DEPARTMENT OF EDUCATION (S)
Government of Manipur

CHAPTER 3
ACIDS, BASES AND SALTS

SOLUTIONS

TEXTUAL QUESTIONS & ANSWERS

Let us answer these (Page 48)

1. **Dissolve a small amount of $NaHCO_3$ in water. Add 1 drop of methyl orange into it. What is the colour of the mixture? Add lime juice in the above solution till the evolution of the gas stops. What is the colour of the mixture now?**
   Ans: $NaHCO_3$ is a base. In basic medium methyl orange gives yellow colour.
   Addition of lime juice makes the solution acidic. In acidic medium methyl orange gives orange red colour.
2. **How many grams of sulphuric acid (H_2SO_4) will be needed to react completely with a solution containing 10.6 g of sodium carbonate (Na_2CO_3)?**
   Ans: $Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + CO_2 + H_2O$
   Here, 1 mole of Na_2CO_3 reacts with 1 mole of H_2SO_4 to form 1 mole of Na_2SO_4, 1 mole of CO_2 and 1 mole of H_2O.
   Molecular mass of Na_2CO_3 = (23x2) + (12x1) + (16x 3) = 46+12+48 = 106 u
   Molecular mass of H_2SO_4 = (1x2) + (32x1) +(16x4) =2+32+64 =98u
   ∴ 106 g of Na_2CO_3 can react with 98 g of H_2SO_4
   ∴ 10.6 g of Na_2CO_3 can react with 98x10.6 ÷ 106 g of H_2SO_4 =9.8 g

Let us answer these (Page 49)

1. **What is the nature of metal oxides – acidic or basic?**
   Ans: Basic.
2. **Two metallic compounds A and B react separately with acid to form salt and water. The compound A also produces an effervescence. What could be A and B?**
   Ans: Both A and B react with acid to give salt and water. So they are bases.
   A gives effervescence. So A is a metal carbonate or metal bicarbonate while B is a metal oxide or hydroxide.
3. **When milk becomes curd lactic acid is produced as one of the products. Give reason why it is not advisable to keep curd in copper and brass vessels?**
   Ans: Lactic acid from curd reacts with copper metal to produce copper lactate which is toxic to our health. So curd should not be kept in copper or brass vessels.
4. **Carbon dioxide reacts with lime water, $Ca(OH)_2$ to form salt, $CaCO_3$ and water as**
   $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$
   Base salt water
   Indicate the nature of CO_2. What will be the general nature of non-metallic oxides?
   Ans: CO_2 is acidic in nature as it reacts with the base, $Ca(OH)_2$ to give salt and water.
   The general natures of non-metallic oxides are acidic.
5. **Write the reaction between sodium hydroxide and sulphur dioxide.**
   Ans: $NaOH + SO_2 \longrightarrow Na_2SO_3 + H_2O$
   Sodium hydroxide, Sulphur dioxide, Sodium sulphite
6. **What will happen when CO_2 gas is passed into water? Write the chemical equation.**
   Ans: CO_2 reacts with water to give carbonic acid, H_2CO_3.
   $CO_2 + H_2O \longrightarrow H_2CO_3$
   Carbonic acid

7. **Write the reaction that takes place between water and sulphur dioxide.**
Ans: $SO_2 + H_2O \longrightarrow H_2SO_3$
Sulphurous acid

8. **Give definition of base.**
Ans: A base is a substance which has bitter to test, slippery to touch and can form hydroxide ion (OH^-) in aqueous solution are called bases.
Metal carbonates and bicarbonates are also bases.

9. **Define acids.**
Ans: Compounds which can give out hydrogen ion (H^+) to form Hydronium ion (H_3O^+) in aqueous solution are called acids.

10. **Give the definition of acidic oxides.**
Ans: Non-metallic oxides which dissolve in water to give acids are called acidic oxides.
Eg: CO_2, SO_2 etc.

Let us answer (Page 54)

1. **Is the dilution of acid with water exothermic or endothermic?**
Ans: It is exothermic.

2. **"NaOH dissolves in water with the absorption of heat". Is it correct or not? If not give the correct statement.**
Ans: The given statement is not correct. Dissolution of NaOH in water is exothermic. Therefore the statement should be " NaOH dissolves in water with the release of heat".

3. **Why does an aqueous solution of an acid conduct electricity?**
Ans: In aqueous solution acids are dissociated into hydrogen ion (H^+) to form Hydronium ion (H_3O^+) and anion. These ions help in the conductivity of acids .

