid to liberate atomic hydrogen called nascent hydrogen. Nascent hydrogen reduces alkyl halide. Addition of hydrogen is called reduction.

(ix) Which process produces an alkane?

(a) Combustion
(b) Hydration
(c) Dehydration
(d) Hydrogenation

Answer: (d)
Explanation: Hydrogenation means addition of hydrogen to a carbon-carbon multiple bond. Hydrogenation of alkenes and alkynes result in formation of alkanes.

(x) Does not react with aqueous solution of bromine.

(a) C_2H_6
(b) C_2H_4
(c) C_2H_2

Answer: (a)
Explanation: Aqueous solution of bromine (bromine water) reacts with alkenes and

(d) C_3H_6	alkynes and corresponding halo alkanes are formed. Here only ethane (an alkane) does not react with bromine water because there is no multiple bond where bromine can be added. All other options are alkenes or alkynes.

Q.2. Give short answers.

(i) Give three examples of unsaturated hydrocarbons.

Ans:

$CH = CH$ — **Ethene**

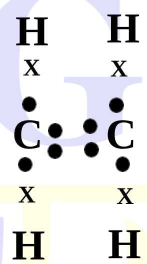
$CH \equiv CH$ — **Ethyne**

$CH_3 - CH = CH_2$ — **Propene**

$CH_3 - C \equiv CH$ — **Propyne**

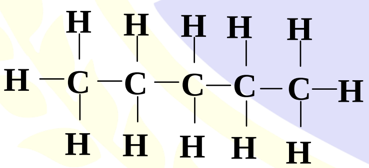
(ii) Draw electron dot and cross structure of ethene.

Ans: Stem: **Eth** means two carbons
Suffix: **ene** means carbon to carbon double bond (alkene)
Molecular formula: $C_2H_{(2x2)} = C_2H_4$

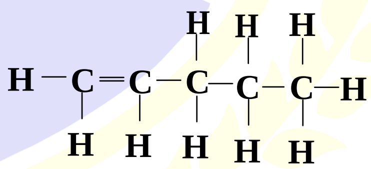


(iii) Draw structural formulas of alkane, an alkene and an alkyne containing five carbon atoms.

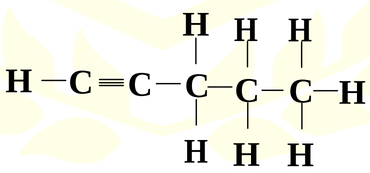
Ans:



n-Pentane
(alkane)



1-Pentene
(alkene)



1-Pentyne
(alkyne)

(iv)	**How can you differentiate ethane from ethene?**
Ans:	The decolorization of bromine solution is used as a simple test for **presence of unsaturation.** Bromine is a reddish brown liquid but the product formed by its reaction with alkenes or alkynes is colourless. When bromine water is added to an alkene or alkyne, the reddish brown colour disappears. Ethane does not decolourize bromine solution while ethene due to its double bond can decolourize it.

$$\underset{\textbf{Ethane}}{CH_3-CH_3} + Br_{2(aq)} \longrightarrow \text{No reaction}$$

$$\underset{\textbf{Ethene}}{CH_2=CH_2} + Br_{2(aq)} \longrightarrow \underset{\textbf{1,2-Dibromo ethane}}{\underset{Br\quad\;\; Br}{CH_2-CH_2}}$$

Explanation: When bromine (Br_2) reacts with ethene, it adds to double bond. One bromine atom attaches to one doubly bonded carbon and second bromine atom attaches to other doubly bonded carbon. This type of reaction is called **addition reaction.**

(v)	**What do you mean by dehydration reaction? Give one example.**
Ans:	Dehydration means loss of water or removal of water from a compound. Alcohols are dehydrated when their vapours are passed over heated alumina or they are treated with conc. H_2SO_4. Alcohols dehydrate to form alkenes. The reactions are given below:

$$\underset{\textbf{Ethanol}}{CH_3-\underset{OH}{CH_2}} \xrightarrow[340\text{ - }450\,^{o}C]{Al_2O_3} \underset{\textbf{Ethene}}{CH_2=CH_2} + H_2O$$

$$\underset{\textbf{1-Propanol}}{CH_3-CH_2-\underset{OH}{CH_2}} \xrightarrow[170\,^{o}C]{\text{Conc. }H_2SO_4} \underset{\textbf{Propene}}{CH_3-CH=CH_2} + H_2O$$

Q.3. How can you convert

(i) Ethene into ethane

Ans: Ethene can be converted into ethane by its hydrogenation in the presence of Ni.

$$\underset{\text{Ethene}}{CH_2 = CH_2} + H_2 \xrightarrow[200\text{-}300\ ^oC]{Ni} \underset{\text{Ethane}}{CH_3 - CH_3}$$

(ii) Methane into carbon tetrachloride

Ans: Methane and chlorine react in diffused light to form series of halo alkanes. This is a substitution reaction and one by one all hydrogen atoms of methane are substituted by chlorine atoms.

$$\underset{\text{Methane}}{CH_4} + Cl_2 \xrightarrow[\text{sunlight}]{\text{diffused}} \underset{\text{Chloromethane}}{CH_3Cl} - HCl$$

$$\underset{\text{Chloromethane}}{CH_3Cl} + Cl_2 \xrightarrow[\text{sunlight}]{\text{diffused}} \underset{\text{Dichloromethane}}{CH_2Cl_2} + HCl$$

$$\underset{\text{Chloromethane}}{CH_3Cl} + Cl_2 \xrightarrow[\text{sunlight}]{\text{diffused}} \underset{\text{Dichloromethane}}{CH_2Cl_2} + HCl$$

$$\underset{\text{Trichloromethane}}{CHCl_3} + Cl_2 \xrightarrow[\text{sunlight}]{\text{diffused}} CCl_4 + HCl$$

Tetrachloromethane
(Carbon tetrachloride)

(iii) Ethene into glycol

Ans: When ethene (or any other alkene) is treated with dilute alkaline aqueous solution of $KMnO_4$ (1%), addition of two hydroxyl groups occurs across the double bond. The colour of $KMnO_4$ solution is discharged during the reaction. This test is used for the presence of an alkene and is known as **Baeyer's test.**

$$\underset{\text{Ethene}}{3CH_2 = CH_2} + 2KMnO_4 + 4H_2O \longrightarrow 3\underset{OH}{\underset{|}{CH_2}} - \underset{OH}{\underset{|}{CH_2}} + 2MnO_2 + 2KOH$$

Ethylene glycol

(iv) Ethyl chloride into ethane

Ans: Ethyl chloride can be converted into ethane by their reduction in presence of Zn and dilute acid. Zn reacts with aqueous acid to liberate atomic hydrogen called nascent hydrogen. Nascent hydrogen reduces alkyl halide. Addition of nascent hydrogen is called reduction.

$$\underset{\substack{\text{Chloro ethane}\\ \text{(Ethyl chloride)}}}{CH_3-\underset{\displaystyle Cl}{\underset{|}{CH_2}}} + 2[H] \xrightarrow[HCl_{(aq)}]{Zn} \underset{\text{Ethane}}{CH_3-CH_3} + HCl$$

(v) Ethyl bromide into ethene

Ans: Dehydrohalogenation of alkyl halides result in the formation of alkenes. Dehydrohalogenation means removal of hydrogen as well as a halogen from a compound. When ethyl bromide reacts with alcoholic KOH, it is converted to ethene by the removal of Br from its carbon atom and a H from its neighboring carbon.

$$\underset{\text{Bromoethane (Ethyl bromide)}}{CH_3-\underset{\displaystyle Br}{\underset{|}{CH_2}}} + KOH \xrightarrow{\text{Alcohol}} \underset{\text{Ethene}}{CH_2=CH_2} + KBr + H_2O$$

Q.4. Write a chemical equation to show the preparation of an alkane from an alkene and an alkyne.

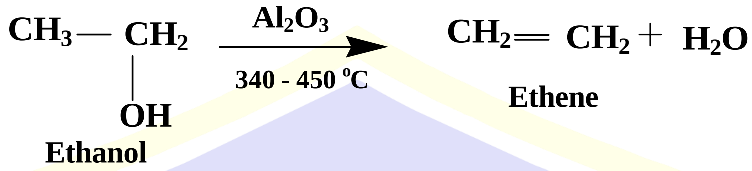
Ans: Hydrogenation of alkenes and alkynes result in the production of alkane. Reaction for the conversion of propene (alkene) and propyne (alkyne) to propane (alkane) are given as follows:

$$\underset{\text{Propene}}{CH_3-CH=CH_2} + H_2 \xrightarrow[200\text{-}300\ ^oC]{Ni} \underset{\text{Propane}}{CH_3-CH_2-CH_3}$$

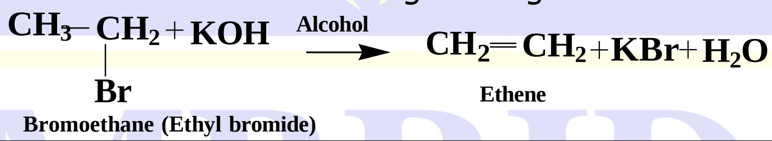
$$\underset{\text{Propyne}}{CH_3-C\equiv CH} + H_2 \xrightarrow[200\text{-}300\ ^oC]{Ni} \underset{\text{Propene}}{CH_3-CH=CH_2} \xrightarrow[200\text{-}300\ ^oC]{H_2/Ni} \underset{\text{Propane}}{CH_3-CH_2-CH_3}$$

Q.5. Write a chemical equation to show the preparation of ethene from dehydration of an alcohol and dehydrohalogenation of alkyl halides.

Ans: **Dehydration** means loss of water or removal of water from a compound. Alcohols are dehydrated when their vapours are passed over heated alumina or they are treated with conc. H_2SO_4. Alcohols dehydrate to form alkenes. The reactions are given below:

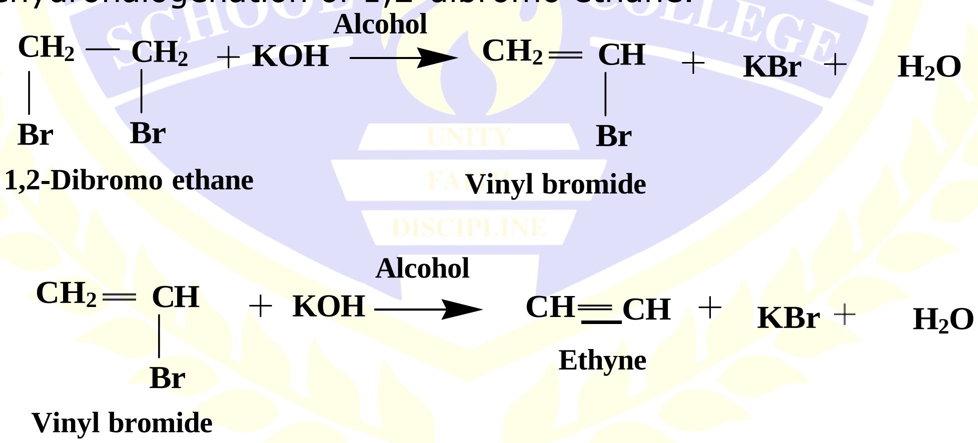


Dehydrohalogenation of alkyl halides result in the formation of alkenes. Dehydrohalogenation means removal of hydrogen as well as a halogen from a compound. When ethyl bromide reacts with alcoholic KOH, it is converted to ethene by the removal of Br from its carbon atom and a H from its neighboring carbon.

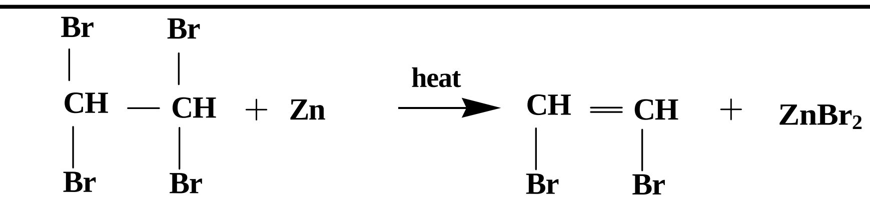


Q.6. Write a chemical equation to show the preparation of ethyne from dehalogenation of 1,2-dihalide and a tetrahalide.

Ans: Alkynes can be prepared by **dehydrohalogenation of vicinal dihalides.** Vicinal dihalide on treatment with alcoholic potassium hydroxide eliminates two molecules of hydrogen halides from adjacent carbon atoms. Reaction occurs in two steps. Ethyne can be prepared by dehydrohalogenation of 1,2-dibromo ethane.

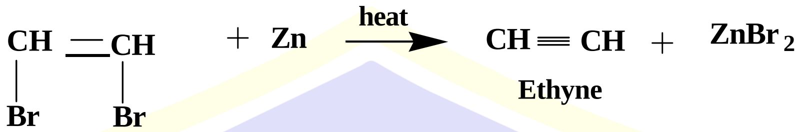


Dehalogenation of tetrahalides results in the formation of alkynes. Tetra halides on treatment with Zn dust undergo dehalogenation forming an alkyne.



1,1,2,2-Tetrabromo ethane

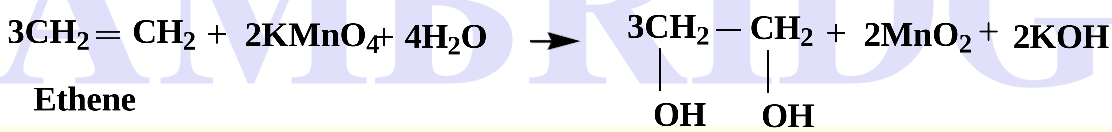
1,2-Dibromo ethene



1,2-Dibromo ethene

Q.7. Write chemical equations showing reaction of $KMnO_4$ with ethene and ethyne.

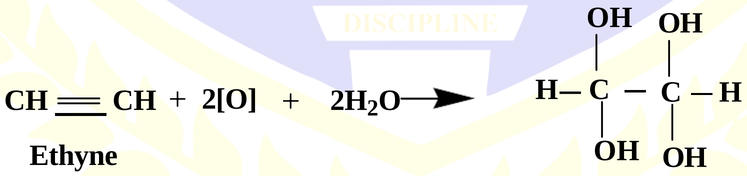
Ans: When **ethene** (or any other alkene) is treated with dilute alkaline aqueous solution of $KMnO_4$ (1%), addition of two hydroxyl groups occurs across the double bond. The colour of $KMnO_4$ solution is discharged during the reaction. This test is used for the presence of an alkene and is known as **Baeyer's test.**



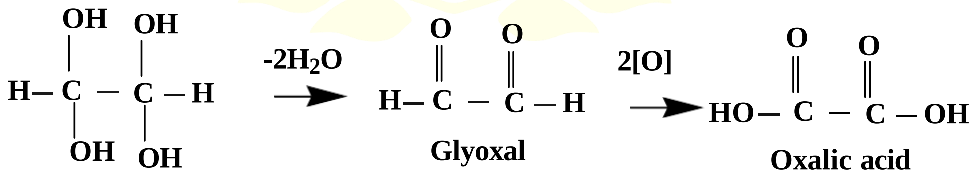
Ethylene glycol

Ethyne like other alkynes do not react with dilute alkaline $KMnO_4$ aqueous solution, however in strong alkaline solution of $KMnO_4$, it is oxidized to oxalic acid. At first four hydroxyl groups are added across the triple bond, but this is unstable so it loses two water molecules and later oxidize to oxalic acid.

$$4KMnO_4 + 4KOH \longrightarrow 4K_2MnO_4 + 4[O]$$



Tetrahdroxyethane



Tetrahdroxyethane

Q.8. List some industrial uses of ethene and ethyne.

Ans:
- Ethene is used in the manufacture of polythene, one of the most familiar plastic.
- Ethene is also converted to ethylene glycol which is used as antifreeze in auto mobile radiators.
- Ethene is used in the manufacture of acetic acid and ethyl alcohol.
- Polymers can be found everywhere, e.g. clothes, carpets, curtains, towels, sheets, floor tiles, furniture, toys etc, are polymers made from ethene and ethyne.
- Ethyne is widely used in the oxy-acetylene welding and cutting metals.
- Ethyne is also used in the preparation of polymers like PVC (polyvinyl chloride), polyvinyl acetate, synthetic rubber, nylon, etc.

Q.9. Explain why a systematic method of naming chemical compounds is necessary.

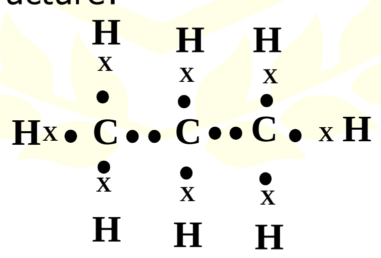
Ans: Millions of organic compounds exist. To understand, recognize and classify these compounds, systematic naming of organic compounds is necessary. Previously same organic compounds had different local names. Organic chemists began in the last century to devise a system of naming organic compounds that depend on their structure. An international body, **the International Union of Pure and Applied Chemistry** (**IUPAC**, pronounced "eye-you-pac") constantly reviews the rules for naming organic compounds. IUPAC system of naming organic compounds is based on the following principle.

Each different organic compound should have different name.

Q.10. Draw electron dot and cross structure for

(a) Propane

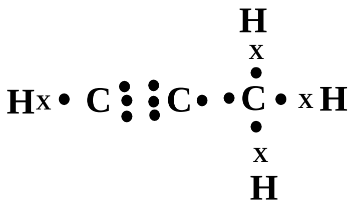
Ans: Stem: **Prop** means three carbons
Suffix: **ane** means carbon to carbon single bond (alkane)
Molecular formula: $C_3H_{(2x3)+2} = C_3H_8$
Electron dot & cross structure:



(a) Propyne

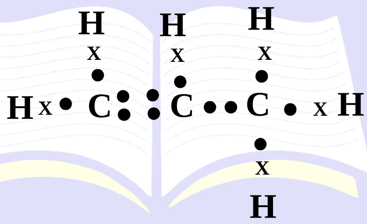
Ans: Stem: **Prop** means three carbons
Suffix: **yne** means carbon to carbon triple bond (alkyne)
Molecular formula: $C_3H_{(2x3)-2} = C_3H_4$

Electron dot & cross structure:



(a) **Propene**

Ans: Stem: **Prop** means three carbons
Suffix: **ene** means carbon to carbon double bond (alkene)
Molecular formula: $C_3H_{(2x3)}$ = C_3H_6
Electron dot & cross structure:



THINK TANK

Q.11. Write chemical equations for the preparation of propene from

(a) $\mathbf{CH_3 - CH_2 - CH_2 - OH}$

Ans

$$\underset{\text{1-Propanol}}{CH_3 - CH_2 - \underset{|}{\overset{}{CH_2}}\!\!-OH} \xrightarrow[170\ ^oC]{\text{Conc. } H_2SO_4} \underset{\text{Propene}}{CH_3 - CH = CH_2} + H_2O$$

(b) $\mathbf{CH_3 - C \equiv CH}$

Ans

$$\underset{\text{Propyne}}{CH_3 - C \equiv CH} + H_2 \xrightarrow[200\text{-}300\ ^oC]{Ni} \underset{\text{Propene}}{CH_3 - CH = CH_2}$$

Q.12. Write down structural formulas for the products which are formed when 1-butene is reacted with

(a) $\mathbf{H_2/Ni}$

Ans

$$\underset{\text{1-Butene}}{CH_3 - CH_2 - CH = CH_2} + H_2 \xrightarrow[200\text{-}300\ ^oC]{Ni} \underset{\text{n-Butane}}{CH_3 - CH_2 - CH_2 - CH_3}$$

(b) Dilute alkaline aqueous $KMnO_4$ solution

Ans

$$\underset{\text{1-Butene}}{3CH_3-CH_2-CH=CH_2} + 2KMnO_4 + 4H_2O \longrightarrow \underset{\text{Butane-1,2-diol (Butylene glycol)}}{3CH_3-CH_2-\underset{|\atop OH}{CH}-\underset{|\atop OH}{CH_2}} + 2MnO_2 + 2KOH$$

(c) Bromine water

Ans

$$\underset{\text{1-Butene}}{CH_3-CH_2-CH=CH_2} + Br_{2(aq)} \longrightarrow \underset{\text{1,2-Dibromo butane}}{CH_3-CH_2-\underset{|\atop Br}{CH}-\underset{|\atop Br}{CH_2}}$$

(d) Chlorine

Ans

$$\underset{\text{1-Butene}}{CH_3-CH_2-CH=CH_2} + Cl_2 \longrightarrow \underset{\text{1,2-Dichloro butane}}{CH_3-CH_2-\underset{|\atop Cl}{CH}-\underset{|\atop Cl}{CH_2}}$$

Q.13. Identify A, B, C, D in the following reactions:

(a)

$$\text{Propene} \xrightarrow{Br_2} A \xrightarrow[KOH]{\text{Alcohol}} B$$

Ans

$$\underset{\text{Propene}}{CH_3-CH=CH_2} + Br_2 \longrightarrow \underset{\underset{A}{\text{1,2-Dibromo propane}}}{CH_3-\underset{|\atop Br}{CH}-\underset{|\atop Br}{CH_2}} \xrightarrow[KOH]{\text{Alcohol}} CH_3-\underset{|\atop Br}{C}=CH + KBr + H_2O \longrightarrow \underset{B}{H_3C-CH\equiv CH} + KBr + H_2O$$

Name of compound A = 1,2-Dibromopropane
Name of compound B = Propene

(b)

$$\text{Ethyl alcohol} \xrightarrow{\text{Conc. } H_2SO_4} C \xrightarrow{Br_2} D$$

Ans

$$\underset{\text{Ethyl alcohol}}{CH_3-\underset{|\atop OH}{CH_2}} \xrightarrow[170\ ^oC]{\text{Conc. } H_2SO_4} \underset{\underset{C}{\text{Ethene}}}{CH_2=CH_2} + H_2O$$

$$\underset{\text{Ethene}}{CH_2=CH_2} + Br_2 \longrightarrow \underset{\underset{D}{\text{1,2-Dibromo ethane}}}{\underset{|\atop Br}{CH_2}-\underset{|\atop Br}{CH_2}}$$

Name of compound C = Ethene
Name of compound D = 1,2-Dibromo ethane

Q.14. Construct a scheme to convert ethene into ethyne.

