O-level

SALTS

A salt is a compound formed when the replaceable hydrogen atom(s) of an acid are replaced by a metal or ammonium ion (NH_4^+)

Types of salts

There two different types of salts

- Normal salt
- Acidic salt

Normal salt

It is the one in which all the replaceable hydrogen from the acid has been replaceable by the metal ion(s).

Example

Sodium chloride	$NaCl$
Sodium sulphate	Na_2SO_4
Calcium carbonate	$CaCO_3$
Calcium sulphate	$CaSO_4$
Calcium chloride	$CaCl_2$
Ammonium chloride	NH_4Cl

The formation of the normal salt is illustrated by the equation below;

$$2Na_{(s)} + H_2SO_{4(aq)} \rightarrow Na_2SO_{4(aq)} + H_2 \text{ (normal salt)}$$

Acidic salt

Is a salt in which part of replaceable hydrogen of the acid has been replaced by a metal

$2Na_{(s)} + 2H_2SO_{4(aq)} \rightarrow 2\,NaHSO_{4(aq)} + 2\,H_{2(g)}$ (acid salt)

Examples include

- sodium hydrogen carbonate ($NaHCO_3$)
- Sodium hydrogen sulphate $NaHSO_4$
- Calcium hydrogen sulphate $Ca(HSO_4)_2$
- Calcium hydrogen carbonate $Ca\,(HCO_3)_2$ etc.

Preparation of salts

1. From metal salt by direct combination of metals or oxide with acid e.g.

   $Na_{(s)} + 2HCl_{(aq)} \rightarrow 2NaCl_{(aq)} + H_{2(g)}$

   The mixture is dried using a drying agent or evaporating to dryness

2. **By neutralisation;** this is the process by which a base reacts with an acid to form a salt and water only e.g. Sodium chloride can be prepared from sodium hydroxide and dilute hydrochloric acid .

   $2NaOH + 2\,HCL_{(aq)} \rightarrow 2NaCl_{(aq)} + H_2O_{(l)}$

3. **Direct combination(synthesis);**

   Aluminium chloride and iron (III)chloride can be prepared from the element directly

   $2Al_{(s)} + 3Cl_{2(g)} \rightarrow 2\,AlCl_{3(s)}$

   $2\,Fe_{(s)} + 3Cl_{2(g)} \rightarrow 2\,FeCl_{3(s)}$

Precipitation

Insoluble zinc carbonate, silver chloride (AgCl), and lead chloride can be prepared by precipitation e.g. silver chloride is prepared from solution of silver nitrate and dilute hydrochloric acid where a precipitate of silver chloride is formed.

$AgNO_{3(aq)} + HCl_{(aq)} \rightarrow AgCl(s) + HNO_{3\,(aq)}$

The precipitate of AgCl is washed several times with distilled water.

NOTE: insoluble salts can be prepared by either precipitation method or direct synthesis

Other examples of salts prepared by precipitation include;

- Lead chloride ($PbCl_2$)
- Lead sulphate ($PbSO_4$), barium sulphate ($BaSO_4$) etc.

Preparation of zinc sulphate from zinc

- Add dilute $H_2SO_{4(s)}$ mixed with little copper sulphate to zinc in a beaker
- Add more zinc to saturate the solution

  Filter to remove the un dissolved zinc
- Warm the filtrate to concentrate it
- Cool to room temperature
- Filter the crystals of zinc sulphate-7-water
- Wash the crystals with little cold distilled water
- Dry the crystals between filter papers

$Zn_{(s)} + H_2SO_{4(l)} \rightarrow ZnSO_{4(aq)} + H_2$

Preparation of iron (II) sulphate-7-water ($FeSO_4$ -$7H_2O$)

- Add warm dilute sulphuric acid to iron filling in a beaker
- Add more iron fillings to saturate the solution
- Filter to remove the un dissolved iron filings
- Warm the filtrate slightly to concentrate it

- Cool to room temperature
- Filter the crystals of iron (II) sulphate-7-water
- Wash the crystals with cold distilled water
- Dry the crystals between filter papers

$Fe_{(s)} + H_2SO_{4(aq)} \rightarrow FeSO_{4(aq)} + H_{2(g)}$

Preparation of copper (II) sulphate-5-water from copper oxide

- Pour dilute sulphuric acid in a beaker, warm gently. (to increase on the solubility)
- Add copper oxide to the warm acid.
- Add more copper oxide to saturate the solution.
- Filter to remove the un dissolved copper oxide
- Evaporate the filtrate concentrate it cool to room temperature
- Filter the crystals of copper (II) sulphate-5-water
- Wash the crystals with little cold distilled water
- Dry the crystals between the filter paper

$CuO + H_2SO_{4(aq)} \rightarrow CuSO_{4(aq)} + H_2O_{(l)}$

N.B: Magnesium sulphate, zinc sulphate, and lead (II) nitrate can be prepared in the same way.

$Mg(OH)_{2(s)} + H_2SO_{4(aq)} \rightarrow MgSO_{4(aq)} + 2H_2O_{(l)}$

$PbO_{(s)} + 2HNO_{3(aq)} \rightarrow Pb(NO_3)_{2(aq)} + H_2O_{(l)}$

Preparation of sodium hydrogen sulphate.

- Add 20cm^3 of 2M NaOH in a clean conical flask.
- Titrate with 2M H_2SO_4 from a burette using methyl orange indicator.
- The solution formed contains sodium sulphate.

  $2NaOH_{(aq)} + H_2SO_{4(aq)} \rightarrow Na_2SO_{4\ (aq)} + 2H_2O_{(l)}$
- Note the volume of H_2SO_4 used, say x cm^3.

- Measure another 20 cm^3 of 2M NaOH in a clean beaker.
- Add 2x cm^3 of 2M H_2SO_4
- The solution formed contains sodium hydrogen sulphate.

$NaOH_{(aq)} + H_2SO_{4(aq)} \rightarrow NaHSO_{4(aq)} + H_2O_{(l)}$

EXERCISE

1(a) Nitric acid is a strong monobasic acid. Explain what is meant by the term;

(i)Strong acid

(ii) Basicity

(a) State two properties of Nitric acid as an acid.

1. Define the following terms. Giving two examples in each case;
    - (i) Normal salt
    - (ii) Acid salt

(b) Write an equation for the reaction between NaOH(aq) and dilute H_2SO_4

2002: $2_{(2)}$; 2003: 44, 13, 31, $14_{(2)}$; 1989: 12, 3, 41,1, 9; 1990: 23; 1992: 28, 14, $13_{(2)}$; 1994: 4, 5, 14; 1996: 9,10; 1995:11, 15, $8_{(2)}$, 35; 1999: 14; 2004: $12_{(2)}$; 2012: $12_{(2)}$, $13_{(2)}$, 8; 2006: 13, 11, $2_{(2)}$;$12_{(2)}$; 2000: 43, 45; 2001: 19; 1991: 20; 1993: 8, 26; 1998: 4, 9,33, 48; 1999: 13, 3; 2007: 7, 41, 47, $3_{(2)}$; 2005: 15, 20, 23, 28; 2008: 16, 49; 2009: 12, 15, 20, 21, 23, 32, 36, 39; 1997: 3, 7, 20, $1_{(2)}$; 2010: $9_{(2)}$. ; 2015: 7