4. **How does dilution affect on the concentration of H_3O^+ ion of an acid?**
Ans: With dilution the concentration of H_3O^+ ion per unit volume decreases.

5. **What will happen to the concentration of H_3O^+ in a given volume of an acid if it is mixed with a same amount of NaOH solutions?**
Ans: Concentration of H_3O^+ ion will decrease because NaOH will neutralise it to give Na+ and H_2O. If same amount of NaOH is added, the reacting medium becomes neutral

EXERCISES

(Text Book Questions & Answers, Page no. 59)

1. **Write the products obtained when Na_2SO_4 is hydrolysed. i.e, reacts with water?**
Ans: The products obtained are sodium hydroxide and sulphuric acid
$Na_2SO_4 + H_2O \leftrightharpoons H_2SO_4(aq) + NaOH(aq)$
(Na_2SO_4 is formed by incomplete neutralization of H_2SO_4 and NaOH)
(see text book Page No. 56)

2. **Write the formula of the acid and the base from which the salt Na_2CO_3 is obtained.**
Ans: The formula of acid is carbonic acid, H_2CO_3 and the formula of base is sodium hydroxide, NaOH.

3. **p^H of samples of HCl and acetic acid are 2 and 3.5 respectively.Which one is a stronger acid?**
Ans: Lower the value of p^H stronger is the acid. Therefore HCl is stronger acid than acetic acid.

4. **$Fe(OH)_3$ is less soluble in water than $Ca(OH)_2$. Which one is a weaker base?**
Ans: Since $Fe(OH)_3$ is less soluble in water, it will give less number of OH^- ion to compare with $Ca(OH)_2$. Therefore $Fe(OH)_3$ is a weaker base.

5. **Device an experiment set up to show that dilute hydrochloric acid is a good conductor of electricity.**
Ans. Let us take 25ml of dilute hydrochloric acid in a beaker. Two nails which are fix to a rubber cork are dipped in the solution and connected to the two terminals to a 6 volt battery with wires through a bulb and a switch as shown in the figure. When the key is pressed, the bulb begins to glow. When HCl is added to water (H_2O) it dissociated into H^+ and Cl^-.
$HCl + H_2O \leftrightharpoons H_3O^+ (aq) + Cl^-$
The ions conduct electricity in water. Hence dilute HCl is a good conductor of electricity.

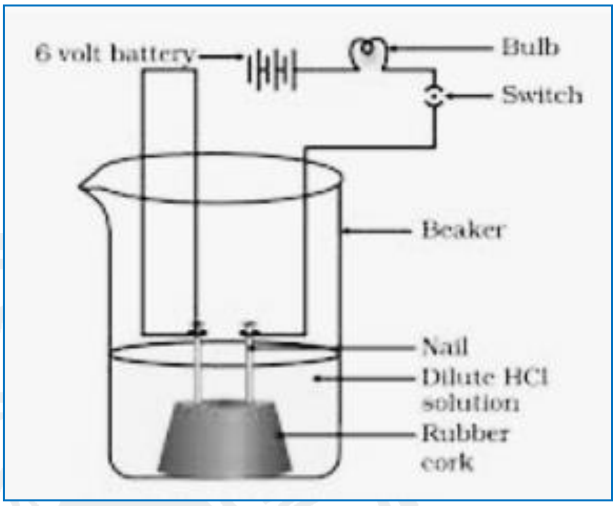

Fig.1. Experiment to show that dil. Hcl is a good conductor of electricity.

EXTRA QUESTIONS & ANSWERS

1. **NaOH is a stronger base than NH_4OH. Which of the equimolar solutions of the two will have higher p^H value?**
Ans: NaOH. Because greater the value of p^H stronger is the base.

2. **Compounds like $NaHSO_4$ and Mg(OH)Cl are known as acid and basic salts. Why are they so called? Write one equation each for the formation of the above type of salts.**
Ans: $NaHSO_4$ (Sodium hydrogen sulphate) is known as acid / acidic salt due to the presence of replaceable H-atom and can further react with base to form normal salt.
H_2SO_4 (aq) + NaOH (aq) → $NaHSO_4$ (aq) + H_2O (l)
(Incomplete neutralization reaction)
Mg(OH)Cl (Hydroxyl Magnesium chloride) is known as basic salt due to the presence of replaceable OH group and can further react with acid to form normal salt.
$Mg(OH)_2$(aq) + HCl (aq) → Mg(OH)Cl (aq) + H_2O (l)
(Incomplete neutralization reaction)

3. **Explain the fact that HCl changes the colour of blue litmus paper to red only in the presence of water but not in the dry state.**
Ans: Dry HCl does not turn blue litmus red as no free H^+ Ions releases to form H_3O^+ Ions in dry state.
In presence of water HCl turns blue litmus red which indicates that there is free H^+ Ions to form H_3O^+ Ions in aqueous HCl.
HCl (g) + H_2O (l) → H_3O^+ (aq) + Cl^-(aq)

5. **Dilute hydrhloric acid reacts with a metal carbonate to evolve a gas "A". When the gas is passed through sodium hydroxide solution a salt "B" is formed.**
Identify "A" and "B". What are the name of the reaction between "A" and sodium hydroxide? Write the hydrolysis reaction of salt "B" and predict the p^H range of the salt solution.
Ans: Metal carbonate reacts with dilute hydrochloric acid to give carbon dioxide gas.
When CO_2 gas is passed through sodium hydroxide solution, sodium bicarbonate is formed.
$NaOH + CO_2 \rightarrow NaHCO_3$
Thus the gas "A" is CO_2 and the salt "B is $NaHCO_3$.CO_2 is acidic oxide and NaOH is a base.So the reaction is neutralisation reaction.
Hyrolysis of $NaHCO_3$:
$NaHCO_3 + H_2O \rightarrow NaOH + H_2CO_3$
Hydrolysis of $NaHCO_3$ gives sodium hydroxide,NaOH and carbonic acid,H_2CO_3. NaOH is a strong base and H_2CO_3 is a weak acid. Thus the salt solution has basic character. Therefore its p^H range is in between 7 to 14.

6. **Take about 10 ml of dilute Na_2CO_3 solution in a beaker. Add two drops of methyl orange indicator into it. What is the colour of the mixture? Now add dilute HCl solution drop by drop into the beaker till the effervescence stops. Add a few drops of dilute HCl. What will be the colour of the solution now?**
Ans: In basic medium the colour is yellow. When dilute HCl is added the colour becomes orange red.

7. **Name the organic acid present in cabbage and green leafy vegetables.**
Ans: Ascorbic acid.

8. **Why is the aqueous solution of sodium carbonate alkaline?**
Ans: Sodium carbonate reacts with water to give strong base sodium hydroxide and weak acid, carbonic acid. Due the formation of strong base, NaOH the aqueous solution of sodium carbonate is alkaline.

9. **Sodium hydroxide solution cannot be kept in aluminium container.Give reason.**
Ans: It is because sodium hydroxide reacts with aluminium metal to form sodium meta aluminate and hydrogen gas.

10. **Which of the two solutions of same concentration, hydrochloric acid and acetic acid will have higher p^H ? Give reason.**
Ans: Acetic acid.
Acetic acid is a weak acid and contains lower concentration of hydronium ion so has higher p^H value.

11. **Urine sample of a patient was found to contain excess of uric acid. What will be the p^H range of this urine sample?**
Ans: p^H 0 to 7.

12. **Write the reaction between aqueous solution of sodium hydroxide and acetic acid.**
Ans: $NaOH + CH_3COOH \rightarrow CH_3COONa + H_2O$
Sodium hydroxide   Acetic acid   Sodium acetate

PROBABLE QUESTIONS FROM TEXT BOOK

Q1. What are indicators?

Ans:- Those substances which can indicate the nature of a solution whether acidic or basic by changing in their colours in different solutions are known as indicators.

Q2. How can you identify a given chemical formula as inorganic or organic acids. Illustrate with examples.

Ans:- In inorganic acid the replaceable hydrogen atom is always present in left hand side of the chemical formula. e.g. HCl, HNO_3, H_2SO_4 etc.

In organic acids, the replaceable hydrogen atom is always present at right hand side of the chemical formula i.e. in carboxylic group (- COOH).

E.g. HCOOH, CH_3COOH, C_2H_5COOH

Q3. What are the chemical properties of acid? Give examples.

Ans:-

(i) All acids form hydronium ions (H_3O^+) when dissolves (react) with water.

e.g. HCl + H_2O → H_3O^+ + Cl^-

(ii) Reaction with metals:-

When acid reacts with metals, they form salt and hydrogen gas.

Metal + Acid → Salt + Hydrogen

e.g. H_2SO_4 (aq) + Zn (s) → Zn SO_4 (aq) + H_2 (g)

(iii) Reaction of acid with metal oxide

When metal oxide reacts with acid they form salt and water.

