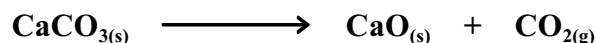


## Designing an Experiment To Measure The Enthalpy Change of a Reaction

Design an experiment to measure the enthalpy change for the following reaction:



### Introduction:

In the chemical industry, before any reaction is performed, the engineers use the specific heats of formation of the substances involved to predict the heat that will be absorbed or released in the reaction. The design of the reaction vessels must include heating or cooling technology to maintain the optimum reaction temperature to control the rate of the reaction. Hence, a knowledge of specific heats of formation, Hess's Law, and heats of reaction is necessary for efficient industrial chemical productions.

Hess's Law is a powerful chemical principle used to predict the heats of a reaction by subtracting the sum of the standard heats of formation of the reactants from the sum of the standard heats of formation of the products. However, sometimes it is difficult or even impossible to determine the enthalpy of a reaction directly. In these situations, an indirect method employing calorimetry and Hess's Law can be used.

### Prelab Assignment

1. From the introduction, formulate a problem statement. Explain if you expect the reaction to be endothermic or exothermic?
2. State the manipulated variables and list the controlled variables.
3. List the equipment and materials necessary.
4. Write an equation for the reaction of marble chips,  $\text{CaCO}_{3(s)}$ , with  $\text{HCl}_{(aq)}$ .
5. Write an equation for the reaction of  $\text{CaO}_{(s)}$  with  $\text{HCl}_{(s)}$ .
6. Use standard enthalpy of formation from Data Book to determine  $\Delta H$  for reaction 4 and reaction 5 above.
7. Determine a combination of the equations 4 and 5 above to yield the equation for the decomposition of  $\text{CaCO}_{3(s)}$ . Determine the enthalpy for this reaction from those calculated in 6 above.

### Procedure

You will be provided with  $\text{CaCO}_{3(s)}$ ,  $\text{CaO}_{(s)}$ , and 2M  $\text{HCl}_{(aq)}$ .

Determine the quantities of reagents required for the reactions necessary. Clearly state which reagent is in excess, showing all your calculations.

Prepare a suitable data table for each part of your reaction.

### Data Analysis

Use Hess's Law to determine the enthalpy for the decomposition of  $\text{CaCO}_{3(s)}$ .

Having determined the theoretical value for this reaction in the Prelab Assignment 7 above, calculate the percent error of the result obtained by you in this experiment.

List some sources of error, and therefore, modifications to the lab in order to reduce these errors.

### Extension

If a student had used (a)  $\text{CaCO}_{3(s)}$  powder, (b) 6M  $\text{HCl}_{(aq)}$ , (c) or heated the 2M  $\text{HCl}$  to 60 °C in reaction 4 of the Prelab Assignment, explain how each of these factors may have affected her results.

Explain how would you measure  $\Delta H$  for the following reaction:

