5. Acids, alkalies and salts

Let us assess

1. Question

Complete the chemical equations for the following ionisation reactions.

$KCl \rightarrow K^{+}$ + ...

$HNO_3 \rightarrow H^{+}$ + ...

$Mg(OH)_2 \rightarrow$ ..... + $2OH^{-}$

$H_2SO_4 \rightarrow 2H^{+}$ + ...

$NH_4Cl \rightarrow NH^{+}_4$ .....

$CaSO_4 \rightarrow$ ..... + SO^{2-}_4

Answer

Ionisation reaction involves the conversion of neutral molecules into their constituent ions (ions are charged atoms or molecules). In the above question, we can complete the ionisation reactions by breaking the given compounds into ions (cations and anions) as follows:

Note: cations are positively charged ions and anions are negatively charged ions.

•$KCl \rightarrow K^{+} + Cl^{-}$

KCl dissociates into potassium ion and chloride ion.

•$HNO_3 \rightarrow H^{+} + NO_3^{-}$

Nitric acid ionises to give a proton and nitrate ion.

•$Mg(OH)_2 \rightarrow Mg^{2+} + 2OH^{-}$

Magnesium hydroxide ionises to give magnesium ion and two hydroxide ions.

•$H_2SO_4 \rightarrow 2H^{+} + SO_4^{2-}$

Sulphuric acid dissociates to give two protons and a sulphate ion.

•$NH_4Cl \rightarrow NH^{+}_4 + Cl^{-}$

Ammonium chloride ionises to give ammonium ion and chloride ion.

•$CaSO_4 \rightarrow Ca^{2+} + SO_4^{2-}$

Calcium sulphate ionises to give calcium ion and sulphate ion.

2. Question

Identify the symbols of ions from the box and write against their names.

SO_3^{2-}, NO_3^{-} , HCO_3^{-}, OH^{-}, CO_3^{2-}, HSO_4^{-}

Carbonate -

Bisulphate -

Sulphite -

Nitrate -

Hydroxide -

Bicarbonate -

Answer

We can observe that all the ions given in the question are negatively charged. All of them are anions. Names of given anions can be written as follows:

Name	Anion
Carbonate	CO_3^{2-}
Bisulphate	HSO_4^-
Sulphite	SO_3^{2-}
Nitrate	NO_3^-
Hydroxide	OH^-
Bicarbonate	HCO_3^-

3. Question

Name the salt formed by the reaction between magnesium hydroxide [$Mg(OH)_2$] and dilute hydrochloric acid [HCl].

Write the chemical equation for the reaction.

Which acid is used for preparing Magnesium sulphate?

Answer

•Name of salt is magnesium chloride [$MgCl_2$]

Magnesium hydroxide is a strong base [$Mg(OH)_2$] and hydrochloric acid [HCl] is a strong acid. When a base and an acid react, they mutually nullify their properties and gives rise to the formation of salt and water. Such reactions are called neutralisation reactions. Thus magnesium hydroxide and hydrochloric acid will react to give salt and water and name of this salt is magnesium chloride.

•$Mg(OH)_2 + 2HCl \rightarrow MgCl_2 + H_2O$

The reaction between magnesium hydroxide and hydrochloric acid is a neutralisation reaction in which acid and base react to give salt and water. Thus one mole of magnesium hydroxide reacts with two moles of hydrochloric acid to give magnesium chloride (salt) and water.

•Sulphuric acid [H_2SO_4] is used for preparing magnesium sulphate.

The chemical formula for magnesium sulphate is [$MgSO_4$]. From its formula, we can conclude that for its preparation we require a base that can provide us with the magnesium ion and an acid which can give us sulphate ion. In the given problem, we are using magnesium hydroxide as a base which will give us magnesium ion. Now the acid which can give us sulphate ion is sulphuric acid. The preparation of [$MgSO_4$] can be represented as follows:

$Mg(OH)_2 + H_2SO_4 \rightarrow MgSO_4 + H_2O$

4. Question

List the cations and anions of the substances given in the table.