Ans

$$\underset{\text{Ethene}}{CH_2 = CH_2} + Br_{2(aq)} \longrightarrow \begin{array}{cc} CH_2 & - \; CH_2 \\ | & \;\; | \\ Br & \;\; Br \end{array}$$

1,2-Dibromo ethane

$$\begin{array}{l} H_2C = CH_2 \\ \;\;\;\; | \qquad\; | \\ \;\;\; Br \quad\; Br \end{array} + KOH \xrightarrow{\text{Alcohol}} \begin{array}{l} HC = CH_2 \\ \;\;| \\ Br \end{array} + KBr + H_2O$$

Vinyl Bromide

$$\begin{array}{l} HC = CH_2 \\ \;\;| \\ Br \end{array} + KOH \xrightarrow{\text{Alcohol}} HC \equiv CH + KBr + H_2O$$

Propyne

Q.15. You are given flammable liquid hydrocarbons. One of them is an alkene and the other is an alkane. How would you find out which is which?

Ans Alkenes have a carbon-carbon double bond while alkanes have all carbon-carbon single bonds. Alkenes are more reactive and can decolourize bromine water or dilute alkaline $KMnO_4$ aqueous solution. The decolorization of bromine solution is used as a simple test for **presence of unsaturation.** Bromine is a reddish brown liquid but the product formed by its reaction with alkenes is colourless.

- For this purpose take these hydrocarbons in two different test tubes.
- Add small quantity of bromine aqueous solution in each test tube and slowly shake it.
- The test tube containing alkene will decolourize bromine water while colour of solution containing alkane will remain unchanged.

Example:

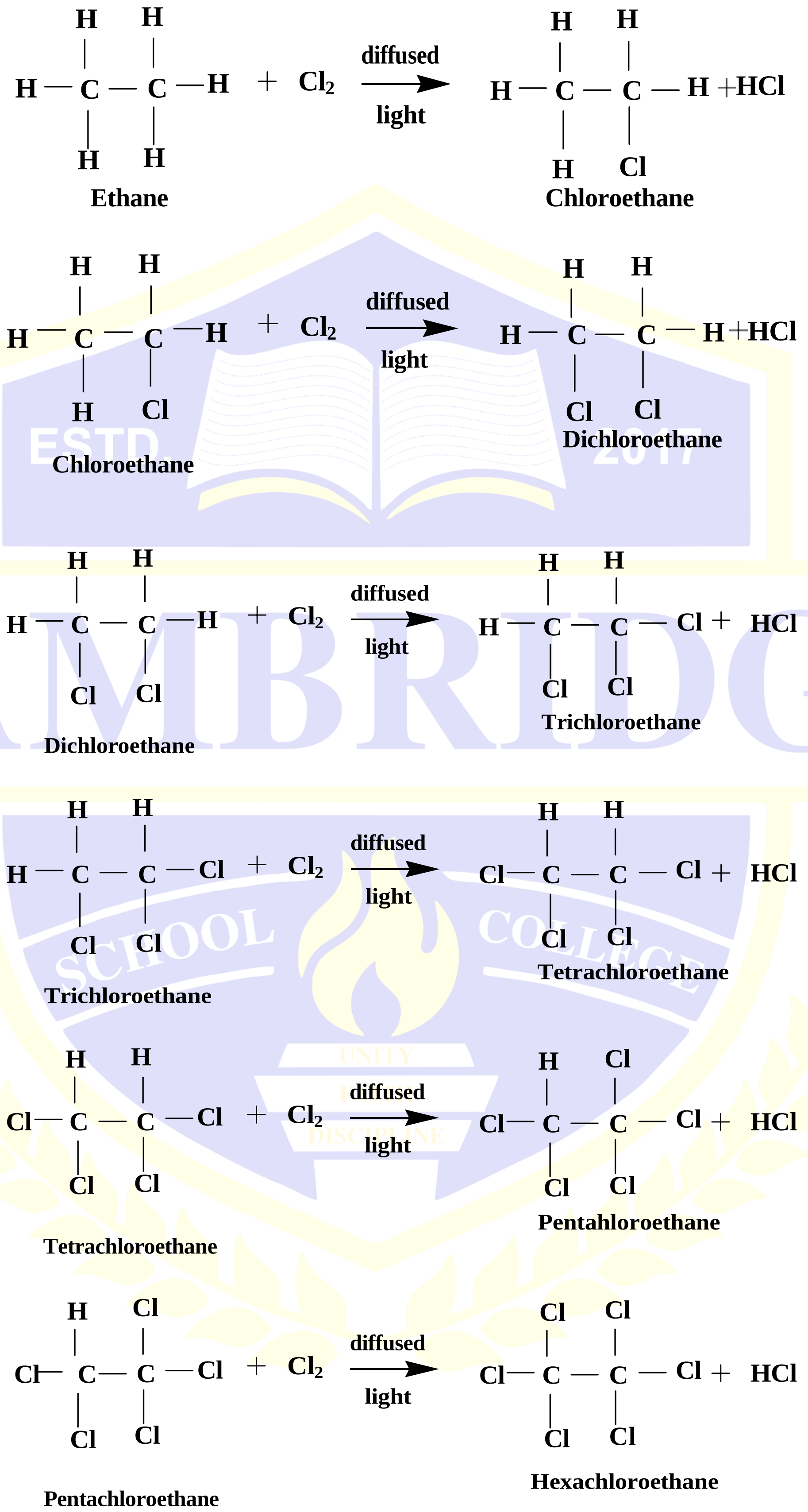
$$\underset{\text{Ethane}}{CH_3 - CH_3} + Br_{2(aq)} \longrightarrow \text{No reaction}$$

$$\underset{\text{Ethene}}{CH_2 = CH_2} + Br_{2(aq)} \longrightarrow \begin{array}{cc} CH_2 & - \; CH_2 \\ | & \;\; | \\ Br & \;\; Br \end{array}$$

1,2-Dibromo ethane

Q.16. **How many possible products are there when chlorine reacts with ethane? Draw them all.**

Ans



INFO BOXES

Info Box No. 1.

Q. How carbon dioxide causes green house effect?

Ans: Green house effect is referred to entrapment of heat energy. Carbon dioxide is released in atmosphere due to burning of fossil fuels and causes green house effect. Carbon dioxide and other gases in the air let the sun rays in, to warm the surface of earth. When the earth tries to radiate this heat back into the space, molecules of these gases trap this energy.

Info Box No. 2.

Q. What are polymers? Which compounds are used to prepare polymers and what are uses of polymers?

Ans: Polymers is derived from two words, „poly" means „many" and „mer" means „unit", so polymers are large molecules composed of hundreds and thousands of small units. Alkenes are starting material for the synthesis of many valuable materials, especially polymers. Some alkenes and alkynes serve as starting materials for synthesis. For instance ethane and ethyne are used to synthesize a number of polymers. Polymers can be found everywhere e.g. clothes, carpets, curtains, towels, sheets, floor tiles, furniture, toys etc, are polymers made from ethene and ethyne. Even in the car, the dashboard, seats, tyres, floor mat, ceiling, are also made of polymers. Hydrocarbons are also used as raw materials for the synthesis of synthetic rubber, plastic, films, adhesives, drugs and dyes. In the field of medicine, body replacement parts are made from polymers. In future, artificial bones that can stimulate bone growth and artificial lungs as well as artificial hearts are also under experimental stages.

Info Box No. 3.

Q. What are uses of ethylene?

Ans: Ethylene or ethene is the most important commercial organic chemical. Its uses are as follows:

- It is used in the manufacture of polythene, one of the most familiar plastic.
- It is also converted to ethylene glycol which is used as antifreeze in auto mobile radiators.
- It is used in the manufacture of acetic acid and ethyl alcohol.
- It is used for ripening of fruits.

Info Box No. 4.

Q. How alkenes especially ethene is used for ripening of fruits and vegetables?

OR

Write a note on artificial ripening of fruits and vegetables.

Ans: Alkenes occur widely in nature. Ripening fruits and vegetables give off ethene which helps in further ripening. So artificially ethene is used to hasten the normal ripening process. For example 1 kg of tomatoes can be ripened by exposure to 0.1 mg of ethene for 24 hours. The red colour of tomatoes is due to an alkene called lycopene.

Info Box No. 5.

Q. What is the use of oxy-acetylene torches?

Ans: Acetylene is used in oxy-acetylene torches for cutting and welding metals. Such torches can produce temperature as high as 3000 ^{o}C.

Info Box No. 6.

Q. Why hydrocarbons are considered as a source of energy?

OR

What is a combustion reaction? How this reaction provides energy?

Ans: Natural gas, petroleum and coal are important sources of hydrocarbons. These hydrocarbons are major sources of energy. When they burn in air a highly exothermic reaction occurs. This reaction is called **combustion reaction.**

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

Hydrocarbons are used as fuels to meet energy needs in homes, industries, motor vehicles and power generation.

Info Box No. 7.

Q. What are uses of halogenated hydrocarbons?

Ans: Many halogenated hydrocarbons have important commercial uses.

- Methyl chloride is a gas at room temperature. Dichloromethane, trichloromethane and tetrachloromethane are liquids. These three liquids can be used as solvent for gases, oils and other organic substances.
- Chloroform is used as an anesthetic.
- Tetrachloromethane has carcinogenic effects at high concentration.

PREVIOUS BOARD QUESTIONS

Multiple Choice Questions

2014

Complete the following reaction:

$$CH \equiv CH + H_2 \xrightarrow[200\text{-}300\,^{o}C]{Ni} \_\_\_\_\_\_\_\_\_\_$$

(a) $CH_2 - CH_2$
(b) $CH_2 = CH_2$
(c) $CH_2 \equiv CH_2$
(d) $CH_3 - CH_3$

Answer: (b)

Explanation: hydrogenation of alkynes yield alkenes.

$$\underset{\text{Ethyne}}{CH \equiv CH} + H_2 \xrightarrow[200\text{-}300\,^{o}C]{Ni} \underset{\text{Ethene}}{CH_2 = CH_2}$$

2014

Which of the following reacts explosively with methane?

(a) F_2
(b) Cl_2
(c) Br_2
(d) I_2

Answer: (a)

Explanation: F_2 is highly reactive and being highly electronegative element, it reacts explosively.

2014

What percent of alkaline aqueous solution of $KMnO_4$ is used to detect the presence of an alkene?

(a) 0.001 %
(b) 0.01 %
(c) 0.1 %
(d) 1 %

Answer: (d)

Explanation: 1 % alkaline aqueous solution of $KMnO_4$ is used to detect the presence of an alkene. This is known as **Baeyer's test.**

$$\underset{\text{Ethene}}{3CH_2 = CH_2} + 2KMnO_4\ 4H_2O \rightarrow \underset{\text{Ethylene glycol}}{3\underset{OH}{\underset{|}{CH_2}} - \underset{OH}{\underset{|}{CH_2}}} + 2MnO_2 + 2KOH$$

2014

Which process produces an alkane?

(a) Combustion
(b) Hydration
(c) Dehydration
(d) Hydrogenation

Answer: (d)

Explanation: hydrogenation is addition of hydrogen across a double bond and it result in the formation of alkane.

$$\underset{\text{Propene}}{CH_3 - CH = CH_2} + H_2 \xrightarrow[200\text{-}300\,^{o}C]{Ni} \underset{\text{Propane}}{CH_3 - CH_2 - CH_3}$$

2015

Which is used for dehydrohalogenation?

(a) Alcoholic KOH
(b) Al_2O_3
(c) Conc. H_2SO_4
(d) Bromine water

Answer: (a)

Explanation: Dehydrohalogenation means removal of hydrogen as well as a halogen from a compound. Dehydrohalogenation of alkyl halides result in the formation of alkenes.

$$\underset{\text{Bromoethane (Ethyl bromide)}}{CH_3-\underset{\displaystyle Br}{\underset{|}{CH_2}}} + KOH \xrightarrow{\text{Alcohol}} \underset{\text{Ethene}}{CH_2=CH_2} + KBr + H_2O$$

2015

Hydrogen is added to propene according to following equation:

$$CH_3-CH=CH_2 + H_2 \xrightarrow[200\text{-}300\ ^\circ C]{} CH_3-CH_2-CH_3$$

Which of the following catalyst is used for this reaction?

(a) $Zn/HCl_{(aq)}$
(b) Ni
(c) Pt
(d) Zn

Answer: (b)

Explanation: Ni is used as a catalyst for hydrogenation at 200 – 300 $^\circ$C. Pt can also be used as a catalyst for hydrogenation but at room temperature.

$$\underset{\text{Propene}}{CH_3-CH=CH_2} + H_2 \xrightarrow[200\text{-}300\ ^\circ C]{Ni} \underset{\text{Propane}}{CH_3-CH_2-CH_3}$$

2016

By dehydration we mean, the removal of

(a) Hydrogen halide
(b) Hydrogen
(c) Water
(d) Halogen

Answer: (c)

Explanation: „Hydra" is the word for water and „de" is used for removal of something, so dehydration means the removal of water. Dehydration is the term used when two hydrogen atoms and one oxygen atom are removed from a compound and water is formed.

2016

Which process, produces an alkane

(a) Dehydration
(b) Hydrogenation
(c) Hydration
(d) Combustion

Answer: (b)

Explanation: hydrogenation is addition of hydrogen across a double bond and it result in the formation of alkane.

$$\underset{\text{Propene}}{CH_3-CH=CH_2} + H_2 \xrightarrow[200\text{-}300\ ^\circ C]{Ni} \underset{\text{Propane}}{CH_3-CH_2-CH_3}$$

Short Questions

2014

How can you convert ethyne into ethane?

Ans: Hydrogenation of alkenes and alkynes result in the production of alkane. Ethyne can be converted into ethane in the presence of Ni in two steps, firstly ethyne is converted to ethene and hydrogenation of ethene leads to the formation of ethane.

$$\underset{\text{Ethyne}}{CH \equiv CH} + H_2 \xrightarrow[200\text{-}300\,^{o}C]{Ni} \underset{\text{Ethene}}{CH_2 = CH_2}$$

$$\underset{\text{Ethene}}{CH_2 = CH_2} + H_2 \xrightarrow[200\text{-}300\,^{o}C]{Ni} \underset{\text{Ethane}}{CH_3 - CH_3}$$

2014

Complete and balance the following chemical reactions?

Ans: Same as Self Assessment 12.7

2014

Write down the uses of ethyne (acetylene).

Ans: Some uses of acetylene are as follows:

4. Acetylene is widely used in the oxy-acetylene welding and cutting metals.
5. Acetylene is also used in the preparation of polymers like PVC (polyvinyl chloride), polyvinyl acetate, synthetic rubber, nylon, etc.
6. Acetylene is also used for artificial ripening of fruits.

2014

Draw structural formula of the following:

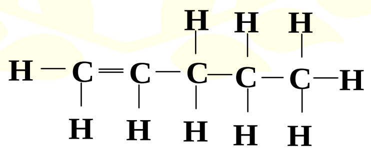
a. **1-Butyne**

Ans: Stem: **But** means four carbons

Suffix: **yne** means carbon to carbon triple bond (alkyne)

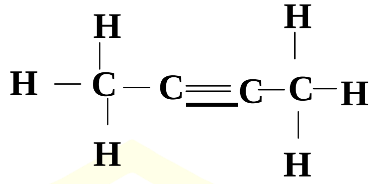
Molecular formula: $C_4H_{(2x4)-2} = C_4H_6$

Position of triple bond: between carbon 1 & 2



b. **2-Butyne**

Ans: Stem: **But** means four carbons
Suffix: **yne** means carbon to carbon triple bond (alkyne)
Molecular formula: $C_4H_{(2x4)-2} = C_4H_6$
Position of triple bond: between carbon 2 & 3



Describe halogenations briefly?

OR

What do you know about halogenations? Write the chemical reaction during diffused and bright sunlight.

OR

Write at least three reactions of methane and chlorine in diffused sunlight.

2014 & 2016

<u>**Ans:**</u> **Halogenation is** substitution of halogens to alkanes to form alkyl halides. Methane and chlorine react **in diffused light** to form series of halo alkanes. This is a substitution reaction and one by one all hydrogen atoms of methane are substituted by chlorine atoms.

$$\underset{\text{Methane}}{CH_4} + Cl_2 \xrightarrow[\text{sunlight}]{\text{diffused}} \underset{\text{Chloromethane}}{CH_3Cl} - HCl$$

$$\underset{\text{Chloromethane}}{CH_3Cl} + Cl_2 \xrightarrow[\text{sunlight}]{\text{diffused}} \underset{\text{Dichloromethane}}{CH_2Cl_2} + HCl$$

$$\underset{\text{Chloromethane}}{CH_3Cl} + Cl_2 \xrightarrow[\text{sunlight}]{\text{diffused}} \underset{\text{Dichloromethane}}{CH_2Cl_2} + HCl$$

$$\underset{\text{Trichloromethane}}{CHCl_3} + Cl_2 \xrightarrow[\text{sunlight}]{\text{diffused}} \underset{\substack{\text{Tetrachloromethane} \\ \text{(Carbon tetrachloride)}}}{CCl_4} + HCl$$

In direct sunlight the reaction of methane with chlorine is highly explosive and forms carbon and HCl.

$$\underset{\text{Methane}}{CH_4} + 2Cl_2 \xrightarrow[\text{sunlight}]{\text{direct}} \underset{\text{carbon black}}{C} - 4HCl$$

2015

How are alkenes prepare from the following:

a. **Alcohol**

Ans:

$$\underset{\text{1-Propanol}}{CH_3-CH_2-\underset{\large OH}{\underset{|}{CH_2}}} \xrightarrow[170\,^{o}C]{Conc.\ H_2SO_4} \underset{\text{Propene}}{CH_3-CH=CH_2} + H_2O$$

b. **Alkyl halide**

Ans:

$$\underset{\text{1-Bromo propane}}{CH_3-CH_2-\underset{\large Br}{\underset{|}{CH_2}}} + KOH \xrightarrow{Alcohol} \underset{\text{Propene}}{CH_3-CH=CH_2} + KBr + H_2O$$

2015

Complete the following reactions

a.

$$CH_3-CH_2-\underset{\large Br}{\underset{|}{CH_2}} + KOH \xrightarrow{Alcohol}$$

Ans:

$$\underset{\text{1-Bromo propane}}{CH_3-CH_2-\underset{\large Br}{\underset{|}{CH_2}}} + KOH \xrightarrow{Alcohol} \underset{\text{Propene}}{CH_3-CH=CH_2} + KBr + H_2O$$

b.

$$CH_3-CH_2-\underset{\large OH}{\underset{|}{CH_2}} \xrightarrow[170\,^{o}C]{Conc.\ H_2SO_4}$$

Ans:

$$\underset{\text{1-Propanol}}{CH_3-CH_2-\underset{\large OH}{\underset{|}{CH_2}}} \xrightarrow[170\,^{o}C]{Conc.\ H_2SO_4} \underset{\text{Propene}}{CH_3-CH=CH_2} + H_2O$$

c.

$$CH_3-CH=CH_2 + KMnO_4 + H_2O \longrightarrow$$

Ans:

$$\underset{\text{Propene}}{3CH_3-CH=CH_2} + 2KMnO_4 + 4H_2O \longrightarrow \underset{\text{Propylene glycol}}{3CH_3-\underset{\large OH}{\underset{|}{CH}}-\underset{\large OH}{\underset{|}{CH_2}}} + 2MnO_2 + 2KOH$$

2016

Draw electron dot cross structure for:

a) Propane **b) propene** **c) propyne**

Ans: Same as Review exercise Q.No.10

Long Questions

2015 & 2016

How alkynes are prepared from a) Vicinal dihalides b) Tetra halides

OR

Write general methods of preparation of alkynes.

