Liquid Crystal Sheets

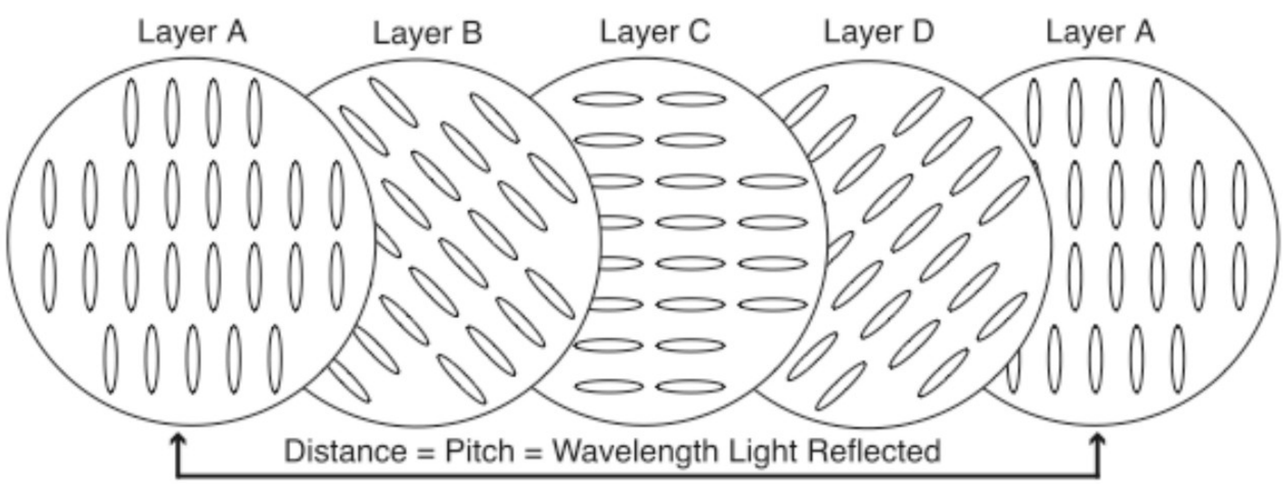
LC-2025B, LC-2530B, LC-3035B, LC-ASTX

Why do liquid crystals change color with temperature?

The long, cigar-shaped molecules of a liquid crystal align themselves into orderly flat planes. The molecules in each flat plane are oriented at a slight angle from the molecules in the plane below it. Eventually, as the stack builds up and each layer is offset by a slight twisting from the one below it, two layers will have the same orientation. The distance between these two aligned layers is called the **pitch**.

When white light is directed at this stack of molecules, the wavelength of light equal to this pitch distance is reflected back. At cold temperatures, the pitch is far apart—red light is reflected back. At higher temperatures, the molecules move faster and the layers twist more, causing the pitch to become shorter—reflecting blue light.

Each liquid crystal has only a few degrees of temperature where the organization is such that light is reflected back. On either side of this temperature range, all light is absorbed and the liquid crystal appears black.



NGSS Correlations

Our Liquid Crystal Sheets and these lesson ideas will support your students' understanding of these Next Generation Science Standards (NGSS):

Elementary

2-PS1-1
Students can use Liquid Crystal Sheets to plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

2-PS1-4
Students can use Liquid Crystal Sheets to collect data to construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.

4-PS3-2
Students can use Liquid Crystal Sheets to make observations to provide evidence that energy can be transferred from place to place by heat currents.

Middle School

MS-PS3-3
Students can use Liquid Crystal Sheets s to apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.

MS-PS3-4
Students can use Liquid Crystal Sheets for an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.

DCI-MS/PS3.A: Definitions of Energy.
The temperature is a measure of the average kinetic energy of particles of matter. The Liquid Crystal Sheets creates a beautiful thermal print when acted on by an object, such as your hand. Each color represents a different temperature.