Substance	Chemical formula	Cation	Anion
Potassium chloride	KCl	K^+	Cl^-
Magnesium chloride	$MgCl_2$	.....	.....
Sodium nitrate	$NaNO_3$	.....	.....
Ammonium chloride	NH_4Cl	.....	.....
Aluminium sulphate	$Al_2(SO_4)_3$	.....	.....
Calcium phosphate	$Ca_3(PO_4)_2$	.....	.....

Answer

Salts are neutral compounds which are ionic in nature and dissociate into positive and negative ions when dissolved in water. The positively charged ion is called cation and the negatively charged ion is called anion.

Thus in the above question we need to dissociate the given salts into the respective positive and negative ions, which can be done as follows:

Substance	Chemical formula	Cation	Anion
Potassium chloride	KCl	K^+	Cl^-
Magnesium chloride	$MgCl_2$	Mg^{2+}	Cl^-
Sodium nitrate	$NaNO_3$	Na^+	NO_3^-
Ammonium chloride	NH_4Cl	NH_4^+	Cl^-
Aluminium sulphate	$Al_2(SO_4)_3$	Al^{3+}	SO_4^{2-}
Calcium phosphate	$Ca_3(PO_4)_2$	Ca^{2+}	PO_4^{3-}

5. Question

A little distilled water is taken in a beaker.

A. What is the pH value of distilled water?

B. What happens to the pH value when the following substances are added to the water in the beaker? Justify your answer.

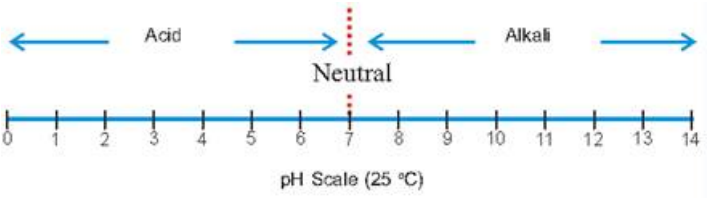
a) Caustic soda

b) Vinegar

Answer

A. pH value of distilled water is 7.

The pH scale is the method to express the acidity/alkalinity of a solution. It is based on the amount of H^+ ions present in a given solution.



Lesser the value of pH, more will be the acidity. For a neutral solution the pH value is 7. Distilled water is neutral in nature because equal number of H^+ and OH^- are present in it. Thus distilled water has a pH value of 7.

B. The pH value will change when caustic soda or vinegar is added to the distilled water as follows:

a. pH value will increase and become much greater than 7 on adding caustic soda to water.

Caustic soda is general name for NaOH which is a strong base. So when we add caustic soda to water, it will make the water basic in nature. A basic solution has a pH greater than 7. So we can say that adding caustic soda will make the pH of water greater than 7.

b. pH value will decrease and become slightly less than 7 on adding vinegar to water.

Vinegar contains acetic acid which is a weak acid. So when we add vinegar to water, it will make the water acidic in nature. An acidic solution has a pH less than 7. So we can say that adding vinegar will make the pH of water less than 7.

6. Question

Some salts are given in column A. Their chemical formulae and uses are given in column B and column C irregularly. Match the columns by identifying the correct chemical formulae and the uses of the salts.

A	B	C
Salt	Chemical formula	Use
Washing soda	$CuSO_4.5H_2O$	Fire extinguisher
Gypsum	$NaHCO_3$	Fungicide
Blue vitriol	$Na_2CO_3.10H_2O$	Cement manufacture
Baking soda	$CaSO_4.2H_2O$	Glass manufacture

Answer

The correct match between salts, their formulas, and their uses is as follows:

A	B	C
Salt	Chemical formula	Use
Washing soda	$Na_2CO_3.10H_2O$	Glass manufacture
Gypsum	$CaSO_4.2H_2O$	Cement manufacture
Blue vitriol	$CuSO_4.5H_2O$	Fungicide
Baking soda	$NaHCO_3$	Fire extinguisher

Some other uses of given salts can be summarised as follows:

Washing soda

•Used in glass, soap and paper industries.

•Used for removing hardness of water.

•Can be used as cleaning agent for domestic purposes.

