

ARISE Curriculum Guide

Chemistry: Topic 10—States of Matter

ChemMatters

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Articles for Student Use

- Artificial Snow: Powder for the Slopes: Dec. 2000, pp. 10-11.
An Atomic Tour: Oct. 1983, pp. 4-7.
Breakfast of Crystals: Oct. 1983, pp. 8-12.
The Case of the Missing Caffeine: April 1999, pp. 12-13.
Cooking with Steam: Feb. 1987, pp. 17-19.
How Dense is It? Feb. 2002, p. 10.
The Fizz-Keeper: Does it Really Keep the Fizz? Feb. 2002, pp. 11-13.
Hot and Cold Packs: Feb. 1987, pp. 7-11.
Making Ice Cream: Dec. 1995, pp. 4-7.
Maple Syrup. Sweet Sap Boils Down to This: Feb. 2002, pp. 8-9.
Matches. Striking Chemistry at Your Fingertips: *ChemMatters*, Dec. 2002, pp. 14-16.
Memory Metal: Oct. 1993, pp. 4-7.
Polywater: Dec. 1987, pp. 10-13.
Saint's Blood: Feb. 1993, pp. 12-15.
Scuba: The Chemistry of an Adventure: Feb. 2001, pp. 7-9.
Silly Putty: April 1986, pp. 15-19.
A Supercritical Clean Machine: April 2000, pp. 14-15.

Articles for Teacher Use

Number and Topic: 1. Matter and Change
6. Chemical Names and Formulas/Compounds and Elements
8. Chemical Reactions
10. Phases, Solids, Liquids and Gases (States of Matter)
11. Thermochemistry,

Source: *ChemMatters*, Dec. 2002, pp. 14-16, "Matches. Striking Chemistry at Your Fingertips"

Type of Material: Student Journal Article

Building on: Chemical names and formulas/compounds and elements, chemical reactions and thermochemistry

Leading to: Reaction rates, redox reactions

Links to Physics: Matter, energy, thermodynamics, heat

Links to Biology:

Good Stories: Entire article is a "good story"

Activity Description: Article describes the history of the development of the common match, covering early matches and their inherent weaknesses and dangers. Good review of chemical equations and/or a review or introduction to redox reactions.

Number and Topic: 1. Matter and Change (Classification of Matter)
10. Phases, Solids, Liquids and Gases (States of Matter)
16. Covalent Bonds, Molecular Shapes and Intermolecular Forces,
17. Water, Aqueous Solutions

Source: *ChemMatters*, Dec. 1987, pp. 10-13, "Polywater"

Type of Material: Student Journal Article

Building on: Basic properties of water

Leading to: Discovery of "polywater" and how its existence was disproved

Links to Physics: Density, spectra

Links to Biology:

Good Stories: Entire article is a "good story."

Activity Description: This article relates the story behind the discovery of "polywater." It goes into the evidence for its existence, the excitement and hype that accompanied its reported discovery, the enthusiastic acceptance of its existence by some scientists versus the skepticism of others, and how its existence was eventually disproved. Although the article contains a lot of science content and information about the properties of water, its greatest value may very well lie in its exposition of the fact that at times science may take a wrong turn; it includes self-correcting features that work strongly towards correcting errors and arriving at the truth.

Number and Topic: 2. Measurement
10. Phases, Solids, Liquids and Gases (States of Matter)
Source: *ChemMatters*, Feb. 2002, p. 10, "How Dense is It?"
Type of Material: Activity
Building on: Measurement, density
Leading to: More of a review
Links to Physics: Measurement, density
Links to Biology:
Good Stories:
Activity Description: Students make and calibrate a hydrometer to determine the relative densities of solutions.

