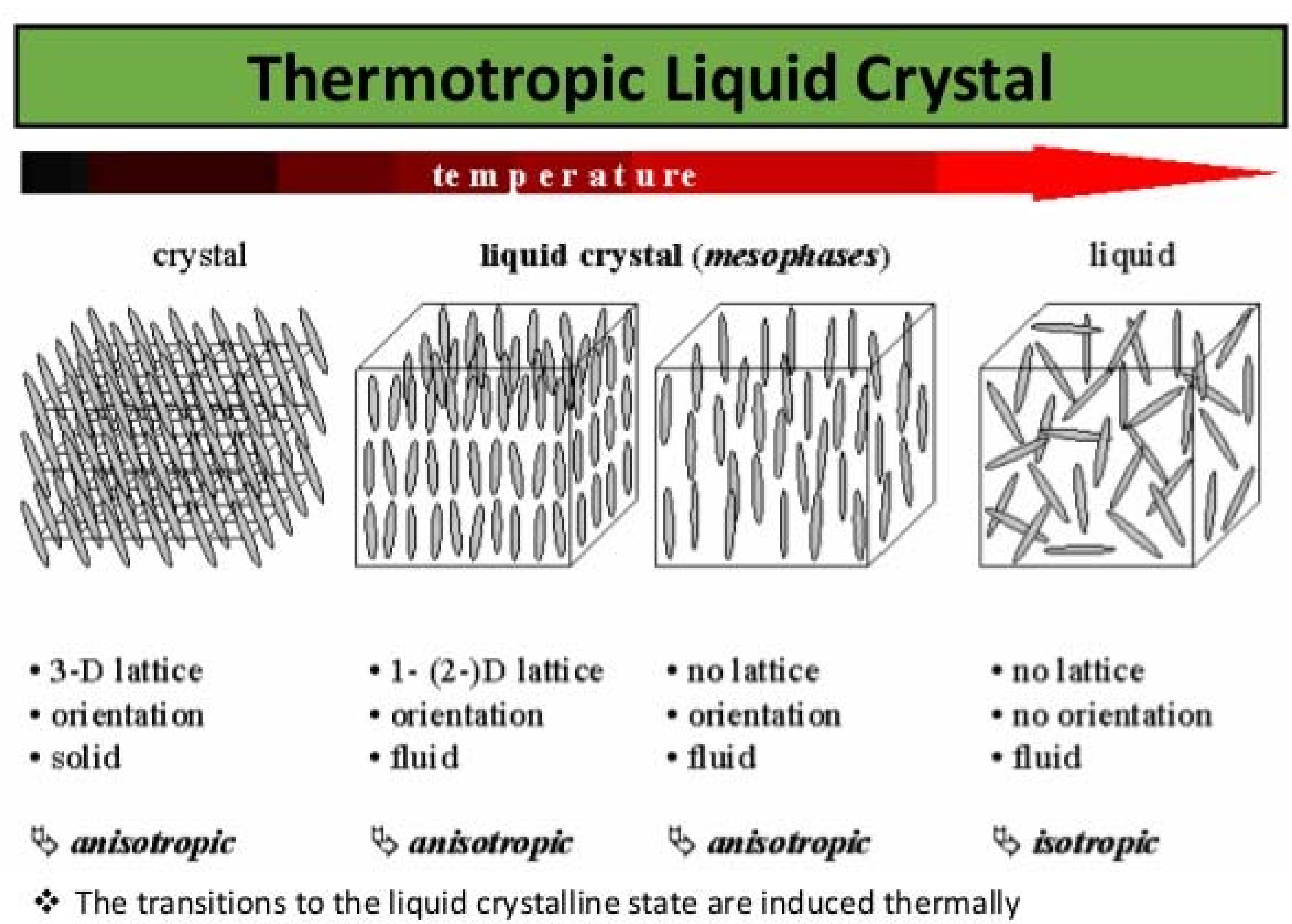
STATION 3

Solids, liquids and gases are the three states of matter that are most familiar to us. Actually, another state of matter, the mysterious dark matter, is much more prevalent in our Universe. Even in our solar system, most of the matter is a 4th state of matter called plasma that makes up the sun and stars. There is even another state of matter that most of us see everyday called a liquid crystal state. In a very simplistic way, liquid crystals have properties intermediate between the solid and liquid states. This exhibit will give you several experiences with the unusual and useful properties of liquid crystals.

