ACIDS, BASES AND SALTS

Question (1): Define the terms: Acid, alkali and salt.

Answer: An acid is a compound, which releases hydronium ions (H_3O^+) as the only positive ions in solution.

An alkali is a compound, which releases hydroxyl ions (OH^-) as the only negative ions in solution.

A salt is one of the products of neutralization between an acid and a base; water being the only other product. OR A salt gives positive ions other than H^+ ion and negative ions other than OH^- ion in solution.

Question (2): Identify the number of replaceable hydrogen ions (H^+) in the following acids:

HCl, CH_3COOH,

H_2SO_4, H_3PO_4.

Answer: HCl = 1 CH_3COOH = 1

H_2SO_4 = 2 H_3PO_4 = 3.

Question (3): What is a neutralization reaction?

Answer: Neutralization is essentially a chemical reaction between H_3O^+ ions of an acid with OH^- ions of the base, to give undissociated molecules of water.

Question (4): What are strong and weak acids? Give one example of each?

Answer: A strong acid is one, which is almost completely dissociated in solution. Examples: Dilute nitric acid, dilute sulphuric acid and dilute hydrochloric acid.

A weak acid is one, which is only partially ionized in solution (degree of dissociation is >30%). Examples: Acetic acid, carbonic acid and sulphurous acid.

Question (5): Why is acetic acid called a weak acid though there are 4 'H' atoms in the molecule?

Answer: Acetic acid is called a monobasic acid because only one of the 4 'H' atoms of the acid is released as H^+ ion in solution.

Question (6): How does a strong acid differ from a concentrated acid?

Answer: The strength of an acid depends upon its dissociation power whereas concentration depends on water content in the acid.

Question (7): Name a salt of a strong acid HNO_3 and a weak base like NH_4OH. Represent the reaction that takes place.

Answer: The salt that results due to the above reaction is Ammonium nitrate (NH_4NO_3). The reaction is represented as:

$$HNO_3 + NH_4OH \longrightarrow NH_4NO_3 + H_2O$$

Question (8):

1) Name a strong base and a weak base.
2) Name a hydrated salt.

Answer:

1) A strong base is sodium hydroxide (NaOH) and a weak base is ammonium hydroxide (NH_4OH).

2) A hydrated salt is copper sulphate crystals ($CuSO_4.5H_2O$).

Question (9): Name the following:

1) Two non-hydrated crystalline salts
2) Two neutral salts
3) Two basic salts
4) Two acid salts

Answer:

1) Two non-hydrated crystalline salts are: sodium chloride (NaCl) and potassium nitrate (KnO_3)

2) Two neutral salts are: sodium chloride (NaCl) and sodium sulphate (Na_2SO_4)

3) Two basic salts are: basic copper carbonate ($CuCO_3.Cu(OH)_2$) and basic lead carbonate ($PbCO_3.Pb(OH)_2$)

4) Two acid salts are: sodium bicarbonate ($NaHCO_3$) and sodium phosphate (NaH_2PO_4)

Question (10): Name the salts of sulphuric acid.

Answer: The salts of sulphuric acid are bisulphate and sulphate.
Examples: $NaHSO_4$, $KHSO_4$ and Na_2SO_4.

Question (11): Define the term "pH"; what does" pH" stand for?

Answer: The term "pH" is defined as the negative logarithm of H^+ ion concentration of a given solution; the concentration being expressed as moles per litre.

Mathematically pH = - log $[H^+]$ 'pH' stands for: Power of hydrogen ion concentration, 'p' for power and 'H' for H^+ ion concentration.

Question (12): What is 'pH' scale? Explain briefly.

Answer: The strength of an acid or a base is expressed in terms of hydronium ion concentration. This is expressed on a scale known as 'pH' scale. It is a 14 point scale; i.e., it has values ranging from 0 to 14, indicating the value of negative logs of H^+ ion concentration of the solution.

Some important benchmark values in the pH scale are: pH = 7 indicates neutral solutions e.g., aqueous solutions. pH > 7 to 14 indicates alkaline solutions and pH < 7 to 0 indicate acidic solutions.

Question (13): What is the 'pH' of pure water and that of rain water? Explain the difference.

Answer: The pH of pure water is seven. Rain water is slightly acidic because as rain drop fall, the carbon dioxide in the air dissolves with drops to form very weak carbonic acid. Accordingly, rain water has a pH that is slightly below 7.

Question (14): What is the pH of solution 'A' which liberates CO_2 gas with a carbonate salt? Give the reason?

