Exercise-3B

1. Define the following and give two examples in each case: (a) a normal salt, (b) an acid salt, (c) a mixed salt.
Solution:

(a) A normal salt:
Normal salts are the salts formed by the complete replacement of the ionizable hydrogen atoms of an acid by a metallic or an ammonium ion.
Eg: Na_2SO_4, NaCl

(b) An acidic salt:
Acid salts are formed by the partial replacement of the ionizable hydrogen atoms of a polybasic acid by a metal or an ammonium ion.
Eg: $NaHSO_4$, Na_2HPO_4

(c) A mixed salt:
Mixed salts are those salts that contain more than one basic or acid radical.
Eg: $NaKCO_3$, $CaOCl_2$

2. Answer the following questions related to salts and their preparations:
(a) What is a salt?
(b) What kind of salt is prepared by precipitation?
(c) Name a salt prepared by the direct combination. Write an equation for the reaction that takes place in preparing the salt you have named.
(d) Name the procedure used to prepare a sodium salt such as sodium sulphate.
Solution:

(a) Salt is a compound formed by the partial or total replacement of the ionizable hydrogen atoms of an acid by a metallic ion or an ammonium ion.
(b) An insoluble salt can be prepared by precipitation.
(c) A salt prepared by direct combination is Iron (III) chloride.
The reaction is given as below:
$2Fe + 3Cl_2 \rightarrow 2FeCl_3$
(d) By neutralizing sodium carbonate or sodium hydroxide with dilute sulphuric acid:
$Na_2CO_3 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O + CO_2$
$2\ NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

3. Describe giving all practical details, how would you prepare:
(a) Copper sulphate crystals from mixture of charcoal and black copper oxide,
(b) Zinc sulphate crystals from Zinc dust (powered Zinc and Zinc oxide)
(c) sodium hydrogen carbonate crystals
(d) Calcium sulphate from calcium carbonate
Solution:

(a) Copper sulphate crystals from a mixture of charcoal and black copper oxide:

The carbon in the charcoal reduces the black copper oxide to reddish-brown copper. The lid must not be removed until the crucible is cool or the hot copper will be re-oxidized by air.
Take dilute sulphuric acid in a beaker and heat it on wire gauze. Add cupric oxide in small quantities at a time, with stirring till no more of it dissolves and the excess compound settles to the bottom.
Filter it hot and collect the filtrate in a china dish. Evaporate the filtrate by heating to the point of crystallization and then allow it to cool and collect the crystals of copper sulphate pentahydrate.
Reaction:
$CuO + H_2SO_4 \rightarrow CuSO_4 + H_2O$
$CuSO_4 + 5H_2O \rightarrow CuSO_4.\ 5H_2O$

(b) Zinc sulphate crystals from Zinc dust:
Take dilute sulphuric acid in a beaker and heat it on wire gauze. Add some granulated zinc pieces with constant stirring. Add till the Zinc settles at the base of the beaker. Effervescences take place because of the liberation of hydrogen gas. When effervescence stops, it indicates that all the acid has been used up. The excess of zinc is filtered off. Collect the solution in a china dish and evaporate the solution to get crystals. Filter, wash them with water and dry them between the folds of paper. The white needle crystals are of hydrated Zinc sulphate.
Reaction:
$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$
$ZnSO_4 + 7\ H_2O \rightarrow ZnSO_4.\ 7\ H_2O$

(c) Lead sulphate from metallic lead:
Metallic lead is converted to lead oxide by oxidation. Then lead sulphate is prepared from insoluble lead oxide, by first converting it into soluble lead nitrate. Then the lead nitrate solution is treated with sulphuric acid to obtain white ppt. of Lead sulphate.
Reaction:
$PbO + 2HNO_3 \rightarrow Pb(NO_3)_2 + H_2O$
$Pb(NO_3)_2 + H_2SO_4 \rightarrow PbSO_4 + 2HNO_3$

(d) Sodium hydrogen carbonate crystals:
Dissolve 5 grams of anhydrous sodium carbonate in about 25 ml of distilled water in a flask. Cool the solution by keeping the flask in a freezing mixture. Pass carbon dioxide gas in the solution. Crystals of sodium bicarbonate will precipitate out after some time. Filter the crystals and dry it in folds of filter paper.
Reaction:
$Na_2CO_3 + CO_2 + H_2O \rightarrow 2NaHCO_3$

