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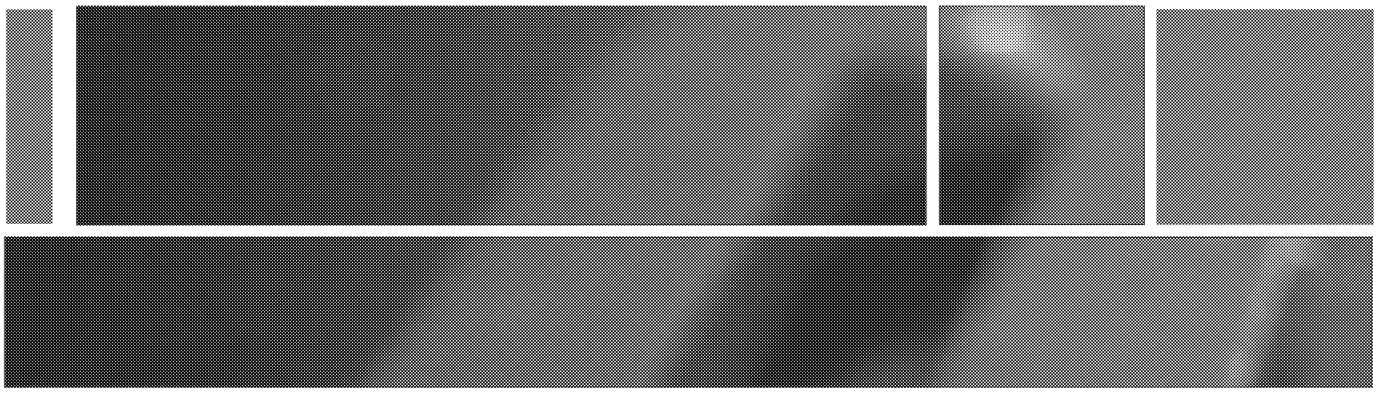
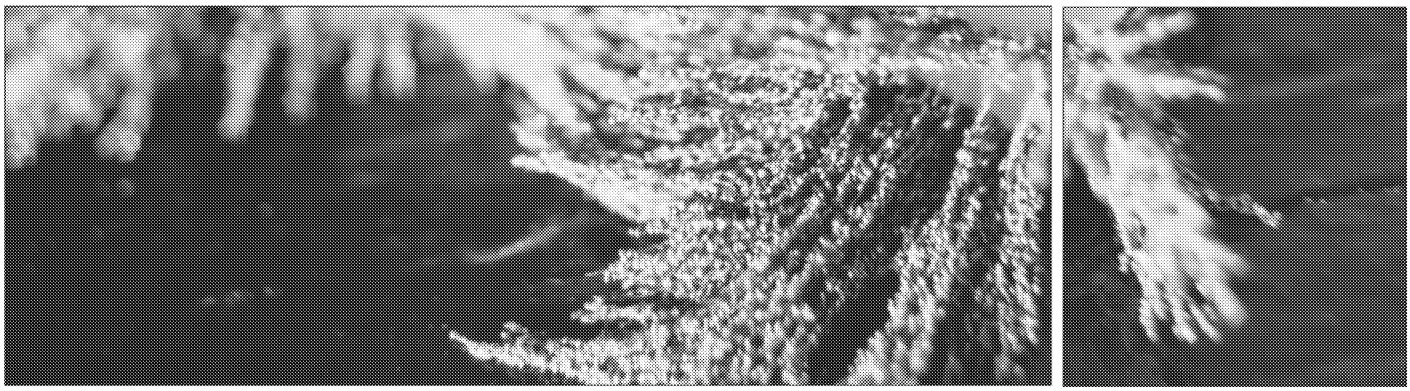
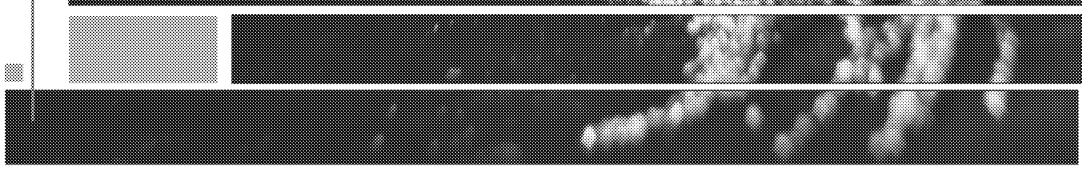
EASY Science Demos & Labs

Physics







Thomas Kardos

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Preface

As a middle school teacher, many times I found myself wishing for a quick and easy demonstration to illustrate a word, a concept, or a principle in science. Also, I often wanted a brief explanation to conveniently review basics and additional information without going to several texts.

This book is a collection of many classroom demonstrations. Explanation is provided so that you can quickly review key concepts. Basic science ideas are hard to present on a concrete level; the demonstrations fill that specific need. You will also find 10 specially created laboratory activities for middle school students that are safe enough for young people to do on their own. These labs add a deeper level of understanding to the demonstrations.

