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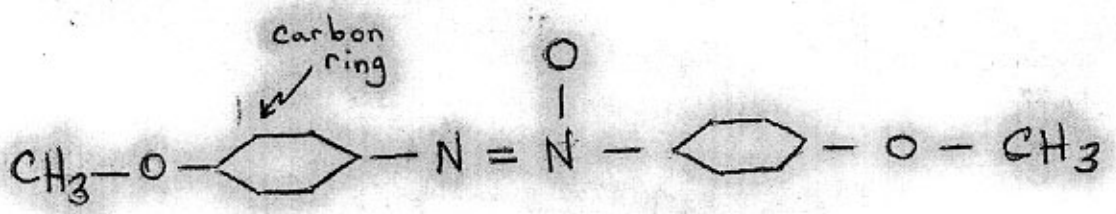
LIQUID CRYSTALS- STRANGE STATES OF MATTER

Components of Liquid Crystals are long, rod-like, organic molecules. Example: p-azoxyanisole (PAA for short). A molecule looks like the following:

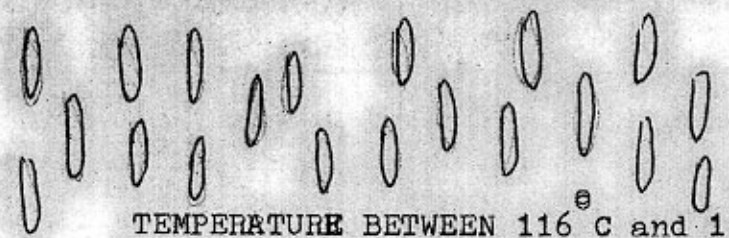


PAA MOLECULE

PAA exists in the nematic liquid crystal state for temperatures between 116° and 136° C. For the temperature greater than 136° C, the long molecules point at random and are arranged in space at random.

TEMPERATURE GREATER THAN 136° C

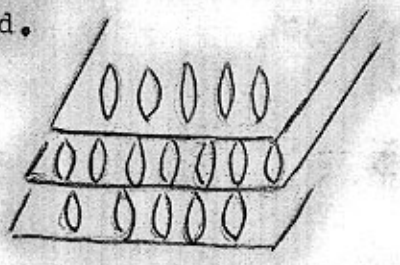
For temperatures between 116° C and 136° C, the long molecules point mostly in one direction but are arranged at random.



TEMPERATURE BETWEEN 116° C and 136° C

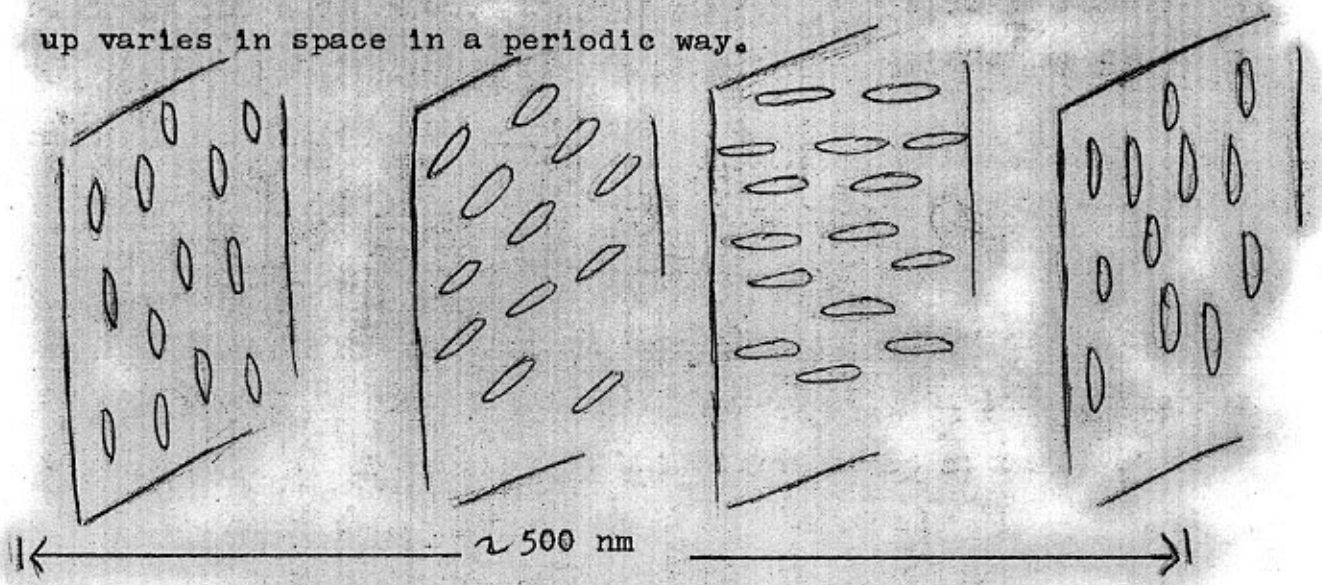
Thus, for 116° temperature 136° C, PAA exhibits a crystalline aspect; a direction is picked out, the direction along which the long molecules point and a liquid aspect; the molecules are arranged in space at random. Hence, the name liquid crystal.