Answer: The pH of solution 'A' is lesser than 7. Carbonates salts react with acids (A) to liberate CO_2 gas.

Question (15): What is the pH of solution 'B' which liberates NH_3 gas with an ammonium salt? Give reason?

Answer: The pH of solution 'B' is lesser than 7 because 'B' is an alkali as it liberates NH_3 gas.

Question (16): How do you increase or decrease the pH of pure water?

Answer: By adding a few drops of alkali to pure water, it's pH increases; and by adding a few drops of an acid decreases the pH of pure water.

Question (17): What are indicators?

Answer: Indicators are chemicals that show whether the given solution is acidic or basic, by the sudden change of color.

Question (18): Name the common acid-base indicators used in the laboratory with their color change.

Answer: The three common indicators used in the laboratory are:

Indicator	Final colour	
	Acid	Alkali
Litmus	Red	Blue
Methyl orange	Pink	Yellow
Phenolphthalein	Colourless	Deep pink

Question (19): What is a universal indicator? What is its advantage?

Answer: A universal indicator is a mixed indicator of organic chemicals which not only shows whether the given solution is acidic or basic, but also shows the approximate pH values by giving a wide particular colour for a specific value of pH.

Question (20): What is the action of litmus on ferric chloride solution and why?

Answer: An aqueous solution of $FeCl_3$ salt undergoes hydrolysis and releases H^+ ions from the stronger acid HCl formed. Hence, the resulting solution is acidic and turns blue litmus turns red.

$$FeCl_3 + 3H_2O \longrightarrow Fe(OH)_3 + 3HCl$$

$$HCl \longrightarrow H^+ + Cl^-$$

Question (21): What is the action of Na_2CO_3 solution on litmus and why?

Answer: In solution Na_2CO_3 salt undergoes hydrolysis and releases OH^- ions from the stronger alkali NaOH. Consequently, the resulting solution is basic and turns red litmus blue.

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

$$NaOH \longrightarrow Na^+ + OH^-$$

Question (22): What is the action of $NaHSO_4$ solution on litmus and why?

Answer: Blue litmus turns red in $NaHSO_4$ solution due to the release of H^+ ions along with Na^+ ions. Thus, $NaHSO_4$ is an acid salt.

Question (23): Though $NaHSO_4$ solution releases H^+ ions, why is it not called an acid?

Answer: $NaHSO_4$ solution is not called an acid because an acid should release only H^+ ions as positive ions and not any other positive ions. But $NaHSO_4$ is solution releases H^+ ions as well as Na^+ ions also as positive ion.

Question (24): Define the term ' normal salt ' with examples.

Answer: A normal salt is produced when all the replaceable 'H' atoms of an acid are completely replaced by a metal or NH_4 group, during neutralization with a base.
Examples: NaCl, $K_2CO_3$and $(NH_4)_3PO_4$.

Question (25): Define the term 'acid salt' with examples.

Answer: An acid salt is formed when the available 'H' atoms of an acid are only partially replaced by a metal, during neutralization with a base, and hence there are still 'H' atoms present in the salt that are available for replacement.

Examples : $NaHSO_4$, $NaHCO_3$, $Na_2HPO_4$and NaH_2PO_4

Question (26): Define the term 'basic salt' with an example.

Answer: A basic salt is formed by the incomplete neutralization of a base with an acid or partial replacement of hydroxyl radicals of a diacidic base or a triacidic base with an acid radical.
Example: Zn(OH)Cl, $Cu(OH)NO_3$.

Question (27): Define a double salt. Give some examples.

Answer: A double salt is formed between two simple salts by crystallization from a saturated solution of a mixture of the two. Examples:

$$K_2SO_4.Al_2(SO_4)_3.24H_2O \text{ (Potash alum)}$$

$$(NH_4)_2SO_4.Al_2(SO_4)_3.24H_2O \text{ (Ammonium alum)}$$

$FeSO_4.(NH_4)_2SO_4.6H_2O$ (Mohr's salt).

Question (28): Define mixed salt giving some examples.

Answer: Mixed salts contain more than one acid radical or basic radical other than H^+ and OH^- ions. Examples:

$K^+Ca^{2+}PO_4^{3-}$

(Potassium calcium phosphate)

$Ca^{2+}(OCl)^-Cl^-$ [Bleaching powder (Calcium chloro hypochlorite)]

$Na^+K^+SO_4^{2-}$ (Sodium potassium sulphate).

Question (29): Define complex salts with examples.