An actual teacher demonstration is something full of joy and expectation, like a thriller with a twist ending. Keep it that way and enjoy it! Try everything beforehand.

We need to support each other and leave footprints in the sands of time. Teaching is a living art. Happy journey! Happy sciencing!

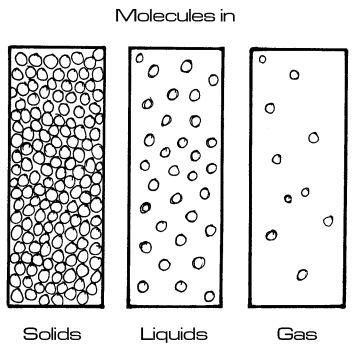
—Thomas Kardos

Suggestions for Teachers

1. A • (bullet) denotes a demonstration. Several headings have multiple demonstrations.
2. **Materials:** Provides an accurate list of materials needed. You can make substitutions and changes as you find appropriate.
3. Since many demonstrations will not be clearly visible from the back of the room, you will need to take this into account as part of your classroom management technique. Students need to see the entire procedure, step by step.
4. Some demonstrations require that students make observations over a short period of time. It is important that students observe the changes in progress. One choice is to videotape the event and replay it several times.
5. Some demonstrations can be enhanced by bottom illumination: Place the demonstration on an overhead projector and lower the mirror so that no image is projected overhead.
6. I use a 30-cup coffeepot in lieu of an electric hot plate, pans, and more cumbersome equipment to heat water for student experiments and to perform many demonstrations.
7. As the metric system is the proper unit of measurement in a science class, metric units are used throughout this book. Where practical, we also provide the U.S. conventional equivalent.
8. Just a few demonstrations may appear difficult to set up, for they have many parts. Be patient, follow the listing's steps, and you will really succeed with them.

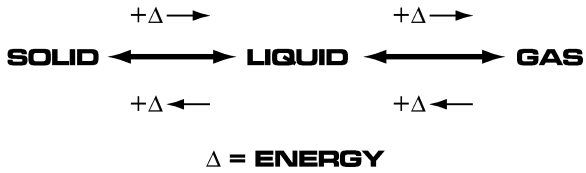
Demo 8
Kinetic Molecular Theory: States of Matter

The kinetic molecular theory explains how matter behaves and how it changes from one state into another. Molecules in **solids** are held quite closely together by molecular bonds. All molecules vibrate. If heat energy is added, the molecules move faster and farther apart, until they begin to slide over each other. At this point, the solid has changed into a **liquid.** If more energy is added, some molecules escape from the surface of this loose bond in the liquid and begin to move even farther apart. The new state of these escaping molecules is **gas.** If energy is removed, a gas changes into a liquid and a liquid changes into a solid. These are the phases (states) of matter.



Materials: ice cubes, ice cube tray, water, freezer

- Take several ice cubes and let them melt in a glass until they change into water. Ice cubes melt, for heat energy *is added.*
- Fill an ice cube tray with water and place in a freezer. Water, a liquid, becomes a solid. Heat energy *has been removed.* Changes of states are reversible.



Materials: three identical 10-inch-long boxes, clear plastic wrap, masking tape, 15 marbles

- Remove the tops of the boxes and modify two of them to be 5 inches and 7 inches long. The boxes will represent molecules in solid, liquid, and gaseous states. Place 5 marbles in each and cover them with transparent plastic wrap. Tape the wrap. Have students shake the 5-inch box. Then have them shake the 7-inch box a bit harder and the 10-inch box even harder. The behavior of the marbles resembles the behavior of molecules in matter.

(continued)

Materials: coffeepot, water

- Take a coffeepot, fill it partially with water, and let it warm. Make certain that its lid is in place. After the water has warmed up (in electric units a warning light goes on or off), lift the lid and let students observe how water is forming drops on the top of the lid. Have them observe the whitish cloud coming up from the pot. They will call it steam, but it is not. Steam is invisible. What they are seeing is the water vapor that forms as the invisible steam cools down and condenses into many tiny water droplets that look white. The lid, a little bit cooler than the air inside the coffeepot, also condenses gaseous water and forms water droplets. This is why water drips off the lid when you uncover the coffeepot or any other cooking pot.

Materials: a glass or two, several ice cubes, insulated container

- Place a glass in an insulated container and place several ice cubes around the glass. Let the glass become chilled. Take the glass out and show the class how it frosts. This frost is the **condensation** of water in the air. The molecules of water condense since the glass is colder than the environment.

1. Assessing Laboratory Reports

This book contains 10 student laboratory assignments, for which students should be expected to produce written reports. Go over what you want to see in a lab report with your students before they start. Information should include:

- **Purpose**: Why is this lab being performed? What is the objective of the lab?
- **Hypothesis:** Given the initial level of knowledge, what do students expect for an outcome and why?
- **Materials list:** Students should be told that one of the main reasons for writing lab reports is so that others can replicate the lab. A well-organized materials list makes it easier for a reader to understand the lab, and makes redoing the experiment much easier as well.
- **Procedure:** Likewise, a student should include each step of the procedure that the lab partners or group actually followed.
- **Data:** What events or measurements were observed in the lab? In physics, observations of changes in states of matter, as well as quantifications of findings, are all very important.
- **Conclusion:** What were the results? What were the limitations? Did a student's hypothesis match the data? If something went wrong, what does the student think happened?

(continued)

14. Units: Conversions and Constants

From	To	× By
Acres	Square feet	43,560
Acres	Square meters	4,046.8564
Acre-feet	Cubic feet	43,560
Avogadro's number	6.02252×10^{23}	
Barrel (US dry)	Barrel (US liquid)	0.96969
Barrel (US liquid)	Barrel (US dry)	1.03125
Bars	Atmospheres	0.98692
Bars	Grams/square centimeter	1,019.716
Cubic feet	Acre-feet	2.2956841×10^{-5}
Cubic feet	Cubic centimeters	28,316.847
Cubic feet	Cubic meters	0.028316984
Cubic feet	Gallons (US liquid)	7.4805195
Cubic feet	Quarts (US liquid)	29.922078
Cubic inches	Cubic centimeters	16.38706
Cubic inches	Cubic feet	0.0005787037
Cubic inches	Gallons (US liquid)	0.004329004
Cubic inches	Liters	0.016387064
Cubic inches	Ounces (US liquid)	0.5541125
Cubic inches	Quarts (US liquid)	0.03463203
Cubic meters	Acre-feet	0.0008107131
Cubic meters	Barrels (US liquid)	8.386414
Cubic meters	Cubic feet	35.314667
Cubic meters	Gallons (US liquid)	264.17205
Cubic meters	Quarts (US liquid)	1,056.6882
Cubic yards	Cubic centimeters	764,554.86
Cubic yards	Cubic feet	27
Cubic yards	Cubic inches	46,656
Cubic yards	Liters	764.55486
Cubic yards	Quarts (US liquid)	807.89610
Days (mean solar)	Days (sidereal)	1.0027379
Days (mean solar)	Hours (mean solar)	24
Days (mean solar)	Hours (sidereal)	24.065710
Days (mean solar)	Years (calendar)	0.002739726
Days (mean solar)	Years (sidereal)	0.0027378031
Days (mean solar)	Years (tropical)	0.0027379093
Days (sidereal)	Days (mean solar)	0.99726957
Days (sidereal)	Hours (mean solar)	23.93447
Days (sidereal)	Hours (sidereal)	24
Days (sidereal)	Minutes (mean solar)	1,436.0682

(continued)

A

absolute frame of reference: the now-outdated idea that motion is not relative; that velocity can be measured specifically

acceleration: the rate at which an object's velocity changes with time; the change may be in speed, or direction, or both.

acceleration due to gravity: the acceleration of a free-falling object; its value near the earth's surface is 9.8 m/s/s.

amplitude: for a wave or a vibration, the maximum displacement on either side of the equilibrium, or midpoint of the wave

angle of incidence: the angle at which light strikes a surface

angle of reflection: the angle at which light is reflected from a surface; angles of incidence and reflection are always the same, hence, the equation, "The angle of incidence is equal to the angle of reflection."

Archimedes' principle: An immersed object, submerged or floating, is buoyed up by a force equal to the weight of fluid displaced.

B

Bernoulli's principle: Pressure of a fluid on a surface decreases as the fluid's velocity relative to the surface increases.

block and tackle: a series of pulleys that reduces the effort needed to lift a weight

Brownian motion: random movement of microscopic particles suspended in liquids or gases resulting from the impact of molecules of the fluid surrounding the particles

buoyancy: the degree to which an object floats in a liquid

C

calorie: energy required to raise the temperature of one gram of water one degree C

cathode ray oscilloscope (CRO): a scientific instrument that is used to read fluctuations in an electrical quantity as a sine wave

closed system: a system that has no energy release or input, and in which entropy increases; the universe is believed to be a closed system.

coherent: Wave fronts that remain in phase; a laser is an example of a coherent light source.

compression: the region of increased pressure in a longitudinal wave

condensation: the change of state from gas to liquid

conductor: material that conducts heat or electricity

conservation of momentum: principle that the amount of momentum within a system remains constant, even when the system undergoes change

constant: a number never known to vary, or a section of an experiment kept the same while other things change to test for a particular principle

constructive interference: superimposition of waves in which the waves reinforce one another

cosmic ray: one of a variety of high-speed particles that travels through the universe, and has its origins in a supernova

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