High School

HS-PS3-4
Students can use Liquid Crystal Sheets to plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (Second Law of Thermodynamics).

Suggested Science Idea(s)

4-PS3-2
Students can place their hand on the Liquid Crystal Sheets to observe the transfer of heat energy to the surface of the temperature sensitive material. Each color represents a different temperature.

MS-PS3-3
Each color represents a different temperature as students test a device that either minimizes or maximizes thermal energy transfer. There are three temperature ranges of sheets available for investigations.

MS-PS3-4
Students can use the Liquid Crystal Sheets for an investigation to determine the relationships among the energy transferred by different objects.

HS-PS3-4
Students can use the Liquid Crystal Sheets for an investigation to determine the relationships among the energy transferred by different objects.

Teacher Demonstration: THERMOCLINE

Have you ever swam in a lake, pond, or ocean and been able to feel an obvious temperature difference in the water? That line of temperature change is called a "thermocline." A thermocline is the transition layer between warmer water and cooler water. The Liquid Crystal sheets can be used to demonstrate this layer in a visually memorable way.

1. Using two rubber bands, fasten a Liquid Crystal sheet (LC-2530B, 25-30 degrees) to the side of a water bottle.
2. Pour ice cold water into the water bottle until it is half full. (The colder the better—near freezing is best.)
3. Ensure that the water level in the water bottle is about halfway up the Liquid Crystal sheet. You should be able to see a difference in the color on the Liquid Crystal sheet.
4. Using a hot plate, stove or some other heating device, bring some water to a near boil.
5. **Carefully and slowly** pour the hot water into the water bottle. You should see a SIGNIFICANT difference in color on the sheet. The obvious line between the cold water and the hot water is the thermocline.*

NOTE: Because this is a small water sample, the cold and hot water will mix rather quickly. The thermocline will not be obvious very long, but it should be observable. The larger the water sample is, the longer the thermocline will be visible using the Liquid Crystal sheets—especially if you are careful to add the hot water gently.

* The warm/cold water will sort separately because of the difference in density. (Warm on top, cold on bottom)

Class Activity 1: INVISIBLE/VISIBLE HANDPRINT

1. Place your warm hand, palm side down, directly on a tabletop. (The cooler the tabletop, the better.) Press down for 30 seconds or more—long enough to warm up the surface.
2. Remove your hand when you are satisfied that it has transferred some heat to the tabletop. Can you see your handprint? (You shouldn't be able to.)
3. Now remove the backing off the Liquid Crystal sheet, and place the sheet on the table where your hands were. Can you see your handprint now?
4. Does the Liquid Crystal sheet seem to detect temperature changes more quickly in one gender or is the reaction time approximately the same for both male students and female students? What can you infer?

Class Activity 2: LIGHT EFFICIENCY

Nearly all light sources give off more than just light—they also give off heat. Of course, the amount of heat varies greatly from one light source to another. Generally, the less heat given off by a light source, the more efficient it is considered. Conduct this experiment to determine which light source is most efficient and which is least efficient.

1. Collect several different kinds of light sources (such as an incandescent bulb, a CFL bulb, an LED, etc. If you use a candle, please take extra precautions.)
2. Place your light source on a table.
3. Using masking tape, tape a straight line on the table, starting from the light source and extending approximately one foot.
4. Measure and mark every four inches (4", 8", 12").
5. Before you test your first light source, develop a hypothesis: which source do you think will give off the most heat?
6. Tape the Liquid Crystal sheet to the end of a straight edge. What to use as a straight edge will depend on the height of your light source. You will need to place one end of the straight edge on the table, while the Liquid Crystal sheet is the same height as the light source.
7. Starting at the 12" mark, hold the straight edge so that it is perpendicular to the table. Note any change you see in the color of the Liquid Crystal sheet.
8. After that observation has been made, move the sheet to the 8" mark.
9. Take note of any change.
10. Next, move the sheet to the 4" mark.
11. Again, take note of any change.
12. Finally, move the sheet so that it is right next to the light source—but not touching it. Do not allow the sheet to stay next to the light source for more than a few seconds.
13. Take note of any change.
14. Repeat steps 7-13 with the same light source two more times to confirm that you get the same results.
15. Now try a different light source and repeat steps 7-13 with the same Liquid Crystal sheet. Continue with as many light sources as you have collected.
16. When you are done, examine your data and compare the results.
17. Draw a conclusion based on the data you have collected. Is there a way you could have controlled variables better?

