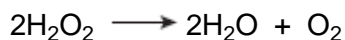


1

An equation for the decomposition of hydrogen peroxide is shown below.



State the measurements you would take in order to investigate the rate of this reaction.

.....
.....
.....
.....

(Total 2 marks)

2

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



- (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.

.....

.....

.....

.....

(1)

(Total 6 marks)

3

An equation for the decomposition of hydrogen peroxide is



- (a) The rate of reaction can be determined by collecting the oxygen formed and measuring its volume at regular intervals.

Draw a diagram to show the apparatus that you would use to collect and measure the volume of the oxygen formed.

(2)

- (b) Explain how you could use your results from the experiment in part (a) to determine the initial rate of this reaction.

.....

.....

.....

.....

.....

(2)

- (c) The rate of decomposition of hydrogen peroxide is increased by the addition of cobalt(II) ions.

Outline the essential features of an additional experiment to show that the rate of decomposition is increased by the addition of cobalt(II) chloride. Use the same method and the same apparatus as in part (a).

.....

.....

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.....

.....

(2)
(Total 6 marks)

4

A laboratory technician discovered four badly-labelled bottles, each containing one pure white solid. Each bottle contained a compound of a different Group 2 metal (magnesium, calcium, strontium and barium).

Some tests were carried out on the solids or, if the compound was soluble, on the aqueous solution. The results are given in the table.

Test	Compound 1	Compound 2	Compound 3	Compound 4
Added to water	Dissolves	Insoluble	Dissolves	Dissolves
Solution or solid added to HCl(aq)	Solution remains colourless	Gives off carbon dioxide gas and a colourless solution forms	Solution remains colourless	Solution remains colourless and heat released
Solution or solid added to NaOH(aq)	Solution gives a white precipitate	Solid remains insoluble	Solution gives a slight white precipitate	Solution has no visible change
Solution or solid added to H ₂ SO ₄ (aq)	Solution has no visible change	Gives off carbon dioxide gas and a white solid remains	Solution slowly forms a slight white precipitate	Solution forms a white precipitate

(a) One of the bottles has a very faint label that could be read as 'Magnesium Sulfate'.

Use the information in the table to deduce which **one** of the four compounds is magnesium sulfate and explain your answer.

Compound

Explanation

.....

.....

.....

.....

(3)

(b) The bottle containing **Compound 2** has a 'TOXIC' hazard symbol.

Use the information in the table to identify **Compound 2**.

Explain both observations in the reaction with $\text{H}_2\text{SO}_4(\text{aq})$.

Identity of **Compound 2**

Explanation

.....

.....

.....

.....

(3)

(c) Identify the compound that is strontium hydroxide.

Give an equation for the reaction of strontium hydroxide with sulfuric acid.

Compound

.....

Equation

.....

(2)

(Total 8 marks)

5

The table below shows observations of changes from some test-tube reactions of aqueous solutions of compounds **Q**, **R** and **S** with five different aqueous reagents. The initial colours of the solutions are not given.

	BaCl₂ + HCl	AgNO₃ + HNO₃	NaOH	Na₂CO₃	HCl (conc)
Q	no change observed	pale cream precipitate	white precipitate	white precipitate	no change observed
R	no change observed	white precipitate	white precipitate, dissolves in excess of NaOH	white precipitate, bubbles of a gas	no change observed
S	white precipitate	no change observed	brown precipitate	brown precipitate, bubbles of a gas	yellow solution

- (a) Identify each of compounds **Q**, **R** and **S**.
You are **not** required to explain your answers.

Identity of **Q**

.....

Identity of **R**

.....

Identity of **S**

.....

(6)

(b) Write ionic equations for each of the positive observations with **S**.

.....

.....

.....

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.....

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.....

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(4)
(Total 10 marks)

Mark schemes

1	Measure <u>volume</u> of gas / <u>mass loss</u> <i>If 'measure concentration' must explain how to score mark</i>	1
	At (regular) time intervals <i>Ignore references to temperature</i> <i>Accept 'against time'</i> <i>Do not accept 'with time' or 'over time' on its own</i>	1
		[2]
2	(a) (Measure the) <u>volume of gas</u> / <u>mass of the container + contents</u>	1
	Suitable named piece of equipment <i>Gas syringe (or inverted burette or measuring cylinder, as long as student has referred to the cylinder being filled with water) / balance.</i> <i>Equipment must be correct for the measurement stated.</i>	1
	(b) Any one of: <ul style="list-style-type: none">• Mass of magnesium <i>Allow amount of magnesium.</i>• Surface area of magnesium	1
	(c) (i) Gravity: Conical flask or beaker and funnel / Vacuum: Sealed container with a side arm and Buchner or Hirsch funnel <i>Must be either gravity filtration (with a V-shaped funnel) or vacuum filtration (with a side-arm conical flask) appropriately drawn.</i>	1
	Filter paper <i>Must show filter paper as at least two sides of a triangle (V-shaped) for gravity filtration or horizontal filter paper for vacuum filtration.</i>	1
	(ii) Wash with / add (a small amount of cold) water <i>Ignore filtering.</i>	1
		[6]
3	(a) Stoppered flask or similar with side arm <i>Allow gas outlet through stopper.</i>	1

Calibrated container for collection eg gas syringe

Allow collection over water, but must use calibrated vessel for collection.

Lose 1 mark if apparatus is not gas tight.

1

(b) Plot a graph of 'volume (of gas)' against 'time'

1

Determine the slope (gradient) at the beginning

1

(c) Repeat with same volume **or** concentration of hydrogen peroxide and at the same temperature

Ignore references to results.

Do not allow 'keep everything the same' or words to that effect.

Must mention volume or concentration and temperature.

1

Add cobalt(II) chloride to one experiment

1

[6]

4

(a) Compound 1

If M1 incorrect, CE = 0

M1

1

No visible change with H₂SO₄

M2

1

Gives white ppt with NaOH

M3

1

(b) BaCO₃

1

The carbonate ion releases CO₂

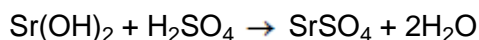
1

but the BaSO₄ formed is highly insoluble.

1

(c) Compound 4

1



Allow ionic equation; ignore state symbols

1

[8]

5

(a) **Q** is calcium or magnesium

1

bromide

1

R is aluminium

1

chloride

1

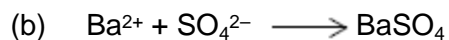
S is iron(III)

1

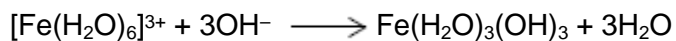
sulfate

1

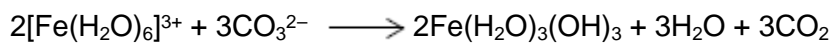
Mark this question independently



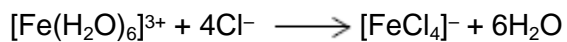
1



1



1



1

[10]