Answer all the questions below as fully as you can then check your answers

1. Which of the following reactions is likely to be the fastest?

a) Rusting of iron

b) Fermentation of sugar

c) A firework exploding

d) Digestion of food

2. Which of the following is NOT a valid way to measure the rate of a reaction?

a) Measuring the change in temperature

b) Measuring the volume of gas produced

c) Measuring the time taken for a colour change

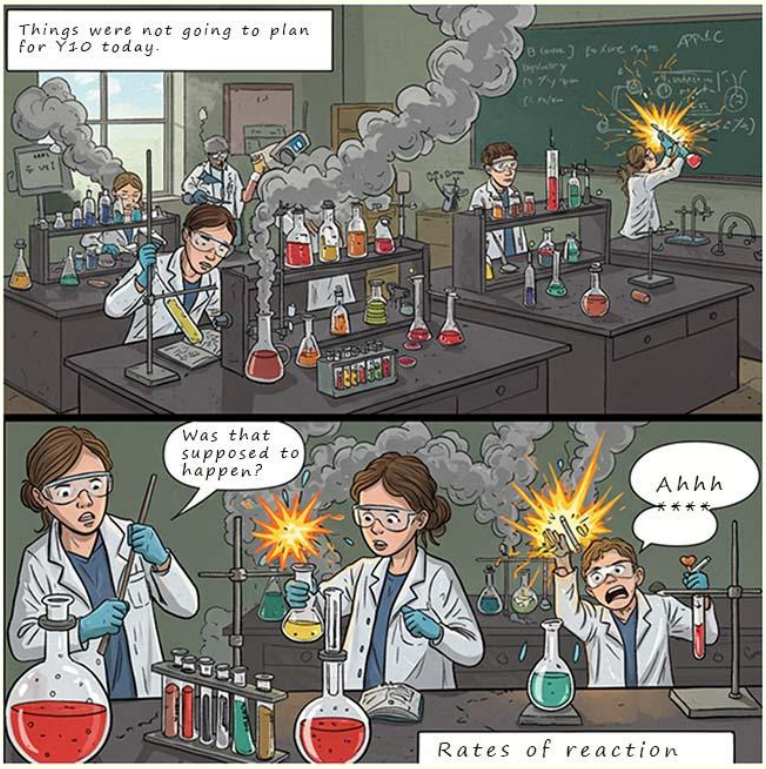
d) Measuring the change in mass

3. The equation below highlights the reaction between calcium carbonate and hydrochloric acid, which product is most easily measured to determine the rate of this reaction?

Calcium carbonate $_{(s)}$ + hydrochloric acid$_{(aq)}$ ⟶ calcium chloride$_{(aq)}$ + carbon dioxide$_{(g)}$ + water$_{(l)}$

a) Calcium chloride b) Water c) Carbon dioxide d) Hydrochloric acid

4. Explain why it's important to be clear about what you are measuring when determining the rate of a reaction.



b. Draw a labelled diagram to show how you could measure the rate of reaction which produces carbon dioxide gas as a product and explain how you would use your apparatus to measure the rate of reaction at regular intervals.

4c. Describe the trend observed in a typical graph of gas volume produced against time for a reaction like the one between calcium carbonate and hydrochloric acid.

5. Why is the mass loss method for measuring reaction rate *not* particularly suitable for a lightweight gas like hydrogen?

6. Explain why timing how long it takes for a cross to disappear in the reaction between sodium thiosulfate and hydrochloric acid is a valid method for measuring the rate of reaction.

7. Compare and contrast the gas syringe method and the inverted measuring cylinder method for measuring the volume of gas released in a reaction. Discuss the advantages and disadvantages of each.

8. A student is investigating the rate of reaction between magnesium and hydrochloric acid. They plan to measure the volume of hydrogen gas produced using hydrochloric acid at different concentrations. Describe an experiment they could carry out, including the apparatus they would use, the measurements they would take, and how they would analyse their results to determine the rate of reaction.

Answers

1. Which of the following reactions is likely to be the fastest?

a) Rusting of iron b) Fermentation of sugar

c) A firework exploding d) Digestion of food

Answer: c) A firework exploding

2. Which of the following is NOT a valid way to measure the rate of a reaction?

a) Measuring the change in temperature

b) Measuring the volume of gas produced

c) Measuring the time taken for a colour change

d) Measuring the change in mass

Answer: a) Measuring the change in temperature

3. The equation below highlights the reaction between calcium carbonate and hydrochloric acid, which product is most easily measured to determine the rate of this reaction?

$$\text{Calcium carbonate}_{(s)} + \text{hydrochloric acid}_{(aq)} \longrightarrow \text{calcium chloride}_{(aq)} + \text{carbon dioxide}_{(g)} + \text{water}_{(l)}$$

