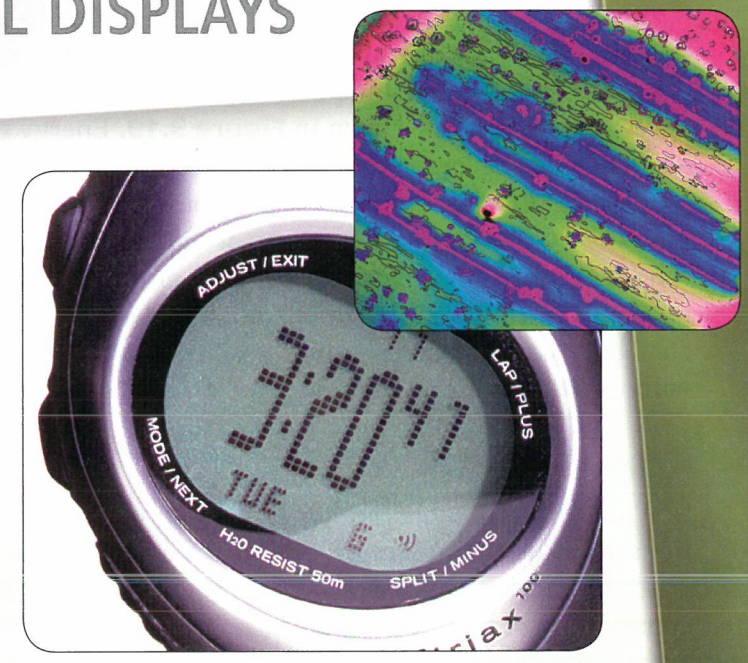
EARTH SCIENCE AND TECHNOLOGY

LIQUID CRYSTAL DISPLAYS

You wake up in the morning, glance at your alarm clock, and get ready for school. You microwave your breakfast, grab your music player and dash out the door, checking your wristwatch as you go. Once at school, you pull out your calculator and get ready for the big math exam. Did you know you have used liquid crystal display (LCD) technology five times already? LCD is common display technology, used often because it is thin, lightweight, and energy efficient.



Digital watch displays are made possible through LCD technology. The inset photograph shows a polarized light micrograph of a LCD.

What is a liquid crystal? You know that liquids and crystals are two states of matter; but how is it possible to be both a liquid and a crystal? Recall that particles in a liquid can slide past each other in a container, while particles in a solid are packed together and cannot move separately. Liquid crystals are long molecules that keep their orientation—if they were oriented side-to-side in a thin layer on a glass plate, they would keep that side-to-side orientation. Because of their liquid property, the crystals can move around almost like a school of fish. Therefore, they share characteristics with both solids and liquids. This unique property makes them useful for a variety of electronic applications.

How do LCDs work? Consider a digital watch, for example. If you look closely at it, you can see the numbers, even when they are not darkened. These are the tracks that are engraved in the middle layer of a display "sandwich." Two plates of glass make up the outer portion of this sandwich. The inner portion of the sandwich, the tracks, contains liquid crystals that are in their natural, "relaxed" state. In the relaxed state, light passes through the plates of glass, and is reflected out.

If an electric current is applied across a track of liquid crystals, the crystals lose their original orientation. As long as a small current passes through them, light entering the plates of glass will not be reflected. In other words, that track will appear black.

Seems simple enough, right? That is why LCD displays are becoming more and more popular. They can be all black or color. There are, however, some flaws with LCD technology that need to be corrected. For example, it has a narrow viewing angle; if you tilt your watch slightly you can no longer see the numbers as clearly, if at all. With further research, however, LCD might just become the vision of the future.

WRITING in Earth Science

Diagram Visit glencoe.com to research the different layers of an LCD. Create a drawing showing all the different layers and how they fit together.