Ans: Same as Q.6 of review exercise.

CHAPTER 13

BIOCHEMISTRY

SELF ASSETSSMENT EXERCISES

SELF-ASSESSMENT EXERCISE 13.1

Q.1: Classify sucrose, lactose and maltose in monosaccharide, disaccharide, or trisaccharide. Give reason.

A. Since sucrose consists of two monomers therefore sucrose is a disaccharide, which we call table sugar or sugar itself.

- Sucrose is disaccharide of glucose and fructose
- Lactose is a disaccharide of glucose and galactose.
- Maltose is disaccharides of a glucose and glucose.

Q.2: Is Galactose a monosaccharide?

A. Galactose is a monosaccharide because it cannot hydrolyze and consists of only one unit.

Q.3: Raffinose, $C_{18}H_{38}O_{16}$ hydrolyzed as follows. Is raffinose a disaccharide?

$$C_{18}H_{38}O_{16} + 2H_2O \rightarrow 3C_6H_{12}O_6$$

Raffinose, found in molasses contains the three hexoses. Therefore raffinose is a tri-saccharide.

SELF –ASSESSMENT EXERCISE 13.2

Q.1: List:

- **Three examples of monosaccharide**
- **Three examples of disaccharides**
- **One example of trisaccharides**
- **Two examples of polysaccharides**

Answer: ***Examples of Monosaccharide:***

Glucose, Mannose, Galactose, Fructose

Examples of disaccharides:

Maltose, lactose, sucrose

Examples of trisaccharides

Cellulose, glycogen, starch

Two examples of polysaccharides

Starch and cellulose

Q.2: List sources of:

Sucrose Maltose Lactose

Answer:

Sources of sucrose:

Sucrose is obtained from sugar-cane, sugar beet, honey and fruits.

Sources of maltose

Maltose is found in cereals. It is also found in beverages, beer, cereal, pasta, and potato.

Sources of lactose

Lactose is main sugar in milk and dairy products.

SELF ASSESSMENT EXERCISE 13.3

Q.1: What two functional groups are found in amino acid?

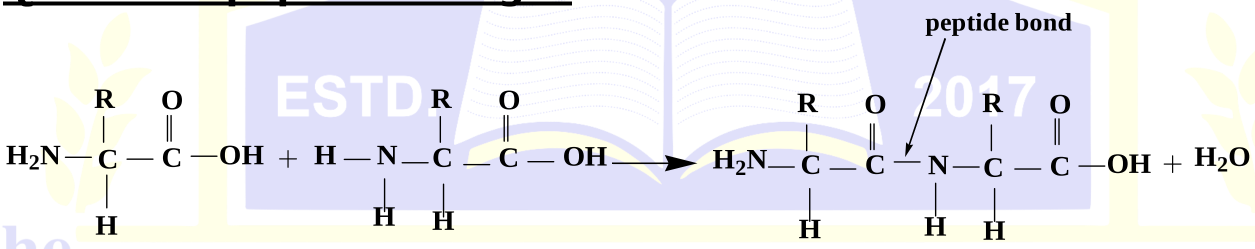
Answer: An amino acid has two functional groups. All amino acids have a carbonyl and amino group in order for them to form long continuous chains of protein.

Q.2: Define

Protein: Proteins are complex nitrogenous substances that produce amino acids on complete hydrolysis.

Amino acids: Amino acids are biologically important organic compounds made from amine ($-NH_2$) and carbonyl acid ($-COOH$) functional groups along with a side-chain specific to each amino acid.

Q.3: Draw peptide linkage?



Amino acid | Amino acid | Dipeptide

Q.2: Define

Essential amino acids

Essential amino acids cannot be made by the body. As a result, they must come from food.

The essential amino acids are histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine.

Non Essential amino acids.

―Non essential‖ means that our bodies produce an amino acid, even if we don't get it from the food we eat.

They include alanine, asparagine, aspartic acid, and glutamic acid.

SELF ASSESSMENT EXERCISE 13.4

Q.1: Define

Lipids:

A fatty or waxy organic compound that is readily soluble in non polar solvent (i.e., ether) but not in polar solvent (i.e. water) its major biological functions involve energy storage, structural component of cell membrane and cell signaling.

Examples of lipids are waxes, oil sterols, cholesterol, fat soluble vitamins, monoglycerides, diglycerides, triglycerides, (fats) and phospholipids.

Fats:

Fats are large number of oily compounds that are widely found in plans and animals mainly as a reserve source of energy.

Some examples of food that contain fats are butter, oil, nuts, meat, fish, and some dairy products.

Oils:

A lipid is called oil; it is liquid at room temperature. Oil contains proportion of unsaturated fatty acid units.

Q.2: Consult table 13.1 and write:

No. of Carbon Atoms	Condensed Structure	Name	Source
4	CH_3-CH_2-CH_2-COOH	Butyric Acid	Butter
6	CH_3-$(CH_2)_4$-COOH	Caproic Acid	Butter
16	CH_3-$(CH_2)_{14}$-COOH	Palmitic Acid	Palm Oil
18	CH_3-$(CH_2)_{16}$-COOH	Stearic Acid	Beef Fat
18	CH_3-$(CH_2)_7$-CH=CH$(CH_2)_7$-COOH	Oleic Acid	Olive Oil

I: The names of two fatty acids that are components of fats:

- Stearic Acid CH_3-$(CH_2)_{16}$-COOH
- Butyric Acid CH_3-CH_2-CH_2-COOH

II: The name of one Fatty acid that is component of oil:

- Oleic Acid CH_3-$(CH_2)_7$-CH=CH$(CH_2)_7$-COOH

SELF ASSESSMENT EXERCISE 13.5

Q.1: How do DNA and RNA differ in structure?

Deoxyribonucleic Acid DNA:

DNA exists in the form of two strands twisted around each other in a spiral formation called double helix. Each chain or strand is made up of a deoxyribose sugar, phosphate unit and a nitrogen base. These strands are held together by hydrogen bonds. The order of the base pairs in a strand is a code that stores information which is used to produce proteins.

Ribonucleic Acid RNA

RNA exists in a form of single strand. It is made up of ribose sugar, phosphate unit and nitrogen base. RNA is synthesized by DNA to transmit the genetic information. RNA is responsible for directing synthesis of new proteins.

Q.2: Name the two kinds of Nucleic Acids?

There are two kinds of Nucleic Acids, Deoxyribonucleic Acid DNA and ribonucleic acid RNA.

Q.3: Write Difference between DNA and RNA.

DNA	RNA
DNA has the bases adenine, thymine, guanine and cytosine.	RNA has the bases adenine, uracil, guanine, and cytosine.
DNA has the sugar de-oxyribose sugar.	RNA has the sugar ribose.
DNA is double stranded.	RNA is single stranded.

Q.4: What is the sugar unit of DNA?

Deoxyribose

Q.5: What is the sugar unit of RNA?

Ribose

SELF ASSESSMENT EXERCISE 13.6

Q 1: Define Vitamins?

Vitamins specific organic compounds which are required by our bodies to prevent specific diseases cannot be produced by our bodies.

Q 2: Is vitamin C soluble in fat or water?

Vitamin C is soluble in water.

Q 3: Give example of fat soluble vitamins.

Vitamin A, D. E and K

REVIEW EXERCISE

Q 1: Select the correct answer.

(i) Which compound found in every living cell, serves as the information and control center?

(a) Amino acid
(b) Protein
(c) Lipid
(d) DNA

Answer: (d)

Explanation:
DNA has ability to store genetic informations and to pass it on from generation to generation. Thus DNA acts as information and control centre.

(ii) Plants convert glucose into:

(a) Starch
(b) Lipids
(c) Proteins
(d) Amino acids

Answer: (a)

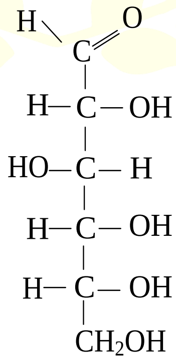
Explanation:
In plants glucose is produced during the process of photosynthesis and later on excess glucose is stored in the form of starch.

(iii) Glucose is a

(a) Tetrose
(b) Disaccharide
(c) Pentose
(d) Hexose

Answer: (d)

Explanation:



Glucose is an aldohexose. It is an aldehyde which contains six carbons, so it is a **hexose**. Glucose is a pentahydroxy aldehyde, which belong to monosaccharide group of carbohydrates.

(iv) Which is not a dextrose sugar?

(a) Glucose
(b) Mannose
(c) Galactose
(d) Fructose

Answer: (d)
Explanation:
Glucose, mannose and galactose are dextrose sugars because they rotate the plane of polarized light to right (clockwise). However fructose is levorotatory as it rotates the plane of polarized light to left (anti-clockwise), thus it is not a dextrose sugar.

(v) Raffinose $C_{18}H_{38}O_{16}$ on hydrolysis forms simple sugars:

(a) 1
(b) 2
(c) 3
(d) 3 to 9

Answer: (c)
Explanation:
Raffinose, found in molasses contains the three hexoses. Therefore raffinose is a tri-saccharide.

$$C_{18}H_{38}O_{16} + 2H_2O \rightarrow 3C_6H_{12}O_6$$

Raffinose hydrolyse to form 3 molecules of simple sugar.

(vi) Which is not a source of starch?

(a) Wheat
(b) Rice
(c) Cotton
(d) Potato

Answer: (c)
Explanation:
Wheat, rice and potatoes, all are sources of starch whereas; **cotton** is a source of **cellulose** and is used to make rayon and cellulose acetate, which are used in textile industry for making clothes.

(vii) Which is not a protein?

(a) Gelatin
(b) Antibiotics
(c) Enzymes
(d) Cholesterol

Answer: (d)
Explanation:
Cholesterol is not a protein, it belongs to fats. In our bodies cholesterol is essential for the synthesis of several harmones, vitamin D and bile acids.

(viii) Soaps and detergents are made from:

(a) Proteins
(b) Carbohydrates
(c) Fats and oils
(d) All of these

Answer: (c)
Explanation:
Fatty acids (fats and oil) react with sodium hydroxide to form soaps and detergents through the process called saponification.

(ix) Which is not present in DNA?

(a) Deoxyribose sugar
(b) Ribose sugar
(c) Phosphate unit
(d) Nitrogen base

Answer: (b)
Explanation:
Ribose sugar is part of RNA (and not DNA) along with phosphate unit and nitrogen base.

(x) Raffinose $C_{18}H_{38}O_{16}$ is a:

(a) Monosaccharide
(b) Disaccharide
(c) Oligosaccharide
(d) Polysaccharide

Answer: (c)

Explanation: Raffinose, found in molasses contains the three hexoses. Therefore raffinose is a tri-saccharide.

$$C_{18}H_{38}O_{16} + 2H_2O \rightarrow 3C_6H_{12}O_6$$

Raffinose hydrolyse to form 3 molecules of simple sugar. Oligosaccharide is the group of carbohydrates which may contain 2-9 molecules of simple sugars. So raffinose is an oligosachharide.

Q.2. Give short answer:

Q.2(i) Decide whether sucrose sia disaccharide or a monosaccharide. Give reason?

Ans: Since sucrose consists of two monomers; therefore sucrose is a disaccharide (which we call table sugar, cane sugar or ―sugar‖ itself). Sucrose is a disaccharide of Glucose and Fructose.

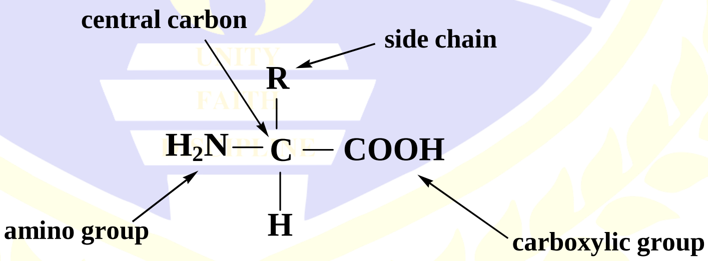
Q.2(ii) What is a dextrose sugar?

Ans: ***Dextrose – rotatory or dextrose sugars:***

Some monosaccharide molecules can rotate plane of polarized light to clockwise or right side. They are called dextrose-rotatory or dextrose sugars. Glucose, mannose, galactose are dextrose sugars.

Q.2(iii) Write formula of an amino acid and identify functional group in it?

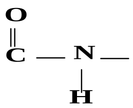
Ans: An amino acid has two functional groups. All amino acids have a carbonyl and amino group in order for them to form long continuous chains of proteins.



Amino acid

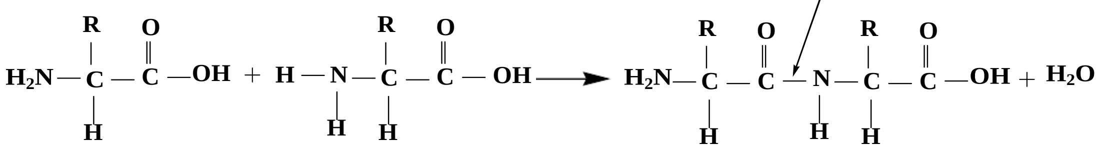
Q.2(iv) What is a peptide bond?

Ans: ***Peptide bond:***

The linkage 

which joins two amino acid units is called a peptide bond.

The resulting molecule is called a dipeptide.



Q.2(v) Which compounds are included in lipids?

Ans: ***Lipids include***:

- Fats oils
- Cholesterol
- Sex hormones
- Components of cell membrane called phospholipids
- Some vitamins (A,D and K)

Q.2(vi) ***What is the function of DNA?***

Ans: ***Function of DNA:***

DNA can store and transmit all the genetic information needed to build organisms. For instance, in human beings, the single fertilized egg cell carry the information for making legs, hands, head, liver, heart, kidney etc. DNA is found primarily in the cell nucleus.

The key to the ability of DNA to store genetic information and to pass it on from generation to generation is its double stranded structure.

Q.3 **Distinguish between mono, di, and tri saccharides. Give examples.**

Ans: ***Monosaccharide:***

Monosaccharide is a simple sugar consisting of only one unit. It serves as building blocks for more complex carbohydrate forms.

Examples: some important monosaccharides include:

- Glucose
- Fructose
- Galactose
- Lyxose
- Xylose

Disaccharides

Disaccharides are a group of sugars linked of two monosaccharide groups linked together through the loss of sugar.

Examples: Some examples include

- Maltose = glucose + glucose
- Sucrose = glucose + fructose
- Lactose = glucose + galactose

Trisachharides

Trisaccharides are sugar containing three hexoses.

Examples:

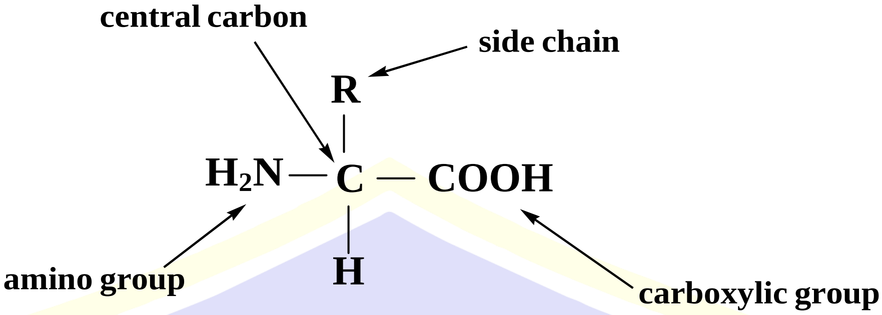
Raffinose found in molasses contains the three hexoses, Nigerotiose, maltotriose and melezitose.

Q.4 Describe bonding in protein molecule?

Ans: ***Amino acid as a building block of proteins:***

An amino acid has two functional groups, carboxyl and amino groups.

Structure of an amino acid:



Amino acid

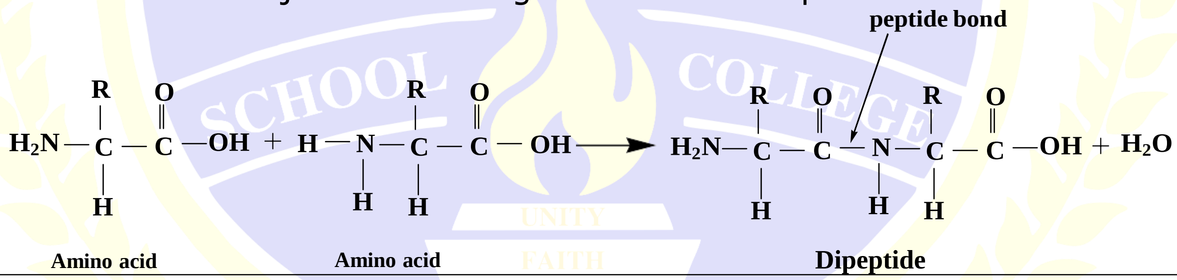
Joining two molecules of amino acid:

Molecules of amino acids join together through ($-NH_2$) group of one molecule and carboxyl group (-COOH) of another molecule by eliminating a molecule of water.

Peptide bond:

The linkage $-\overset{\overset{O}{\|}}{C}-NH-$ which joins two amino acid units is called a peptide bond.

The resulting molecule is called a dipeptide. There is still an amino acid on the left and a carboxyl group on the right. Each of these groups can react further to join more amino acid units. In this way thousands of amino acid units join to form a giant molecule of protein.



Q.5 Explain sources and uses of lipids.

Ans: *Sources of lipids:*

Animals, plants and marine organism such as salmon and whales are rich source of lipids. Milk is an important source of animal fats from which butter, cheese, ghee etc are obtained. Seeds of many plants such as sunflower, corn, cotton, ground nut, coconut, olive etc are good source of vegetable oils. Cod liver oil is obtained from salmon and whales.

Some sources of lipids are as follows:

Name	***Source***
Butyric Acid	Butter
Caproic Acid	Butter
Palmitic Acid	Palm Oil
Stearic Acid	Beef Fat
Oleic Acid	Olive Oil

Uses of lipids:

Fats and oils have several important functions in living organisms.

i. Butter ghee vegetable oil is used for cooking, frying of food and preparing bakery products and sweets.
ii. In mammals, a layer of fat is present under the skin. This layer acts as a thermal insulation.
iii. Fats protect delicate organs from shocks. A layer of fats around our heart and kidney protect these organs from injury.
iv. Lipids provide some vitamins such as A, D and E, which are essential for health. These vitamins are insoluble in water and soluble in lipids.
v. Fats and oils are important food stores in living organisms. They provide about teice, as much energy per gram as do carbohydrates.
vi. Vegetable oil and converted into vegetable ghee or margarine by catalytic hydrogenation.
vii. Fats and oils are used for manufacture of materials like soap, detergents, cosmetics, polish, paint and varnishes.
viii. In our bodies cholesterol is essential for the synthesis of several hormones vitamin D and bile acids.

Q.6 Give sources and uses of proteins.

Ans: *Sources of proteins:*

Meat, fish, egg, milk and cheese are important sources of protein. Plants also provide us proteins. For e.g., Pulses, beans, meat, egg, fish etc are rich in proteins.

Uses of proteins

1. We require proteins in our diet, to provide amino acids to make muscles, hair, enzymes and repair of body tissue.
2. Proteins are essential for the formation of protoplasm and components of cells.
3. Proteins are essential for both physical and mental growth especially in children
4. A protein called <u>Galatin</u> is obtained by heating bones and tendons in water. It is used in bakery goods.
5. Enzymes are proteins that catalyze especially biological reactions, without which life would be impossible.
6. The <u>antibodies</u> that help us to fight against disease are large protein molecules.

Q.7 Give sources and uses of Carbohydrates.

Ans: ***Sources of carbohydrates:***

Carbohydrates are most abundant class of carbon containing compounds.

Monosaccharides:

Monosaccharides such as glucose, fructose and galactose are obtained from fruits, vegetables and cereals. They are also present in honey.

Disaccharides:

Disaccharides such as sucrose are obtained from sugarcane, sugar beet and fruits. Maltose is found in cereals. Lactose is main sugar in milk and dairy products.

