

1. March/2020/Paper_42/No.2

(a) Group 2 metals form stable carbonates and sulfates.

(i) State and explain the trend in the thermal stability of the Group 2 carbonates down the group.

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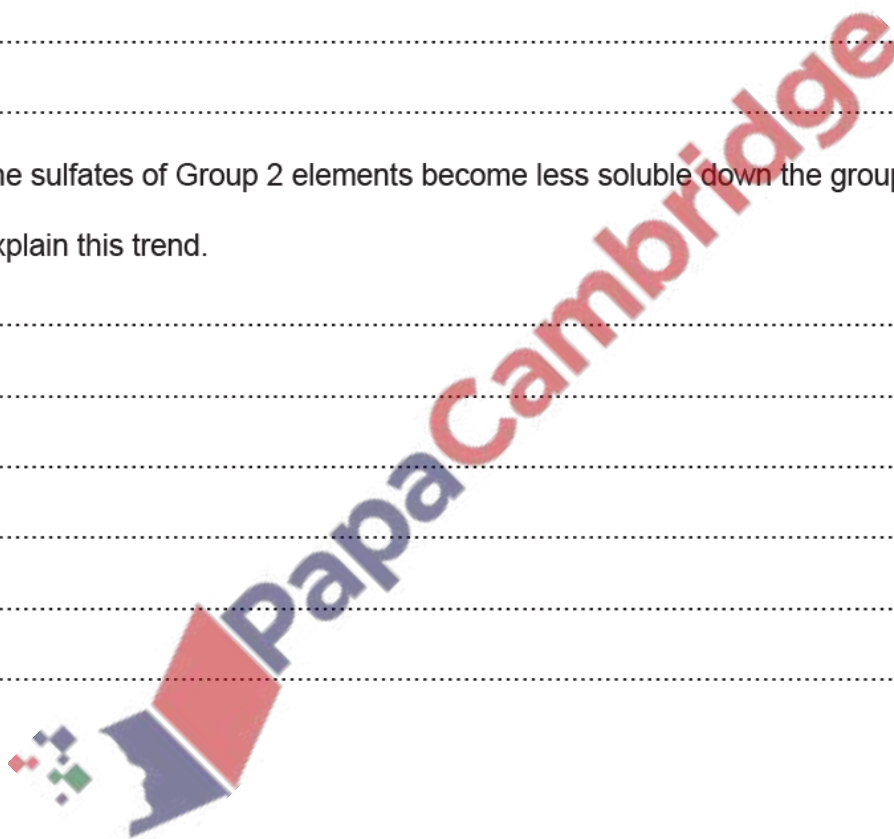
[3]

(ii) The sulfates of Group 2 elements become less soluble down the group.

Explain this trend.

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[3]



(b) Aluminium is extracted from Al_2O_3 by electrolysis. Al_2O_3 is dissolved in cryolite in this process.

(i) The half-equation for the reaction at the anode is shown.



Use this half-equation to write the ionic equation for the electrolysis of Al_2O_3 .

..... [1]

(ii) Aluminium oxide is electrolysed for 3.0 hours using carbon electrodes and a current of 3.5×10^5 A.

Calculate the mass of aluminium that is formed.

mass of aluminium = g [3]

(iii) Cryolite can be made from SiF_4 .

The first step in this conversion is the reaction of SiF_4 with H_2O , forming H_2SiF_6 and SiO_2 .

Write an equation for this reaction.

..... [1]

[Total: 11]

(a) (i) Describe and explain the trend in the solubility of the Group 2 hydroxides down the group.

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..... [4]

Group 2 hydroxides decompose on heating to give the corresponding metal oxide and water vapour.

(ii) Suggest which of $Mg(OH)_2$ and $Sr(OH)_2$ will decompose at a lower temperature.

Explain your answer.

