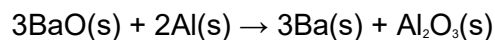


**Q1.** Barium can be extracted from barium oxide (BaO) in a process using aluminium. A mixture of powdered barium oxide and powdered aluminium is heated strongly. The equation for this extraction process is shown below.



Some standard enthalpies of formation are given in the table below.

|                                           |        |                                    |
|-------------------------------------------|--------|------------------------------------|
| Substance                                 | BaO(s) | Al <sub>2</sub> O <sub>3</sub> (s) |
| $\Delta H_f^\ominus / \text{kJ mol}^{-1}$ | -558   | -1669                              |

(a) (i) State what is meant by the term *standard enthalpy of formation*.

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(3)

(ii) State why the standard enthalpy of formation of barium and that of aluminium are both zero.

.....

(1)

(iii) Use the data to calculate the standard enthalpy change for the reaction shown by the equation above.

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(3)

- (b) (i) Suggest the major reason why this method of extracting barium is expensive.  
 ..... (1)
- (ii) Using barium oxide and aluminium powders increases the surface area of the reactants. Suggest **one** reason why this increases the rate of reaction.  
 ..... (1)
- (c) (i) Write an equation for the reaction of barium with water.  
 ..... (1)
- (ii) A solution containing barium ions can be used to test for the presence of sulfate ions in an aqueous solution of sodium sulfate.  
 Write the **simplest ionic** equation for the reaction which occurs and state what is observed.  
 Simplest ionic equation  
 .....  
 Observation ..... (2)
- (iii) State how barium sulfate can be used in medicine. Explain why this use is possible, given that solutions containing barium ions are poisonous.  
 Use .....  
 Explanation .....  
 ..... (2)
- (Total 14 marks)**

- Q2.** (i) For the elements Mg–Ba, state how the solubilities of the hydroxides and the solubilities of the sulphates change down Group II.
- (ii) Describe a test to show the presence of sulphate ions in an aqueous solution. Give the results of this test when performed on separate aqueous solutions of magnesium chloride and magnesium sulphate. Write equations for any reactions occurring.
- (iii) State the trend in the reactivity of the Group II elements Mg–Ba with water.

Write an equation for the reaction of barium with water.

**(Total 11 marks)**

**Q3.** Which one of the following statements is correct?

- A** The first ionisation energies of the elements in Period 3 show a general decrease from sodium to chlorine.
- B** The electronegativities of Group 2 elements decrease from magnesium to barium.
- C** The strength of the intermolecular forces increases from hydrogen fluoride to hydrogen chloride.
- D** The ability of a halide ion to act as a reducing agent decreases from fluoride to iodide.

**(Total 1 mark)**

**Q4.** This question concerns the chemistry of the Group II metals Mg to Ba. An aqueous solution of a Group II metal chloride,  $\text{XCl}_2$ , forms a white precipitate when dilute aqueous sodium hydroxide is added. A separate sample of the solution of  $\text{XCl}_2$  does **not** form a precipitate when dilute aqueous sodium sulphate is added.

An aqueous solution of a different Group II metal chloride,  $\text{YCl}_2$ , does **not** form a precipitate when dilute aqueous sodium hydroxide is added. A separate sample of the solution of  $\text{YCl}_2$  forms a white precipitate when dilute aqueous sodium sulphate is added.

Suggest identities for the Group II metals **X** and **Y**. Write equations, including state symbols, for the reactions which occur.

**(Total 6 marks)**

**Q5.** Which one of the following is the electron arrangement of the strongest reducing agent?

- A**  $1s^2 2s^2 2p^5$
- B**  $1s^2 2s^2 2p^6 3s^2$
- C**  $1s^2 2s^2 2p^6 3s^2 3p^5$
- D**  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$

**(Total 1 mark)**

**Q6.** State the trends in solubility of the hydroxides and of the sulphates of the Group II elements Mg–Ba.

Describe a chemical test you could perform to distinguish between separate aqueous solutions of sodium sulphate and sodium nitrate. State the observation you would make with each solution. Write an equation for any reaction which occurs.

**(Total 6 marks)**

**Q7.** A chemical company's records refer to the following acids

|                   |               |
|-------------------|---------------|
| hydrochloric acid | nitric acid   |
| hydrobromic acid  | sulfuric acid |
| hydriodic acid    |               |

A waste tank was thought to contain a mixture of two of these acids. A chemist performed test-tube reactions on separate samples from the waste tank. The results of these tests are shown below.

| Test | Reagent | Observations |
|------|---------|--------------|
|------|---------|--------------|

|          |                          |                   |
|----------|--------------------------|-------------------|
| <b>A</b> | Barium chloride solution | White precipitate |
| <b>B</b> | Silver nitrate solution  | White precipitate |

- (a) Use the result from Test **A** to identify an acid in the company's records which must be **present** in the waste tank.

.....

(1)

- (b) Use the results from Test **A** and Test **B** to identify an acid in the company's records which must be **absent** from the waste tank.

.....

(1)

- (c) The chemist suspected that the waste tank contained hydrochloric acid. State how the precipitate formed in Test **B** could be tested to confirm the presence of hydrochloric acid in the waste tank. State what you would observe.

Test .....

.....

Observation .....

.....

(2)

- (d) Suggest one reason why carbonate ions could not be present in the waste tank.

.....

(1)

(Total 5 marks)

**Q8.** Which one of the following is a correct procedure for isolating a sample of hydrated copper(II) sulphate from a mixture of hydrated copper(II) sulphate and barium sulphate?

- A filter, crystallise filtrate, dry the crystals
- B filter, dry the solid on the filter paper
- C add water, filter, dry the solid left on the filter paper
- D add water, filter, crystallise filtrate, dry the crystals

(Total 1 mark)

**Q9.** The elements in Group 2 can be used to show the trends in properties down a group in the Periodic Table.

- (a) State the trend in atomic radius down Group 2 from Mg to Ba and give a reason for this trend.

*Trend* .....

*Reason* .....

(2)

- (b) State and explain the trend in melting points of the elements down Group 2 from Mg to Ba.

*Trend* .....

*Explanation* .....

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(3)

- (c) State the trend in reactivity with water of the elements down Group 2 from Mg to Ba. Write an equation for the reaction of magnesium with steam and an equation for the reaction of strontium with water.

*Trend* .....

*Equation for magnesium* .....

*Equation for strontium* .....

(3)

- (d) Sulfates of the Group 2 elements from Mg to Ba have different solubilities. Give the formula of the least soluble of these sulfates and state **one** use that depends upon the insolubility of this sulfate.

*Formula* .....

*Use* .....

(2)  
(Total 10 marks)

**Q10.** Both strontium carbonate and strontium sulfate are white solids which are insoluble in water. Strontium carbonate reacts with hydrochloric acid to produce a solution of strontium chloride. Strontium sulfate does not react with hydrochloric acid.

Describe how you would obtain strontium sulfate from a mixture of strontium carbonate and strontium sulfate.

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(Total 2 marks)