Group ii metals essay sample

Science, Chemistry

Aim

To find out the properties and trends of Group II elements using Magnesium, Calcium and Barium to investigate reactions of the metals with water, the reaction of the oxides with water and acid, the solubility's of the hydroxides and carbonates and the thermal stabilities of the carbonates.

Introduction

Group II elements are arranged in the second column in the Periodic Table, which have the same electron configurations in their valence shell and known as the alkaline earth metals [1] [3]. Their physical properties are that they are all metals with a shiny, silvery-white colour and the melting points are higher than other metal elements but not as high as the Group I elements. [2]

In this experiment only 3 elements in Group II were used, which were Magnesium (24Mg), Calcium (40Ca) and Barium (137Ba):

24Mg:

Appearance: silvery white solid at room temp

Electron configuration: [Ne] 3s2

Uses: Mg can be found in many places on this planet. Mg ions are required in catalytic action in all living organisms. It can also be used several high volume manufacturing applications. [4]

40Ca:

Appearance: soft grey metal

Electron configuration: [Ar] 4s2

Uses: Ca is one of the most indispensable elements in the human body. It also can be used as a deoxidizing agent to reduce other substances to make alloys. [5]

137Ba

Appearance: soft silvery metal

Electron configuration: [Xe] 6s2

Uses: Barium compounds, and especially barite (BaSO4), are extremely important to the petroleum industry. Barium oxide is used to facilitate the release of electrons. [6] However it can never be found in nature in its pure form due to its reactivity with air. [2]

Methods

Experiment 1: reaction of the metals with water

Equipments:

100cm3 beaker

Tweezers

Chemicals:

Magnesium metals

Calcium metals

Barium metals

Universal indicator solution

100cm3 beaker was half filled with water. A small piece of calcium was picked up using tweezers and dropped into the water. Observations were recorded and when the reaction appeared finished, the universal indicator solution was put into the beaker. The universal indicator was used to measure the acidity of the aqueous solution and pH number was recorded along with other observations and recordings.

The same process was followed using magnesium and Barium but the Barium had to be done in a fume cupboard and pH value and other observations were recorded.

Experiment 2: Reaction of the oxides with water and acid

Equipments:

Test tubes

Spatula

Chemicals:

Magnesium oxide

Calcium oxide

Barium oxide

Universal indicator solution

Hydrochloric acid

A spatula was used to transfer a very small quantity of the three oxides into separate test tubes. The test tubes were shaken after one-third of water was added in it. Observations were recorded. A few drops of universal indicator solution were added into the three test tubes. Any observations were recorded. Hydrochloric acid was added drop by drop to each of the three test tubes. After every drop, the test tubes were shaken in order to enable the solution to mix properly. The colour changes were recoded.

The experiment with Barium oxide was still completed in the fume cupboard.

Experiment 3: Solubility’s of the hydroxides and carbonates

Equipments:

Test tubes

Disposable pipette

Chemicals:

Magnesium nitrate solution

Calcium nitrate solution

Barium nitrate solution

Sodium hydroxide solution

Sodium carbonate solution

About 1 cm depth of magnesium nitrate solution was poured into two test tubes. One of the test tubes was added. An equal volume of sodium hydroxide solution and the same quantity of sodium carbonate solution was added to the other test tube. Both test tubes were shaken and the observation was recorded.

The same procedures were applied to Calcium nitrate solution and Barium nitrate solution but the Barium nitrate solution experiment was done in the fume cupboard. Observations were recoded.

Experiment 4 Thermal stabilities of the carbonates

Equipment:

Test tubes

Bunsen burner

Vent-plug

Beaker

Spatula

Chemicals:

Lime water

Magnesium carbonate

Calcium carbonate

Barium carbonate

About a 0. 5 cm depth of solid magnesium carbonate was placed in a test tube using a spatula and the equipment was set up as in the diagram below:

image00. png

A Bunsen burner was used to heat the test tube. The Bunsen burner was first set as a moderate flame to heat the test tube for a few minutes and then changed to a roaring flame if nothing happened. The observation was recorded.

After the experiment, the Bunsen burner was first removed otherwise the limewater would have been sucked back into the test tube, which would result in the glass test tube shattering.

The experiment using Calcium carbonate and Barium carbonate were done in the same way as the magnesium carbonate but the Barium carbonate was used in the fume cupboard.

After all the experiments had been completed all the used chemicals were placed into labeled container especially the Barium compounds. All the glassware equipments were rinsed out and left to the original places.

Results

Experiment1: reaction of the metals with water

Metal

Observations when metal added to water

pH of water

Mg

Few bubbles

6. 0

Ca

Leaving a cloudy solution

Dissolve into H2O

Fizzes

Produce sound

Floating on the surface

10. 0

Ba

Fizzes

Floating around the surface

Leaning a cloudy solution

11. 0

These three elements all reacted with water. As the electron shells increased the reaction was more active.