Cellulose

Cellulose is obtained from plants. E.g., cotton is pure cellulose.

Starch

Starch is present in cereals, wheat, barley, rice, maize, potato, sweet potato etc.

Uses of carbohydrates:

a. Carbohydrates are store and transport energy in both plants and animals. 1g of glucose provides us 15.6 KJ of energy.
b. Carbohydrates are structural materials for plants. Cellulose in the human diet is referred as fiber. It is found in bread, whole meal bread, fruit and vegetables. We cannot digest it but it is very important for us. It helps the muscles of our intestine to move food efficiently through the digestive track. It absorbs and carries away toxic chemicals in food that would otherwise harm us. It also helps in lowering cholesterol and regulates blood pressure.
c. Sucrose is used as common table sugar.
d. Glucose is stored in animal muscles and liver cells in the form of glycogen.
e. Glycogen serves as long term energy reservoir. It can be converted back to glucose when needed for energy. Plants store excess energy as starch.
f. Starch is used to make rectifies spirit by fermentation process.
g. Cows, cattle, goat, deer, sheep and termites derive nutrition from cellulose.
h. We use cellulose in the form of wood for heat, housing and furniture.
i. Wood is also used to make paper and wood pulp.
j. Cellulose fiber of cotton is used to make rayon and cellulose acetate, which are used in textile industry for making cloth.

Q.8 Differentiate between fats and oils.
Ans:

Fats	*Oils*
Fats are solid at room temperature.	Oils are liquid at room temperature.
Fats are mostly made by animals.	Oils are mostly made by plants.
Fats are more saturated.	Oils are less saturated.

Conclusion:

Fats contain larger proportion of saturated fatty acid units while oils contain larger proportion of unsaturated fatty acid units.

Q.9 Define and explain Vitamins:

Ans: ***Vitamins:***

Vitamins are specific organic compounds which are required by our bodies to prevent specific diseases but cannot be produced by our bodies.

They must be present in our diet in addition to proteins, fats, carbohydrates and minerals.

Vitamin D deficiency causes softening of bones. Vitamin B_3 deficiency causes inflammation and abnormal pigmentation.

Types of Vitamins:

There are two types of vitamins.

a) **Fat soluble vitamins:**

Fat soluble vitamins dissolve in fats and oils, e.g., vitamin A, D, E and K.

b) **Water soluble vitamins:**

Water soluble vitamins dissolve in water, e.g., vitamin B (complex) and C.

Importance of vitamins:

Vitamins are substances that are essential for our bodies.

Vitamin A:

Vitamin A is important in vision. It helps in the chemical transmission of images from eye to the brain. It also keeps the cornea moist.

Vitamin C:

Vitamin C is required for the formation of blood and boosting the immune system that protects against illness ranging from common cold to cancer.

Vitamin B:

Vitamin B helps to regulate nerve impulse transmission, in the formation of hemoglobin and activates more than 100 different enzymes.

Vitamin D:

Vitamin D regulates blood calcium. It is necessary for proper bone and teeth growth.

Q.10 Why are vitamins important for us?

Ans: ***Importance of Vitamins:***

(As same above Q9 importance of vitamins)

Q.11 Describe importance of nucleic acids.

Ans: ***Importance of nucleic acids:***

Nucleic acids are vital components of all life. They are found in very living cell. They serve as the information and control centers of the cell.

Q.12 Explain why agricultural and nutritional sciences are vital?

Ans: ***Vital importance of agricultural and nutritional sciences:***

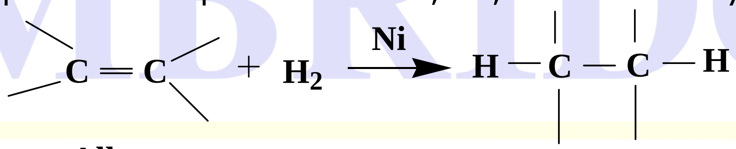
Protein deficiency leads to physical and mental retardation. Excess lipids or fats may lead to heart diseases or stroke, cancer, diabetes and other health problems. The nutritional chemists recommend that no more than 30% of our daily caloric intake come from fat.

Healthy crops, fruits and vegetables are necessary for our proper growth and health. So both agricultural nutrition sciences are vital for us.

Q.13 Explain hydrogenation of vegetable oil.

Ans: ***Hydrogenation:***

Addition of hydrogen to an alkene is called hydrogenation. This reaction takes place in the presence of Ni, Pd, or Pt as catalyst.



Alkene

Alkane

This reaction is used to make marganine or vegetable ghee. Fatty acid components of vegetable oil contain carbon-carbon double bonds. When hydrogen is added to these oils, they become saturated and harder.

Q.14 List commercial uses of enzymes?
Ans: ***Enzymes:***

Enzymes are large protein molecules. They are biological catalysts. They catalyze chemical reactions in living organisms. Enzymes are also commercially important. They are used in the production of sweeteners, chocolate, syrup, bakery products, and infant foods, detergents to remove food stains, in cheese making, in paper and pulp industries to remove sticky matter, to prepare fabric for cloths, furniture and other house hold items.

Uses of Enzymes:

a. Enzymes like diastase, invertase and zymase are used in the fermentation of molasses and starch to produce ethanol.
b. Amylase is used in bread making.
c. Proteases and amylase are used in detergents to remove stains on the cloths.
d. Lactose is used in infant foods.

Q.15 Explain the use of dextrose in drips?
Ans: ***Use of dextrose in drips:***

5% m/v aqueous solution of dextrose is used in drip. 5% m/v aqueous solution means 5 gram of dextrose dissolved in water to form $100cm^3$ of solution. It is intravenously given to patient who is severely dehydrated or is unable to eat or is not allowed to eat.

Q.16 Separate water soluble vitamins form the following:
Vitamin A, Vitamin B, Vitamin C, Vitamin E
Ans: ***Water soluble Vitamins:***
Water soluble vitamins are vitamin A vitamin B and Vitamin C.

THINK TANK

Q.17 Compare components of both protein and carbohydrates.
Ans:

Components of Protein	Components of Carbohydrates
1. Carbon	Carbon
2. Hydrogen	Hydrogen
3. Oxygen	Oxygen
4. Nitrogen	

Q.18 What three elements are important in both proteins and carbohydrates?
Ans: Carbon, hydrogen and oxygen

Q.19 What is the name of the bond that forms between two amino acids in building a protein?
Ans: Peptide bond

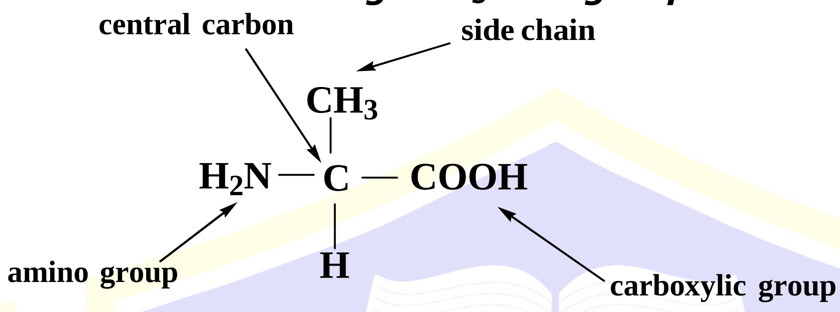
Q.20 How many molecules of water are needed to allow a disaccharide to form monosaccharides?

Ans: One water molecule

Q.21 Draw structure of each of the following molecules.

(a) ***An amino acid having –CH_3 as R group:***

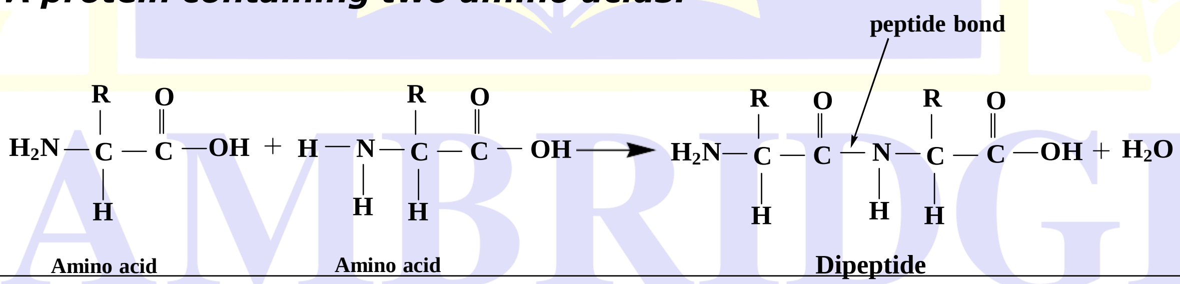
Ans:



Amino acid

(b) ***A protein containing two amino acids:***

Ans:

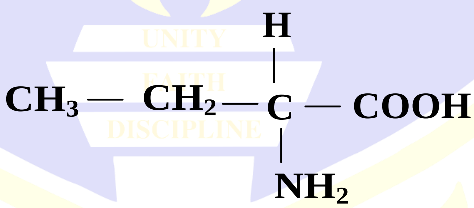


Q.22 What five elements are primarily responsible for the makeup of DNA and RNA?

Ans: The five elements are carbon, oxygen, hydrogen, nitrogen, and phosphorus.

Q.23 Write structural formula of an amino acid containing four carbon atoms:

Ans:



INFO BOXES

INFO BOX NO. 1

Q. Explain how agricultural and nutritional sciences are vital for us?
OR
Why we have to take all groups of food every day?

Ans: Protein deficiency leads to physical and mental retardation. Excess lipids or fats may lead to heart diseases or a stroke, cancer, diabetes and other health problems. The nutritional chemists recommended that no more than 30% of your daily caloric intake come from fat. Healthy crops, fruits and vegetables are necessary for our proper growth and health. So both agricultural and nutritional sciences are vital for us.

INFO BOX NO. 2

Q. What is 5% m/v aqueous solution of dextrose? Why is it given intravenously?

Ans: 5% m/v aqueous solution of dextrose is used in drips. 5% m/v aqueous solution means 5 grams of dextrose dissolved in water to form 100 cm^3 of solution. It is intravenously given to patient who is severely dehydrated or is unable to eat or is not allowed to eat.

INFO BOX NO. 3

Q. When do most of the growths occur in human life? What is importance of protein during early growth?

Ans: Most of the growth occurs in first 2 years of life. The human brain reaches nearly full size by this age. Protein deficiency leads to both physical and mental retardation.
An extreme lack of proteins and vitamins causes a deficiency disease called **kwashiorkor.** The symptoms include retarded growth, discolouration of skin and hair, bloating, a swollen belly and mental apathy.

INFO BOX NO. 4

Q. Define enzymes? What are their uses?

Ans: Enzymes are large protein molecules. They are biological catalysts. They catalysts chemical reactions in living organism. Enzymes are also commercially important. They are used in the production of sweeteners, chocolate syrup, bakery products, infant foods, detergents to remove food stains, in cheese making, in paper and pulp industries to remove sticky matter, to prepare fabrics for clothes, furniture and other household items. For example

a) Enzymes like diastase, invertase and zymase are used in the fermentation of molasses and starch to produce ethanol.
b) Amylase is used in bread making.
c) Proteases and amylase are used in detergents to remove food stains on the clothes
d) Lactase is used in infant foods.

INFO BOX NO. 5

Q. What is kwashiorkor? What are its causes? What are its symptoms?

Ans: An extreme lack of proteins and vitamins causes a deficiency disease called kwashiorkor. The symptoms include retarded growth, discolouration of skin and hair, bloating, a swollen belly and mental apathy.

INFO BOX NO. 6

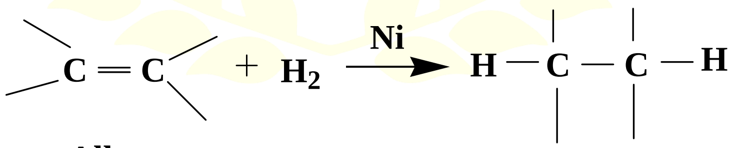
Q. From which source does cholesterol come?

Ans: All the cholesterol in human diet comes from animal products such as milk, meat, cheese and eggs. No vegetable product contains cholesterol.

INFO BOX NO. 7

Q. What is hydrogenation? Give a reaction and an example?

Ans: Addition of hydrogen to alkene is called hydrogenation. This reaction takes place in the presence if Ni, Pd or Pt as catalyst.



Alkene **Alkane**

This reaction is used to make margarine or vegetable ghee. Fatty acid component of vegetable oil contains carbon- carbon double bonds. When hydrogen is added to these oils, they become saturated and harder.

INFO BOX NO. 8

Q. **Explain about recombinant DNA technology? What are its uses?**

OR

Write a note about insulin?

Ans: Recombinant DNA technology**,** joining together of DNA molecules from two different species that are inserted into a host organism to produce new genetic combinations that are of value to science. Insulin is a protein coded by DNA. It is required for the proper use of glucose by cell. People with diabetes formerly had to use insulin from cattle. Now human insulin is made using recombinant DNA technology. Scientists take the human gene for insulin production and paste into the DNA of E. coli, a bacterium commonly found in the human digestive tract. The bacterial cell multiply rapidly, making billions of copies of themselves and each new E. Coli cell carries in its DNA, a gene for human insulin.

INFO BOX NO. 9

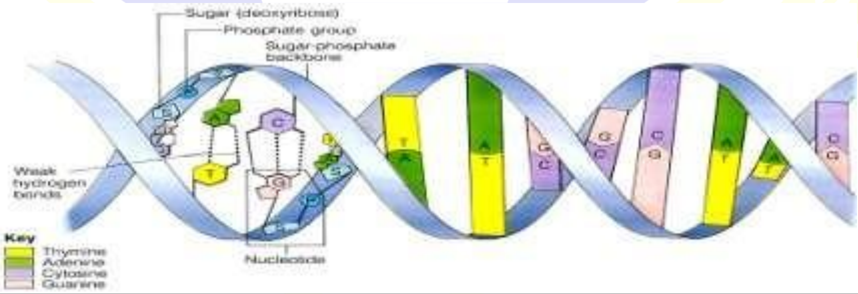
Q. **Why flax seeds are used in chicken feed?**

Ans: It has recently been shown that feeding hens, a diet containing a lot of flax seeds lowers the amount of cholesterol in egg. As cholesterol causes many heart diseases, so an egg with less cholesterol is healthier.

INFO BOX NO. 10

Q. **Describe DNA fingerprinting? Explain how it is done? What are its uses?**

Ans: The variations in DNA of individuals form a basis of a method for identifying a person from samples of their hairs, skin cells or body fluids. Because DNA sequences like fingerprints are unique for each individual, this method is called **DNA fingerprinting**. Only a tiny sample is need. The pattern is compared with the DNA of a sample from a known individual. If the DNA fingerprints are identical, it can be stated with a high degree of chemistry that the DNA in the unknown sample is from individual.



INFO BOX NO. 11

Q. Write a note on natural products as food additives.

OR

Why natural products are added in prepared food?

Ans: Some natural products are added in the prepared food to enhance colour, flavor, and fragrance. These are called **food additives.** Many of such substances are extracted from fruits and other plant materials. For instance vanilla, banana oil, grape flavoring, almond flavoring, strawberry flavoring, pine apple flavoring etc. corn syrup is used in greatest amont as resins in many food preparations.

A number of natural products are also added to the food to prevent deficiency diseases. Vitamin C is frequently added to fruit jucies and flavored drinks to prevent scurvy and elimination of rickets. Vitamin A is added to margarine to prevent night blindness.

INFO BOX NO. 11

Q. How vitamins can be lost during cooking?

OR

When we willingly let go our vitamins through drain?

Ans: Some foods lose their vitamin contents when they are cooked in water and then drained. The water soluble vitamins go down the drain with water. For example rice, pulses, beans, gram, peas etc.

Extensive or long time cooking may also result in the loss of vitamins.

INFO BOX NO. 11

Q. Write a note on sources and diseases caused by the deficiency of

OR

When we willingly let go our vitamins through drain?

Vitamin	Sources	Necessary for	Deficiency symptoms
A	Milk, butter, fish oils, eggs, fresh green vegetable	Eyes and skin	Night blindness, dry skin
B complex	Whole meal bread, rice, yeast liver, soybeans, fresh green vegetables	Energy production in cells, nerves, skin	Skin diseases, tongue inflammation , anemia, bleeding gums
C	Oranges, lemons tomatoes fresh green vegetables.	Blood vessels, gums, healing wounds, preventing colds	Scurvy
D	Milk, butter, eggs, fish oils	Bones, teeth	Rickets, osteomlacia
E	Whole meal bread, rice eggs, butter, fresh green vegetables	Antioxidant	Hemolysis of red blood cells, sterility
K	Fresh green vegetables liver	Clotting blood	Hemorrhage delayed blood clotting

PREVIOUS BOARD QUESTIONS

Multiple Choice Questions

2016

Raffinose $C_{18}H_{32}O_{16}$ is a

(a) Disaccharide
(b) Monosaccharide
(c) Trisaccharide
(d) Polysaccharide

Answer: (c)

Explanation: Raffinose, found in molasses contains the three hexoses. Therefore raffinose is a tri-saccharide.

$$C_{18}H_{38}O_{16} + 2H_2O \rightarrow 3C_6H_{12}O_6$$

Raffinose hydrolyses to form 3 molecules of simple sugar.

2016

Which is not a dextrose sugar

(a) Glucose
(b) Mannose
(c) Fructose
(d) Galactose

Answer: (c)

Explanation:

Glucose, mannose and galactose are dextrose sugars because they rotate the plane of polarized light to right (clockwise). However fructose is levorotatory as it rotates the plane of polarized light to left (anti-clockwise), thus it is not a dextrose sugar.

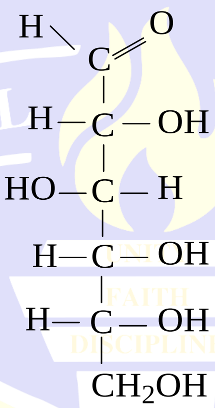
2015

Glucose is

(a) Tetrose
(b) Disaccharide
(c) Pentose
(d) Hexose

Answer: (d)

Explanation:



Glucose is an aldohexose. It is an aldehyde which contains six carbons, so it is a hexose. Glucose is a pentahydroxy aldehyde, which belong to monosaccharide group of carbohydrates.

2015

The disease caused due to deficiency of vitamin D is

(a) Rickets
(b) Scurvy
(c) Hemolysis of blood vessels
(d) Night blindness

Answer: (a)

Explanation:

Rickets is a disease caused due to deficiency of vitamin D. Bones are softened and later on de-shaped in this disease. Fracture of bones may also result. This disease occurs mostly in childhood.

2015

Raffinose $C_{18}H_{32}O_{16}$ is a/an

(a) Polysaccharide
(b) Disaccharide
(c) Monosaccharide
(d) Oligosaccharide

<u>Answer:</u> (c)

<u>Explanation:</u>

Raffinose, found in molasses contains the three hexoses. Therefore raffinose is a tri-saccharide.

$$\mathbf{C_{18}H_{38}O_{16} + 2H_2O \rightarrow 3C_6H_{12}O_6}$$

Raffinose hydrolyse to form 3 molecules of simple sugar. Oligosaccharide is the group of carbohydrates which may contain 2-9 molecules of simple sugars. So raffinose is an oligosachharide.

2015

Which of the following disease is caused due to deficiency of vitamin A?

(a) Night blindness
(b) Anaemia
(c) Scurvy
(d) Rickets

<u>Answer:</u> (a)

<u>Explanation:</u>

Night blindness, is a condition making it difficult or impossible to see in relatively low light. It is a symptom of several eye diseases. Night blindness may exist from birth, or be caused by injury or malnutrition (for example, a lack of vitamin A).

2014

Which of the following acid is found in butter?

(a) Caproic acid
(b) Palmitic acid
(c) Stearic acid
(d) Oleic acid

<u>Answer:</u> (a)

<u>Explanation:</u>

Caproic acid is found in butter. Butyric acid is also found in butter.

2014

Which of the following is a water soluble vitamin?

(a) Vitamin A
(b) Vitamin B
(c) Vitamin D
(d) Vitamin K

<u>Answer:</u> (b)

<u>Explanation:</u>

Vitamin A, vitamin D and Vitamin K are fat soluble vitamins. Vitamin B is water soluble vitamin. Other water soluble vitamin is Vitamin C.

2014

Kwashiorkor is a disease caused by extreme lack of

(a) Protein
(b) Carbohydrates
(c) Fats
(d) Minerals

<u>Answer:</u> (a)

<u>Explanation:</u>

Kwashiorkor is a disease caused by extreme lack of proteins. Due to this disease mental and physical growth of a child is retarded. This disease is common in underdeveloped countries.