18. Can you design your own experiment using the Liquid Crystal sheets?

Class Activity 3: INSULATORS vs. CONDUCTORS

1. Collect two pieces of material—one Styrofoam, and one metal. Each piece should be the size of your Liquid Crystal sheet.
2. Place the Styrofoam piece under the Liquid Crystal sheet.
3. Place your hand on the sheet for 15-20 seconds.
4. Start a timer as soon as you raise your hand.
5. Stop the timer when Liquid Crystal sheet returns to its normal, black state. Record how long it took.
6. Repeat steps 3-5 two more times.
7. Using a piece of metal, repeat steps 2-6.
8. Find the average of all times and compare the data.
9. Draw a conclusion based on the data you have collected.

Class Activity 4: COLD vs. HOT

1. Place an ice cube on one side of the Liquid Crystal sheet.
2. In an area close to the ice cube, press two or three fingers upon the Liquid Crystal sheet.
3. Leave both the ice cube and your fingers in place for 10-20 seconds.
4. Remove both the ice cube and your fingers and observe the differences in the appearance of the two sides of the Liquid Crystal sheet.
5. Now place your whole hand over the Liquid Crystal sheet and leave it there until the entire sheet has changed color.
6. Now place an ice cube over the center of the sheet. Watch the sheet change back to black from the center out.
7. After the sheet has returned to black, place it a few inches away from your mouth, and exhale slowly. Watch the warm air leaving your body changes the color of the Liquid Crystal sheet.

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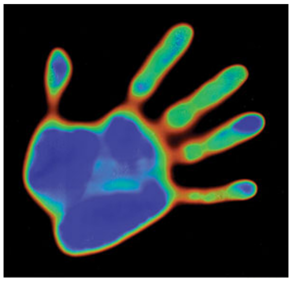


Touch and See Square (SS-900)

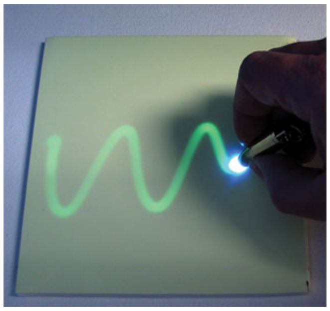
Place your hand on this black plastic square and create a beautiful thermal hand print. Each color represents a different temperature. Can be used over and over again. A great addition to your Science Table.

Heat Sensitive Paper

Our thermochromic paper changes color within the temperature range of 31°C (88°F) to 37°C (98°F). As the paper is held in your warm hands, the color will begin to change or disappear. As it cools, it changes back. The cycle repeats itself indefinitely.

Heat Sensitive Pencils (MO-7)

These unique pencils will tell you that 'you're getting warmer' as you make your point. These thermochromic pencils will actually change color with the heat from your hand! Excellent motivational prizes or a sure-fire way to guarantee your students won't lose their pencils. 25 pencils in assorted colors.



Write & See Squares (SS-910)

Move the violet light on the yellow vinyl square and observe the brightly glowing trail. Blue light has enough energy to excite the phosphorescent pigment in the vinyl. The excited pigment then slowly releases energy as green light. Red Light does not have enough energy to affect the pigment. Contains a mounted sheet of phosphorescent vinyl (~15 cm x 15 cm) and an incredible violet PhotonLight LED flashlight on a key-chain ring.