Topic2: ACIDS, BASES AND SALTS

Sub topic- Acid- Base Indicators
L.O: To differentiate acids and bases using indicators

Acids	**Bases**
– Sour in taste --Change blue litmus to red – eg. Hydrochloric Acid HCl Sulphuric Acid $H2SO_4$ Nitric Acid HNO_3 Acetic Acid CH_3COOH	- Bitter in taste - Change red litmus to blue - Eg. Sodium hydroxide $NaOH$ Potassium hydroxide KOH Calcium hydroxide $Ca(OH)_2$ Ammonium hydroxide NH_4OH

Acid- Base Indicators

- Substances which indicate whether a substance is acidic or basic by change in colour.
- Litmus solution is a natural indicator. It is a purple dye extracted from lichens.
- Substances whose odour changes in acidic or basic media are called **olfactory** indicators. (eg : clove oil, vanilla essence, onion).
- Turmeric, a natural indicator, turns reddish brown in basic medium but remains yellow in acidic and neutral medium. http://youtu.be/Olezbt9cxfo

	Indicator	**ACIDS**	**BASES**
1	Red litmus solution	Remains red	Turns blue
2	Blue litmus solution	Turns red	Remains blue
3	Phenolphthalein solution	Remains colourless	Pink
4	Methyl orange solution	Orange red	Golden yellow

Sub topic- Chemical Properties of Acids and Bases

L.O: To analyze the chemical properties of acids and bases

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1. With Metals   http://youtu.be/e-Njp175AiM

Acid + Metal $\longrightarrow$ Salt + Hydrogen

Active metals displace hydrogen gas from the acid.

$2HCl + Zn \longrightarrow ZnCl_2 + H_2$

$2HNO_3 + Zn \longrightarrow Zn(NO_3)_2 + H_2$

$H_2SO_4 + Zn \longrightarrow ZnSO_4 + H_2$

$2CH_3COOH + Zn \longrightarrow (CH_3COO)_2Zn + H_2$

Base + Metal $\longrightarrow$ Salt + Hydrogen

Note – Such reactions are not possible with all the metals.

$NaOH + Zn \longrightarrow \underset{\text{Sodium zincate}}{Na_2ZnO_2} + H_2$

2. Action of Acids with Metal Carbonates and Metal Hydrogencarbonates

http://youtu.be/CreO-rVrxT0

Metal Carbonate + Acid $\longrightarrow$ Salt + Carbondioxide + Water

$Na_2CO_{3(s)} + 2\,HCl_{(aq)} \longrightarrow 2\,NaCl_{(aq)} + CO_{2(g)} + H_2O(l)$

Metal hydrogencarbonate + Acid $\longrightarrow$ Salt + Carbondioxide + Water

$NaHCO_3 + HCl \longrightarrow NaCl + CO_2 + H_2O$

Lime water Test :

On passing CO_2 gas, lime water turns milky.

$\underset{\text{Lime water}}{Ca(OH)_2\,(aq)} + CO_{2(g)} \longrightarrow \underset{\text{White precipitate (milky)}}{CaCO_{3\,(s)}} + H_2O\,(l)$

On passing **excess** CO_2 , the white precipitate disappears.

$CaCO_{3(s)} + H_2O\,(l) + CO_{2(g)} \longrightarrow \underset{\text{Soluble in water}}{Ca(HCO_3)_2\,aq}$

3. Reactions of acids and bases with each other

Neutralisation Reactions

- The reaction between an acid and a base to give salt and water.
- The effect of a base is nullified by an acid (and vice versa) to give salt and water.

Acid	+	**Base**	$\longrightarrow$	**Salt**	+	**Water**
$HCl_{(aq)}$	+	$NaOH_{(aq)}$	$\longrightarrow$	$NaCl_{(aq)}$	+	$H_2O(l)$

4. Reactions of oxides with acids and bases

- An oxide is the compound formed by the reaction of an element with oxygen.
  Metallic oxides: CaO, MgO, CuO, Fe_2O_3
  Non-metallic oxides: CO_2, SO_2, SO_3