The equations for the reactions were:

Mg (s) + H2O (l) MgO (s) + H2 (g)

Ca (s) + H2O (l) CaO (s) + H2 (g)

Ba (s) + H2O (l) BaO (s) + H2 (g)

[3]

Experiment 2: Reaction of the oxides with water and acid

Metal oide

Dissolved to give an alkaline solution

Is HCl neutralised

Colour

pH

MgO

Not very dissolvable.

Still can see some white small substances

Yes

green

8. 5

CaO

Fizzles

Cloudy solution

Dissolve

pH 11. 0

Yes

green

8. 5

BaO

Fizzle.

Cloudy solution.

Dissolve.

pH 11. 0

yes

green

8. 5

All these three oxides reacted with acid and all were neutralized. The pH values were around pH11 when dissolved. Forming cloudy solution when water was added.

The equations of these reactions were:

MgO (s) + 2HCl (aq) MgCl2 (aq) + H2 (g)

CaO (s) + 2HCl (aq) CaCl2 (aq) + H2 (g)

BaO (s) + 2 HCl (aq) BaCl2 (aq) + H2 (g)

[3]

Experiment 3: Solubility’s of the hydroxides and carbonates

Substances

Observation with hydroxide

Observation with carbonate

Mg(NO3)2

turbid

A little precipitate

Cloudy(little) solution

Ca(NO3)2

turbid

More white precipitate

Turbid solution.

A large of precipitate

Ba(NO3)2

White precipitate;

Clear white substances

Turbid solution

Precipitate(little)

All three solutions were increasingly soluble in hydroxide but increasingly insoluble in carbonate.

The balanced equations for the reactions were:

For hydroxide:

Mg(NO3)2(a. q) + 2 NaOH(a. q) Mg(OH)2(s) +2 NaNO3(a. q)

Ca(NO3)2(a. q) + NaOH (a. q) Ca(OH)2(aq) + 2NaNO3(a. q)

Ba(NO3)2(a. q) + NaOH (a. q) Ba(OH)2(aq) + 2NaNO3(a. q)

For carbonate

Mg(NO3)2(a. q) + Na2CO3 (a. q) MgCO3(aq) + 2NaNO3(a. q)

Ca(NO3)2 (a. q) + Na2CO3 (a. q) CaCO3(s) + 2NaNO3(a. q)

Ba(NO3)2 (a. q) + Na2CO3 (a. q) BaCO3(s) + 2NaNO3(a. q)

Experiment 4: Thermal stabilities of the carbonates

Carbonate

observation

Magnesium carbonate

Bubbles forming constantly in slime water.

heat —bubble

Calcium carbonate

Bubbles forming quicker than when heat magnesium carbonate.

heat —bubble

Sequence of the thermal stabilities of the carbonates:

Mg

Ca

Less stable

This experiment didn’t use Barium due to its toxicity and the thermal stability could be predicted, which was less stable than calcium.

The thermal stabilities of the elements decreased as went down the group in the Periodic Table.

The general equation of a carbonate:

XCO3 (s) heat XO(s) + CO2 (g) [3]

The carbonate was decomposed into oxides and carbon dioxide. Carbon dioxide could be detected by lime water.

Lime water (i. e. calcium hydroxide) was used to test the carbon dioxide and the precipitate would produce to prove the existence of carbon dioxide.

Reaction of the lime water

Ca(OH)2 (aq) + CO2(g) CaCO3(s) + H2O (l)

Discussion

In experiment 4, there was a procedure to detect carbon dioxide by using lime water. Lime water was expected to become turbid once carbon dioxide was produced but in the experiment the lime water did not become turbid at all, this may be because the heating time was too short to enable the air in the test tube to come out. In addition, It also may be because there was not enough or no CO2 produced or there was something wrong with the lime

water. Perhaps it was old. [7] To solve this problem, we could use fresher lime water or placed more substances in the test tube to enable there were enough CO2 to come out react with lime water and make it turbid.

Therefore, trends in the properties of alkaline earth metals and their compounds could be concluded as follow:

metal

Reactivity with water

Reactivity with acid

Solubility of hydroxides

Solubility of carbonate

Thermal stability

Be

Poor

increase

Poor

increase

Insoluble

Insoluble

Increasingly

soluble

Does not exist

Increasingly

insoluble

less stable

Mg

Ca

Sr

Ba

[3]

Reference

[1] http://en. wikipedia. org/wiki/Periodic_table#Periodic_trends_of_groups (Apr. 2008)

[2] The Chemistry of Group II Metals Handout from Michele Raychaudhuri. 1. Apr. 2008

[3] Lewis. R. and Evans. W. 2006. Chemistry. Page197. 3rd edition. Palgrave Macmillan. New York.

[4] http://en. wikipedia. org/wiki/Magnesium#Biology (Apr. 2008)

[5] http://en. wikipedia. org/wiki/Calcium#Applications (Apr. 2008)

[6] http://en. wikipedia. org/wiki/Barium (Apr. 2008)

[7] From Michele Raychaudhuri. Mon, April 7, 2008 8: 58 am