Rate of Decomposition of Metal Carbonates

Concepts:

Metal carbonates, kinetics of decomposition, rate of reaction

Use the following recommendations to increase and/or decrease the challenge difficulty for your students.

Short-on-time Inquiry Lab:

The purpose of this short inquiry lab is to explore and compare the thermal decomposition of various metal carbonates at high temperatures. Students will qualitatively compare the rate of thermal decomposition of several metal carbonates, and will speculate about their differences in thermal stability.

Guided Inquiry Lab:

The purpose of this guided inquiry lab is to explore the kinetics of thermal decomposition of various metal carbonates at high temperatures. In Part I, students will qualitatively compare the rate of thermal decomposition of several metal carbonates. In Part II, they will measure the initial rate of thermal decomposition of a metal carbonate. Copper(II) carbonate will generate carbon dioxide gas as a decomposition product, hence special equipment is provided to collect and measure the volume of gas generated. The initial rate of reaction will be determined by graphical analysis of the results.

Open Inquiry Lab:

The purpose of this open inquiry lab is to explore the kinetics of thermal decomposition of various metal carbonates at high temperatures. In Part I, students will qualitatively compare the rate of thermal decomposition of several metal carbonates. In Part II, they will measure the initial rate of thermal decomposition of one of the metal carbonates. The metal carbonate will generate carbon dioxide gas as a decomposition product, hence special equipment is provided to collect and measure the volume of gas generated. The initial rate of reaction will be determined by graphical analysis of the results.

Advanced Inquiry Lab:

The purpose of this advanced inquiry lab is to explore the kinetics of thermal decomposition of various metal carbonates at high temperatures. In Part I, students will qualitatively compare the rate of thermal decomposition of several metal carbonates. In Part II, they will measure the initial rate of thermal decomposition of one of the metal carbonates. The metal carbonate will generate carbon dioxide gas as a decomposition product, hence special equipment is provided to collect and measure the volume of gas generated. The initial rate of reaction will be determined by graphical analysis of the results.

Outcomes:

Students will observe that sodium carbonate and potassium carbonate do not decompose under the conditions of temperature applied in this experiment. In contrast, calcium carbonate and copper carbonate will undergo appreciable thermal decomposition, and will emit carbon dioxide as a result. The released carbon dioxide will cause the limewater solution to turn cloudy due to formation of calcium carbonate upon reaction with calcium hydroxide in solution. In Part II of the guided, open, or advanced versions, students will measure the amount of carbon dioxide released when a sample of one of the metal carbonates is exposed to high temperatures as a function of time. Graphical analysis of the results will show that carbon dioxide production levels off over time, and the initial rate of thermal decomposition of the metal carbonate will be estimated from the linear portion of the graph.

Associated Phenomena:

Fast and Slow Processes

Standards

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing explanations and designing solutions Using mathematics and computational thinking	HS-PS1.B. Chemical Reactions	Patterns Energy and Matter in Systems

Performance Expectations

HS-PS1-5: Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.

HS-PS1-7: Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.