There exist more complicated liquid crystal states. For example, in the Smectic A state the long molecules are arranged in planees and are aligned.



Smectic A Liquid Crystal State

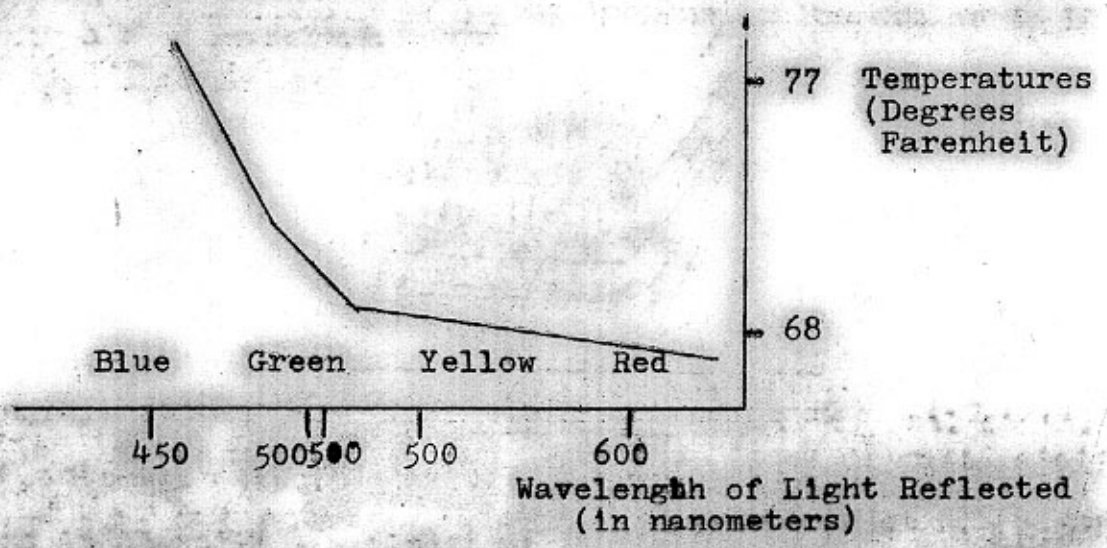
Another liquid state is the Cholesteric liquid crystal state. In this state the direction along which the molecules are lined up varies in space in a periodic way.



Cholesteric Liquid Crystal State

The repeat distance between equivalent planes is comparable to the wave length of visible light. Furthermore, when the wavelength of light is exactly equal to this distance, the

liquid crystal strongly reflects light of this wavelength or color. The repeat distance varies as the temperature is changed. Therefore, the color of the light reflected changes as the temperature changes.



Thus one may make a thermometer by observing how the color of the scattered light changes as the temperature changes.

Suggestions for Classroom Activities

(The liquid crystal sheets used in the demonstrations were obtained from the Edmund Scientific Company)

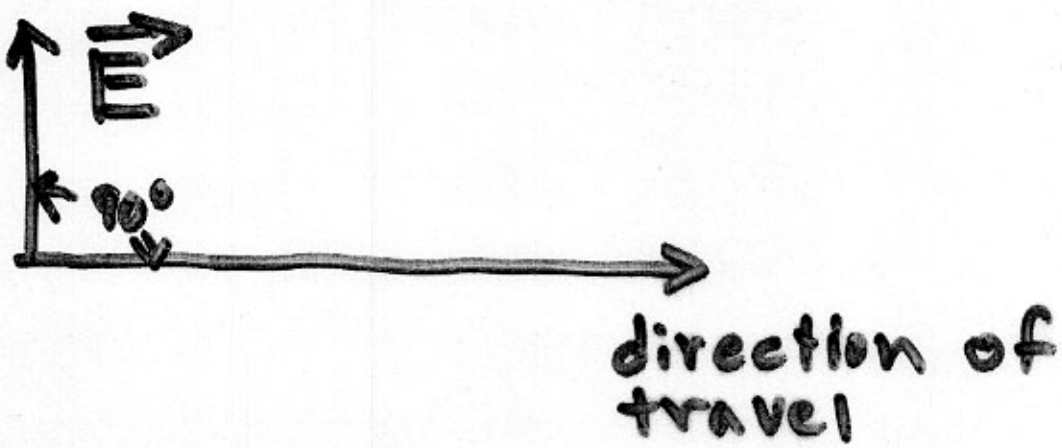
Observe effects of hot and cold on liquid crystals
Observe the effect of a handprint on a liquid crystal
Observe the effect of cooling by evaporation on a liquid crystal