(a) Reaction of metallic oxides with acids

Metal Oxide	+	**Acid**	$\longrightarrow$	**Salt**	+	**Water**
$CuO\ (s)$ Black	+	$2HCl(aq)$	$\longrightarrow$	$CuCl_{2(aq)}$ blue-green	+	$H_2O(l)$

Metallic oxides give salt and water on reacting with acids. Hence, **metallic oxides are basic in nature**. MOB

(b) Reaction of Non Metallic Oxide with Base

Non metallic oxide	+	**Base**	$\longrightarrow$	**Salt**	+	**Water**
$CO_{2(g)}$	+	$Ca(OH)_{2(aq)}$	$\longrightarrow$	$CaCO_{3\ (s)}$	+	$H_2O(l)$

Non-metallic oxides give salt and water on reacting with acids. Hence, **non-metallic oxides are acidic in nature.**

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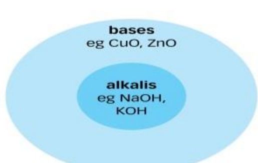
Bases and alkalis

- Bases are oxides or hydroxides of metals.
- All bases do not dissolve in water
- Soluble bases are called alkalis. They are soapy to touch, bitter and corrosive.
- All alkalis are bases, but all bases are not alkalis.



L.O: To investigate what do all acids and all bases have in common

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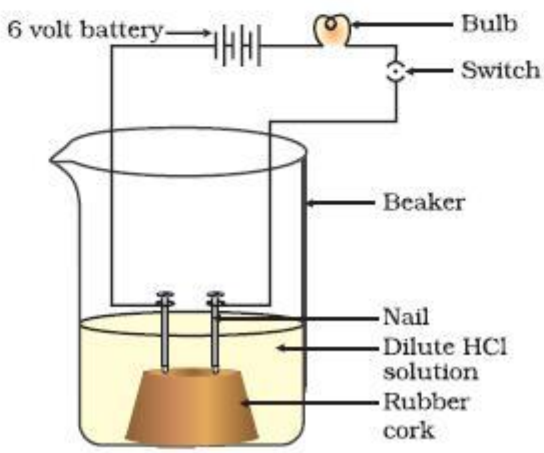
T.B page 22, activity 2.8



- Repeat the experiment with dilute sulphuric acid, glucose solution, alcohol solution, sodium hydroxide solution, calcium hydroxide solution.
- Glowing of bulb indicates that there is a flow of electric current through the solution carried by the **H^+ (aq)** ions or **OH^- (aq)** ions in solution.

- Conclusion:
  i. All acidic solutions and basic solutions conduct electricity.
  ii. All acids produce **H^+ (aq)** ions in solution, which are responsible for their acidic properties.
  iii. All bases produce O**H^-** **(aq)** ions in solution, which are responsible for their basic properties.

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L.O : To analyze what happens to an acid or a base in a water solution

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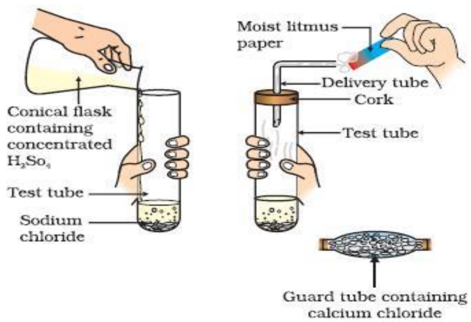
T.B Activity 2.9, page 23



- Acids produce H^+ ions in the presence of water.
- The separation of H+ ions from an acid cannot occur in the absence of water.
  (**Dry** HCl gas does <u>not</u> change the colour of **dry** blue litmus paper to red)
- H^+ ion cannot exist alone. It combines with water molecules and exists as H^+ (aq) or hydronium ion (H_3O^+).
  $H^+ + H_2O \longrightarrow H_3O^+$
- **Acids give H^+ (aq) or (H_3O^+) in water.**
  $HCl + H_2O \longrightarrow H_3O^+ + Cl^-$
- **Soluble bases (alkalis) provide OH^- (aq) ions in water**
  NaOH (s) in water $\longrightarrow$ Na^+ (aq) + OH^- (aq)
- **Neutralization reaction: The net reaction???**

Acid	+	**Base**	$\longrightarrow$	**Salt**	+	**Water**
HX (aq)	+	MOH(aq)	$\longrightarrow$	MX (aq)	+	H_2O (l)

H^+ (aq) + **OH^- (aq)** $\longrightarrow$ H_2O (l)

- <u>Mixing of water with an acid or a base</u>.