2014

Disorders of red blood cells is caused due to the deficiency of

(a) Vitamin A
(b) Vitamin D
(c) Vitamin E
(d) Vitamin K

Answer: (c)

Explanation:

Disorders of red blood cells like hemolysis are caused due to deficiency of vitamin E. Vitamin E is a fat-soluble vitamin that acts as an antioxidant. Vitamin E deficiency can cause cell membranes to break down. If the cell membranes that break down are the ones that belong to red blood cells, **hemolytic anemia** develops, which is a type of anemia characterized by the destruction of red blood cells.

2014

Chemical formula of oleic acid is

(a) $C_{17}H_{33}COOH$
(b) $C_{17}H_{35}COOH$
(c) $C_{15}H_{29}COOH$
(d) $C_{15}H_{31}COOH$

Answer: (a)

Explanation:

$C_{17}H_{33}COOH$ is chemical formula of oleic acid.

Short Questions

2016

Write the general formula of amino acid and identify functional group in it.

Ans:

Answer same as Chapter 13, Review Exercise **Q.No.2 part iii**

2016

Differentiate between fats and oils.

Ans:

Answer same as Chapter 13, Review Exercise **Q.No.8**

2016

What five elements are primarily responsible for the makeup of DNA and RNA?

Ans:

Carbon, hydrogen, oxygen, nitrogen and phosphorous are five elements that are primarily responsible for the makeup of DNA and RNA.

2015 & 2016

Write three functions of proteins.

OR

Write three uses of proteins.

Ans:

1. We require proteins in our diet, to provide amino acids to make muscles, hair, enzymes and repair of body tissue.
2. Proteins are essential for the formation of protoplasm and components of cells.
3. Enzymes are proteins that catalyze especially biological reactions, without which life would be impossible.
4. The antibodies that help us to fight against disease are large protein molecules.
5. A protein called Galatin is obtained by heating bones and tendons in water. It is used in bakery goods.

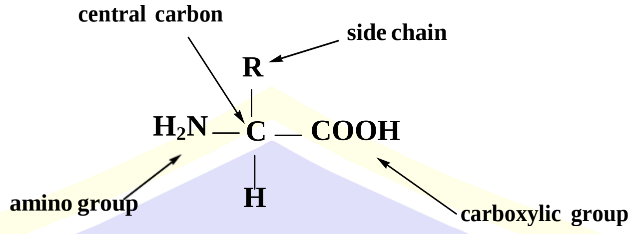
2015

What are the two functional groups found in amino acids? Draw peptide linkage.

Ans:

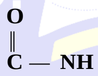
Amino acids are biologically important organic compounds made from amine ($-NH_2$) and carbonyl acid ($-COOH$) functional groups along with a side-chain specific to each amino acid.

Structure of an amino acid:

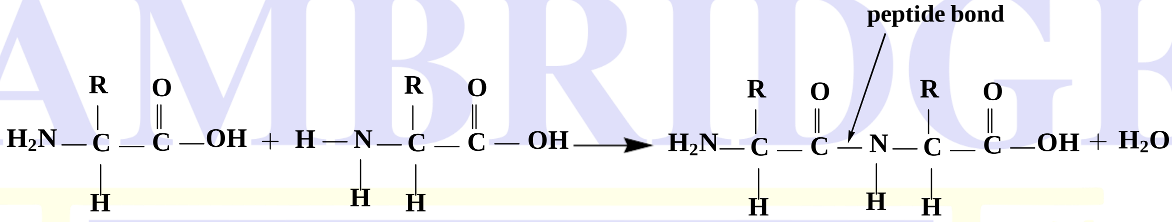


Amino acid

Peptide linkage:

The linkage  which joins two amino acid units is called a peptide bond.

The resulting molecule is called a dipeptide. In this way thousands of amino acid units join to form a giant molecule of protein.



Amino acid　　Amino acid　　**Dipeptide**

2015

Define carbohydrates. How do plants prepare carbohydrates?

Ans: A carbohydrate is a biological molecule consisting of carbon (C), hydrogen (H) and oxygen (O) atoms, usually with a hydrogen–oxygen atom ratio of 2:1 (as in water); in other words, with the empirical formula $C_x(H_2O)_y$ (where x could be different from y). Some exceptions exist; for example, deoxyribose, a sugar component of DNA, has the empirical formula $C_5H_{10}O_4$. Carbohydrates are technically hydrates of carbon; structurally it is more accurate to view them as polyhydroxy aldehydes and ketones.

Plants synthesize carbohydrates through photosynthesis.

$$6H_2O + 6CO_2 \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} C_6H_{12}O_6 + 6O_2$$

Plants convert glucose into starch and cellulose.

2015

Write three uses of carbohydrates.

Ans:

Uses of carbohydrates:

1. Carbohydrates are store and transport energy in both plants and animals. 1g of glucose provides us 15.6 KJ of energy.

2. Carbohydrates are structural materials for plants. Cellulose in the human diet is referred as fiber. It is found in bread, whole meal bread, fruit and vegetables. We cannot digest it but it is very important for us. It helps the muscles of our intestine to move food efficiently through the digestive track. It absorbs and carries away toxic chemicals in food that would otherwise harm us. It also helps in lowering cholesterol and regulates blood pressure.
3. Sucrose is used as common table sugar.
4. Glucose is stored in animal muscles and liver cells in the form of glycogen.
5. <u>Glycogen</u> serves as <u>long term energy reservoir</u>. It can be converted back to glucose when needed for energy. Plants store excess energy as starch.

2015

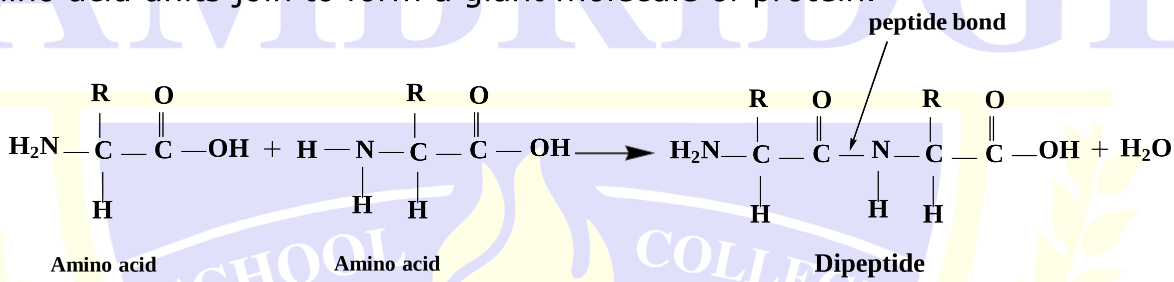
What is peptide bond? Explain with an example.

<u>Ans:</u>

Peptide bond:

The linkage $\overset{O}{\overset{\|}{C}}\ NH-$ which joins two amino acid units is called a peptide bond.

The resulting molecule is called a dipeptide. There is still an amino acid on the left and a carboxyl group on the right. Each of these groups can react further to join more amino acid units. In this way thousands of amino acid units join to form a giant molecule of protein.



2015

Define fat. Write uses of lipids.

<u>Ans:</u>

Fat is one of the three main macronutrients, along with carbohydrate and protein. Fats, also known as triglycerides, are esters of three fatty acid chains and the alcohol glycerol. Lipids comprise a group of naturally occurring molecules that include fats, waxes, sterols, fat-soluble vitamins (such as vitamins A, D, E, and K), monoglycerides, diglycerides, triglycerides and others.
A lipid is called **fat** if it is solid at room temperature. A lipid is called **oil** if it is liquid at room temperature.

Uses of lipids:

Fats and oils have several important functions in living organisms.

i. Butter ghee vegetable oil is used for cooking, frying of food and preparing bakery products and sweets.
ii. In mammals, a layer of fat is present under the skin. This layer acts as a thermal insulation.
iii. Fats protect delicate organs from shocks. A layer of fats around our heart and kidney protect these organs from injury.

iv. Lipids provide some vitamins such as A, D and E, which are essential for health. These vitamins are insoluble in water and soluble in lipids.
v. Fats and oils are important food stores in living organisms. They provide about teice, as much energy per gram as do carbohydrates.
vi. Vegetable oil and converted into vegetable ghee or margarine by catalytic hydrogenation.
vii. Fats and oils are used for manufacture of materials like soap, detergents, cosmetics, polish, paint and varnishes.
viii. In our bodies cholesterol is essential for the synthesis of several hormones vitamin D and bile acids.

2014

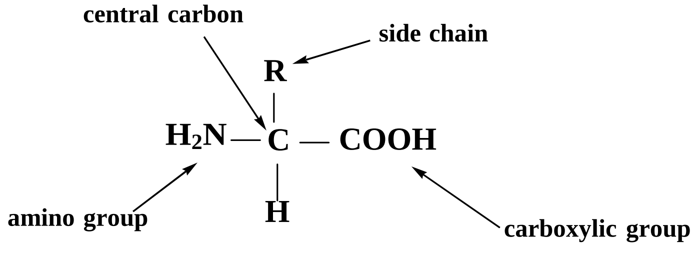
What are carbohydrates? Write down their classification. Also giveexamples of each type.

Ans:
A carbohydrate is a biological molecule consisting of carbon (C), hydrogen (H) and oxygen (O) atoms, usually with a hydrogen–oxygen atom ratio of 2:1 (as in water); in other words, with the empirical formula $C_x(H_2O)_y$ (where x could be different from y). Carbohydrates are technically hydrates of carbon; structurally it is more accurate to view them as polyhydroxy aldehydes and ketones.
Carbohydrates are classified as monosaccharides, oligosachharides and polysachharides.
Monosaccharides: Monosaccharides are the simplest carbohydrates. They cannot be hydrolysed. They have general formula $(CH_2O)_n$ where n is 3 to 7 carbon atoms. Examples are Glucose ($C_6H_{12}O_6$), Mannose, Galactose, Fructose ($C_6H_{12}O_6$), etc.
Oligosachharides: Carbohydrates which on hydrolysis form 2 to 9 molecules of monosaccharides or simple sugars are called oligosaccharide. Examples are Maltose, lactose, sucrose, etc.
Polysaccharides: Carbohydrates which upon hydrolysis form 100 to 1000 units of simple sugars are called polysaccharides. Examples are Cellulose, glycogen, starch, etc.

2014

Write a short note on "Amino Acids as Building Block".

Ans:
Amino acid as a building block of proteins:
An amino acid has two functional groups. All amino acids have a carbonyl and amino group in order for them, to form long continuous chains of proteins. Amino acids are **building blocks** of protein synthesis. Twenty different amino acids are involved in protein synthesis.
Essential and non essential amino acids:
Out of twenty amino acids, our bodies can synthesize only twenty such amino acids, called —non essential amino acids‖ . The remaining ten are called -essential amino acids‖
Structure of an amino acid:



Amino acid

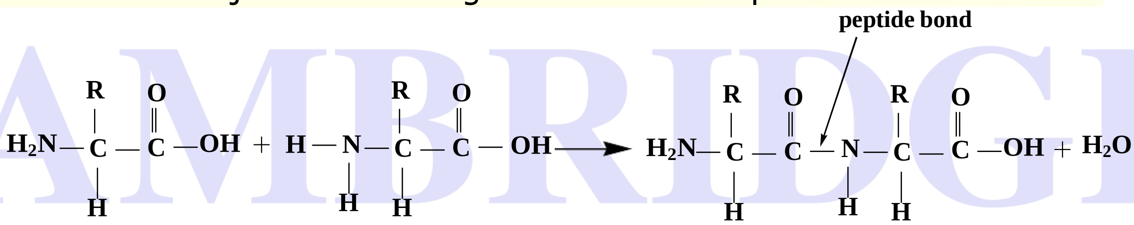
Joining two molecules of amino acid:

Molecules of amino acids join together through ($-NH_2$) group of one molecule and carboxyl group (-COOH) of another molecule by eliminating a molecule of water.

Peptide bond:

The linkage $\overset{O}{\overset{\|}{C}}-NH-$ which joins two amino acid units is called a peptide bond.

The resulting molecule is called a dipeptide. There is still an amino acid on the left and a carboxyl group on the right. Each of these groups can react further to join more amino acid units. In this way thousands of amino acid units join to form a giant molecule of protein.



Amino acid   Amino acid   Dipeptide

2014	**Differentiate between Deoxyribose Nucleic Acid (DNA) and Ribose Nucleic Acid (RNA).** **Ans:** Answer same as **Self Assessment 13.5, Q.No. 3**

Long Questions

2016 & 2015

What are vitamins? Describe the different types of vitamins.

OR

Write a note on types of vitamins.

Ans:

Vitamins:

Vitamins are specific organic compounds which are required by our bodies to prevent specific diseases but cannot be produced by our bodies.

They must be present in our diet in addition to proteins, fats, carbohydrates and minerals.

Vitamin D deficiency causes softening of bones. Vitamin B_3 deficiency causes inflammation and abnormal pigmentation. Vitamins are substances that are essential for our bodies.

Types of Vitamins:

There are two types of vitamins.

***a)* Fat soluble vitamins:**

Fat soluble vitamins dissolve in fats and oils, e.g., vitamin A, D, E and K. taking excess of fat soluble vitamins maybe harmful. For instance large excess of vitamin A can cause irritability, dry skin and feeling of pressure inside the head. Too much vitamin D can cause pain in bones, hard deposits in joints and kidneys, and weight loss.

Vitamin A:

Vitamin A is important in vision. It helps in the chemical transmission of images from eye to the brain. It also keeps the cornea moist.

Vitamin D:

Vitamin D regulates blood calcium. It is necessary for proper bone and teeth growth.

***b)* Water soluble vitamins:**

Water soluble vitamins dissolve in water, e.g., vitamin B (complex) and C. our body has limited capacity to store these vitamins. If taken in excess, these are readily excreted from the body. Water soluble vitamins are not toxic even if taken in excess.

Vitamin C:

Vitamin C is required for the formation of blood and boosting the immune system that protects against illness ranging from common cold to cancer.

Vitamin B:

Vitamin B helps to regulate nerve impulse transmission, in the formation of hemoglobin and activates more than 100 different enzymes.

2015

Write important functions of fats and oils in living organisms.

Ans:

Answer same as Chapter 13, **Review Exercise Q.No.5**

201

What are fatty acids? Give the condensed structures and sources of the following fatty acids.

i) Butyric acid **ii) Caproic acid** **iii) Palmitic acid**

iv) Stearic acid **v) Oleic acid**

Ans:

Fatty Acids

Fatty acids are long chain carboxylic acids. They are building block of lipids. Fats and oils are both simple lipids. They are esters of fatty acid with a trihydroxy alcohol (glycerol). Stearic acid is one such fatty acid, which is building block of animal fats. Some common fatty acids are given below:

No. of Carbon Atoms	Condensed Structure	Name	Source
4	CH_3-CH_2-CH_2-COOH	Butyric Acid	Butter
6	CH_3-$(CH_2)_4$-COOH	Caproic Acid	Butter
16	CH_3-$(CH_2)_{14}$-COOH	Palmitic Acid	Palm Oil
18	CH_3-$(CH_2)_{16}$-COOH	Stearic Acid	Beef Fat
18	CH_3-$(CH_2)_7$-CH=CH$(CH_2)_7$-COOH	Oleic Acid	Olive Oil

2014

What is Recombinant DNA Technology? Explain this process and how it is important for human life.

Ans:
Answer same as Chapter 13, **Info box No.8**

2014

What are the components of nucleotide?

Ans: Nucleic acids are long chain molecules made up of nucleotides. Each nucleotide consists of three components.

i. Nitrogenous base
ii. A pentose sugar or five carbon sugar
iii. Phosphate group

CHAPTER 14

THE ATMOSPHERE

SELF ASSETSSMENT EXERCISES

SELF-ASSESSMENT EXERCISE 14.1

Q.1: What two gases make up most of the air?

Nitrogen = 78% and oxygen= 21%

Q.2: Which gas has highest percentage in the air?

Nitrogen = 78%

Q.3: Which gas has lowest percentage in the air?

Hydrogen= 0.0005%

Q.4: Why the percentage of water has not been mentioned in the pie chart?

As the amount of water varies place to place, season to season and time to time, so it has not been mentioned in the chart. For example on a rainy day or in rainy season % age of water may be 4% in a tropical region, whereas; in a desert in summer season it may be 0.05% or even less.

SELF ASSESSMENT 14.2

Q: Describe how temperature changes as one moves from earth's surface into the atmosphere up to 50 km?

1km increase in altitude = 6.5 ^{o}C cooler

50 km increase in altitude = 6.5 ^{o}C * 50 = 325 ^{o}C

SELF ASSESSMENT 14.3

Q.1: What are pollutants?

Anything that is in the air, water or soil which has a harmful effect on some part of the environment is called pollutants.

Q.2: List some effects of sulphur dioxide on human beings?

Sulphur dioxide is readily absorbed in the respiratory system. Being powerful irritant, it aggravates the symptoms of people who suffer from asthma, bronchitis, emphysema and other lung diseases.

Q.3: List some of the air pollutants?

Important air pollutants are as follows:

1. Sulphur oxides (SO_x)
2. Carbon Monoxide (CO)
3. Nitrogen oxides (NO_x)
4. Methane (CH_4)
5. Chlorofluorocarbons (CFCs)
6. Lead compounds
7. Ozone

SELF ASSESSMENT 14.4

Q.1: Write names of the main pollutants in the air?

Important air pollutants in the air are as follows:

1. Sulphur oxides (SO_x)
2. Carbon Monoxide (CO)
3. Nitrogen oxide (NO_x)
4. Methane (CH_4)
5. Chlorofluorocarbons (CFCs)
6. Ozone

Q.2: complete the following reactions:

a. $2SO_2(g) + O_2(g) \rightarrow 2SO_3$

b. $2C(s) + O_2(g) \rightarrow 2CO$

c. $2CO(g) + O_2(g) \rightarrow 2CO_2$

SELF ASSESSMENT EXERCISE 14.5

Q.1: Write three human activities that are responsible for air pollution.

- Burning fossil fuel
- Cutting trees
- Use of Freon gas

Q.2: Write three natural processes that are contributing in air pollution.

Natural sources:

Many natural processes such as forest fires and dust storms release smoke and dust particles into the air, Volcanoes emit clouds of dust and poisonous gases among with ash. Termites and cows also release large amount of methane in the air. Considerable electrical discharge in the atmosphere produces nitrogen oxides.

Q.3: List main sources of the following air pollutants?

- SO_2
  Power stations and industries using fossil fuels
- CO
  Incomplete burning of wood, fuels and vehicle exhaust
- NO_2
  Exhaust fumes of motor vehicles, power stations and industries using fossil fuels.

SELF ASSESSMENT EXERCISE 14.6

Q.1: Define Global Warming?

The warming of the atmosphere which is due to our influence on the green house effect is known as global warming.

Q.2: List some effects of global warming

Effects of global warming:

Global warming is due to an upset in the natural balance of the concentration of green house gases in the atmosphere. If global warming continues, then Temperature of the earth will gradually increase. The earth climate may change, affecting both where there is rainfall and how much there is of it. This could both increase the risks of flooding in some regions and drought in others. Polar ice may melt and cause significant increase in sea levels. So the atmosphere becomes hotter.

Q.3: List some substances that are responsible for global warming?

The main causes of global warming, in order of the magnitude of their impact are:

Carbon dioxide from

- Fossil fuel
- Deforestation

Methane from

Cattle and rice paddies

Nitrogen oxides

From farming, Nitrogen oxides have 300 times more heat trapping capacity per unit volume than carbon dioxide, and we release them every time we supply fertilizer to soil.

CFCs and HCFCs (chlorofluorocarbons and hydro-chlorofluorocarbons) used in refrigeration are also powerful green house gases. These gases occur in lower concentrations in the atmosphere, but because they are so much more potent than carbon dioxide in some cases hundreds of time more potent per unit of volume, they contribute to global warming as well.

SELF ASSESSMENT EXERCISE 14.7

Q.1: Define acid rain?

Acid rain is defined as rain having pH less than 5.6

Q.2: Write names of gases that cause acid rain?

SO_2 and NO_2

Q.3: What is the effect of acid rain or iron and marble? Give balanced chemical equations?

Sulphuric acid and metals:

Sulphuric acid eats away metals to form water soluble salts and hydrogen.

$$Fe\ (s) + H_2SO_4 \rightarrow FeSO_4\ (aq) + H_2\ (g)$$

Marble building and statues:

Marble buildings and statues are disintegrated by acid rain.

$$CaCO_3 + H_2SO_4 \rightarrow CaSO_4\ (aq) + H_2O\ (g) + CO_2\ (g)$$

$$CaCO_3\ (s) + 2HNO_3\ (aq) \rightarrow Ca\ (NO_3)_2 + H_2O\ (g) + CO_2\ (g)$$

Q.4: List some effects caused by acid rain:

Acid rain corrodes metals, stone buildings and statues. Marbles statues are slowly eroded by acid rain.