Number and Topic: 4. Atomic Structure
6. Chemical Names and Formulas/Compounds and Elements
10. Phases, Solids, Liquids and Gases (States of Matter)
12. Gases/Gas Laws/Kinetic Theory
16. Covalent Bonds, Molecular Shapes and Intermolecular Forces
17. Water, Aqueous Solutions
Source: *ChemMatters*, Oct. 1983, pp. 4-7, "An Atomic Tour"
Type of Material: Student Journal Article
Building on: Basic knowledge of atomic and molecular structures
Leading to: Modeling, molecular motions, Boltzmann's distribution, composition of air, structure of water, polarity, hydrogen bonds, structure of ice
Links to Physics:
Links to Biology:
Good Stories:
Activity Description: This article, written by the late Isaac Asimov, takes the reader on an imaginary journey where he/she becomes smaller and smaller until he/she can see individual atoms and molecules. The article goes on to describe several molecular structures and motions.

Number and Topic: 6. Chemical Names and Formulas/Compounds and Elements
10. Phases, Solids, Liquids and Gases (States of Matter)
17. Water, Aqueous Solutions
21. Organic Chemistry
Source: *ChemMatters*, Dec. 1995, pp. 4-7, "Making Ice Cream"
Type of Material: Student Journal Article and Activity
Building on: Basic chemical knowledge of molecular structures
Leading to: Colloids, lipids, emulsifiers, sugars, colligative properties
Links to Physics:
Links to Biology: Food, lipids, proteins
Good Stories: Relates the history of ice cream and some government regulations regarding the labeling of the product.
Activity Description: Article discusses the composition of ice cream and the science behind its preparation and ends with a student activity to make home-made ice cream.

Number and Topic: 8. Chemical Reactions
10. Phases, Solids, Liquids and Gases (States of Matter)
Source: *ChemMatters*, Feb. 1993, pp. 12-15, "Saint's Blood"
Type of Material: Student Journal Article and Activity
Building on: Chemical Reactions, phases and phase changes
Leading to: Discussion of thixotropic mixtures and an activity designed to prepare one
Links to Physics:
Links to Biology:
Good Stories: Tells the story of Saint Januarius' feast in Naples, Italy, when a vial holding what is purported to be the clotted blood of Saint Januarius is displayed, moved and turns to a liquid.
Activity Description: The article explains why the "blood" is almost certainly not human blood, but rather a thixotropic mixture that can be prepared in the lab and probably was prepared by an early alchemist.

Number and Topic: 8. Chemical Reactions
10. Phases, Solids, Liquids and Gases (States of Matter)
11. Thermochemistry
17. Water, Aqueous Solutions
Source: *ChemMatters*, Feb. 1987, pp. 7-11, "Hot and Cold Packs"
Type of Material: Student Journal Article and Activity
Building on: Chemical reactions
Leading to: Thermodynamics of the dissolving process
Links to Physics: Thermodynamics, heat, energy, entropy
Links to Biology:
Good Stories:
Activity Description: Article discusses both "hot packs" and "cold packs" and how they utilize both chemical reactions and simple crystallization to either release heat or absorb heat from their surroundings.

Number and Topic: 10. Phases, Solids, Liquids and Gases (States of Matter)
17. Water, Aqueous Solutions
Source: *ChemMatters*, Feb. 2002, pp. 8-9, "Maple Syrup. Sweet Sap Boils Down to This"
Type of Material: Student Journal Article
Building on: Phases, phase changes
Leading to: Colligative properties, boiling points vs. concentration
Links to Physics: Matter, energy
Links to Biology: Plants, photosynthesis, food, energy flow
Good Stories:
Activity Description: Article describes how maple syrup is made. It elucidates the science involved along with why maple syrup comes in different grades and how the grade is related to how rapidly and at what temperature the sap is evaporated and the point at which the syrup is harvested from the evaporating sap.

Number and Topic: 10. Phases, Solids, Liquids and Gases (States of Matter)
17. Water, Aqueous Solutions

Source: *ChemMatters*, Feb. 2002, pp. 11-13, "The Fizz-Keeper: Does it Really Keep the Fizz?"

