Access Tuition

A-Level Chemistry

Group 2

Question Paper

Time available: 58 minutes
Marks available: 53 marks

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1. This question is about Group 2 elements and their compounds.

(a) Explain why the melting point of magnesium is higher than the melting point of sodium.

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(2)

(b) Give an equation to show how magnesium is used as the reducing agent in the extraction of titanium.

Explain, in terms of oxidation states, why magnesium is the reducing agent.

Equation

_____

Explanation _____

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_____

_____

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(2)

(c) State what is observed when dilute aqueous sodium hydroxide is added to separate solutions of magnesium chloride and barium chloride.

Observation with magnesium chloride _____

Observation with barium chloride _____

(2)
(Total 6 marks)

2. This question is about the elements in Group 2 and their compounds.

(a) Use the Periodic Table to deduce the full electron configuration of calcium.

_____

(1)

(b)   Write an ionic equation, with state symbols, to show the reaction of calcium with an excess of water.

_____

(1)

(c)   State the role of water in the reaction with calcium.

_____

(1)

(d)   Write an equation to show the process that occurs when the first ionisation energy of calcium is measured.

_____

(1)

(e)   State and explain the trend in the first ionisation energies of the elements in Group 2 from magnesium to barium.

Trend _____

Explanation _____

_____

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_____

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(3)
(Total 7 marks)

3.   This question is about the Group 2 metals and their compounds.

(a)   Explain why the first ionisation energy of barium is less than the first ionisation energy of calcium.

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_____

(2)

(b)   Magnesium reacts readily with steam.

State **two** observations you would make when magnesium reacts with steam. Write an equation for the reaction.

Observation 1_____

_____

Observation 2_____

_____

Equation_____

(3)

(c)   Explain why different observations are made when aqueous barium chloride is added separately to aqueous magnesium sulfate and to aqueous magnesium nitrate.

Write the simplest ionic equation, including state symbols, for any reaction that occurs.

Explanation _____

_____

_____

_____

_____

Equation_____

(2)

(Total 7 marks)

4.   The elements in Group 2 from Mg to Ba can be used to show the trends in properties down a group in the Periodic Table.

(a)   State the trend in atomic radius for atoms of the elements down Group 2 from Mg to Ba Give a reason for this trend.

Trend_____

Reason _____

_____

_____

_____

_____

(2)

(b)   The Group 2 elements react with water.

(i)   State the trend in reactivity with water of the elements down Group 2 from Mg to Ba

_____

(1)

(ii)   Write an equation for the reaction of strontium with water.

_____

(1)

(c)   Give the **formula** of the hydroxide of the element in Group 2 from Mg to Ba that is most soluble in water.

_____

(1)
(Total 5 marks)

5. There are many uses for Group 2 metals and their compounds.

(a)   State a medical use of barium sulfate.
State why this use of barium sulfate is safe, given that solutions containing barium ions are poisonous.

Use _____

Why this use is safe _____

_____

_____

(2)

(b)   Magnesium hydroxide is used in antacid preparations to neutralise excess stomach acid.

Write an equation for the reaction of magnesium hydroxide with hydrochloric acid.

_____

(1)

(c)   Solutions of barium hydroxide are used in the titration of weak acids.

State why magnesium hydroxide solution could **not** be used for this purpose.

_____

_____

(1)

(d)   Magnesium metal is used to make titanium from titanium(IV) chloride.

Write an equation for this reaction of magnesium with titanium(IV) chloride.

_____

(1)

(e)   Magnesium burns with a bright white light and is used in flares and fireworks.

Use your knowledge of the reactions of Group 2 metals with water to explain why water should **not** be used to put out a fire in which magnesium metal is burning.

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(2)

(Total 7 marks)

6. A student investigated how the initial rate of reaction between sulfuric acid and magnesium at 20 °C is affected by the concentration of the acid.

The equation for the reaction is

$$H_2SO_4(aq) + Mg(s) \longrightarrow MgSO_4(aq) + H_2(g)$$

(a)   The student made measurements every 20 seconds for 5 minutes. The student then repeated the experiment using double the concentration of sulfuric acid.

State a measurement that the student should make every 20 seconds. Identify the apparatus that the student could use to make this measurement.

_____

_____

_____

_____

(2)

(b)   State **one** condition, other than temperature and pressure, that would need to be kept constant in this investigation.