a) Calcium chloride b) Water c) Carbon dioxide

d) Hydrochloric acid

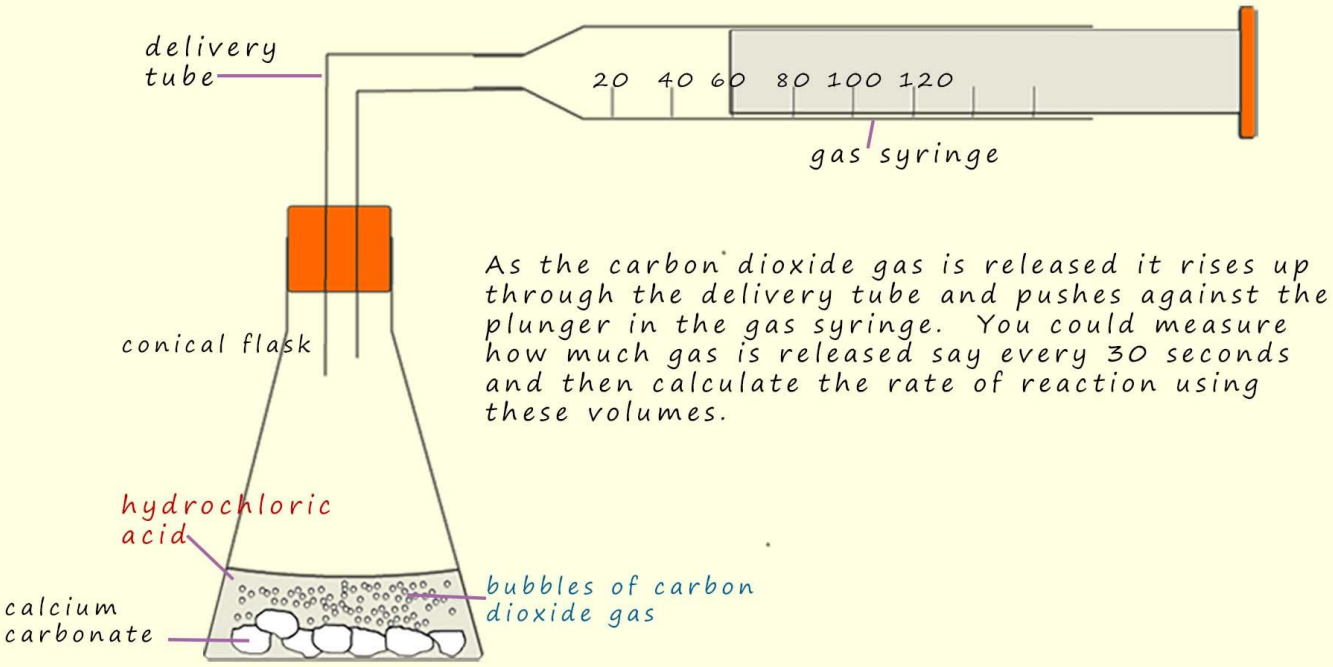
Answer: c) Carbon dioxide- use a gas syringe to measure the volume of Co_2 released over a certain period of time.

4. Explain why it's important to be clear about what you are measuring when determining the rate of a reaction.

Answer: The rate of reaction can be determined by measuring the consumption of reactants or the production of products. It's crucial to specify which one is being measured because different methods are suitable for different substances.

b. Draw a labelled diagram to show how you could measure the rate of reaction which produces carbon dioxide gas as a product and explain how you would use your apparatus to measure the rate of reaction at regular intervals.

Answer: Set-up the apparatus shown below.



To measure the rate of reaction record the volume of gas released every 30s and work out the rate using the equation:

Rate of reaction = volume of gas released/time

So in this example the time will always be 30s but the volume of gas released will change as the reaction proceeds. Reactions are usually quick to begin with but slow down as the amount of reactants available decrease as they are turned into products.

4c. Describe the trend observed in a typical graph of gas volume produced against time for a reaction like the one between calcium carbonate and hydrochloric acid.
Answer: The graph typically shows a steep initial rise in gas volume, indicating a fast reaction rate. As time progresses, the gradient of the line decreases, showing that the rate of reaction is slowing down. Eventually, the line becomes flat, indicating that the reaction has stopped.

5. Why is the mass loss method for measuring reaction rate *not* particularly suitable for a lightweight gas like hydrogen?

Answer: The mass change due to the release of a lightweight gas like hydrogen would be too small to measure accurately, making the results unreliable.

6. Explain why timing how long it takes for a cross to disappear in the reaction between sodium thiosulfate and hydrochloric acid is a valid method for measuring the rate of reaction.

Answer: The cross disappears because of the formation of solid sulfur, which makes the solution cloudy (turbid). The faster the sulfur forms, the faster the reaction. Therefore, the time taken for the cross to disappear is inversely proportional to the rate of reaction.

7. Compare and contrast the gas syringe method and the inverted measuring cylinder method for measuring the volume of gas released in a reaction. Discuss the advantages and disadvantages of each.

Answer: Both methods measure the volume of gas produced. The gas syringe is more accurate and directly measures the volume. However, it can be more expensive. The inverted measuring cylinder is simpler and cheaper but less accurate, as gas can dissolve in the water, especially for very soluble gases. It is unsuitable for gases highly soluble in water.

8. A student is investigating the rate of reaction between magnesium and hydrochloric acid. They plan to measure the volume of hydrogen gas produced using hydrochloric acid at different concentrations. Describe an experiment they could carry out, including the apparatus they would use, the measurements they would take, and how they would analyse their results to determine the rate of reaction.

Answer: The student could use a gas syringe connected to a conical flask containing magnesium and hydrochloric acid, similar to the one used above in Q4b. They would record the volume of hydrogen gas collected in the syringe at regular intervals (e.g., every 30 seconds). The experiment would be repeated and an average would be worked out from the collected volumes. This would help identify any anomalous results produced.

The student would repeat the experiment using the same sized pieces/mass of magnesium ribbon in the same volume of acid and ensure that the acid is at the same temperature. These are all control variables.

At least 5 different concentrations of acid could be used, not to dilute so that the reaction is so slow and not to concentrated so that it is over so quickly that there is an inadequate time left to record the results. Possible concentrations for the acid could be: 0.5, 0.75, 1.0, 1.5, 2.0M

The rate of reaction would be worked out using the equation:

Rate of reaction = volume of gas released/time

They would then plot a graph of gas volume against time.