

GHS

May, 2020

S.3 CHEMISTRY

ACIDS, BASES, SALTS AND QUALITATIVE ANALYSIS

MARKING GUIDE

INSTRUCTIONS:

- *Section A contains Six Structured questions*
- *Section B contains 4 Essay questions*
- *Attempt ALL questions from both Section A and Section B*

SECTION A

1. Write equation(s) only to show the reaction that would take place if each of the following was strongly heated in air.

(a). KNO_3



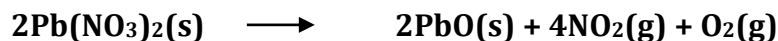
(b). $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$



(c). FeCO_3



(d). $\text{Pb}(\text{NO}_3)_2$



2. (a). Define the term acid

An acid is a compound/substance which when dissolved in water produces hydrogen ions as the only positively charged ions.

(b). State what would be observed if an aqueous solution of each of the following substances were tested with a blue litmus paper.

(i). Ammonium chloride

Aqueous solution of ammonium chloride forms ammonium hydroxide (Weak alkali) and hydrochloric acid (strong acid). Ammonium hydroxide partially ionizes forming very few hydroxide ions, hydrochloric acid ionizes fully producing a lot of hydrogen ions.

Therefore the solution is acidic due to excess hydrogen ions present.

Observation

Blue litmus paper turns red/pink.

(ii). Sodium chloride

Aqueous solution of sodium chloride forms sodium hydroxide (Strong alkali) and hydrochloric acid (strong acid). Sodium hydroxide ionizes fully producing a lot of hydroxide ions while hydrochloric acid ionizes fully producing a lot of hydrogen ions.

Therefore the solution is neutral since all the hydrogen ions neutralize the hydroxide ions.

Observation:

There is no observable change on the blue litmus paper.

(iii). potassium carbonate

Aqueous solution of potassium carbonate produces potassium hydroxide (strong alkali) and carbonic acid (weak acid). Potassium hydroxide ionizes fully producing a lot of hydroxide ions while carbonic acid ionizes partially producing very few hydrogen ions.

Therefore the solution is basic/alkaline due to the excess hydroxide ions present.

Observation:

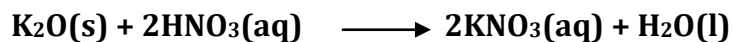
The blue litmus paper remains blue in colour.

(c). Write the equation for the reaction between potassium oxide and:

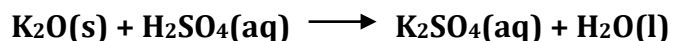
(i). Hydrochloric acid



(ii). nitric acid



(iii) Sulphuric acid



3. A mixture containing Copper(II) sulphate and Copper(II) carbonate was shaken with excess water and filtered.

(a). Identify the residue

Explanation:

Copper(II) sulphate is soluble in water

Copper(II) carbonate is insoluble.

All sulphates are soluble in water except PbSO₄, BaSO₄, CaSO₄ (only slightly soluble in water).

All carbonates are insoluble in water except carbonates of Sodium, Potassium and ammonium.

Therefore, Residue is Copper(II) carbonate (the insoluble salt).

(b). The dry residue was heated strongly.

(i). State what was observed

Green solid of Copper(II) carbonate turned to a black solid of Copper(II) oxide

(ii). Write an equation for the reaction



(c). (i). Name the reagent that can be used to identify the anion in the filtrate

Filtrate is Copper(II) sulphate:

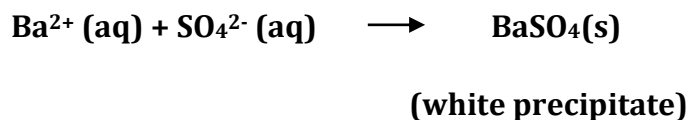
Anion is a sulphate - SO_4^{2-}

Reagent: Barium chloride and dilute hydrochloric acid

OR

Barium nitrate and dilute nitric acid

(ii). Write an ionic equation for the anion and the reagent you have named in c(i)



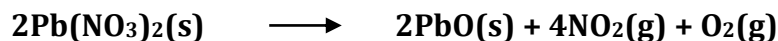
4. (a).Lead(II) nitrate was heated until there was no further change.