Gypsum

•Used in cement industry.

•Used for making toys, decorative items.

•Used to support fractured bones.

Blue vitriol

•Being a fungicide, used to control molds and fungus from the places like lawns, gardens and some other wet areas where fungi grows.

Baking soda

•Used in antacids (which neutralise the excess acidity in our stomachs)

•Used in fire extinguishers.

7. Question

The pH values of some substances are given in the table. Analyse the table and answer the questions that follow.

Substance	pH value
Vinegar	4.2
Lime water	10.5
Milk	6.4
Water	7
Tooth paste	8.7
Blood	7.36

a. Is blood acidic or alkaline in nature?

b. The pH value of pure milk is 6.4. Does the pH value increase or decrease when milk changes to curd? Justify your answer.

c. Among the substances given in the table,

i) Which one is strongly alkaline?

ii) Which one has weak acidic nature?

Answer

a. Blood is slightly alkaline in nature.

A neutral solution has a pH of exactly 7, while an acidic solution has a pH less than 7 and a basic solution has a pH more than 7. Since the blood has a pH value of 7.36, it is alkaline in nature but we can say it only slightly alkaline.

b. The pH value decreases when milk changes to curd.

The process of conversion of milk into curd involves the formation of lactic acid. This lactic acid makes the curd more acidic than milk. On pH scale the acidity increases with the decrease in pH value. Thus pH value decreases from 6.3 to 4.5 when milk changes into curd.

c. i) Lime water is strongly alkaline.

The pH scale varies from 0 to 14. A neutral solution has a pH of exactly 7. Acidic solution has a pH less than 7 and basic solution has a pH greater than 7.

General rule: Lesser the pH more will be acidity.

OR

More the pH more will be alkalinity.

Since lime water has a pH of 10.5 (which is much greater than 7), so it is strongly alkaline.

ii) Milk has the weak acidic nature.

Both milk and vinegar has a pH less than 7 so both are acidic in nature. But milk has a pH slightly less than 7 (6.3) while vinegar has a pH which is much lower than 7 (4.2). Therefore, milk has weak acidic nature as compared to vinegar.

Extended activities

1. Question

Organic acids are present in a number of substances we use. (e.g. Tomato, orange, apple, grapes, curd etc.)

Identify the organic acids in each of them and prepare a list.

Answer

Number of acids are present in the fruits/vegetables and other eatables that we use. Such sources are listed below with the acids associated with them:

Name of source	Acid
Tomato	Oxalic acid
Orange	Citric acid
Apple	Malic acid
Grapes	Tartaric acid
Curd	Lactic acid
Lemon	Citric acid
Vinegar	Acetic acid
Tamarind	Tartaric acid

2. Question

Haven’t you identified the pH value of the soil in relation with different crops? Identify the pH value of soil samples collected from different places.

Identify the crop that is suitable for the soil of each area on the basis of its pH value.

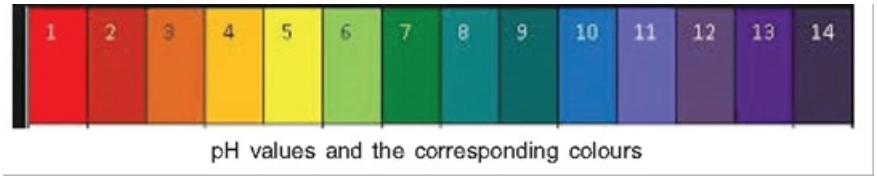
Answer

Plants require a specific pH range for their healthy growth. So it is very necessary to analyse the pH of soil. The pH value of soil can be determined as follows:

•Take about 2g of soil in a test tube and add 5 ml distilled water to it.

•Shake the contents and then filter. Collect the filtrate in a test tube.

•Measure the pH using universal indicator and match the colour from following chart:



pH values and the corresponding colours

The pH value of soil of different places along with the suitable crops is summarised as follows:

Different places	pH value of soil	Suitable crops
Northern plains	6.5-8.4	Sugarcane, Rice
Mountain	5.0-6.5	Fruit, tea
Desert	7.6-8.4	Wheat, grams
Karnataka farms	5.5	Coffee, rubber

3 A. Question

Complete the chemical equations for the ionisation of phosphoric acid.

$H_3PO_4 \rightarrow H^+ + H_2PO_4^-$

(Dihydrogen phosphate ion)

$H_2PO_4^- \rightarrow H^+ +$ .....

(Hydrogen phosphate ion)

..... $\rightarrow H^+ + PO_4^{3-}$

(Phosphate ion)

Answer

Those acids which contain more than one H^+ ion, they dissociate in stages. Phosphoric acid is also an example of such acid.

Dissociation of phosphoric acid takes place in following stages:

$H_3PO_4 \rightarrow H^+ + H_2PO_4^-$

(Dihydrogen phosphate ion)

$H_2PO_4^- \rightarrow H^+ + HPO_4^{2-}$

(Hydrogen phosphate ion)

$HPO_4^{2-} \rightarrow H^+ + PO_4^{3-}$

(Phosphate ion)

3 B. Question

How many types salts can be formed by phosphoric acid? Why?

Answer

Three types of salt.

We can see that phosphoric acid dissociates to give three types of anions which can combine with any metal cation to form a salt. So, three anions can result into only three types of salts.

3 C. Question

Write the chemical name of the following salts.

$Mg(H_2PO_4)_2$

$MgHPO_4$

$Mg_3(PO_4)_2$

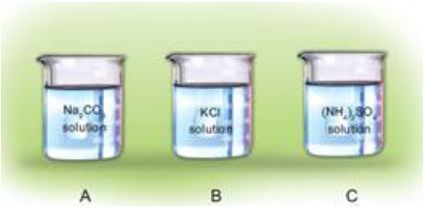
Answer

The chemical names corresponding to given salts are as follows:

Chemical Formula	Chemical Name
$Mg(H_2PO_4)_2$	Magnesium dihydrogen phosphate
$MgHPO_4$	Magnesium hydrogen phosphate
$Mg_3(PO_4)_2$	Magnesium phosphate

4. Question

Solutions of sodium carbonate, potassium chloride and ammonium sulphate are taken in separate beakers.



Dip litmus paper (red, blue) in each beaker

i. Observe the colour change of litmus paper and tabulate.

Salt	Colour of litmus paper	Nature of the substance
A		
B		
C		

ii. Name the acids and alkalies that react with each other to form each of the salts given above?

iii. Can you explain the colour change of the litmus paper on the basis of the nature of the acid and alkali that react with each other to form the salt?

(Hint: potassium chloride is a salt formed by the reaction between strong acid and strong alkali)

Answer

Litmus paper acts as an indicator to distinguish between acid and base. Blue litmus paper turns red in acidic medium and red litmus paper turns blue in basic medium.

i)

Salt	Colour of litmus paper	Nature of the substance
A) Na_2CO_3	Blue	basic
B) KCl	No change	neutral
C) $(NH_4)_2SO_4$	Red	acidic

ii) The following acids and alkalies react to give the corresponding salts.

Salt	Alkali	Acid
Na_2CO_3	NaOH	H_2CO_3
KCl	KOH	HCl
$(NH_4)_2SO_4$	NH_4OH	H_2SO_4

Acids and alkalies react to give salt and water.

•When a strong acid and a strong base react they give a neutral salt. Example: KCl

•When a strong acid and a weak base react they give an acidic salt. Example: $(NH_4)_2SO_4$

•When a weak acid and a strong base react they give a basic salt. Example: Na_2CO_3

iii) Litmus paper shows different colours in acidic and basic medium.

•When a strong acid and a strong alkali react, they give a neutral salt. Thus the litmus paper does not change its colour. Blue litmus paper remains blue and red litmus paper remains red. Example: KCl

•When a strong acid and a weak alkali react, they give an acidic salt. Thus blue litmus paper turns red and red litmus paper remains red. Example: $(NH_4)_2SO_4$

•When a weak acid and a strong alkali react, they give a basic salt. Thus red litmus paper turns blue and blue litmus paper remains blue. Example: Na_2CO_3