Warning sign - concentrated acids & bases

- The process of dissolving an acid or a base in water is **highly exothermic**.

- Add acid slowly to water with constant stirring.

- **Never add water to concentrated acids. Why??**
  - The heat generated during mixing may cause the mixture to splash out and cause burns.
  - The glass container may break due to excessive local heating.

- When an acid or a base is mixed with water they become dilute. This results in decrease in the concentration of H_3O^+ or OH^- per unit volume in acids and bases respectively.

Dilution

- The process of decreasing the concentration of H_3O^+ or OH^- per unit volume by the mixing of an acid or base with water is called dilution.

- On dilution, the acid or base is said to be diluted.

- When dilution increases, concentration per unit volume decreases; and vice versa.

Process	Result
Adding water to an acid or base	**Dilution - increases.** **Concentration of H_3O^+ or OH^- per unit volume - decreases.**
Adding excess acid to acid solution or Adding excess base to basic solution	**Dilution - decreases** **Concentration of H_3O^+ or OH^- per unit volume - increases.**

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Sub topic: Strength of acids and bases, pH scale

L.O: 1.To analyze the strength of acid or base solutions

2.To predict the nature of a substance from its pH value

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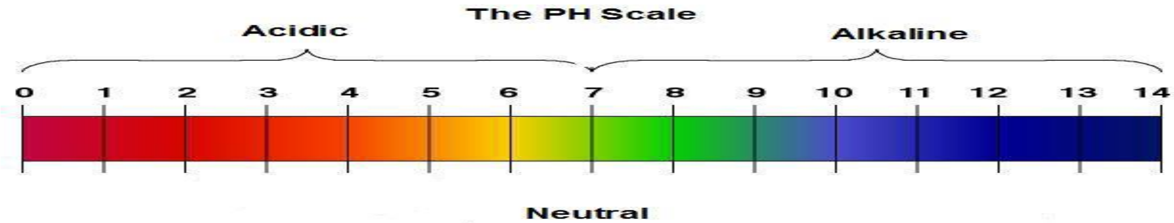
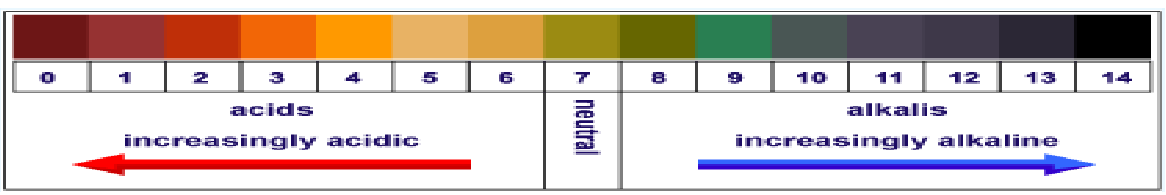
Universal indicator:

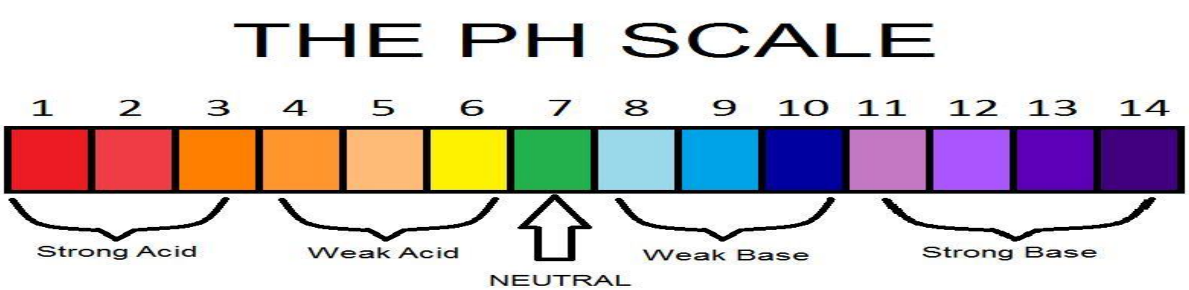
- Is a mixture of several indicators
- Shows different colours at different concentrations of H^+ ions in a solution; thus helps to identify how strong a given acid or base is.
- Used for measuring the $\mathbf{p^H}$ of a solution. (pH = Potenz Hydrogen. In German, potenz = power)