_____

_____

(1)

(c)   When the student had finished the investigation, an excess of sodium hydroxide solution was added to the reaction mixture. This was to neutralise any unreacted sulfuric acid. The student found that a further reaction took place, producing magnesium hydroxide.

(i)   Draw a diagram to show how the student could separate the magnesium hydroxide from the reaction mixture.

(2)

(ii)   Suggest **one** method the student could use for removing soluble impurities from the sample of magnesium hydroxide that has been separated.

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_____

_____

_____

(1)

(Total 6 marks)

7. (a)   Anhydrous strontium chloride is not used in toothpaste because it absorbs water from the atmosphere. The hexahydrate, $SrCl_2.6H_2O$, is preferred.

A chemist was asked to determine the purity of a sample of strontium chloride hexahydrate. The chemist weighed out 2.25 g of the sample and added it to 100 cm^3 of water. The mixture was warmed and stirred for several minutes to dissolve all of the strontium chloride in the sample. The mixture was then filtered into a conical flask. An excess of silver nitrate solution was added to the flask and the contents swirled for 1 minute to make sure that the precipitation was complete.

The silver chloride precipitate was separated from the mixture by filtration. The precipitate was washed several times with deionised water and dried carefully. The chemist weighed the dry precipitate and recorded a mass of 1.55 g.

(i)   Calculate the amount, in moles, of AgCl in 1.55 g of silver chloride (M_r = 143.4).

_____

(1)

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(ii)   The equation for the reaction between strontium chloride and silver nitrate is

$$SrCl_2 \; + \; 2AgNO_3 \longrightarrow 2AgCl \; + \; Sr(NO_3)_2$$

Use your answer from part (i) and this equation to calculate the amount, in moles, of $SrCl_2$ needed to form 1.55 g of silver chloride.

_____

_____

(1)

(iii)   Use data from the Periodic Table to calculate the M_r of strontium chloride hexahydrate. Give your answer to 1 decimal place.

_____

_____

(1)

(iv)   Use your answers from parts (a)(ii) and (a)(iii) to calculate the percentage by mass of strontium chloride hexahydrate in the sample. Show your working.
Give your answer to the appropriate precision.

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_____

_____

_____

(2)

(v)   Several steps in the practical procedure were designed to ensure an accurate value for the percentage by mass of strontium chloride hexahydrate in the sample.

1   Explain why the solution of strontium chloride was filtered to remove insoluble impurities before the addition of silver nitrate.

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_____

(1)

2   Explain why the precipitate of silver chloride was washed several times with deionised water.

_____

_____

(1)

(b) Magnesium hydroxide and magnesium carbonate are used to reduce acidity in the stomach. Magnesium hydroxide can be prepared by the reaction of solutions of magnesium chloride and sodium hydroxide.

(i) Write the **simplest ionic** equation for the reaction that occurs between magnesium chloride and sodium hydroxide.
Include state symbols in your equation.

_____

(1)

(ii) Other than cost, explain one advantage of using magnesium hydroxide rather than magnesium carbonate to reduce acidity in the stomach.

_____

_____

(1)

(c) Calcium ethanoate, $(CH_3COO)_2Ca$, is used in the treatment of kidney disease.
Thermal decomposition of calcium ethanoate under certain conditions gives propanone and **one** other product.

Write an equation for the thermal decomposition of calcium ethanoate.

_____

(1)

(d) Salts containing the chromate(VI) ion are usually yellow in colour.
Calcium chromate(VI) is soluble in water.
Strontium chromate(VI) is insoluble in water, but will dissolve in a solution of ethanoic acid.
Barium chromate(VI) is insoluble in water and is also insoluble in a solution of ethanoic acid.

Describe a series of tests using solutions of sodium chromate(VI) and ethanoic acid that would allow you to distinguish between separate solutions of calcium chloride, strontium chloride and barium chloride.
State what you would observe in each test.

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(3)

(e)   The strontium salt of ranelic acid is used to promote bone growth. Analysis of a pure sample of ranelic acid showed that it contained 42.09% of carbon, 2.92% of hydrogen, 8.18% of nitrogen, 37.42% of oxygen and 9.39% of sulfur by mass.

Use these data to calculate the empirical formula of ranelic acid.
Show your working.

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(2)
(Total 15 marks)