Answer: Complex salts dissociate to give one simple ion and one complex ion in solution. Examples:

$$Na\,[Ag(CN)_2]\,(aq) \longrightarrow \underset{\text{Complex ion}}{Na^+ + [Ag(CN)_2]^-}$$

$$[Cu(NH_3)_4]\,SO_4 \longrightarrow \underset{\text{Complex ion}}{[Cu(NH_3)_4]^{2+} + SO_4^{2-}}$$

Question (30): What happens if NaOH is added to ferrous ammonium sulphate solution and warmed? What is the inference?

Answer: When NaOH is added to ferrous ammonium sulphate solution and warmed, both ferrous ion and ammonium ion separate and exhibit their individual properties. A green precipitate of $Fe(OH)_2$ is formed and the smell of NH_3 gas from $(NH_4)^+$ ion is observed. Hence it is an example of the formation of a double salt.

Question (31): What happens if sodium hydroxide is added to cuprammonium sulphate solution and what is the inference?

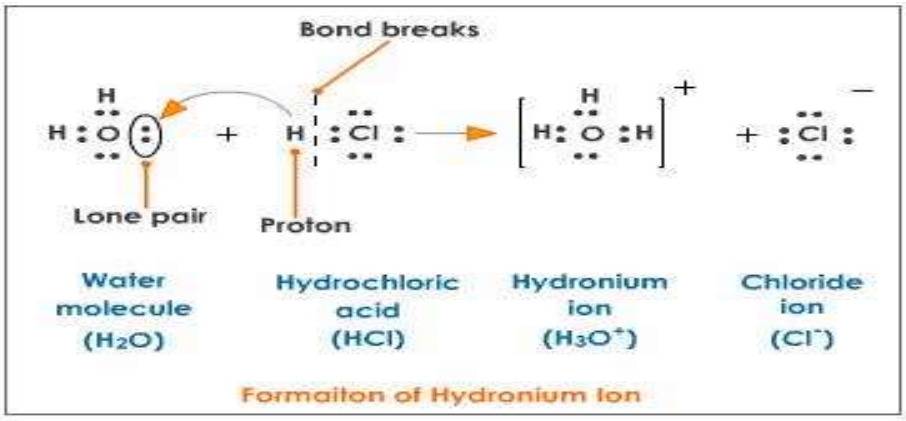
Answer: When sodium hydroxide is added to cuprammonium sulphate solution, no blue precipitate of $Cu(OH)_2$ is seen, which is normally observed for Cu^{2+} ion. Hence it is an example of a complex salt.

Question (32): When lead dioxide reacts with concentrated HCl and produces a salt and water, the reaction is not called a neutral reaction why?

Answer: For a reaction to be called a neutral reaction the products should be only salt and water. But in the above reaction, Cl_2 gas is also liberated.

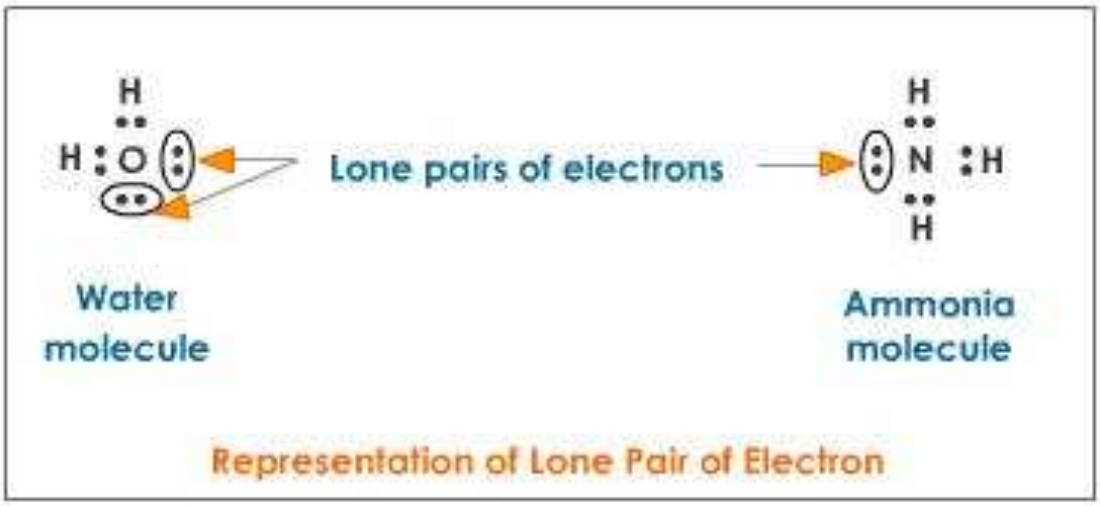
Question (33): Indicate the formation of hydronium ion with Lewis dots structure between HCl and H_2O?

