

Experiment 25

Calorimetry

Andy Warhol



A set of nested coffee cups is a good constant pressure calorimeter.

- To determine the specific heat of a metal
- To determine the enthalpy of neutralization for a strong acid–strong base reaction
- To determine the enthalpy of solution for the dissolution of a salt

OBJECTIVES

The following techniques are used in the Experimental Procedure:

TECHNIQUES



Accompanying all chemical and physical changes is a transfer of heat (energy); heat may be either evolved (exothermic) or absorbed (endothermic). A **calorimeter** is the laboratory apparatus that is used to measure the quantity and direction of heat flow accompanying a chemical or physical change. The heat change in chemical reactions is quantitatively expressed as the **enthalpy (or heat) of reaction**, ΔH , at constant pressure. ΔH values are negative for exothermic reactions and positive for endothermic reactions.

INTRODUCTION

Three quantitative measurements of heat are detailed in this experiment: measurements of the specific heat of a metal, the heat change accompanying an acid–base reaction, and the heat change associated with the dissolution of a salt in water.

ΔH values are often expressed as J/mol or kJ/mol

The energy (heat, expressed in joules, J) required to change the temperature of one gram of a substance by 1°C is the **specific heat**¹ of that substance:

Specific Heat of a Metal

$$\text{specific heat} \left(\frac{J}{g \cdot ^\circ C} \right) = \frac{\text{energy } (J)}{\text{mass } (g) \times \Delta T (^\circ C)} \quad (25.1)$$

or, rearranging for energy,

$$\text{energy } (J) = \text{specific heat} \left(\frac{J}{g \cdot ^\circ C} \right) \times \text{mass } (g) \times \Delta T (^\circ C) \quad (25.2)$$

ΔT is the temperature change of the substance. Although the specific heat of a substance changes slightly with temperature, for our purposes, we assume it is constant over the temperature changes of this experiment.

The specific heat of a metal that does not react with water is determined by (1) heating a measured mass of the metal, M , to a known (higher) temperature; (2) placing it into a measured amount of water at a known (lower) temperature; and (3) measuring the final equilibrium temperature of the system after the two are combined.

¹The specific heat of a substance is an intensive property [independent of sample size], as are its melting point, boiling point, density, and so on.

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Katrin Zwirgmaier



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