4. The following is the list of methods for the preparation of salts.
A - Direct combination of two elements.
B - reaction of dilute acid with a metal.
C - reaction of dilute acid with an insoluble base.
D - Titration of dilute acid with a solution of soluble base.
E - reaction of two solutions of salts to form a precipitate.
Choose from the above list A to E, the best method of preparing the following salts by giving a suitable equation in each case:
1. Anhydrous ferric chloride, **2. Lead chloride,**

3. Sodium sulphate, **4. Copper sulphate.**
Solution:

1. Anhydrous ferric chloride: - A (Direct combination of two elements)
$2Fe + 3Cl_2 \rightarrow 2FeCl_3$

2. Lead chloride: - E (Reaction of two solutions of salts to form a precipitate)
$Pb(NO_3)_2 + 2HCl \rightarrow PbCl_2 + 2HNO_3$

3. Sodium sulphate: - D(Titration of dilute acid with a solution of soluble base)
$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

4. Copper sulphate: - C (Reaction of dilute acid with an insoluble base)
$Cu(OH)_2 + H_2SO_4 \rightarrow CuSO_4 + 2H_2O$

5. Name:
(a) A chloride which is insoluble in cold water but dissolves in hot water,
(b) A chloride which is insoluble,
(c) Two sulphates which are insoluble,
(d) A basic salt,
(e) An acidic salt,
(f) A mixed salt,
(g) A complex salt,
(h) A double salt,
(i) a salts whose solubility increases with temperature,
(j) A salt whose solubility decreases with temperature.
Solution:

(a) Lead chloride
(b) Silver chloride
(c) Barium sulphate and lead sulphate
(d) Basic lead chloride
(e) Sodium hydrogen sulphate
(f) Sodium potassium carbonate
(g) Sodium argentocyanide
(h) Potash alum
(i) Potassium bromide and potassium chloride
(j) Calcium sulphate

6. Fill in the blanks with suitable words:
An acid is a compound which when dissolved in water forms hydronium ions as the only …… ions. A base is a compound which is soluble in water and contains..... ions. A base reacts with an acid to form a.....and water only. This type of reaction is known as …….
Solution:

An acid is a compound which when dissolved in water forms hydronium ions as the only positively charged ions. A base is a compound which is soluble in water and contains hydroxide ions. A base reacts with an acid to form a salt and water only. This type of reaction is known as neutralisation.

7. What would you observe when:
(a) Blue litmus is introduced into a solution of hydrogen chloride gas.
(b) Red litmus paper is introduced into a solution of ammonia in water
(c) Red litmus paper is introduced in Caustic soda solution?
Solution:

(a) Blue litmus will turn into red indicating the solution is acidic.
(b) No change will be observed.
(c) As caustic soda is basic in nature it will turn red litmus blue.

8. Explain why:
(a) It is necessary to find out the ratio of reactants required in the preparation of sodium sulphate.
(b) Fused calcium chloride is used in the preparation of $FeCl_3$.
(c) Anhydrous $FeCl_3$ cannot be prepared by heating hydrated iron (III) chloride.
Solution:

(a) As sodium hydroxide and sulphuric acid are both soluble, an excess of either of them cannot be removed by filtration. Hence, it is necessary to find out the ratio of reactants required in the preparation of sodium sulphate.

(b) Fused calcium chloride is used to kept iron chloride dry as it is highly deliquescent.

(c) On heating hydrated ferric chloride, HCl acid is released and basic salt ferric oxide (FeOCl) remains. Thus, anhydrous ferric chloride cannot be prepared by heating its hydrate.

9. Give the preparation of the salt shown in the left column by matching with the methods given in the right column. Write a balanced equation for each preparation.

Salt	**Method of preparation**
Zinc Sulphate	**Precipitation**
Ferrous sulphide	**Oxidation**
Barium Sulphate	**Displacement**
Ferric sulphate	**Neutralisation**
Sodium sulphate	**Synthesis**

Solution:

Zinc Sulphate – Displacement
$Zn(OH)_2 + H_2SO_4 \rightarrow ZnSO_4 + 2H_2O$

Ferrous sulphide – synthesis
$Fe + S \rightarrow FeS$

Barium sulphate – Precipitation

$BaCl_2 + H_2SO_4 \rightarrow BaSO_4 + 2HCl$

Ferric Sulphate – Oxidation
$Fe + H_2SO_4 \rightarrow FeSO_4 + H_2$

Sodium sulphate – Neutralisation
$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

10. (a) Give the pH value of pure water. Does it change if common salt is added to it?
(b) Classify the following solutions as acids, bases or salts. Ammonium hydroxide, barium chloride, sodium chloride, sodium hydroxide, H_2SO_4 and HNO_3
Solution:

(a) The pH of pure water is 7 at 25°C. No, the pH does not change when common salt (NaCl) is added as it's a normal salt.
(b) Acids: H_2SO_4 and HNO_3
Bases: Ammonium hydroxide and sodium hydroxide.
Salts: Barium chloride and sodium chloride.

11. Define the term neutralization.
(a) Give a reaction, mentioning clearly acid and base used in the reaction.
(b) If one mole of a strong acid reacts with one mole of a strong base, the heat produced is always same. Why?
Solution:

Neutralization is the process by which H^+ ions of an acid react completely with the $[OH]^-$ ions of a base to give salt and water only.
(a) $NaOH + HCl \rightarrow NaCl + H_2O$
(Base) (Acid) (Salt)
(b) Neutralization is simply a reaction between H^+ ions given by strong acid and OH^- ions given by strong base. In case of all strong acids and strong bases, the number of H^+ and OH^- ions produced by one mole of a strong acid or strong base is always same. Hence the heat of neutralization of a strong acid with strong base is always same.

12. Write the balanced equation for the preparation of the following salts in the laboratory:
(a) A soluble sulphate by the action of an acid on an insoluble base,
(b) An insoluble salt by the action of an acid on another salt,
(c) An insoluble base by the action of a soluble base on a soluble salt
(d) A soluble sulphate by the action of an acid on a metal.
Solution:

(a) $MgCO_3 + H_2SO_4 \rightarrow MgSO_4 + H_2O + CO_2$
(b) $Pb(NO_3)_2 + H_2SO_4 \rightarrow PbSO_4 + 2HNO_3$
(c) $Pb(NO_3)_2 + Na_2CO_3 \rightarrow PbCO_3 + 2NaNO_3$
(d) $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

13. You are provided with the following chemicals:
$NaOH$, Na_2CO_3, H_2O, $Zn(OH)_2$, CO_2, HCl, Fe, H_2SO_4, Cl_2, Zn
Using suitable chemicals from the given list only, state briefly how you would prepare:
(a) Iron(III) chloride, **(b) Sodium sulphate,**
(c) Sodium zincate, **(d) Iron(II) sulphate,**
(e) Sodium chloride ?
Solution:

(a) Iron (III) Chloride: Iron chloride is formed by direct combination of elements.
$2Fe + 3Cl_2 \rightarrow 2FeCl_3$
(b) Sodium sulphate: By neutralization of caustic soda with dilute sulphuric acid
$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$
(c) Sodium zincate: By the action of metals with alkalis
$Zn + 2NaOH \rightarrow Na_2ZnO_2 + H_2$
(d) Iron (II) sulphate: Iron sulphate is prepared by the action of dilute acid on an active metal.
$Fe + H_2SO_4 \rightarrow FeSO_4 + H_2$
(e) Sodium chloride: By the neutralization reaction of strong acid with strong base
$NaOH + HCl \rightarrow NaCl + H_2O$

14. For each of the salt: A, B, C and D, suggest a suitable method of its preparation.
(a) A is a sodium salt.
(b) B is an insoluble salt.
(c) C is a soluble salt of copper.
(d) D is a soluble salt of zinc.
Solution:

(a) By neutralisation:
$NaOH + HCl \rightarrow NaCl + H_2O$
(b) By precipitation:
$Pb(NO_3)_2 + 2NaCl \rightarrow PbCl_2 + 2NaNO_3$
(c) $CuCO_3 + H_2SO_4 \rightarrow CuSO_4 + H_2O + CO_2$
(d) Simple displacement:
$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

15. Choosing only substances from the list given in the box below, write equations for the reactions which you would use in the laboratory to obtain:
(a) Sodium sulphate **(b) Copper sulphate**
(c) Iron(II) sulphate **(d) Zinc carbonate**

Dilute sulphuric acid	Copper	Copper carbonate
	Iron	Sodium carbonate
	Sodium	
	Zinc	

Solution:

(a) $Na_2CO_3 + H_2SO_4$ (dil) $\rightarrow Na_2SO_4 + H_2O + CO_2$
(b) $CuCO_3 + H_2SO_4$ (dil) $\rightarrow CuSO_4 + H_2O + CO_2$

(c) $Fe + H_2SO_4$ (dil) $\rightarrow FeSO_4 + H_2$
(d) $Zn + H_2SO_4$ (dil) $\rightarrow ZnSO_4 + H_2$
$ZnSO_4 + Na_2CO_3 \rightarrow ZnCO_3 + Na_2SO_4$

16. From the formula listed below, choose one, in each case, corresponding to the salt having the given description: $AgCl$, $CuCO_3$, $CuSO_4.5H_2O$, KNO_3, $NaCl$, $NaHSO_4$, $Pb(NO_3)_2$, $ZnCO_3$, $ZnSO_4.7H_2O$.
(a) an acid salt
(b) an insoluble chloride
(c) on treating with concentrated sulphuric acid, this salt changes from blue to white
(d) on heating, this salt changes from green to black
(e) this salt gives nitrogen dioxide on heating
Solution:

(a) $NaHSO_4$
(b) $AgCl$
(c) $CuSO_4.5H_2O$
(d) $CuCO_3$
(e) $Pb(NO_3)_2$

17. (a) $Ca(H_2PO_4)_2$ is an example of a compound called _____(acid salt/basic salt/normal salt).
(b) Write the balanced equation for the reaction of: A named acid and a named alkali.
Solution:

(a) $Ca(H_2PO_4)_2$ is an example of a compound called acid salt.
(b) Sodium hydroxide + Hydrochloric acid → Sodium Chloride + Water
$NaOH + HCl \rightarrow NaCl + H_2O$

18. State the terms defined by the following sentences:
(a) A soluble base.
(b) The insoluble solid formed when two solutions are mixed together.
(c) An acidic solution in which there is only partial ionisation of the solute molecules.
Solution:

(a) Alkali
(b) Precipitate
(c) Weak acid

19. Which of the following methods, A, B, C, D or E is generally used for preparing the chlorides listed below from (i) to (v). Answer by writing down the chloride and the letter pertaining to the corresponding method. Each letter is to be used only once.
A Action of an acid on a metal
B Action of an acid on an oxide or carbonate
C Direct combination
D Neutralisation of an alkali by an acid

E Precipitation (double decomposition)
(i) Copper (II) chloride
(ii) Iron (II) chloride
(iii) Iron (III) chloride
(iv) Lead (II) chloride
(v) Sodium chloride
Solution:

(i) Copper (II) chloride - B
(ii) Iron (II) chloride - A
(iii) Iron (III) chloride - C
(iv) Lead (II) chloride - E
(v) Sodium chloride - D

20. Complete the following table:

Reactants	**Products**	**Method**
Soluble base + Acid (dil)	**Salt + water**	**Neutralisation Titration**
Metal + Non-metal	**Salt (soluble/insoluble)**	**……**
Insoluble base +	**Salt (soluble) + water**	**…….**
Active metal + Acid (dil)	**…… + ……**	**…….**
Soluble salt solution (A) +	**Precipitated salt +**	**…….**
Soluble salt solution (B)	**Soluble salt**	**…….**
Carbonate/ bicarbonate + Acid (dil)	**Salt +.....+ ……**	**Decomposition of carbonate**
Chlorides/nitrates + Acid (conc)	**…… + ……**	**Decomposition of chlorides and nitrates**

Solution:

Reactants	Products	Method
Soluble base + Acid (dil)	Salt + water	Neutralisation Titration
Metal + Non-metal	Salt (soluble/insoluble)	Direct Combination
Insoluble base +	Salt (soluble) + water	…….
Active metal + Acid (dil)	Salt + Hydrogen	Displacement
Soluble salt solution (A) + Soluble salt solution (B)	Precipitated salt + Soluble salt	Precipitation
Carbonate /bicarbonate + Acid (dil)	Salt + Water + Carbon dioxide	Decomposition of carbonate
Chlorides/nitrates + Acid (conc)	Acid salt + HCl/HNO_3	Decomposition of chlorides and nitrates