Answer:



Question (34): Name two compounds, which behave as bases as they have one pair of electrons and hence accept protons?

Answer: Water and ammonia behave as bases due to the presence of lone pair of electrons.



Question (35): Define a base and acid in terms of proton.

Answer: A base is a proton acceptor and an acid is a proton donor.

Question (36):

1) Name the anions that can be detected in the laboratory using dilute HCl or dilute H_2SO_4 and give the ionic equation common to both reactions.

2) Which property of the acid is indicated?

Answer:

1) The three anions that can be identified using dilute acids with their common ionic equations are:

Carbonate or bicarbonate ion $2H^+ + CO_3^{2-} \rightarrow H_2O + CO_2 \uparrow$

Sulphite or bisulphite ion $2H^+ + SO_3^{2-} \rightarrow H_2O + SO_2 \uparrow$

Sulphide ion $2H^+ + S^{2-} \rightarrow H_2S \uparrow$
(dil. acid) (Salt) Gas identified

2) The property is that of releasing H^+ ions by dilute HCl or dilute H_2SO_4 in solution i.e., the acidic property.

Question (37):

1) What do you observe when concentrated H_2SO_4 is added slowly to blue $CuSO_4$ crystals in a test tube and why?

2) Is these any other way of observing the above result?

Answer:

1) The blue crystals turn to white amorphous anhydrous powder. Hence concentrated H_2SO_4 acts as a dehydrating agent, removing the water of crystallization molecules from $CuSO_4.5H_2O$ crystals.

2) Another way of observing the above result is by gentle heating of blue crystals of $CuSO_4.5H_2O$ directly in a test tube.

Question (38): Name two crystalline salts that do not have water of crystallization.

Answer: The chlorides of K, Na and Pb and the nitrates of K, Na, Pb, Ag, $[NH_4^+]$ do not have water of crystallization.

Question (39): How is NaOH an important laboratory reagent?

Answer: NaOH is used to detect cations in salt solutions, by precipitating their hydroxides. The characteristic colour and solubility in excess NaOH of these hydroxides, identifies them. Examples of cations identified are:

Pb^{2+}, Zn^{2+}, Ca^{2+}, Cu^{2+}, Fe^{2+}, Fe^{3+}, and NH_4^+.

In case of NH_4^+ ion, NH_3 gas is liberated.

Question (40): How is NH_4OH used as a laboratory reagent?

Answer: NH_4OH is used to detect cations in their salt solutions by precipitating their hydroxides whose colour and solubility in excess NH_4OH, identifies them.

Examples of cations detected are Pb^{2+}, Zn^{2+}, Cu^{2+}, Fe^{2+} and Fe^{3+}.

Question (41): Name four gases that can be prepared in the laboratory using dilute H_2SO_4. Show how they can be prepared?

Answer: The four gases are:

1) H_2 gas
2) CO_2 gas
3) SO_2 gas
4) H_2S gas

Their respective methods of preparations are:

1) An active metal (above Pb) and dilute H_2SO_4 gives H_2 gas.
2) Any carbonate salt and dilute H_2SO_4 gives CO_2 gas.
3) Any sulphite salt and dilute H_2SO_4 gives SO_2 gas.
4) Any sulphide salt and dilute H_2SO_4 gives H_2S gas.

Question (42): While diluting concentrated H_2SO_4, what care must be taken and why?

Answer: While diluting concentrated H_2SO_4 never add water to concentrated acid; instead, add concentrated H_2SO_4 slowly with stirring to the volume of water. As this reaction is highly exothermic the heat produced will splash the acid and may cause burns.

Question (43): What is the cause of tooth decay?

Answer: The bacteria present in the mouth act on sugar and food particles remaining in the mouth after eating to produce acids. The acid produced lowers the pH in the mouth to 5.5 and begins to attack the hard enamel and corrode it resulting in tooth decay.

Question (44): Plaster of Paris should be stored in a moisture-proof container. Explain why?

Answer: Plaster of Paris (POP) or calcium sulphate with half a molecule of water per molecule of the salt (hemi-hydrate) is a hygroscopic substance. Should it absorb a little water from the surroundings, it evolves heat and quickly sets to a hard porous mass hence it should be stored in a moisture-proof container to keep it dry.