Press your hand on the framed sheet of liquid crystal. What do you observe and why?



CONCEPTS - LIQUID CRYSTALS

We should be familiar with a fifth state of matter called a liquid crystalline state. Used in TV and computer monitors as well as many digital readouts (LCD - liquid crystal display), the liquid crystalline state has properties between those of liquids and solids. Liquid crystals are the subject of the first hands-on activity of this exhibit.

A liquid crystal is a state of matter between the liquid and solid (a "mesophase") states. Liquid crystals change shape like liquids but have the molecular alignment characteristics of a solid crystal. Liquid crystals are composed of organic, rod-shaped molecules that align in parallel, and the common types used in electronic displays are nematic, cholesteric and smectic. Randomly positioned in parallel, nematic LCs react quickly to electric fields, which is why they are used in the great majority of LCD screens. Meaning "thread" in Greek, nematic LCs are monostable and return to their original alignment when the electric field is removed. Cholesteric LCs are lined up in separate layers that form a spiral (helix). The displays retain their image without power (bistable) but are slower to react to changes than nematic screens. Positioned side-by-side in layers, smectic LCs are bistable with similar attributes as cholesteric LCs. They retain their image without power and are slower to react than nematics. Smectic means "soapy" in Greek. Discovered in the 19th Century In 1888, liquid crystals were identified by Austrian botanist Friedrich Reinitzer and German physicist Otto Lehmann. Studying the cholesterol in carrots using a temperature-controlled polarizing microscope, they noticed that the light passing through the carrot compound (later known as "cholesteryl benzoate") exhibited the refraction effect of a solid crystal when heat was applied. By 1907, Germany-based Merck was selling "liquid and flowing crystal" chemicals.
Read more at:
http://www.yourdictionary.com/liquid-crystal#GqDpKad9tJIBhzAz.99

Station 3 - Answers to questions.

From http://www.hallcrest.com/color-change-basics/liquid-crystal-thermometers

The temperature-sensitive elements contain TLC molecules that are very sensitive to temperature and change position / twist in relation to changes in temperature. This change in molecular structure affects the wavelengths of light that are absorbed and reflected by the liquid crystals, resulting in an apparent change in the color of each temperature event.

When the rated temperature of an indicator is reached the TLC molecules twist slightly causing the TLC substance to absorb the red and blue portions of the visible light and reflect the green part. This causes the temperature event to appear green. When the temperature decreases, the molecules begin to twist in the opposite direction, and the TLC reflect a different portion of the spectrum.

From http://www.explainthatstuff.com/thermochromic-materials.html

As their name suggests, liquid crystals are a bit like solids in some respects and liquids in others. The ones we're interested in are in a form known as nematic, in which the molecules are arranged a bit like matches in a box - in layers and roughly pointing the same way. Shine some light on nematic liquid crystals and some of it will reflect back again in a type of reflection known as iridescence - the same phenomenon that makes colors from the scales on a butterfly's wing, the grooves on an old-fashioned LP record, or the surface of a soap bubble.
Simply speaking, incoming light waves reflect off nearby crystals and add together by a process called interference, which produces the reflection. The color of the reflected light depends (in a very precise way) on how closely the crystals are together. Heat up or cool down your nematic liquid crystals and you'll change the spacing between them, altering the amount of interference and changing the color of the reflected light from black, through red and all the colors of the spectrum to violet and back to black again. In a nutshell, the liquid crystals look a different color depending on what temperature they are because changes in temperature make them move closer together or further apart (depending on the material).

Materials.
Liquid crystal sheets are available from several suppliers. For a sheet with a foam backing, please check out Educational Innovations. https://www.teachersource.com/product/touch-and-see-square/chemistry