REVIEW EXERCISE

Select the correct answer:

(i) ***Which gas has highest percentage in the air?***

(a) O_2
(b) N_2
(c) CO_2
(d) O_2

Answer: (b)
Explanation:
Percentage of N_2 in air is approximately 78 %.

(ii) **Lowest temperature in stratosphere is**

(a) -5°C
(b) -55°C
(c) 5°C
(d) 55°C

Answer: (b)
Explanation:
Lowest temperature in stratosphere is -55°C.

(iii) ***Which is /are responsible for acid rain?***

(a) SO_2
(b) NO_2
(c) Both NO_2 and SO_2
(d) O_3

Answer: (c)
Explanation:
Both NO_2 and SO_2 are responsible for acid rains.

$2SO_{2\,(g)} + O_{2\,(g)} \rightarrow 2SO_{3\,(g)}$

$SO_{3\,(g)} + H_2O_{\,(l)} \rightarrow H_2SO_{4\,(aq)}$

$2NO_{2\,(g)} + 3O_{2\,(g)} + 2H_2O_{\,(l)} \rightarrow 4HNO_{3\,(aq)}$

(iv) ***Which is reddish brown gas?***

(a) NO
(b) NO_2
(c) SO_2
(d) O_3

Answer: (b)
Explanation:
Nitrogen dioxide (NO_2) is reddish brown gas with pungent odour. It dissolves readily in water and in the presence of water and oxygen in atmosphere forms nitric acid responsible for acid rains.

$2NO_{2\,(g)} + 3O_{2\,(g)} + 2H_2O_{\,(l)} \rightarrow 4HNO_{3\,(aq)}$

(v) ***Troposphere extends up to***

(a) 50km
(b) 12km
(c) 18km
(d) 80 km

Answer: (b)
Explanation:
Troposphere is the innermost layer of atmosphere and it extends from 0 – 12 km.

(vi) **Stratosphere extends up to**

(a) 12 km
(b) 15km
(c) 50km
(d) 80km

Answer: (c)
Explanation:
Stratosphere is next to Troposphere (the innermost layer of atmosphere) and it extends from 12 – 50 km.

(vii) ***The Ozone layer is found in***

(a) The troposphere
(b) The mesosphere
(c) The thermosphere
(d) The stratosphere

Answer: (d)
Explanation:
The Ozone layer is found in the upper stratosphere, this layer contains about 10 ppm of ozone.

(viii) **Most air pollution is caused by:**

(a) Ozone
(b) Acid rain
(c) Carbon monoxide
(d) The burning of fossil fuel

Answer: (d)
Explanation:
Burning of fossil fuels produces carbon monoxide and SO_x and NO_x. SO_x and NO_x are responsible for acid rains. Thus burning of fossil fuel causes air pollution.

(xix) **Which layer is closest to earth?**

(a) Stratosphere
(b) Troposphere
(c) Mesosphere
(d) Thermosphere

Answer: (b)
Explanation:
Troposphere is the innermost layer of atmosphere, closest to earth and it extends from 0 – 12 km.

(x) ***The outermost layer of earth atmosphere is:***

(a) The mesosphere
(b) The stratosphere
(c) Troposphere
(d) Thermosphere

Answer: (d)
Explanation:
Thermosphere is the outermost layer of earth. It extends from above 80 km. thermo means heat and this layer has temperature as high as 1800 ^{o}C. This is because sunlight strikes the thermosphere first. Oxygen and nitrogen molecules convert this energy into heat energy.

Q.2. GIVE SHORT ANSWERS:

Q.2(i) List two sources of acid train?

Ans: Acid rain is caused mainly by the burning of fossil fuels such as coal and gasoline. Oxides of nitrogen and sulphur are released into the air when fossil fuels are burnt and when they mix the precipitation in clouds and rain is formed.

Q.2(ii) List four human activities that are responsible for air pollution.

Ans:
- Burning fossil fuel
- Cutting trees
- Use of Freon gas
- Production of methane from dead plant material decay

Q.2(iii) What is the importance of stratospheric zone?

Ans: ***Importance of stratospheric ozone:***
Ozone saves us from harmful effects of incoming ultraviolet radiations from the sun. When ozone absorbs energy from the sun, the energy is converted into heat warming the air. The ozone layer protects the living things on the earth from dangerous ultraviolet radiations of the sun.

Q.2(iv) What is role of automobile in air pollution?

Ans: Exhaust fumes of automobiles including dangerous gases such as carbon monoxides of nitrogen, hydrocarbons and particles. These exhaust fumes of automobiles are responsible for air pollution.

Q.2(v) Define atmosphere?

Ans: The envelope of gases and water vapors surrounding the planet earth called atmosphere.
Atmosphere is divided into four layers.

Q.3 Explain temperature variation in stratosphere and troposphere?

Ans: ***Temperature variation in stratosphere:***
In the stratosphere, temperature varies from -55°C to -5°C.
Temperature variation in troposphere:
An altitude increases in the troposphere, the temperature decreases from 17°C to about -55°C. On average, for every 1Km increase I altitude, the air gets about 6.5°C cooler.

Q.4 List components of stratosphere and troposphere.

Ans: ***Components of stratosphere:***

This layer contains little water vapors. Interesting information about this layer is that it contains maximum amount of ozone (about 10ppm/past per million). The presence of ozone is responsible for the rise in temperature in stratosphere.

Components of troposphere:

Nearly all the dust particles and water vapors are in the troposphere. Weather occurs in this layer. Most of all the clouds are formed in the troposphere. Air crafts fly in this region.

***Q.5* Describe sources of air pollution?**

Ans: ***Sources of air pollution:***

Air that contains harmful particles and gases is said to be polluted. Some air pollution occurs naturally. But many types of air pollution are the result of human activities.

Natural sources:

Many natural processes such as forest fires and dust storms release smoke and dust particles into the air, Volcanoes emit clouds of dust and poisonous gases long with ash. Termites and cows also release large amount of methane in the air. Considerable electrical discharges in the atmosphere produce nitrogen oxides.

Human activities:

Most of the air pollution is the result of burning fossil fuel, such as coal, petroleum and natural gas. Nearly half of the air pollution comes from cars and other motor vehicles. Factories and power plants that burn coal or oil release poisonous gases in the air. Burning fossil fuels and incineration release carbon mono-oxide CO, and nitrogen oxide NO, NO_2 and sulphur oxides SO_2, SO_3.

$$C(s) + O_2(g) \text{ limited} \rightarrow CO(g)$$
$$S(s) + O_2(g) \rightarrow SO_2(g)$$
$$N_2(g) + O_2(g) \rightarrow 2NO(g)$$
$$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$$

Chlorofluorocarbons

Chlorofluorocarbons have been widely used as solvents for cleaning electronic circuit boards, as refrigerant in fridges and air- conditioning units and as propeller in aerosol sprays (air fresheners, hairsprays, deodorants, spray paints)

Such products are not —environmental friendly‖ . During manufacture, in use and after disposal, these compounds escape into the air.

Lead particles:

Lead particles in the air come mainly due to the combustion of leaded petrol or fuel used in motor vehicles or from lead based paints.

Ozone:

Ozone is produced when electrical discharge passes through oxygen in the air. You can feel its presence near photocopier, television set, microwave oven and other electrical equipment.

$$3O_2(g) \xrightarrow[\text{Discharge}]{\text{Electrical}} 2O_3(g)$$

Q.6 <u>**Describe acid rain and its effects?**</u>

Ans: ***Acid rain and its effects:***

Acid rain is defined as rain having pH less than 5.6. Normal rain water is saturated with carbon dioxide. It has pH of 5.6. However, the acidity of rain greatly increases in polluted area thunderstorm.

Sulphur dioxide from power plants using fossils fuels and nitrogen oxides from exhaust fumes of automobiles dissolve in rain water producing acids.

$$2\,SO_{2\,(g)} + O_{2\,(g)} \rightarrow 2SO_{3\,(g)}$$
$$SO_{3\,(g)} + H_2O_{(l)} \rightarrow H_2SO_{4\,(aq)}$$
$$2NO_{2\,(g)} + 3O_{2\,(g)} + 2H_2O_{(l)} \rightarrow 4HNO_{3\,(aq)}$$

Therefore during thunderstorm the pH of rain water can be much lower because of sulphuric acid and citric acid formed by lightening. This rain may have pH as low as 2.1. This value is lower than the pH of vinegar or lemon juice.

Effect of acid rain:

Acid rain often falls hundreds of kilometers away from their sources. Acid rain corrodes metals, stone buildings and statues. Marble statues are slowly eroded by acid rain.

Sulphuric acid and metals:

Sulphuric acid eats away metals to form water soluble salts and hydrogen.

$$Fe\ (s) + H_2SO_4 \rightarrow FeSO_4\ (aq) + H_2\ (g)$$

Marble buildings and statues:

Marble buildings and statues are disintegrated by acid rain.

$$CaCO_3 + H_2SO_4 \rightarrow CaSO_4\ (aq) + H_2O\ (g) + CO_2\ (g)$$
$$CaCO_3\ (s) + 2HNO_3\ (aq) \rightarrow Ca\ (NO_3)_2 + H_2O\ (g) + CO_2\ (g)$$

Acid rain also kills fish, and destroys trees. Lake rivers may become too acidic for living things to survive.

Q.7 **Describe ozone depletion and its effects? Ozone depletion and its effects.**

Ans: Human activity releases many compounds in the atmosphere. Such compounds threaten the stability of ozone layer. Over recent years, scientists have discovered a reduction in the amount of ozone in the stratosphere

Ozone hole:

The region in which the amount of ozone has been reduced is called as ozone hole. It was first observed in October 1980 over Antarctica.

Chlorofluorocarbons:

Chlorofluorocarbons (from aerosol cans, air conditioning systems, refrigerators etc) escape into the atmosphere; CFCs are gases or low boiling liquids. They are so inert that they do not react with any other chemicals in the troposphere. They slowly diffuse into the ozone layer uv radiation break CFCs molecule producing chlorine free radicals:

$$CCl_3F\ (g) \xrightarrow{uv} CCl_2F + Cl^{\bullet}$$

1. Chlorine free radical reacts with ozone to form chlorine monoxide and molecule oxygen.
2. CLO reacts with atomic oxygen produced by the decomposition of ozone by uv radiations.

Step 1:

$$Cl^{\bullet}\ (g) + O_3\ (g) \xrightarrow{uv} Cl^{\bullet}O\ (g) + O_2\ (g)$$

Step 2:

$$Cl^{\bullet}O\ (g) + O\ (g) \xrightarrow{uv} Cl^{\bullet}\ (g) + O_2\ (g)$$

Net reaction:

$$O_3\ (g) + O\ (g) \xrightarrow{uv} 2O_2\ (g)$$

The chlorine free radical that reacts in step 1 is regenerated in step 2. One $Cl^{\bullet}$ (chlorine free radical) can, therefore destroyed thousands of ozone molecules.

Fig 14.10 shows depletion of ozone layer over the years.

Q.8 Describe global warming?

Ans: **Global warming:**

The warming of the atmosphere which is due to our influence on the green house effect is known as global warming.

Global warming as a green house effect:

Global warming is due to an upset in the natural balance of the concentration of green house gases in the atmosphere. In global warming continues, then,

i. Temperature of the earth will be gradually increasing.
ii. The earth climate may change, affecting both where there is rainfall and how much there is of it. This could cause both increased risks of flooding in some regions and drought in others.
iii. Pollen ice may melt and cause significance in sea level.
iv. So the atmosphere becomes hotter.

Q.9 **Differentiate between stratosphere and troposphere?**

Ans:

S.No.	Troposphere	Stratosphere
1.	***Location:***	
	The troposphere is the layer of the atmosphere that touches earth. From the surface of earth, the atmosphere extends out 6-8 kilometers from the poles and 17 kilometers from the equator. Between the troposphere and stratosphere is a small layer of the atmosphere called **tropo-pause.** It is present from 0-12 km from surface of earth.	The stratosphere is about 50 kilometers from the surface of the earth. It is present from 50 to 80 km from surface of earth.
2.	***Temperatures Range***	
	The temperature in the troposphere decreases by 6.5 degrees Celsius for every kilometer away from the earth's surface. The temperature stabilizes at around 12 kilometers. Temperature changes from bottom to top of the layer from 17°C to -55°C.	The stratosphere's temperature is about -50 degrees Celsius where it is closest to the earth. The upper layer is actually warmer and average -18 degrees Celsius. The reason for the warming, as this layer gets farther from the earth is the presence of ozone. Ozone absorbs sunlight and deflects it away from the earth. Temperature changes from bottom to top of the layer from -55°C to -5°C.
3.	**Lowest temperature**	
	Lowest temperature of troposphere is -55°C.	Lowest temperature of stratosphere is also -55°C at start of this layer. It gradually increases as we go upward.
4.	**Highest temperature**	
	Highest temperature of troposphere is 17°C.	Highest temperature of stratosphere is also -5°C

Q.10 Explain ozone formation?

Ans: ***Formation of ozone:***

Ozone is allotropic form of oxygen comprising there oxygen atoms, O_3 (ozone) is an important gas in the atmosphere.

Most of the ultraviolet (uv) radiations, coming from sun are filtered or screened out by the ozone layer.

Otherwise, sunlight would be much more hazardous for human beings, animals and plants. On absorbing uv radiations, ozone molecule breaks up to from a oxygen molecule and atomic oxygen.

$$O_3 (g) \xrightarrow{uv} O_2 (g) + O (g)$$

Atomic oxygen is very reactive. Atomic oxygen reacts readily with an oxygen molecule to form ozone,. There by releasing heat.

$$O_2 (g) + O (g) \xrightarrow{uv} O_3 (g) + heat$$

These reactions maintain level of ozone in stratosphere. Both the destruction and the reformation of ozone powered by uv radiation. In the absence of outside intervention, the rates of ozone destruction and formation are equal. However, human activities disturb this natural balance.

Q.11 Why global warming often is referred to as the green house effect?

Ans: The enhanced green house effect (or accelerated green house effect) is the warming effect caused by all the extra carbon dioxide green house gas that man has put onto the atmosphere in the past 100 years by burying fossil fuels(coals, oil and natural gas).

Global warming is the warming of the earth because of this enhanced green house effect.

Q.12 There is scientific evidence that CFCs contribute to the depletion of ozone, why?

Ans: ***Ozone Hole:***

The region in which the amount of ozone has been reduced is called as ozone hole. It hwas first observed in October 1980 over Antarctica.

The CFCs are so stable that only exposure to strong UV radiations breaks them down. When that happens, the CF molecules release atomic chlorine. One chlorine atom can destroy over 100,000 ozone molecules.

Q.13 Sulphur dioxide is a common pollutant from burning coal. State two effects caused by this pollutant?

Ans: ***Sulphur dioxide (SO_2)***

In the air sulphur dioxide is converted into sulphur trioxide which is responsible for acid rain.

Sulphur dioxide is readily absorbed in the respiratory system. Being powerful irritant, it aggravates the symptoms of people who suffer from asthma, bronchitis, emphysema and other lung diseases.

THINK TANK

Q.14 Dibenzothiophene ($C_{12}H_8S$) is a common sulphur containing compound of coal. It is responsible for acid rain. How?

Ans: Dibenzothiophene ($C_{12}H_8S$) is a sulphur containing compound of coal on burning it produces sulphur dioxide. In the air sulphur dioxide is converted into sulphur trioxide, which is responsible for acid rain.

Q.15 There have been various attempts to remove sulphur from coal before it is burned. Suggest reason?

Ans: Sulphur containing compound of coal on burning produces sulphur dioxide. In the air sulphur dioxide is converted into sulphur trioxide, which is responsible for acid rain therefore various attempts to remove sulphur from coal before it is burned have been done.

Q.16 Analyze the option what are some ways to reduce pollution caused by cars?

Ans: ***Catalytic converter:***

A catalytic converter transforms CO into CO_2, NO into N_2 and O_2 and unburned hydrocarbons to CO_2 and H_2O. Metal like platinum, palladium and rhodium are used as catalyst in the converter. Government of Pakistan should direct car manufacturers to install catalytic converters in car exhaust system. Government should make strict laws. Similar to scrubbers on power plants, catalyst converters reduce NO_2 emissions from cars.

Q.17 Suggest reason for the presence of CO in the cars the car's emissions from cars.

Ans: Carbon monoxide consists of a single carbon atom and a single oxygen atom linked together (CO), and is the product of incomplete combustion of fuel. Most of carbon monoxide is produced when air to fuel ratios are too low in the engine during vehicle starting or when the vehicle is not tuned properly, and at higher altitudes, where thin air reduces the amount of oxygen available for combustion.

Q.18 As a global citizen, how can you play a part to reduce air pollution at a personal level?

Ans:
1. Encourage you family to walk to neighbor hood market.
2. As far as possible use public forms of transport.
3. Reduce the use of aerosols in the house hold.
4. Look after the trees in your neighborhood.
5. If possible share your room with others when the air conditioner, cooler or fan is on.
6. Do not burn leaves in your garden, put them in a compost pit
7. Car should, as far as possible, be fitted with catalytic converter.
8. Use only unleaded petrol.

INFO BOXES

INFO BOX NO. 1

Q. What is composition of dry air?

Ans:

Gas	% by volume
Nitrogen	78 %
Oxygen	21 %
Argon	0.93 %
Carbon dioxide	0.038 %
Neon	0.0018 %
Helium	0.00052 %
Methane	0.00015 %
Krypton	0.00011 %
Hydrogen	0.00005 %

INFO BOX NO. 2

Q. Describe location and highest and lowest temperature of all the layers of atmosphere.

Ans:

Atmospheric Layer	Location OR Altitude(from earth's surface)	Temperature at bottom	Temperature at highest point	Lowest Temperature	Highest Temperature
Troposphere	0-12 km	17 ^{o}C	-55 ^{o}C	-55 ^{o}C	17 ^{o}C
Stratosphere	12-50 km	-55 ^{o}C	-5 ^{o}C	-55 ^{o}C	-5 ^{o}C
Mesosphere	50-80 km	-5 ^{o}C	-93 ^{o}C	-93 ^{o}C	-5 ^{o}C
Thermosphere	Above 80 km	-93 ^{o}C	1800 ^{o}C	-93 ^{o}C	1800 ^{o}C

INFO BOX NO. 3

Q. Explain about Aurora Borealis.

Ans: Aurora Borealis are the brilliant light displays that occur in the ionospheres of northern hemisphere. Auroras are caused by particles from the sun that enter the ionosphere near the poles. These particles strike atoms in the ionosphere, causing them to glow, resulting as light displays.

INFO BOX NO. 4

Q. Write a note on sources, physical properties and harmful effects of major air pollutants.

Ans:

Air pollutants	**Physical properties**	**sources**	**Harmful effects**
Carbon monoxide	Colourless, odourless and poisonous gas	Incomplete burning of wood, fuels and vehicle exhaust	Headache, brain damage, death
Sulphur dioxide	Colourless gas with unpleasant and irritating odour	Power stations and industries using fossil fuels	Breathing difficulties, bronchitis, emphysema, lung cancer, acid rain and green house effect
Oxides of nitrogen	NO is colourless, odourless gas soluble in water. NO_2 is reddish brown gas with pungent odour soluble in water. Both is highly toxic gases	Exhaust fumes of motor vehicles, power stations and industries using fossil fuels.	Coughs, headaches lung diseases, acid rain and greenhouse effect (global warming)
CFCs chlorofluorocarbons	Colourless gases	Aerosol sprays, foams, refrigerants, air conditioning systems.	Green house effect (global warming), thinning of ozone layer
Lead compound	Poisonous solid particles	Exhaust fumes from motor vehicles	Brain damage, forest decline

INFO BOX NO. 5

Q. Describe a green house. What principle applies for construction of green houses?

Ans: A green house is a building which is constructed on the principle of green house effect to promote growth of plants. Green houses are constructed from glass or transparent polymer films. Sunlight can pass through these materials and is used by the plants for photosynthesis. The plants radiate some energy in the form of infrared or heat radiation which cannot pass through these materials and is reflected back. As a result, the atmosphere inside the green-house becomes hot enough to promote plant growth. The temperature inside a greenhouse can be 10°C to 15°C higher than outside.

INFO BOX NO. 6

Q. Describe incineration. What are its advantages and disadvantages?

Ans: Incineration is a waste treatment process in which solid waste is burned at higher temperature. Incineration consumes all combustible materials, leaving behind ash residue and non-combustible material. This process generally reduces the volume of waste by two third, but it is not a clean process. It produces air pollution. It generates considerable smoke and odour. This smoke may contain oxides of nitrogen and sulphur.

INFO BOX NO. 7

Q. What is a catalytic converter?

Ans: A catalytic converter transforms CO into CO_2, NO into N_2 and O_2 and unburned hydrocarbons to CO_2 and H_2O. Metals like platinum, palladium and rhodium are used as catalyst in the converter. Strict laws should be implemented to direct the car manufacturer to install catalytic converters into the automobiles.

PREVIOUS BOARD QUESTIONS

Multiple Choice Questions

2016

Highest temperature in mesosphere is

(a) -55 °C
(b) -93 °C
(c) -5 °C
(d) -60 °C

Answer: (c)

Explanation:
Highest temperature in mesosphere is -5 °C.

2016

Which gas has lowest percentage in air?

(a) Oxygen
(b) Nitrogen
(c) Hydrogen
(d) Carbon dioxide

Answer: (c)

Explanation:
Hydrogen gas has lowest percentage in air, i.e. 0.00005 %.

2015

Which is reddish brown gas

(a) NO
(b) SO_2
(c) O_3
(d) NO_2

Answer: (d)

Explanation: Nitrogen dioxide (NO_2) is reddish brown gas with pungent odour. It dissolves readily in water and in the presence of water and oxygen in atmosphere forms nitric acid responsible for acid rains.

$2NO_{2\,(g)} + 3O_{2\,(g)} + 2H_2O_{(l)} \rightarrow 4HNO_{3\,(aq)}$

2015 & 2014

Lowest temperature in stratosphere is

(a) -55 ^{o}C
(b) -5 ^{o}C
(c) 5 ^{o}C
(d) 55 ^{o}C

Answer: (a)

Explanation:

Lowest temperature in stratosphere is -55°C.

2014

The temperature inside a green house can be_________higher than the outside temperature.

(a) 5 to 10 ^{o}C
(b) 10 to 15 ^{o}C
(c) 15 to 20 ^{o}C
(d) 20 to 25 ^{o}C

Answer: (b)

Explanation:

The temperature inside a green house can be 10 to 15 ^{o}C higher than the outside temperature.

Short Questions

2015 & 2016

There is a scientific evidence that CFCs contribute to the depletion of ozone, Why?

Ans:

Answer same as Chapter 14, **Review exercise, Q. No. 12.**

2016

Write the percentage composition of three main components of atmosphere.

Ans:

Nitrogen gas = 78 %
Oxygen gas = 21 %
Argon gas = 0.98 %

2016

Define global warming.

Ans:

Answer same as Chapter 14, **Review exercise, Q. No. 8**

2015

What is ozone? How is it formed?

Ans:

Answer same as Chapter 14, **Review exercise, Q. No. 10**

2015

Define pollutant. Give some effects of sulphur dioxide on human beings.

Ans:

Pollutant:

Anything that is in air, water or soil which has a harmful effect on some part of the environment is called pollutant. Pollutants damage the environment, health and quality of life.

Sulphur dioxide (SO_2)

In the air sulphur dioxide is converted into sulphur trioxide which is responsible for acid rain.
Sulphur dioxide is readily absorbed in the respiratory system. Being powerful irritant, it aggravates the symptoms of people who suffer from asthma, bronchitis, emphysema and other lung diseases.
Sulphuric acid eats away metals to form water soluble salts and hydrogen.

$$Fe\,(s) + H_2SO_4 \rightarrow FeSO_{4(aq)} + H_{2(g)}$$

Marble buildings and statues are disintegrated by acid rain.

$$CaCO_{3(s)} + H_2SO_{4(aq)} \rightarrow CaSO_{4\,(aq)} + H_2O_{(g)} + CO_{2(g)}$$
$$CaCO_{3(s)} + 2HNO_{3(aq)} \rightarrow Ca\,(NO_3)_2 + H_2O_{(g)} + CO_{2(g)}$$

2015

Write balanced chemical equations of calcium carbonate with:
(i) Sulphuric acid (ii) Nitric acid

Ans:
Marble buildings and statues are disintegrated by acid rain.
(i) Sulphuric acid
$$CaCO_{3(s)} + H_2SO_{4(aq)} \rightarrow CaSO_{4\,(aq)} + H_2O_{(g)} + CO_{2(g)}$$
(ii) Nitric acid
$$CaCO_{3(s)} + 2HNO_{3(aq)} \rightarrow Ca\,(NO_3)_2 + H_2O_{(g)} + CO_{2(g)}$$

2015

Define acid rain. Write name of gases that cause acid rain.

Ans:
Answer same as Chapter 14, **Review exercise, Q. No. 6**

2015

Define global warming. Mention some effects of global warming.

Ans:
Answer same as Chapter 14, **Review exercise, Q. No. 8**

2014

Write down the names and percentages of gases (except nitrogen and oxygen) that make up air.

Ans:

Gas	% by volume
Argon	0.93 %
Carbon dioxide	0.038 %
Neon	0.0018 %
Helium	0.00052 %
Methane	0.00015 %
Krypton	0.00011 %
Hydrogen	0.00005 %

2014	**What do you know about Aurora Borealis?** **<u>Ans:</u>** Answer same as Chapter 14, **Info Box No. 3**
2014	**Write down any three natural processes that contribute the air pollution.** **<u>Ans:</u>** Answer same as Chapter 14, **Self Assessment 14.5, Q. No. 2**
2014	**List the layers of atmosphere. Give their altitude and maximum and minimum range of temperature.** **<u>Ans:</u>** Answer same as Chapter 14, **Info Box No. 2**
2014	**What is incineration? How is it dangerous for us?** **<u>Ans:</u>** Answer same as Chapter 14, **Info Box No. 6**
2014	**Write briefly about ozone depletion and its harmful effects.** **<u>Ans:</u>** Answer same as Chapter 14, **Review exercise, Q. No. 7**
2013	**Name the four layers of atmosphere** **<u>Ans:</u>** Answer same as Chapter 14, **Info Box No. 2**
2013	**In which layer is ozone present?** **<u>Ans:</u>** Ozone is present in stratosphere. Answer same as Chapter 14, **Review exercise, Q. No. 2 part iii**
2013	**What harm do chlorofluoro carbons cause to the ozone layer?** **<u>Ans:</u>** Answer same as Chapter 14, **Review exercise, Q. No. 7**

<u>Long Questions</u>

2015	**What is ozone layer? How does ozone layer depletion occur?** **<u>Ans:</u>** Answer same as Chapter 14, **Review exercise, Q. No. 10 & 12**

CHAPTER 15

WATER

SELF ASSESSMENT 15.1

Q: List household, industrial and agricultural uses of water?

- **Household use of water:**
  We need water for drinking, cooking and cleaning.
- **Industrial use of water:**
  It cools automobile engines, nuclear power plants, steel mills and parts of heavy machinery in industrial units.
- **Agriculture use of water:**
  Farmers need a large amount of water for their fields for growing fruits, vegetables and crops.

SELF ASSESSMENT EXERCISE 15.2

Q: Differentiate between permanent and temporary hardness:

Carbonate Hardness Compounds (Temporary Hardness)	Non Carbonate Hardness Compounds (Permanent Hardness)
1. Calcium Carbonate ($CaCO_3$)	2. Calcium sulphate $CaSO_4$
3. Magnesium Carbonate ($MgCO_3$)	3. Magnesium Sulphate $MgSO_4$
4. Calcium Bicarbonate [$Ca(HCO_3)_2$]	4. Calcium Chloride $CaCl_2$
5. Magnesium Bicarbonate [$Mg(HCO_3)_2$]	5. Magnesium Chloride $MgCl_2$
6. Calcium Hydroxide [$Ca\ (OH)_2$]	
7. Magnesium hydroxide $Mg(OH)_2$	

Carbonate hardness is sometimes called temporary hardness because it can be removed by boiling water. Non carbonate hardness cannot be removed by boiling the water, so it is called as permanent hardness.

Q: Differentiate between soft and hard water:

SOFT WATER	HARD WATER
• Water free from soluble salts of calcium and magnesium is called soft water.	• Presence of calcium and magnesium salts in the form of hydrogen carbonate, chloride and Sulphate in water makes water -hard‖ .
• Soft water gives lather with soap.	• Hard water does not give lather with soap.

• Soft water does not form scum with soap, suitable for laundry.	• Hard water forms scum (precipitate) with soap, therefore unsuitable for laundry.

SELF ASSESSMENT EXERCISE 15.3

Q: Write chemical equations to show the changes that occur when hard water containing calcium hydrogen carbonate and magnesium hydrogen carbonate is boiled?

$$Ca\ (HCO_3)(aq) \rightarrow 2CaCO_3(s) + CO_2\ (g) + 2H_2O\ (l)$$

$$Mg\ (HCO_3)(aq) \rightarrow 2MgCO_3(s) + CO_2\ (g) + 2H_2O\ (l)$$

SELF ASSESSMENT EXERCISE 15.4

Q: Complete the following reactions:

$$\boldsymbol{Ca\ (HCO_3)_2\ (aq) \xrightarrow{\boxed{\text{Heat}}} 2CaCO_3(s) + CO_2\ (g) + 2H_2O\ (l)}$$

$$\boldsymbol{Ca\ (HCO_3)_2\ (aq) + Ca\ (OH)_2 \rightarrow 2CaCO_3(s) + 2H_2O\ (l)}$$

$$\boldsymbol{Ca^{+2}\ (aq) + Na_2Z \rightarrow 2Na + (aq) + CaZ\ (s)}$$

$$\boldsymbol{Mg^{+2}\ (aq) + Na_2Z \rightarrow 2\ Na + (aq) + MgZ\ (s)}$$

$$\boldsymbol{Mg^{+2}\ (aq) + CO_3^{-2}\ (aq) \rightarrow MgCO_3(s)}$$

$$\boldsymbol{Ca^{+2}\ (aq) + CO_3^{-2}\ (aq) \rightarrow CaCO_3(s)}$$

SELF ASSESSMENT 15.5

Q: List of some water born diseases:

i. Cholera
ii. Dysentery
iii. Jaundice
iv. Hepatitis
v. Typhoid

Q: List of sources of water born diseases:

i. House hold wastes
ii. Industrial wastes

Q: List of steps used in sewage water treatment:

i. Primary sewage treatment
ii. Secondary sewage treatment
iii. Activated sludge treatment
iv. Chlorination

Q: List steps used in raw water treatment:

i. Sedimentation
ii. Coagulation
iii. Filtration
iv. Chlorination

Q: Write effects produced by industrial wastes:

Industrial wastes:

Manufacturing of industrial products are always accompanied by some by-products and waste effluents. These wastes may control highly toxic compounds and heavy metals such as Pd, Cd, Cr, Hg, As, Sb etc. These toxic substances cause serious health problems such as nervous disorders, anemia, high blood pressure, kidney diseases, nausea, dizziness and cancer.

Water from leather tanneries contains large quantities of chromium (vi) salts, chromium (vi) ions are highly toxic and known to cause cancer. Industrial wastes cause irreversible degeneration of the environment causing serious health problems for public and marine life.

Q: Write names of six house hold wastes:

House-hold wastes:

House hold wastes include

- Human wastes
- Live stock wastes
- Soaps and detergents
- Paint and oil
- Food and vegetable waste
- Garbage etc.

REVIEW EXERCISE

Select the correct answer:

I: Percentage of sodium chloride in sea water is

A: 0.02 B: 3.4

C: 97 D: 2

II: The density of water is maximum at:

A: $0^{o}C$ B: $4^{o}C$

C: $100^{o}C$ D: $-4^{o}C$

III: Which salt does not cause the water to become hard?

A. Calcium hydrogen carbonate
B. Magnesium hydrogen carbonate
C. Magnesium sulphate
D. Sodium chloride

IV: Which salt causes temporary hardness in water?

A. Magnesium sulphate
B. Calcium Sulphate
C. Both calcium and magnesium sulphate
D. Magnesium hydrogen carbonate

V: Heating calcium hydrogen carbonate produces:

A: CO_2 B: H_2O

C: $CaCO_3$ D: All of these

VI: Which of the following is not a water born disease?

A: Hepatitis B: Typhoid

C: Dysentery D: Anemia

VII: Which human activity results in contamination of waterbodies?

A: Livestock waste B: Pesticides

C: Septic tents D: All of these

VIII: Which is used to remove permanent hardness in water?

A: Slaked lime B: Washing soda

C: Boiling water D: All of these

Answer:

i. B	ii. B	iii. D	iv. D
v. D	vi. D	vii. D	viii. B

Give short answer:

1. List the impurities present in rain water

Rain water contains pollutants such as soil particles, plant and insect parts, bacteria, algae, and sometimes radioactive materials that the rain/snow has washed out of the atmosphere.

The collected rain water requires treatment even though rain water is not in itself contaminated but as there are many pollutants and impurities present in the atmosphere, such as suspended particles, harmful gases like oxides of nitrogen and sulphur, etc which either react with the rain water or get dissolved in it, therefore treatment of the rain water becomes important.

2. List toxic substances present in household wastes:

House hold waste include human wastes, live stock wastes, soaps and detergents, paints and oils, food and vegetables wastes, garbage etc.

3. In what ways, industrial wastes pollute water?

Industrial wastes:

Manufacturing of industrial products are always accompanied by some by-products and waste effluents. These wastes may contain highly toxic compounds and heavy metals such as Pd, Cd, Cr, Hg, As, Sb etc.

Water from leather tanneries contains large quantities of chromium (vi) salts, chromium (vi) ions are highly toxic and is known to cause cancer.

4. What is water pollution?

Water pollution:

Water pollution is the contamination of water bodies (e.g., lakes, rivers, oceans, aquifers, ground water) Water pollution occurs when pollutants are discharged directly or indirectly into water bodies without adequate treatment to remove harmful compounds.

5. List some water born diseases:

- Cholera
- Dysentery
- Jaundice
- Hepatitis
- Typhoid

6. What are pathogenic microorganisms?

An organism of microscopic size, usually a bacteria or virus, that causes disease.

Q: What is hard water/ why is it sometimes undesirable?

Hard water:

Water which gives little lather or forms scum with soap is called hard water.

Hard water is undesirable:

―Hard water‖ contain dissolved salts of magnesium and calcium, and does not work with soap. It wastes a lot of soap. Second, minerals can be deposited in pipes, and appliances, clogging or wearing them permanently.

Q: List two ways in which lakes and streams become polluted.

Industrial units generally discharge their wastes to open land or into water bodies, lakes, ponds, rivers or oceans. Water from leather tanneries contains large quantities of chromium (vi) salts, chromium (vi) ions are highly toxic and known to cause cancer. Industrial wastes cause irreversible degeneration of the environment causing serious health problems for public and marine life.

Q: Give chemical equations for the:

Reaction of slaked lime with alum:

$$3\,Ca\,(OH)_2\,(aq) + Al_2(SO_4)_3\,(aq) \rightarrow 2Al\,(OH)_3\,(s) + 3Ca\,SO_4(aq)$$

Carbonated rain water with lime stone

$$CaCO_3(s) + H_2CO_3\,(aq) \rightarrow Ca\,(HCO_3)_2\,(aq)$$

Reaction that occurs when temporary hard water is boiled:

$$Ca\,(HCO_3)(aq) \rightarrow 2CaCO_3(s) + CO_2\,(g) + 2H_2O\,(l)$$

$$Mg\ (HCO_3)(aq) \rightarrow 2MgCO_3(s) + CO_2(g) + 2H_2O\ (l)$$

Ions react with sodium zeolite:

$$Ca^{+2}\,(aq) + Na_2Z \quad \rightarrow \quad 2Na^{+}\,(aq) + CaZ\,(s)$$

Q: How can buildings made up of limestone be affected by acid rain?

Acid rain has a corrosive effect on limestone or marble buildings or sculptures. It is well established that either wet or dry deposition of sulphur dioxide significantly increases the rates of corrosion on lime stone, sand stone and marble.

Sulphur dioxide plus water makes sulphurous acid. Therefore buildings made by limestone are affected by acid rain.

Q: Make a list of main methods of softening hard water. In each case write a chemical reaction to summarize the chemical reaction involved.

Methods to remove temporary hardness:

By boiling:

$$M\,(HCO)_3 \quad \rightarrow \quad MCO_3\,(s) + CO_2\,(g) + 2H_2O\,(l)$$

$$W\ \ ere\ M = Ca^{+2}\ and\ Mg^{+2}$$

By adding slaked lime (Clark's method):

$$Ca\,(HCO_3)_2\,(aq) + Ca\,(OH)_2 \quad \rightarrow \quad 2CaCO_3(s) + 2H_2O\,(l)$$

$$Mg\,(HCO_3)_2\,(aq) + Ca\,(OH)_2 \quad \rightarrow \quad CaCO_3(s) + MgCO_3(s) + 2H_2O\,(l)$$

Method to remove permanent hardness:

By adding washing soda:

$$M^{+2}(aq) + CO3^{-2}(aq) \quad \rightarrow \quad MCO_3(s)$$

$$W\ \ ere\ M = Ca^{+2}\ and\ Mg^{+2}$$

By ion exchange resins:

$$M^{+2}(aq) + Na_2Z \quad \rightarrow \quad 2Na^{+}\,(aq) + MZ\,(s)$$

$$W\ \ ere\ M^{+2} = Ca^{+2}\ and\ Mg^{+2}$$

Q: List some disadvantages of water hardness:

Disadvantages of water hardness:

a. Hard water wastes a lot of soap, when used for washing.

b. The soap forms scum with hard water, which adheres to the clothes being washed, scum can spoil the finish of some fabrics.
c. Causes Kettle to fur
d. Can cause hot water pipes, boilers and car radiators to block due to the formation of insoluble calcium and magnesium salts, causing great damage.

Q: What are Earth's four main water sources?

The four main sources of water are ground water, rivers or lakes, oceans and ice (glaciers).

Q: How does hard water differ from soft water?

Soft water:

Water that easily gives lather with soap and does not from scum is called soft water

Hard water:

Water that gives little lather or forms scum with soap is called hard water.

Note:

Most common hardness is the result of Ca^{+2} and Mg^{+2} ions in ground or surface water. Soft water on the other hand contains lower level of calcium and magnesium.

Q: What is the purpose of coagulation in water treatment?

Coagulation:

It is the process in which water is treated with slaked lime or alum. These materials react to form a gelatinous mass of aluminum hydroxide.

$$3\,Ca\,(OH)_2\,(aq) + Al_2(SO_4)_3(aq) \rightarrow 2Al\,(OH)_3(s) + 3CaSO_4(aq)$$

Q: Explain how hard water hampers the cleansing reaction of soap.

Effect of hard water:

Unfortunately, hardness minerals (Ca^{+2} and Mg^{+2} ions) combine with soap to form an insoluble curd (scum) which can remain as a residue on washed laundry. Hardness also tends to counteract soap's alkalinity which reduces its cleaning ability and requires the use of greater quantities to get laundry clean.

Q: Why are municipal water supplies treated with aluminumsulphate and slaked lime?

Coagulation:

`It is the process in which water is treated with slaked lime or alum. These materials react to form a gelatinous mass of aluminum hydroxide:

$$3\ Ca(OH)_2(aq) + Al_2(SO_4)_3(aq) \rightarrow 2Al(OH)_3(s) + 3CaSO_4(aq)$$

The aluminum hydroxide carries down dint particles and bacteria.

Aluminum Sulphate	Lime
The chemical formula of aluminum sulphate is $Al_2(SO_4)_3$. Frequently it is known as filter alum	Hydrated lime's chemical name is calcium hydroxide and its chemical formula is : $Ca(OH)_2$
In water purification, a mixture of 48% of water alum is combined with raw incoming water at rate of 18-24 milligrams per liter.	Adding lime in between this process during the sedimentation and filtrationstep at the rate of 10 to 20milligrams per neutralize the effect of filter alum on the processing water.
However alum is used in water purification process ―coagulant‖ . Coagulant binds extremely fine particles suspended in raw water into large particles that can be removed by filtration and settling. This allows for the removal f unwanted color and cloudiness (turbidity). Additionally the process removes the aluminum it self	When purifying water, adding hydrated lime to the water for pH adjustment is a part of process because filter alum is an acidic salt that lowers the pH of water undergoing purification.

Q: What are some health effects of biological contamination of water?

Bacterial contents may cause infectious diseases such as cholera, jaundice, hepatitis, typhoid, dysentery.

