

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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Table of Contents Chemistry Lab Manual Beran Experiment 25 Answers

1. Understanding the eBook Chemistry Lab Manual Beran Experiment 25 Answers
 - The Rise of Digital Reading Chemistry Lab Manual Beran Experiment 25 Answers
 - Advantages of eBooks Over Traditional Books
2. Identifying Chemistry Lab Manual Beran Experiment 25 Answers
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Chemistry Lab Manual Beran Experiment 25 Answers
 - User-Friendly Interface
4. Exploring eBook Recommendations from Chemistry Lab Manual Beran Experiment 25 Answers
 - Personalized Recommendations
 - Chemistry Lab Manual Beran Experiment 25 Answers User Reviews and Ratings

- Chemistry Lab Manual Beran Experiment 25 Answers and Bestseller Lists
- 5. Accessing Chemistry Lab Manual Beran Experiment 25 Answers Free and Paid eBooks
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 - Chemistry Lab Manual Beran Experiment 25 Answers Budget-Friendly Options
- 6. Navigating Chemistry Lab Manual Beran Experiment 25 Answers eBook Formats
 - ePub, PDF, MOBI, and More
 - Chemistry Lab Manual Beran Experiment 25 Answers Compatibility with Devices
 - Chemistry Lab Manual Beran Experiment 25 Answers Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Chemistry Lab Manual Beran Experiment 25 Answers
 - Highlighting and Note-Taking Chemistry Lab Manual Beran Experiment 25 Answers
 - Interactive Elements Chemistry Lab Manual Beran Experiment 25 Answers
- 8. Staying Engaged with Chemistry Lab Manual Beran Experiment 25 Answers
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Chemistry Lab Manual Beran Experiment 25 Answers
- 9. Balancing eBooks and Physical Books Chemistry Lab Manual Beran Experiment 25 Answers
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Chemistry Lab Manual Beran Experiment 25 Answers
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Chemistry Lab Manual Beran Experiment 25 Answers
 - Setting Reading Goals Chemistry Lab Manual Beran Experiment 25 Answers
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Chemistry Lab Manual Beran Experiment 25 Answers
 - Fact-Checking eBook Content of Chemistry Lab Manual Beran Experiment 25 Answers
 - Distinguishing Credible Sources

13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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