Acid + Metal oxide → Salt + Water

e.g. 2HCl (aq) + ZnO (s) → Zn Cl_2 (aq) + H_2O (l),
(White) (colourless)

(iv) Reaction of acid with base (Neutralization reaction):-

Acid + Base → Salt + Water

e.g. HCl (aq) + NaOH (aq) → NaCl (aq) + H_2O (l)

Q4. What are the chemical properties of bases?

Ans:-

(i) Bases can form hydroxide ions when dissolves in water.

e.g.. $NaOH \xrightarrow{water} Na^+(aq) + OH^-(aq)$

(ii) Reaction of bases with metals:-

When bases react with metals they form salt and hydrogen gas.

Base + Metal → Salt + Hydrogen

2NaOH + Zn → Na_2ZnO_2 + H_2

(iii) Reaction of base with metal hydrogen carbonate

Base + Metal Carbonate → Salt + Water

e.g. NaOH(aq) + $NaHCO_3$(s) → Na_2CO_3(aq) + H_2O (l)

(iv) Reaction of base with non-metallic oxide

When non-metallic oxide reacts with bases they form salt and water.

Base + Non Metallic oxide → Salt + Water

e.g. $Ca(OH)_2$ (aq) + CO_2 (g) → $CaCO_3$(s) + H_2O (l)
(Calcium carbonate)
(Insoluble)

(v) Reaction of base with acid:-

When bases react with acid they form salt and water.

Base + Acid → Salt + Water
e.g. NaOH (aq) + HCl (aq) → NaCl (aq) + H_2O (l)

Q5. **Write the reaction between $NaHCO_3$ and KOH.**
Ans:- *(See Q4.)*

Q6. **Give one reason for acidic character of $NaHCO_3$.**
Ans:- $NaHCO_3$ can neutralized NaOH to form salt and water.
$NaHCO_3$ + NaOH → Na_2CO_3 + H_2O

Q7. **Give one reason for the use of lime for the treatment of acidic soil.**
Ans:- Lime neutralized the acid present in the soil. Nitrifying bacteria which cannot function in acid soil become active again when the soil is treated with lime.

Q8. **Why phenolphthalein is called an indicator? Explain.**
Ans:- Phenolphthalein gives pink colour in alkali but it is colourless in acid solution.

Q9. **A housewife stored curd overnight in a copper vessel. It was found that the curd becomes bluish in colour. Why was it so? Explain. (Q. 2015 P)**
Ans:- Copper reacts with lactic acid present in the curd to form copper lactate. Cu^{2+} ions makes bluish colour in curd.

Q10. **Which gas is generally formed when acid reacts with a metal carbonate? Give one example. How can it be identified? (Q. 2016 P)**
Ans:- Carbon dioxide (CO_2) is formed.
Example: $Na_2\ CO_3$(s) + 2HCl (aq) → 2NaCl (aq) + H_2O (l) + CO_2 (g)
Identification of gas:- When the evolving gas is passed through lime water, the clear liquid changes into milky colour due to the formation of insoluble calcium carbonate.

Q11. **When sodium bicarbonate reacts with dilute hydrochloric acid, a colourless gas is evolved. When the colourless gas is passed through lime water for a short period, the colour of the lime water changes into milky colour, but when the colourless gas passes into the lime water for longer time the milky colour disappear again. Identify the gas. Narrate / explain the different steps with relevant equations.**

Or

What will happens when carbon dioxide gas is passed through lime water for a short period and for a longer time. Give the relevant equation.

Ans:- The colourless gas evolved during the reaction of sodium bicarbonate and hydrochloric acid is carbon dioxide gas.
$NaHCO_3$(s) + HCl (aq) → NaCl (aq) + H_2O (l) + CO_2 (g)
When CO_2 gas passes through lime water for short period in soluble calcium carbonate is formed which make the milky colour of the solution.
$Ca(OH)_2$ (aq) + CO_2 (g) → $CaCO_3$(s) + H_2O (l)
(Calcium carbonate)
(Insoluble)
When carbon dioxide gas passes into the solution for longer period the milkyness of the solution disappear due to the formation of soluble Calcium hydrogen carbonate$[Ca(HCO_3)_2]$
$CaCO_3$(s) + H_2O (l) + CO_2 (g) → $Ca(HCO_3)_2$ (aq)
(Soluble)

Q12. A compound of metal M reacts with dilute HCl liberating a colourless gas which turns lime water milky. Write a balanced equation of the reaction if one of the product is $MgCl_2$. Why does the lime water turns milky? What will happen to the mixture if gas is passed for a longer time?

Ans:- $MgCO_3$(s) + 2HCl(aq) → $MgCl_2$ (aq) + H_2O (l) + CO_2 (g)

Or

Mg (HCO_3)$_2$ (s) + HCl (aq) → $MgCl_2$ (aq) + H_2O (l) + CO_2 (g)

Lime water turns milky due to the formation of insoluble CaCO_3.

$Ca(OH)_2$ (aq) + CO_2 (g) → $CaCO_3$(s) + H_2O (l)

If the gas is passed for a longer time the milky colour will be disappeared due to the formation of soluble $Ca(HCO_3)_2$.

CaCO_3(s) + H_2O (l) + CO_2 (g) → $Ca(HCO_3)_2$ (aq)

Q13. What are the chemical used in the preparation of hydrogen gas for gas balloons sold in the market? Write the chemical equation for the preparation of this gas.

Ans:- Aluminum powder and sodium hydroxide solution.

2NaOH (aq) + 2Al (s) + $2H_2O$ (l) → $2NaAlO_2$ (aq) + $3H_2$ (g)

Q14. Calculate the number of moles of NaOH required in the complete neutralization of 10 moles of H_2SO_4. (2011 C)

Ans: 2NaOH + H_2SO_4 → Na_2SO_4 + 2H_2O

2 moles 1 mole

For complete neutralization of 1 mole of H_2SO_4 requires 2 mole of NaOH.

∴ For complete neutralization of 10 mole of H_2SO_4 requires:

2 x 10 = 20 moles

Q15. Calculate the amount of CO_2 evolved when 10 g of $CaCO_3$ is treated with an excess of dilute hydrochloric acid (HCl).

Ans:- $CaCO_3$(s) + HCl (aq) → $CaCl_2$ (aq) + H_2O (l) + CO_2 (g)

Gram molecular mass of $CaCO_3$ = 40 + 12 + 48 = 100 g.

Gram molecular mass of CO_2 = 12 + 32 = 44 g.

100 g of $CaCO_3$ is treated with HCl (aq) produces 44 g of CO_2.

∴ 10 g of $CaCO_3$ produces $\frac{44x10}{100}$ = 4.4 g of CO_2.

Q16. Calculate the mass of sodium hydroxide required just to completely neutralize a solution containing 4.3 g of H_2SO_4. (Q. 2016 P)

Ans:- 2NaOH + H_2SO_4 → Na_2SO_4 + 2H_2O

Gram molecular mass of 2NaOH = 2(23 + 16 +1) = 80 g.

Gram molecular mass of H_2SO_4 = 2 + 32 + 64 = 98 g.

For complete neutralization of 98 g of H_2SO_4, 80 g of NaOH is required.

∴ For complete neutralization of 4.9 g of H_2SO_4

$\frac{80x4.9}{98}$ g = $\frac{80x49}{98x10}$ = 4 g of NaOH required.

Q17. Why all acids and bases do not have same strength?

Ans:- The strength of an acid depends upon the amounts of H_3O^+ ions, it can produce in equimolar solutions. But all acids do not produce the same amount of H_3O^+ ions.

The strength of base (alkali) depends upon the number of OH^- Ions. It can produce in equimolar solutions. But all alkalis do not produce the same amount of OH^- ions in solution.

Q18. What is p^H scale? What is its range?

Ans:- It is a scale which can indicate the strength of an acid or a base by changing the colour of universal indicator after dipping in the solutions of acid or base (alkali). It ranges from 0 to 14.

Q19. What is universal indicator?

Ans:- It is a mixture of indicators which is found in the strips of paper that can indicate the nature of the strength of an acid or a base.

Q20. Write the products formed when 36.5 g of HCl made to react with 50 g of NaOH. Predict the p^H range of the resultant solution.

Ans:- Here,

HCl (aq) + NaOH (aq) → NaCl (aq) + H_2O (l)

Gram molecular mass of HCl = 36.5 g

Gram molecular mass of NaOH = 40 g

Excess of NaOH = 50 – 40 = 10 g

The solution will be alkaline due to the excess of NaOH.

The p^H range will be in between 7 to 14.

Q21. What will be the nature of aqueous solution of $Al_2(SO_4)_3$ towards litmus paper? Give reason in support of your answer.

Ans:- Blue litmus paper will turn into red. $Al_2(SO_4)_3$ is hydrolyzed to strong acid H_2SO_4 and weak base $Al(OH)_3$.

$Al_2(SO_4)_3 + 6H_2O \rightarrow 3H_2SO_4 + 2Al(OH)_3$

The solution is acidic due to the strong acid H_2SO_4.

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