Causes	Water Borne Diseases
Bacterial infections	Typhoid, cholera, paratyphoid fever, Bacillary dysentery.
Viral infections	Infection hepatitis (jaundice) poliomyelitis
Protozoan infections	Amoebic dysentery

Q: Write a word and balanced chemical equation to show the effect of heat on magnesium hydrogen carbonate in an aqueous solution:

Word Equation:

Magnesium hydrogen carbonate → $\boxed{\text{Heat}}$ *magnesium carbonate +carbon dioxide + oxygen*

Chemical equation:

$$Mg(HCO_3)(aq) \rightarrow \boxed{\text{heat}}\ 2MgCO_3(s) + CO_2(g) + 2H_2O(l)$$

THINK TANK

Q: Why is it cooler near lake than in land in summer?

Since rate of evaporation increases in temperature during summer and evaporation cause cooling therefore it is cooler near lake than inland during summer.

Q: List two cations and anions present in lake or surfacewater/

Cations: $Ca^{+2}, Mg^{+2}\ K^{+}, Na^{+}$

Anions: $SO_4^{-2}, Cl^{-2}, NO_3^{-1}$

Q: Why is waste water chlorinated before it is returned towater body?

Chlorination:

The effluent from sewage plant is treated with chlorine to kill any remaining pathogenic microorganisms.

Q: Hard water causes kettle to fur? This fur can be removedby using an acid explain why?

Using hard water in kettle produces calcium-carbonate scale or fur. Hydrochloric acid can be used to clean calcium carbonate fur deposited from kettles:

$$CaCO_3(s) + 2HCl \rightarrow 2CaCl_2 + CO_2(g) + 2H_2O(l)$$

Q: The following chemical equation is about calciumcompound:

$$\boldsymbol{Comp\ A + Ca\,(OH)_2 \rightarrow\ + H_2O(l)}$$

$$\boldsymbol{Comp\ B + H_2CO_3\,(aq) \rightarrow\ Comp\ C}$$

Give names and formulas of Comp A, Comp C

Comp A

This compound is calcium hydrogen carbonate

$$Ca\,(HCO_3)_2\,(aq) + Ca(OH)_2 \rightarrow 2CaCO_3(s) + 2H_2O\,(l)$$

Comp B

$$2CaCO_3(s) + H_2CO_3\ (aq) \rightarrow Ca\ (HCO_3)_2\ (aq)$$

Therefore Comp C is also calcium hydrogen carbonate.

What happens when compound C is heated?

$$Ca\ (HCO_3)_2\ (aq) \xrightarrow{\boxed{\text{heat}}} 2CaCO_3(s) + CO_2\ (g) + 2H_2O\ (l)$$

Compound C is soluble in water; write a balanced chemical equation to show what happens when its aqueous solution is treated with washing soda?

$$Ca\ (HCO_3)_2\ (aq) + Na_2CO_3\ (aq) \rightarrow CaCO_3(s) + 2NaHCO_3\ (aq)$$

Q: How chemistry helps maintain a clean swimming pool? Explain?

Water in swimming pools are purified from pathogenic organisms by aeration and chlorination. Chlorination is probably the best and the cheapest method of sterilization of water and it is the most effective in destroying pathogenic bacteria. For chlorination, liquid chlorine may be added directly in the swimming pool water.

Q: Why is it advisable to wash hands well with soap after using bathroom?

If your hands are not clean and you touch your face or public surface, you may be infecting yourself and others by spreading germs and diseases. Colds flues and infectious diarrhea are all known to be spread by hand to hand contact. Washing our hands regularly can keep you and those around you healthy by controlling the spread of germs (bacteria and viruses).

CHAPTER 16

CHEMICAL INDUSTRIES

SELF ASSETSSMENT EXERCISES

SELF-ASSESSMENT EXERCISE (16.1)

Q: List important ores of iron, copper, zinc and mercury

Metal	Name of Ore	Formula
Iron	Hematite	FeO
Iron	Magnetite	FeO
Copper	Chalcopyrite	$CuFeS_2$
Zinc	Zinc blende	ZnS
Mercury	Cinnabar	HgS

Q: List the name of metallurgical operations

The main steps in process are:

- Crushing, grinding or pulverizing of the ore.
- Concentration of the ore
- Extraction of metal
- Refining of metal.

Q: List out main processes used to concentrate the ore:

- Magnetic separation
- Cyclone separation
- Flotation process

Q: Write names of methods used in the extraction of a metal from its concentrated ores?

- Roasting
- Smelling
- Refining

Q: List method used to purify metal.

Refining of metal means purification of metals:

Distillation:

Volatile metals like zinc and mercury are purified by this method. The non volatile impurities are left behind in the retort.

Liquification:

This method is used to easily fusible like bismuth, tinned lead. The crude metal is placed on the sloping health of a furnace and heated gently when the metals melt and flows down, leaving behind the infusible impurities which remains sticking to the floor of the hearth.

SELF ASSESSMENT 16.2

Q: Make a list of raw materials of Solvay process. Raw materials:

Commercially, sodium carbonate is manufactured in a continuous process that uses:

1) Ammonia
2) Brine (concentrated sodium chloride solution)
3) Lime stone as a source of CO_2 carbon dioxide and slaked lime.

Q: Outline the basic reactions of Solvay process

Same like Q7 from review question of CH16

Q: List out main steps of Solvay process?

- Preparation of ammonical brine
- Carbonation.
- Filtration.
- Calcinations
- Preparation of carbon dioxide and slaked lime
- Recovery of ammonia

SELF ASSESSMENT 16.3

Q: Calculate the percentage of nitrogen in urea:

Molecular mass of urea $= NH_2 - \overset{\overset{O}{||}}{C} - NH_2$

$= 14+2*1 + 12*1 +16+14+ 2*1$

$=60$ gm

% of nitrogen in urea $= \frac{Mass\ of\ nitrogen}{Mass\ of\ Urea} \times 100$

$= 46.6\%$

Q: Outline the basic reactions that take place in the synthesisof urea?

Reaction between NH_3 and CO_2 to form ammonium carbamate

$$NH_3\ (l) + CO_2\ (l) \rightarrow NH_2COONH_4 + H_2O$$

Distillation of ammonium carbamate

$$NH_2CONH_4 \rightarrow NH_2 - \overset{\overset{O}{||}}{C} - NH_2 + H_2O$$

Urea

Q: What happens when ammonium carbamate is distilled withsteam?

Distillation of ammonium carbamate

$$NH_2COONH_4 \rightarrow NH_2 - \overset{\overset{O}{||}}{C} - NH_2 + H_2O$$

Urea

SELF ASSESSMENT EXERCISE 16.4

Q: Define petroleum?

Petroleum:

The name petroleum is derived from Latin words Petra (rock) and oleum (oil). It is also called crude oil. Petroleum or crude oil is thick dark liquid composed mostly of hydrocarbons.

Q: List names of fractions obtained by the fractionaldistillation of petroleum?

Q: List one use of each petroleum fraction:

Fraction	Number of Carbon Atoms Per Molecule	Boiling Point °C	Important Uses
Liquefied petroleum gas (LPG)	1-4	below 20°C	Cylinder gas for cooking
Petrol	5-10	35-40 °C	Fuel fro motor cars and vehicles
Naphtha	8-12	70-120 °C	Chemical feed stock for making drugs, plastic and other chemical
Kerosene	10-16	170—250 °C	Fuel for jet planes, fuel for heating lightning and cooking.
Diesel	14-20	270-340°C	Fuel for buses, trucks and trains.
Lubricating oil	20-50	350-500°C	Lubricants for machines and engines, waxes and polishes.
Fuel oil	50-70	500-600°C	Fuel for power stations factories and ships
Bitumen	more than 70	more than 500°C	paving roads and making roofing materials

REVIEW EXERCISE

Select the correct answer:

I: The naturally occurring metallic compounds are called as

A. Ore
B. Gangue
C. Mineral
D. Rock

Ii: The separation of minerals from gangue is called concentration which of the following method is used for concentration?

A. Smelting
B. Roasting
C. Refining
D. Floating

Iii: Which of the following steps in not used in the extraction process of metals?

A. Roasting
B. Smelting
C. Floating
D. Bessemerization

Iv: In electrolytic refining of copper ___________________ is used as anode.

A. Pure copper
B. Impure copper
C. Copper sulphate
D. Electrolytic tank

V: Which of the following is not a raw material for the manufacture of soda ash?

A. Ammonia
B. Carbon monoxide
C. Brine
D. Lime stone

Vi: A mixture of Cu2S and FeS called mettle is produce one of the metallurgical operations in the extraction of copper. The name of this operation is

A. Smelting
B. Roasting
C. Bessemerization
D. Electro refining

Vii: Chemical formula of slaked lime is

A. $CaCO_3$
B. CaO
C. $CaOH_2$
D. $CaCl_2$

Viii: Calcinations is the process in which sodium hydrogen carbonate is heated to get sodium carbonate. Which is not obtained in this process?

A. CO_2
B. CO
C. Na_2CO_3
D. H2O

Ix: Percentage of nitrogen in urea is

A. 35
B. 21.2
C. 80
D. 46.6

X: What happens when ammonium carbamate is distilled withsteam?

A. Ammonia is produce
B. Carbamate is released
C. Urea is produced
D. Urea solution is produced

Answers

i. C	ii. D	iii. C	iv. B	v. B
vi. B	vii. C	viii. B	ix. D	x. D

Q: Give short answers:

Q: How are urea prills produced?

The urea solution is concentrated in vacuum evaporators, which is then rapidly cooled and sent to the prilling tower. Urea prills thus produced are packed and then marked.

Q: What is slaked lime? How is it produced?

Slaked lime is $Ca\,(OH)_2$.

Preparation of slaked lime:

Carbon dioxide is produced by heating lime stone in a kiln.

$$CaCO_3\,(l) \rightarrow CaO\,(s) + CO_2\,(g)$$

Carbon dioxide is fed into the carbonating tower from the top. Equal amounts of lime CaO and water are mixed to produce slaked lime $Ca\,(OH)_2$.

$$CaO(s) + H_2O(l) \rightarrow Ca\,(OH)_2$$

Q: Write chemical reaction that takes place during carbonation in Solvay process?

Carbonation:

In the carbonation tower carbon dioxide is passed through ammonical, brine. Following reaction takes place in it.

$$CO_2\,(g) + NH_3\,(g) + H_2O(l) \rightarrow NH_4HCO_3(aq)$$

$$NH_4HCO_3\,(aq) + NaCl\,(aq) \rightarrow NaHCO_3 + NH_4Cl$$

In the tower compartments of carbonating tower, the temperature of the mixture is lowered to 15°C. At this temperature $NaHCO_3$ precipitates out.

Q: Explain the process "roasting" with two examples.

Roasting:

Some minerals are converted to oxide by heating in the air at temperature below their melting point. This process is called roasting. For example, the roasting of ZnS zinc blende is

$$2ZnS\ (s) + 2O_2\ (g) \xrightarrow{\boxed{\text{Heat}}} 2ZnO\ (s) + 2SO_2\ (g)$$

Roasting for Cinnabar is

$$HgS\ (s) + O_2\ (g) \xrightarrow{\boxed{\text{Heat}}} Hg\ (l) + SO_2\ (g)$$

Roasting for copper pyrite ore is

$$2CuFeS_2(s) + O_2\ (g) \xrightarrow{\boxed{\text{Heat}}} Cu_2S\ (s) + 2FeS\ (s) + SO\ (g)$$

Q: Write chemical reaction that takes place during urea formation?

The raw materials for the manufacturer's urea are:

Manufacturing of urea consists of following steps

- Ammonia
- Carbon dioxide

Reaction between NH_3 and CO_2 to form ammonium carbonate

$$NH_3(l) + CO_2(l) \rightarrow NH_4COONH_2 + H_2O$$

Distillation of ammonium carbonate

$$NH_4COONH_2 \rightarrow NH_2\text{-}\overset{\overset{O}{||}}{C}\text{-}NH_2 + H_2O$$

Evaporation of liquid urea and its granulations

The urea solution is concentrated in vacuum evaporators which is then rapidly cooled and snet to the prilling tower. Urea prills thus produced are packed and then marketed.

Q: Describe the following with an example:

Roasting:

Some minerals are converted to oxide by heating in the air at temperature below their melting point. This process is called roasting. For example, the roasting of ZnS zinc blende is

$$2ZnS\ (s) + 2O_2\ (g) \xrightarrow{\boxed{\text{Heat}}} 2ZnO\ (s) + 2SO_2\ (g)$$

Roasting for Cinnabar is

$$HgS\ (s) + O_2\ (g) \xrightarrow{\boxed{\text{Heat}}} Hg\ (l) + SO_2\ (g)$$

Roasting for copper pyrite ore is

$$2CuFeS_2(s) + O_2\ (g) \xrightarrow{\boxed{\text{Heat}}} Cu_2S\ (s) + 2FeS\ (s) + SO\ (g)$$

Smelting:

The method to reduce metal ions to free metal is called smelting. The most common reducing agents are coke, carbon monoxide, and hydrogen.

Some examples are:

$$Fe_2O_3(s) + CO\ (g) \rightarrow 2Fe(l) + 3CO_2(g)$$

$$WO_3\ (s) + 3H_2(g) \rightarrow W(s) + 3H_2O(l)$$

$$ZnO\ (s) + C(s) \rightarrow Zn\ (s) + CO\ (g)$$

However smelting of copper ore is done in two steps:

The roasted copper ore: is heated with coke and stand at about 1100°C. The materials melt and separate into two players the bottom layer that contains mixture of Cu_2S and FeS is called mettle, while the upper layer is called a silicate. Slag formed by the reaction of FeO and sand.

$$2FeS(s) + O_2(g) \rightarrow 2FeO(s) + 2SO_2(g)$$

$$FeO(s) + SiO_2(g) \rightarrow FeSiO_3$$

Bessemerization:

In this process air is blown through the molten copper mettle in a Bessemer converter. Any remaining iron sulphate is oxidized and removed as slag ($FeSiO_3$) in the final smelting step cuprous sulphide (Cu_2S) is oxidized to form cuprous oxide, which reacts with remaining cuprous sulphide to form metallic copper.

Figure

$$2Cu_2S(l) + 3O_2 \rightarrow 2Cu_2O(l) + 2SO_2(g)$$

$$Cu_2S + Cu_2O \rightarrow 6Cu(l) + SO_2$$

The product called blister copper is about 97 % to 99% pure Cu, with entrapped bubbles of SO_2. Bessemerization is also used to convert pure iron into steel.

Flotation process:

Pulverized ore is fed into a tank containing water and an oil-detergent- mixture. The mixture is agitated with air. Detergents wet the minerals practices but not the silicate gangue. The minerals particles rise to the top of the mixture as a forth from where they are skimmed off. Particles of the gauge fall down to the bottom. The copper is concentrated general by floating process.

Q: Make a list of metallurgical operations:

Metallurgy:

The process of separating a metal from its ore and preparing it for use is known as metallurgy.

Basic metallurgical operations

The main steps in process are

- Crushing, grinding or pulverizing of the ore
- Concentration of the ore
- Extraction of metal
- Refining of metal

Q: How was crude oil formed?

Origin/formation of petroleum or crude oil:

It is believed that petroleum was formed from organisms that lived hundreds of millions of years ago. Plants and animals in the sea died. Their remains piled up. Layers of sand, rock and mud buried the dead organisms. Over time, in the absence of air, heat and pressure of sediments and bacterial effect changed the material into dark brownish vacuous liquid called petroleum. It is also called crude oil. The gaseous products accumulated over the petroleum are called as natural gas.

Q: Outline basic reactions of Solvay process:

Basic process

Solvay process consists of following steps:

Prepareation of ammonical brine:

Ammonical brine is prepared by dissolving ammonia gas in brine. Ammonical brine is fed into the carbonating tower.

Carbonation:

In the carbonating tower, carbon dioxide passed through ammonical brine.

Following reaction takes place in it:

$CO_2 + NH_3 + H_2O \rightarrow NH_4HCO_3$

$NaHCO_3 + NaCl \rightarrow NaHCO_3 + NH_4Cl$

In the lower compartment s of carbonating tower, the temperature of the mixture is lowered to 15°C. At this temperature, NaHCO3 precipitates out.

Filtration:

Precipitates of $NaHCO_3$, are separated from the milky solution by filtration. It is used as baking soda.

Calcinations:

Sodium hydrogen carbonate is heated to get sodium carbonate.

$$2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$$

Carbon dioxide is released and recycled in the process.

Preparation of carbon dioxide and slaked lime:

Carbondioxide is produced by heating limestone in kiln

$$CaCO_3(l) \rightarrow CaO(s) + CO_2(g)$$

Carbon dioxide is fed into carbonating tower from the top. Equal amount of CaO and water are mixed to produce slaked lime, $Ca(OH)_2$

$$CaO(s) + H_2O(l) \rightarrow Ca(OH)_2$$

Slaked lime is pumped to the ammonia recovery tower.

Recovery of ammonia:

Solution containing ammonium chloride in the carbonating tower is heated with slaked lime.

$$2NH_4Cl + Ca(OH)_2 \rightarrow 2NH_3 + 2CaCl_2 + 2H_2O$$

Almost all the NH_3 is recovered and is reused in the process.

Q: Describe composition of urea?

Urea is an organic compound with the chemical formula $CO(NH_2)_2$ The molecule has two $-NH_2$ groups joined by a carbonyl (C=O) functional group

$$NH_2 - \overset{\overset{\displaystyle O}{||}}{C} - NH_2$$

Q: Make a list of raw materials for Solvay process?

Sodium carbonate Na_2CO_3 or soda ash is an important industrial chemical. It is used in the manufacturing of glass, soaps, detergents, papers and many other important chemicals.

Sodium carbonate is manufactured in a continuous process known as Solvay process. Commercially, sodium carbonate is manufactures in a continuous process that uses:

1. Ammonia
2. Brine (concentrated sodium chloride solution)
3. Limestone as a source of carbon dioxide and slaked lime $Ca(OH)_2$

Q: Describe the composition of petroleum.

Composition of petroleum:

Petroleum is a mixture of hydrocarbons particularly alkanes, cycloalkanes, and aromatic hydrocarbons. Apart from hydrocarbons, it may also contain compounds containing oxygen and nitrogen.

Q: Relate the study of chemistry to careers in industry?

A person who studies chemistry and works with chemicals is called a chemist. Chemists have opportunities in all the fields of chemistry. For instance, organic chemists have good opportunities to work in industries like petroleum, pesticides and pharmaceutical etc. They can research on new pesticides, medicines, and find new ways to reduce environmental pollution etc.

As a food chemist you work in food processing industry. You can discover new methods to store, improve texture and flavor of foods. In hospitals chemists analyze blood urine and stood samples to detect any disease, disease causing bacteria, virus or other micro organisms.

As nuclear chemist you can work in the development of new nuclear medicines besides giving chemotherapy and radiation therapy to cancer patients.

As inorganic chemist you can work in chemical industries such as detergents , fertilizers, acids, alkalis, soda ash, dyes, explosives etc.

Q: Petroleum is a mixture of several compounds, which separated in a refinery?

- ***What is the name of the apparatus used for this purpose/ what is the name of the process used in separating crude oil?***
- **Write name of the fraction that represents gases.**
- ***Which fraction represents liquids with the lowest boiling points?***

1. a. Fractionating tower
   b. Fractional distillation
2. Liquefied petroleum gas LPG
3. Petrol (35-70 C)

Q: Petroleum is a source of fuels, Name two fuels which arenot obtained from petroleum:

The names of two fuels which are not obtained form petroleum are;

i. Coal
ii. Natural Gas

Q: What has to be done to crude oil before it is used?

Crude oil is a mixture of hydrocarbons. These are separated into useful products, using a process called fractional distillation in fractionating tower.

The useful products (components) are

- Liquid petroleum gas (LPG)
- Gasoline
- Naphtha
- Kerosene oil
- Diesel etc

THINK TANK

Q: The table below lists some petrol fractions with theirapproximate boiling points:

Fractions	Approximate boiling point
P	Below 20
Q	35-70
R	170-250
S	350-500

Name the process by which the fractions are obtained frompetroleum:

Refining (Fractional distillation)

Which fraction will contain shortest chain molecules?

Fraction P, LPG

Which fraction will contain the longest chain molecules?

Fraction S, lubricating oil

In what state will fractions P be at room temperature andpressure?

Gas

Q: Should fossil fuel be burned to provide energy pot should they be used to make useful products like drugs, plastics and chemicals?

Hemp oil is obtained by pressing hemp seeds. It can be used to create bio fuels to replace gasoline from diesel engines. Unlike fossil fuels, bio fuels are renewable and produce less of the green house gas carbon monoxide

Therefore fossil fuels should be used to make useful products like drugs, plastics and chemicals.