Type of Material: Student Journal Article and Activities

Building on: Gases, Water, aqueous solutions

Leading to: Gas solubility, Henry's Law

Links to Physics:

Links to Biology:

Good Stories: Commercial products often make invalid claims based upon questionable science

Activity Description: A commercial product called a "Fizz-Keeper" claims to be able to keep opened bottle of carbonated beverages from going flat. It basically doesn't work, and the article clearly goes through the scientific principles that explain why it wouldn't be expected to work. The article also contains some student activities.

Number and Topic: 10. Phases, Solids, Liquids and Gases (States of Matter)
12 Gases/Gas Laws/Kinetic Theory
17. Water, Aqueous Solutions

Source: *ChemMatters*, Feb. 2001, pp. 7-9, "Scuba: The Chemistry of an Adventure"

Type of Material: Student Journal Article

Building on: States of matter, density, gases, water

Leading to: Heat capacity, refraction, Henry's Law

Links to Physics: Refraction, motion and forces

Links to Biology: Ecosystems

Good Stories: Author relates her personal experiences while learning how to Scuba dive.

Activity Description: Article relates the author's experiences while Scuba diving and then tries to explain the scientific reasons behind the phenomena, for example, why submerged objects appear to be closer or why colors fade.

Number and Topic: 10. Phases, Solids, Liquids and Gases (States of Matter)

Source: *ChemMatters*, Dec. 2000, pp. 10-11, "Artificial Snow: Powder for the Slopes"

Type of Material: Student Journal Article

Building on: States of matter

Leading to: Thermodynamics

Links to Physics: Matter, energy, kinetic theory, thermodynamics, heat, entropy

Links to Biology:

Good Stories:

Activity Description: Article describes how artificial snow is made and the scientific principles that underlie its creation.

Number and Topic: 10. Phases, Solids, Liquids and Gases (States of Matter)
Source: *ChemMatters*, April 2000, pp. 14-15, "A Supercritical Clean Machine"
Type of Material: Student Journal Article
Building on: States of matter
Leading to: Phase diagrams, specifically that of carbon dioxide and properties of polar and nonpolar materials, especially the "like dissolves like" concept
Links to Physics:
Links to Biology: Reducing the emission of toxic substances into the environment
Good Stories:
Activity Description: Article discusses the use of supercritical carbon dioxide for dry cleaning clothes. It includes a discussion of the phase diagram of carbon dioxide, what "supercritical" really means, and why supercritical carbon dioxide might be effective for dry cleaning.

Number and Topic: 10. Phases, Solids, Liquids and Gases (States of Matter)
17. Water, Aqueous Solutions
21. Organic Chemistry
Source: *ChemMatters*, April 1999, pp. 12-13, "The Case of the Missing Caffeine"
Type of Material: Student Journal Article
Building on: Phases, organic chemistry, aqueous solutions
Leading to: Phase diagrams
Links to Physics:
Links to Biology:
Good Stories:
Activity Description: Article discusses caffeine, its structure and presence in various beverages. It goes on to explain different methods by which caffeine can be extracted from a beverage. This leads to a discussion of the phase diagram of carbon dioxide and what is meant by the term "supercritical" fluid.

Number and Topic: 4. Atomic Structure
10. Phases, Solids, Liquids and Gases (States of Matter)
15. Ionic and Metallic Bonds
Source: *ChemMatters*, Oct. 1993, pp. 4-7, "Memory Metal"
Type of Material: Student Journal Article
Building on: Atomic structure, phases
Leading to: Crystal structures
Links to Physics: Matter
Links to Biology: Medical applications of nitinol metal
Good Stories: How nitinol metal was used to repair shoulder problems in Los Angeles Dodgers pitcher Orel Hershiser.
Activity Description: Article deals with Nitinol metal, the "memory" metal that returns to any shape that it was initially set in upon heating—even if it has been twisted or bent into a completely different shape. Article explains why this amazing phenomenon occurs and also shows several practical uses of this unusual property.