p^H / p^H scale

- $\mathbf{p^H}$ is the number which indicates the acidic or basic nature of a solution.
- $\mathbf{p^H}$ scale measures the H^+ ion concentration, $[H^+]$ in a solution
- Measures p^H from **zero** (very acidic) to **14** (very alkaline)
- **Higher the H^+ ion concentration, lower is the p^H value.**
- p^H of a neutral solution is 7.
- p^H value less than 7 represents acidic solution; $[H^+]$ is high; $[OH^-]$ is low.
- p^H value greater than 7 represents basic solution; $[H^+]$ is low; $[OH^-]$ is high.







Strength of acids and bases:

- Strength of acids and bases depends on the no. of H^+ ions and OH^- ions produced respectively.
    a. Strong acids give rise to more H^+ ions.
    eg. HCl, H_2SO_4, HNO_3.

    b. Weak Acids give less H^+ ions
    eg. CH_3COOH, H_2CO_3 (Carbonic acid)

    c. Strong bases give rise to more OH^- ions.
    eg. NaOH, KOH, $Ca(OH)_2$

    d. Weak bases give less OH^- ions.
    Eg. NH_4OH

Substance	**pH**	**Inference (nature)**
Pure water	7	Neutral
Gastric juice (HCl)	1.2	Highly acidic
Acid rain	5.5	Slightly acidic
Blood	7.4	Very slightly basic
Milk of Magnesia	10	Mild base
Sodium hydroxide solution	14	Highly basic

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H.W
You have two solutions A and B. The pH of solution A is 6 and that of solution B is 8. Which solution has more hydrogen ion concentration? Why?

L.O: Importance of pH
To analyze the importance of pH in everyday life
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Importance of pH in everyday life

- **Importance of pH in our digestive system –**
  pH level of our body regulates our digestive system. In case of indigestion, to get relief from pain in our stomach, antacids like milk of magnesia are used. Antacids neutralize the excess acid and we get relief.

- **pH of Acid Rain** : When pH of rain water is less than 5.6 it is called Acid Rain. When this acidic rain flows into rivers these also get acidic, which causes a threat to the survival of aquatic life.

- **pH of Soil** : Plants require a specific range of pH for their healthy growth. If pH of soil of any particular place is less or more than normal than the farmers add suitable fertilizers to it.

- **Our body** functions between the pH range of 7.0 to 7.8. Living organisms can survive only in the narrow range of pH change.

- **Tooth decay and pH** : Bacteria present in the mouth produce acids by degradation of sugar and food particles remaining in the mouth. Using toothpaste which is generally basic can neutralize the excess acid and prevent tooth decay.

- **Bee sting or Nettle sting** contains methanoic acid which causes pain and irritation. Using a weak base like baking soda on it gives relief.

Some naturally occurring acids

Acid	Substance
Acetic acid	Vinegar
Citric acid	Lemon, orange
Tartaric acid	Tamarind, grapes
Ascorbic acid (Vitamin C)	All citrus fruits
Lactic acid	Milk, yoghurt
Malic acid	Apples and Pears
Formic acid	Ant stings

Sub topic- More about salts

L.O: 1. To identify the acid and base from which a salt is formed.

2. To distinguish different family of salts

3. To suggest the pH of salts

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SALTS

- Salts are formed by the neutralization of an acid with a base

Name of Salt	**Formula**	**Derived from (Base)**	**Derived from (Acid)**
Potassium Sulphate	K_2SO_4	KOH	H_2SO_4
Sodium Sulphate	Na_2SO_4	NaOH	H_2SO_4
Sodium Chloride	NaCl	NaOH	HCl
Ammonium Chloride	NH_4Cl	NH_4OH	HCl

Family of salts

- Salts having the same positive or negative radicals are said to belong to a family.

Eg:

Chloride salts	Sodium salts	Sulphate salts
NaCl	NaCl	Na_2SO_4
KCl	$NaNO_3$	K_2SO_4
NH_4Cl	Na_2SO_4	$CaSO_4$
$AlCl_3$	Na_2CO_3	$ZnSO_4$

pH of salts

Salt of	Example	Nature of the salt	pH of the salt
Strong acid & strong base	NaCl	Neutral	Equals 7
Strong acid & weak base	NH_4Cl	Acidic	Less than 7
Weak Acid & strong base	Na_2CO_3	Basic	Greater than 7

Sub topic- Chemicals from Common Salt
L.O: To analyze the preparation, properties and uses of chemicals derived from common salt
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Sodium chloride:

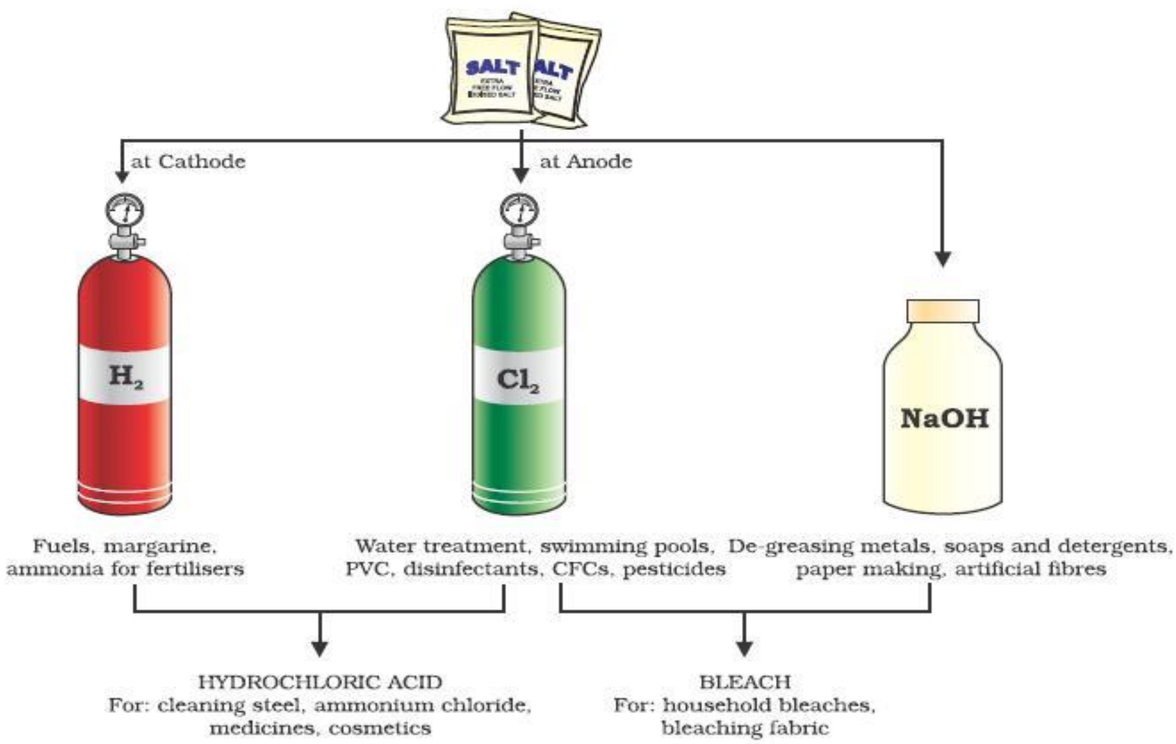
- Known as common salt which is used in our food. It is derived from seawater.
- Common salt is an important raw material for making sodium hydroxide, baking soda, washing soda, bleaching powder etc.