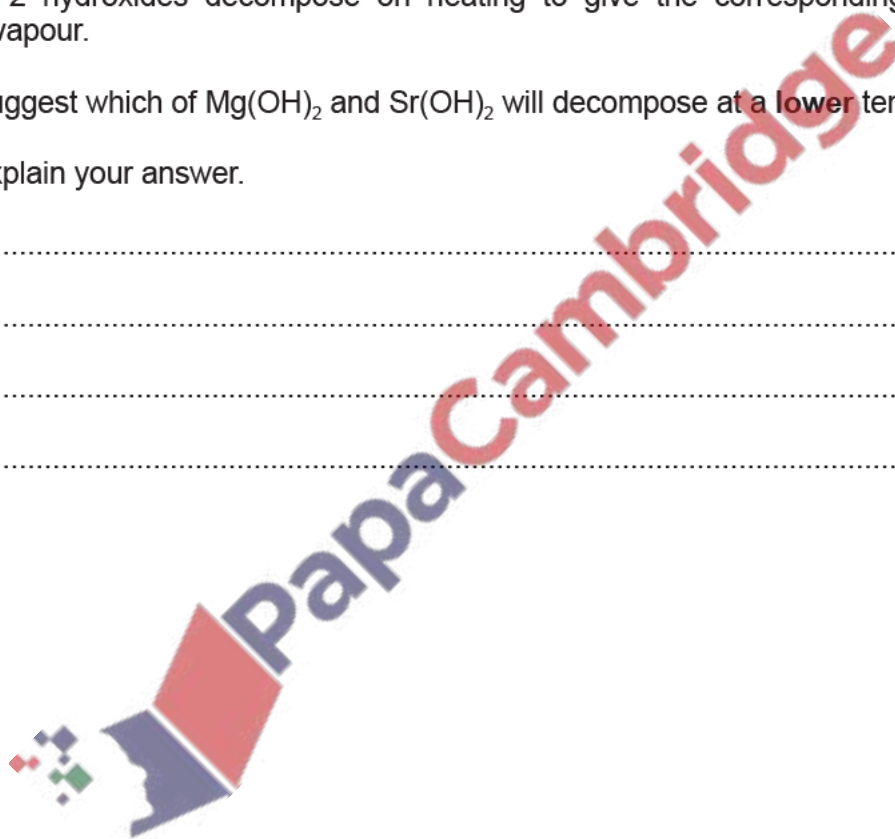
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..... [2]

[Total: 6]



(a) Describe and explain how the solubility of the Group 2 sulfates varies down the group.

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..... [4]

(b) The trend in the decomposition temperatures of Group 2 peroxides, MO_2 , is similar to that of Group 2 carbonates.

Suggest which of barium peroxide, BaO_2 , and calcium peroxide, CaO_2 , will decompose at the lower temperature. Explain your answer.

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..... [2]

(c) Magnesium iodate(V), $\text{Mg}(\text{IO}_3)_2$, decomposes when heated to form magnesium oxide, oxygen and iodine.

Construct an equation for this reaction.

..... [1]

(d) Calcium iodate(V), $\text{Ca}(\text{IO}_3)_2$, is sparingly soluble in water.
The concentration of its saturated solution is $5.6 \times 10^{-3} \text{ mol dm}^{-3}$ at 298 K.

(i) Write an expression for the solubility product, K_{sp} , of $\text{Ca}(\text{IO}_3)_2$, and state its units.

$$K_{\text{sp}} =$$

units = [2]

(ii) Calculate the numerical value for K_{sp} $\text{Ca}(\text{IO}_3)_2$ at 298 K.

$K_{sp} = \dots\dots\dots$ [1]

(iii) When a few cm^3 of concentrated $\text{Ca}(\text{NO}_3)_2(\text{aq})$ is added to a saturated solution of $\text{Ca}(\text{IO}_3)_2$ a white precipitate forms.

Identify the white precipitate and give an explanation for this observation.

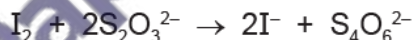
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..... [2]

(e) Iodised salt is sodium chloride mixed with a small amount of sodium iodate(V), NaIO_3 .

- 50.00 g of iodised salt is dissolved in distilled water and the solution made up to 250 cm^3 in a volumetric flask with distilled water.
- 50.0 cm^3 of this solution is pipetted into an excess of aqueous acidified potassium iodide.



- The iodine produced requires 12.40 cm^3 of $0.00200 \text{ mol dm}^{-3}$ aqueous sodium thiosulfate solution for complete reaction.

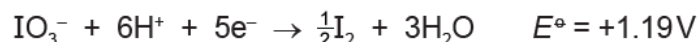


Calculate the mass of sodium iodate(V) present in 50.00 g of iodised salt.



mass of $\text{NaIO}_3 = \dots\dots\dots$ g [3]

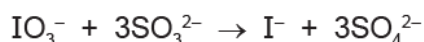
(f) The half-equation for the reduction of iodate(V) ions is shown.



Use data from the *Data Booklet* to predict whether a reaction is feasible when aqueous solutions of acidified iodate(V) ions and bromide ions are mixed. Explain your answer.

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..... [1]

(g) Iodate(V) ions react with sulfite ions in acidic solution at pH 5.00 as shown.



The initial rate of reaction was found to be first order with respect to IO_3^- , first order with respect to SO_3^{2-} and first order with respect to H^+ .

(i) Write the rate equation for this reaction, stating the units of the rate constant, k .

rate = $\text{mol dm}^{-3} \text{s}^{-1}$

units of k = [2]

(ii) The rate of reaction depends on the pH of the solution. Assume all other concentrations remain the same.

Use the expression $x = \frac{\text{rate at pH 5.00}}{\text{rate at pH 4.00}}$ to calculate the value of x .

$x = \dots\dots\dots$ [1]

[Total: 19]