(i). What was observed

White solid (colourless solid) turned to a reddish brown solid when hot which on cooling turns to a yellow solid.

Reddish brown fumes were also produced

(ii). Write an equation for the reaction that took place



(b). Dilute hydrochloric acid was added to a solution of lead(II) nitrate and the resultant solution was warmed.

(a). State what was observed.

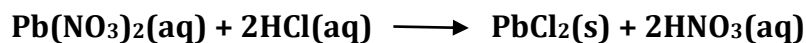
White precipitate which dissolves on warming and re-appears on cooling

(b). What can you deduce from your observation

The solubility of Lead(II) chloride increases with increase in temperatures.

(c). Write an equation for the reaction that took place before warming.

Precipitation reaction/double decomposition reaction.

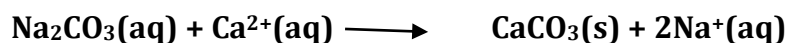


5. (a). A solution of sodium carbonate was added to a solution of calcium ions.

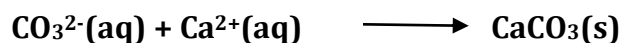
(i). State what was observed.

White precipitate of insoluble calcium carbonate

(ii). Write an equation for the reaction that took place.



Ionic equation.



(b). Dilute hydrochloric acid was added to the mixture formed in (a) above.

(i). State what was observed.

Bubbles of a colourless gas that turns limewater milky (or forms a white precipitate with Calcium hydroxide solution).

Colourless solution was formed.

(ii). Write an equation for the reaction.



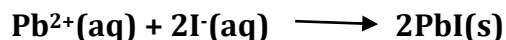
6. State one reagent that can be used to distinguish between each of the following pairs of ions and in each case, state what would be observed if each ion is treated with the reagent.

(a). Lead(II) ions and Aluminium ions

Reagent: **Sodium iodide solution or potassium iodide solution**

Observation

Pb²⁺ - yellow precipitate is formed.



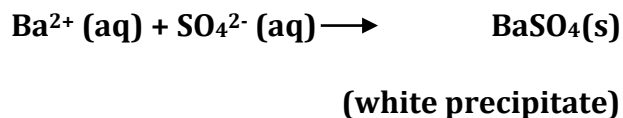
Al³⁺ - No observable change.

(b). Sulphate ion and Carbonate ion.

Reagent: **Barium nitrate followed by dilute nitric acid or Barium chloride followed by dilute hydrochloric acid.**

Observation

SO₄²⁻ - A white precipitate insoluble in the acid.



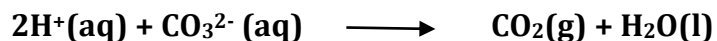
CO₃²⁻ - A white precipitate soluble in the acid to form a colourless solution.

OR

Reagent: **Add a dilute mineral acid (dilute HCl, HNO₃, H₂SO₄)**

SO₄²⁻ - No observable change

CO₃²⁻ - Bubbles of a colourless gas that forms a milky solution with lime water (or a white precipitate with calcium hydroxide solution).



SECTION B

7(a). Define the term:

(i). An acid

An acid is a compound which when dissolved in water, produces hydrogen ions (H⁺) as the only positively charged ions.

(ii). A base

A base is an oxide or hydroxide of a metallic or ammonium ion that reacts with an acid to form a salt and water only.

(iii). An alkali

An alkali is a soluble base.

An alkali is a compound/substance that dissolves in water to produce hydroxide ions (OH⁻) as the only negatively charged ion.

(iv). An indicator

An indicator is a substance whose solution changes colour due to changes in pH.

An indicator is a substance with different colours in different solutions of varying pH values.

An indicator is a substance that changes colour depending on the pH of the solution to which it is added to.

(b). Describe how a pure sample of dry Magnesium sulphate crystals can be prepared in the laboratory and write equations to illustrate your answer.

Preparation of Magnesium Sulphate from Magnesium metal and Dilute sulphuric acid.

Procedure

Dilute sulphuric acid is added into a beaker

Magnesium metal is gradually added to the dilute sulphuric acid in a beaker with continuous stirring.

The mixture is warmed gently to increase on the rate of the reaction.

More magnesium metal is added until effervescence stops indicating that all the acid has been used up.