GEOLAB

PRECIPITATE SALTS

Background: **Many rocks on Earth form from salts precipitated from seawater. Salts precipitate when a salt solution becomes saturated. Solubility is the ability of a substance to dissolve in a solution. When a solution is saturated, no more of that substance can be dissolved.**

Question: *Under what conditions do salt solutions become saturated, and under what conditions does salt precipitate out of solution?*

Suggested materials

Materials

halite (sodium chloride)
250-mL glass beakers (2)
distilled water
plastic wrap
laboratory scale
hot plate
shallow glass baking dish
refrigerator
glass stirring rod

Safety Precautions

Procedure

1. Read and complete the lab safety form.
2. Make a data table to record your observations.
3. Pour 150 mL of distilled water into a 250-mL glass beaker. Add 54 g of sodium chloride and stir until only a few grains remain on the bottom of the beaker.
4. Place the beaker on the hot plate, and turn on the hot plate. Stir the solution until the last few grains of sodium chloride dissolve. The salt solution will then be saturated.
5. Pour 50 mL of the warm, saturated solution into the second 250-mL glass beaker, and cover it with plastic wrap so that it forms a seal. Put this beaker in the refrigerator.
6. Pour 50 mL of the saturated solution into the glass baking dish. Place the dish on the hot plate and heat the salt solution until all the liquid evaporates. **WARNING:** ***The baking dish will be hot. Handle with care.***
7. Place the original beaker with 50 mL of the remaining solution on a shelf or windowsill. Do not cover the beaker.
8. Observe both beakers one day later. If crystals have not formed, wait another day.
9. Once crystals have formed in all three containers, observe the size and shape of the crystals. Write your observations in your data table.

Analyze and Conclude

1. **Describe** the shape of the precipitated crystals in the three containers. Does the shape of the crystals alone identify them as sodium chloride?
2. **Infer** how heating the salt solution affected the solubility of the sodium chloride.
3. **Interpret** what effect cooling has on the solubility of salt. What effect does evaporation have on the solubility of salt?
4. **Evaluate** the relationship between rate of cooling and crystal size.

INQUIRY EXTENSION

Use Other Substances Design an experiment to investigate other soluble substances. Test to see how much of the substance can be dissolved in a given amount of water, how long it takes for the solution to evaporate, and what crystal shapes form. Prepare a short report to share with your class.

CHAPTER 3

Study Guide

STUDY TO GO

Download quizzes, key terms, and flash cards from glencoe.com.

BIG Idea The variety of substances on Earth results from the way that atoms are arranged and combined.

Section 3.1 Matter

Vocabulary

- atomic number (p. 62)
- electron (p. 61)
- element (p. 60)
- ion (p. 64)
- isotope (p. 62)
- mass number (p. 62)
- matter (p. 60)
- neutron (p. 60)
- nucleus (p. 60)
- proton (p. 60)

Key Concepts

MAIN Idea Atoms are the basic building blocks of all matter.

- Atoms consist of protons, neutrons, and electrons.
- An element consists of atoms that have a specific number of protons in their nuclei.
- Isotopes of an element differ by the number of neutrons in their nuclei.
- Elements with full outermost energy levels are highly unreactive.
- Ions are electrically charged atoms or groups of atoms.

Section 3.2 Combining Matter

Vocabulary

- acid (p. 71)
- base (p. 72)
- chemical bond (p. 67)
- chemical reaction (p. 70)
- compound (p. 66)
- covalent bond (p. 67)
- ionic bond (p. 68)
- metallic bond (p. 68)
- molecule (p. 67)
- solution (p. 71)

Key Concepts

MAIN Idea Atoms combine through electric forces, forming molecules and compounds.

- Atoms of different elements combine to form compounds.
- Covalent bonds form from shared electrons between atoms.
- Ionic compounds form from the attraction of positive and negative ions.
- There are two types of mixtures—heterogeneous and homogeneous.
- Acids are solutions containing hydrogen ions. Bases are solutions containing hydroxide ions.

Section 3.3 State of Matter

Vocabulary

- condensation (p. 75)
- crystalline structure (p. 73)
- evaporation (p. 74)
- glass (p. 73)
- plasma (p. 74)
- sublimation (p. 75)

Key Concepts

MAIN Idea All matter on Earth and in the universe occurs in the form of a solid, a liquid, a gas, or plasma.

- Changes of state involve thermal energy.
- The law of conservation of matter states that matter cannot be created or destroyed.
- The law of conservation of energy states that energy is neither created nor destroyed.