1. **<u>Sodium hydroxide</u>** - **NaOH**

   - **Preparation**: Chlor – Alkali Process
   - Products are chlorine and an alkali – NaOH (thus the name chlor-alkali process)
   - Aqueous Solution for sodium chloride (called **brine**) is electrolyzed.
     At anode- Chlorine gas is given off
     At cathode- Hydrogen gas is given off
     Sodium hydroxide is formed near the cathode.

$$2\ NaCl\ (aq) + 2H_2O\ (l) \rightarrow 2\ NaOH\ (aq) + Cl_2\ (g) + H_2(g)$$

Important products from the chlor- alkali process



2. **Bleaching Powder** : **$CaOCl_2$, Calcium oxy chloride.**

- **Preparation** : Action of chlorine (from chlor-alkali process) on dry slaked lime

$$Ca(OH)_2 + Cl_2 \xrightarrow{313K} CaOCl_2 + H_2O$$

- **Uses:**
  1. For bleaching
     - cotton and linen in the textile industry
     - wood pulp in paper industry
     - washed clothes in laundry.
  2. As an oxidizing agent in chemical industries.
  3. For disinfecting drinking water to make it germ free.

3. **Baking Soda – $NaHCO_3$ – Sodium hydrogencarbonate**

- **Preparation:**
  Raw Materials: $NaCl$, NH_3, H_2O, CO_2
  $$NaCl + H_2O + CO_2 + NH_3 \rightarrow NH_4Cl + NaHCO_3$$

- **Properties:**
  Mild non-corrosive base.
  While cooking, baking soda gives out CO_2 and Na_2CO_3
  $$2\,NaHCO_3 \xrightarrow{Heat} Na_2CO_3 + H_2O + CO_2$$

- **Uses :**
  - Used as an antacid, being alkaline neutralizes excess acid in the stomach
  - Used in Soda-acid fire extinguishers
  - For making baking powder (mixture of baking Soda + tartaric acid).
    When baking powder is mixed with water or heated,
    following reaction takes place
  - $NaHCO_3 + \underset{\textbf{(from acid)}}{H^+} \rightarrow CO_2 + H_2O +$ Sodium salt of acid
  - CO_2 produced in the reaction makes the cake fluffy, soft and spongy.

4. **Washing** Soda ($Na_2\,CO_3.10\,H_2O$) – Sodium carbonate decahydrate

- Preparation:
  On heating baking soda, we get sodium carbonate. It is crystallized on adding water.

$$2NaHCO_3 \xrightarrow{Heat} Na_2CO_3 + H_2O + CO_2$$
$$Na_2CO_3 + 10\,H_2O \rightarrow Na_2CO_3.10\,H_2O$$
($10\,H_2O$ is water of crystallization)

- **Uses:**
  - Used in making glass, soap and paper
  - Used in manufacture of sodium compounds such as borax ($Na_2B_4O_7$)
  - As cleaning agent for domestic purposes
  - To remove permanent hardness of water

Water of Crystallization:

- The fixed number of water molecules present in one formulae unit of a salt.

Eg. $CuSO_4. 5\ H_2O$ – Copper Sulphate
$Na_2CO_3. 10H_2O$ – Washing Soda
$CaSO_4. 2H_2O$ – Gypsum

$$\underset{\text{(hydrated) Blue}}{CuSO_4 . 5H_2O} \xrightarrow[\text{on heating}]{} \underset{\text{(anhydrous) white}}{CuSO_4} + 5H_2O$$

$$\underset{\text{White}}{CuSO_4} + 5H_2O \rightarrow \underset{\text{Blue}}{CuSO_4. 5H_2O}$$

Plaster of Paris: $CaSO_4\ ½\ H_2O$ (Calcium sulphate hemihydrate)

On heating at 373K, gypsum **(**$CaSO_4. 2H_2O$) loses water molecules to form plaster of Paris.

$$CaSO_4. 2H_2O \xrightarrow{373\ K} CaSO_4\ ½\ H_2O + 1\ ½\ H_2O$$

Uses :

- Used in making toys, decoration materials, for making surfaces smooth.
- Used in plastering fractured bone

Reason: Plaster of Paris on mixing with water changes to gypsum and sets into hard solid mass.

$$CaSO_4\ ½\ H_2O + 1\ ½\ H_2O \rightarrow CaSO_4. 2H_2O$$

* ½ H_2O- as water of Crystallization is shown.
Explanation: $2CaSO_4$ molecules are attached with one water molecule.
Hence 2 formula units of $CaSO_4$ share one molecule of water or one formula unit share half a molecule of water.

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Refer:

Acids, bases, salts- lesson
http://youtu.be/y5xfZPWTfL0