Number and Topic: 10. Phases, Solids, Liquids and Gases (States of Matter)

Source: *ChemMatters*, Feb. 1987, pp. 17-19, "Cooking with Steam"

Type of Material: Student Journal Article and Activities

Building on: Basic knowledge about boiling

Leading to: A more sophisticated discussion of the energetics involved in phase changes

Links to Physics: Energy, heat

Links to Biology:

Good Stories:

Activity Description: Article discusses the scientific principles involved in steaming things such as vegetables, focusing on the energetics involved in the transformation of a liquid to a gas at its boiling point.

Number and Topic: 10. Phases, Solids, Liquids and Gases (States of Matter)
16. Covalent Bonds, Molecular Shapes and Intermolecular Forces
21. Organic Chemistry

Source: *ChemMatters*, April 1986, pp. 15-19, "Silly Putty"

Type of Material: Student Journal Article

Building on: Basic chemical knowledge

Leading to: Elastomers, dilatancy

Links to Physics: Forces; why silly putty will stretch if pulled slowly but snap if pulled quickly

Links to Biology:

Good Stories: How the material from which Silly Putty is made was considered just a laboratory curiosity until a person observing it just for fun saw its potential as a children's toy.

Activity Description: This article discusses Silly Putty. It explains its unusual properties and relates these properties to its molecular structure.

Flinn ChemTopic Labs

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Activity: Breakfast of Crystals

Activity: Hot and Cold Packs

Activity: How Dense is It?

Activity: Making Ice Cream

Activity: Saint's Blood

Demo: Aloha Chemical Sunset—Colloids and Light Scattering

Demo: Solutions, Colloids, and Suspensions—Principles and Properties

Lab: Energy Changes - Heat of Fusion

Lab: Heat of Vaporization of Liquid Nitrogen

Lab: Separation by Distillation

ICE LABS

[Online Descriptions and Experiments](#)

Number and Topic:	10. States of Matter
Source:	ICE Laboratory Leadership
Type of Material:	Lab 16. Heat of Vaporization of Liquid Nitrogen
Building on:	1. Matter and Change
Leading to:	11. Thermochemistry
Links to Physics:	Energy
Links to Biology:	Heat transfer is an important part of many biological reactions.
Good Stories:	
Activity Description:	To determine the heat energy needed to vaporize (boil) one gram of liquid nitrogen. Nitrogen, the major component of air, is a gas at room temperature with the formula N_2 (g). It can be stored in its liquid form in a specially insulated bottle called a Dewar flask. In this laboratory activity, you will determine the energy needed to vaporize (boil) liquid nitrogen by letting a known mass interact with warm water. The energy given up by the warm water will cause the nitrogen to boil until it is completely converted to gaseous nitrogen. This energy is called the heat of vaporization.

Technology-Adapted Labs

Number and Topic:	10. Phases, Solids, Liquids and Gases (States of Matter)
Source:	Vernier: Chemistry with Computers <i>ChemCom</i> , Fourth Edition, Unit III, Section A, Lab Activity A.2, p. 178. Bill Grosser, Glenbard South High School
Type of Material:	Lab: Separation by Distillation
Building on:	Organic chemistry, fractional distillation, polar substances and non-polar substances.
Leading to:	Heat of vaporization.
Links to Physics:	Energy transfers
Links to Biology:	Polarity and partial polarity are important concepts in understanding the behavior of many biomolecules.
Good stories:	This is a great time to discuss how fractional distillation is used in the petroleum industry to separate fractions in crude oil.
Activity Description:	In this lab students are given a mixture of two liquids and asked to separate and identify the liquids based on boiling points and reaction with iodine.
Technology:	We do this lab using Vernier probes in our technology lab. Students become very actively engaged with the data as it is graphed on the screen as the distillation takes place. This is also a good model to show how resources such as Vernier's prepared labs can be modified to fit with other curriculum. Vernier provides all their labs as Word documents that can be modified by the teacher. The original Vernier lab and the modified lab are both attached to this write-up.