The mixture is filtered to remove the excess/unreacted magnesium metal as the residue.

The Magnesium sulphate solution which is obtained as a filtrate is evaporated using an evaporating dish until a saturated solution is formed.

The saturated solution obtained is allowed to cool as crystals are being formed/until it completely crystallises.

The crystals obtained are washed with a little distilled water to remove traces of the acid.

Then the crystals are dried by pressing them gently between two pieces of filter paper or in sunshine.

NB: Magnesium Sulphate can also be prepared using Magnesium Oxide/ Magnesium hydroxide/ Magnesium Carbonate reacting with dilute sulphuric acid.

(c) i). State what is meant by the term “Solubility of a solute”

Solubility of a solute in a solvent at a particular temperature is the mass in grams of a solute required to saturate 100 grams of a solvent at that temperature.

(ii). The table below shows the solubility of Iron(II) sulphate in water at various temperatures.

Temperature /°C	0	10	20	30	40	50	60
Solubility of FeSO ₄ (g/100g of water)	12	20	32	46	62	85	110

(i). Plot a graph of solubility of Iron(II) sulphate against temperature.

(ii). Using your graph, determine the mass of Iron(II) sulphate that would crystallize if temperatures were cooled from 55°C to 15°C.

8. (a). State the difference between:

(i). A normal salt and an acid salt

A normal salt is a salt formed when all the replaceable hydrogens of the acid are replaced by a metallic ion or Ammonium ion (metal or ammonium radical).

An acid salt is a salt formed when part of the replaceable hydrogens of the acid are replaced by a metallic ion or ammonium ion (metal or ammonium radical).

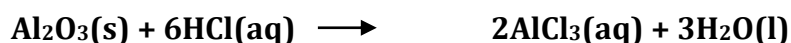
(ii). A base and an Alkali (**Refer to number 7**)

(b). Explain the following observation:

Aluminium oxide reacts with both dilute hydrochloric acid and sodium hydroxide solution.

Aluminium oxide is an amphoteric oxide i.e. it reacts with both acids (hydrochloric acid) and bases (Sodium hydroxide).

Aluminium oxide reacts with hydrochloric acid to form Aluminium Chloride and water.



Aluminium oxide reacts with Sodium hydroxide to form a colourless solution of sodium tetrahydroxoaluminate.

(c). Briefly describe how a pure sample of Lead(II) Sulphate can be prepared. (Diagram not required).

Lead(II) sulphate is insoluble, so its prepared by double decomposition method or precipitation method.

Two soluble salts are reacted together to form an insoluble salt (Lead(II) sulphate) and a soluble salt.

Procedure:

Add lead(II) nitrate solution in a beaker and warm.

Dilute sulphuric acid or sodium sulphate solution is added to the warm lead(II) nitrate solution in a beaker and the mixture stirred.



A white precipitate of Lead(II) sulphate (Insoluble salt) and Sodium nitrate (soluble salt) which is a colourless solution.

The mixture is filtered. Lead(II) sulphate (white precipitate) is obtained as a residue and sodium nitrate (colourless solution) is obtained as a filtrate.

The white precipitate/residue is washed several times with warm distilled water.

The white precipitate/residue/ Lead(II) sulphate is allowed to dry on the filter paper or dry it in an oven.

(d). (i). Describe how a dry sample of copper(II) sulphate may be prepared from Copper(II) oxide.

Preparation of Copper(II) Sulphate from Copper(II) oxide and Dilute sulphuric acid.

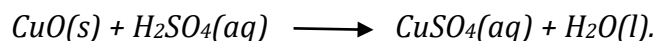
Procedure

Dilute sulphuric acid is added into a beaker

Copper(II) oxide is gradually added to the dilute sulphuric acid in a beaker with continuous stirring.

The mixture is warmed gently to increase on the rate of the reaction.

More Copper(II) oxide is added until no more reacts (a solid settles at the bottom of a beaker) indicating that all the acid has been used up.



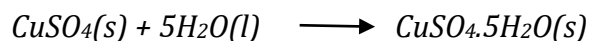
The mixture is filtered to remove the excess/unreacted Copper(II) oxide as the residue.

