

Solids and Liquids—Preface

You don't have to know any chemistry to appreciate the beautiful crystalline structures of minerals and gems or to enjoy the cool relief of an ocean breeze. However, the properties of solids and liquids provide a mirror for us to "see inside" the world of atoms and molecules—to understand the motion of molecules and to compare the interactions among different types of molecules. The properties of solids and liquids offer persuasive and convincing evidence for the kinetic-molecular theory, the most important model for explaining the physical properties of matter. The purpose of *Solids and Liquids*, Volume 11 in the *Flinn ChemTopic™ Labs* series, is to provide high school chemistry teachers with laboratory activities that will help students explain and predict the properties of solids and liquids. Five experiments and six demonstrations allow students to investigate phase transitions, identify the accompanying energy changes, and recognize the underlying influence of attractive forces between molecules.

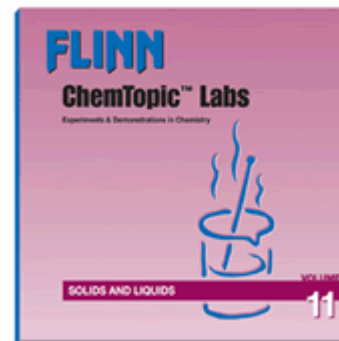
Energy and Phase Changes

Reversible phase changes involving solids and liquids include melting and freezing, evaporation and condensation, and sublimation. In the experiment "It's Just a Phase," students measure heating and cooling curves for lauric acid, a low-melting organic solid, identify the melting point, and interpret the energy changes that accompany solid-liquid phase changes. A quantitative adaptation of this experiment is used in the "Hot Wax" demonstration to determine the amount of heat required to melt a solid. The experiment "How Cool Is That?" looks at the "next" transition in the series, that from liquid to gas. Students measure the temperature changes that occur when different liquids evaporate and analyze the "cooling effect of evaporation" in terms of the existence of intermolecular forces. The ultimate cooling effect of evaporation is observed in the demonstration "Freezing by Boiling." Boiling a liquid at reduced pressure makes it cold enough to freeze—freezing and boiling occur simultaneously! All three phases, solid, liquid, and gas, are also observed simultaneously in the demonstration "Wet Dry Ice," an amazingly simple way to show the triple point of carbon dioxide.

Intermolecular Forces

The properties of solids and liquids depend on the nature and strength of intermolecular attractive forces between molecules. Nowhere is this more evident than in the structure and properties of water. Hydrogen bonds, the strongest type of intermolecular forces, give water its unique properties. In "Properties of Liquids," students observe the "forceful" effects of surface tension in water and compare the capillary

action and surface tension of water versus other liquids. The "Surface Tension Jar" demonstration provides an alternative way to illustrate this interesting phenomenon.



Kinetic-Molecular Theory

The kinetic-molecular theory may be summarized in one simple phrase—molecules in motion. See the "Tennis Ball Distillation" activity for a great way to explain solid-liquid phase changes in terms of this important theory. A tub-full of tennis balls is a perfect demonstration device for comparing the energy and motion of molecules in the solid, liquid, and gas phases. Visualizing molecules in motion also helps explain why different liquids have different vapor pressures at the same temperature and why the vapor pressure of a liquid always increases as the temperature increases. In the experiment "Vapor Pressure of Water," students determine the vapor pressure of water at different temperatures by measuring the volume of "wet air" as a function of temperature. Students can also learn about vapor pressure by examining the chemical principles at work in two popular toys, the drinking bird and the hand boiler. "Teaching with Toys" reminds us all of something we may have forgotten in growing up—that learning is indeed child's play!

Safety and Success!

Chemistry is an experimental science! Depend on Flinn Scientific to give you the information and confidence you need to work safely with your students and help them succeed. As your safer source for science supplies, Flinn Scientific promises you the most reliable safety information for every potential lab hazard. Whether you are looking for an updated classic or a creative simulation, our labs offer you safe solutions and practical alternatives. The selection of experiments and demonstrations in *Solids and Liquids* gives you the ability to design an effective lab curriculum that will work with your students and your resources in your classroom. Best of all, no matter which activities you choose, your students are assured of success. All of the activities in *Solids and Liquids* have been thoroughly tested and retested. You know they will work! Use the experiment summaries and concepts on the following pages to locate the concepts you want to teach and to choose experiments and demonstrations that will help you meet your goals.

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