The Copper(II) sulphate solution which is obtained as a filtrate is evaporated using an evaporating dish until a saturated solution is formed.

The saturated solution obtained is allowed to cool as crystals are being formed/until it completely crystallises.

The crystals obtained are washed with a little distilled water to remove traces of the acid.

Then the crystals are dried by pressing them gently between two pieces of filter paper or in sunshine.

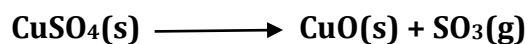
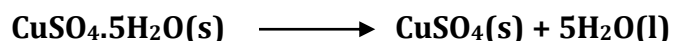


(ii). Crystals of Copper(II) sulphate were heated gently and then strongly until there was no further change. State the observations made and the equation(s) for the reaction(s) that took place.

Observation

Blue solid of hydrates Copper(II) sulphate changed to a white solid of Anhydrous Copper(II) sulphate.

On further heating, a black solid of copper(II) oxide were formed and white fumes of sulphurtrooxide were evolved.



9. (a). (i). Describe how a pure sample of iron(II) sulphate -7-water can be prepared in the laboratory.

Preparation of Magnesium Sulphate from Magnesium metal and Dilute sulphuric acid.

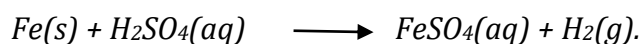
Procedure

Dilute sulphuric acid is added into a beaker

Iron filings are gradually added to the dilute sulphuric acid in a beaker with continuous stirring.

The mixture is warmed gently to increase on the rate of the reaction.

More Iron filings are added until effervescence stops indicating that all the acid has been used up.



The mixture is filtered to remove the excess/unreacted Iron filings as the residue.

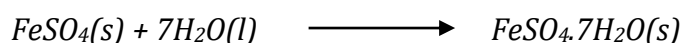
The Iron(II) sulphate solution which is obtained as a filtrate is evaporated using an evaporating dish until a saturated solution is formed.

The saturated solution obtained is allowed to cool as crystals are being formed/until it completely crystallises.

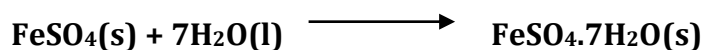
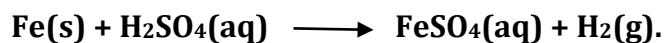
The crystals obtained are washed with a little distilled water to remove traces of the acid.

Then the crystals are dried by pressing them gently between two pieces of filter paper or in sunshine.

NB: Iron(II) Sulphate cannot be prepared using Iron(II) oxide reacting with dilute sulphuric acid.



(ii). Write an equation for the reaction.



(b). (i). State what would be observed when iron(II) sulphate -7- water was heated strongly.

Green solid of hydrated Iron(II) sulphate formed a reddish brown solid of Iron(III) oxide.

White fumes of sulphurtrioxide gas and sulphurdioxide gas were also evolved.

(ii). write an equation for the reaction in b(i).



(c). Sodium hydroxide solution was added dropwise to a solution of iron(II) sulphate until there was no change.

(i). State what was observed

Green precipitate insoluble in excess

(iii). Write an equation for the reaction.

Precipitation reaction.



Ionic equation.



10 (a). Copper(II) carbonate was heated strongly until there was no further change.

(i). State what was observed.

Green solid turned to a black solid

(ii). Write an equation for the reaction.



(iii). Name one reagent that can be used to identify the gaseous product.

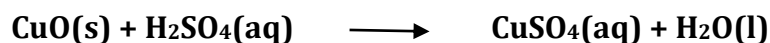
Calcium hydroxide/ lime water.

(b). Excess dilute sulphuric acid was added to the residue in (a).

(i). State what was observed.

A blue solution was formed

(ii). Write an equation for the reaction

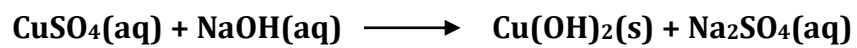


(c). To the product in (b), was added dilute sodium hydroxide solution dropwise until in excess.

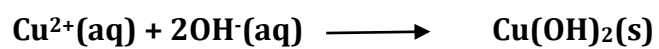
(i). State what was observed.

A pale blue precipitate was formed

(ii). Write an equation for the reaction.



Ionic equation.



END

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