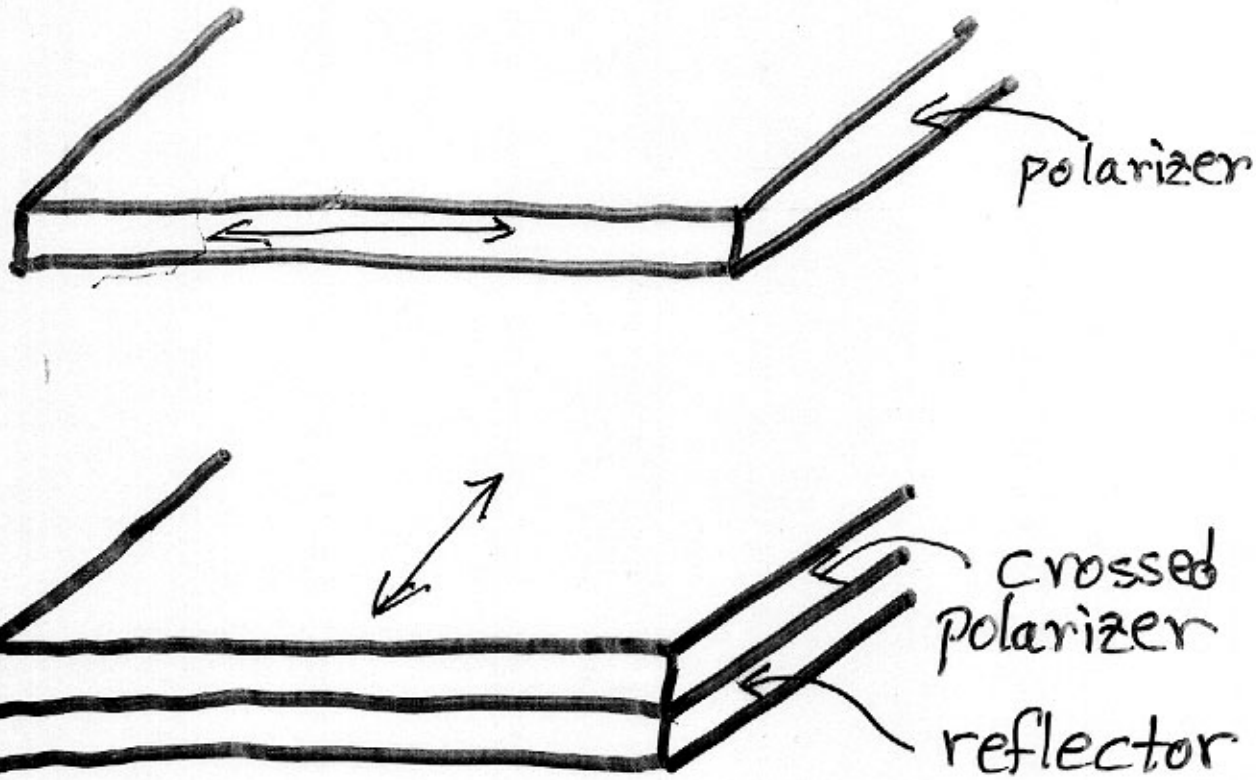
Interpret and discuss these observations in terms of wavelength versus temperature charts provided with liquid crystals.

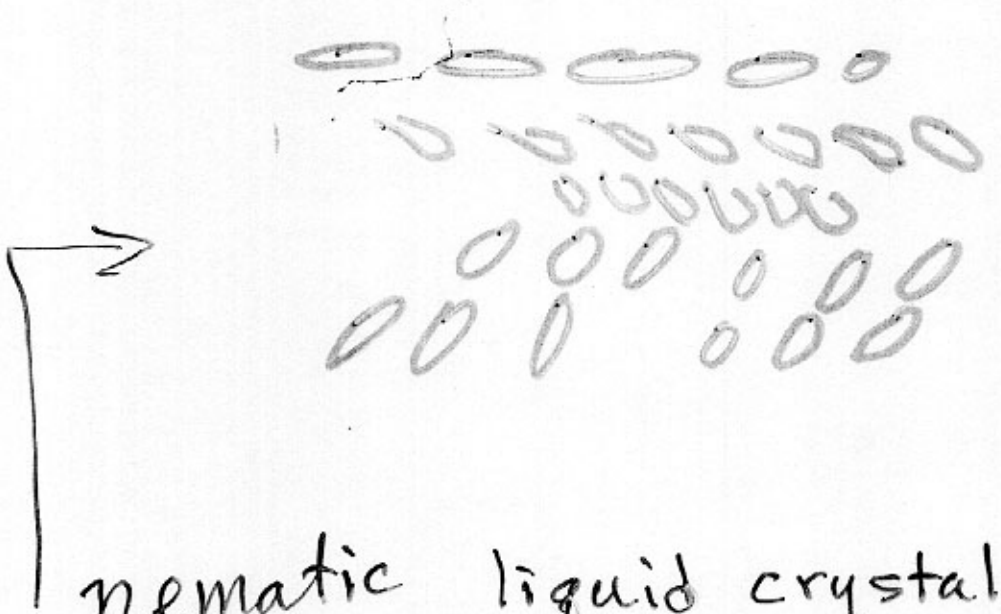
Technology: Twisted Nematic Liquid Crystal Display

How does it work?

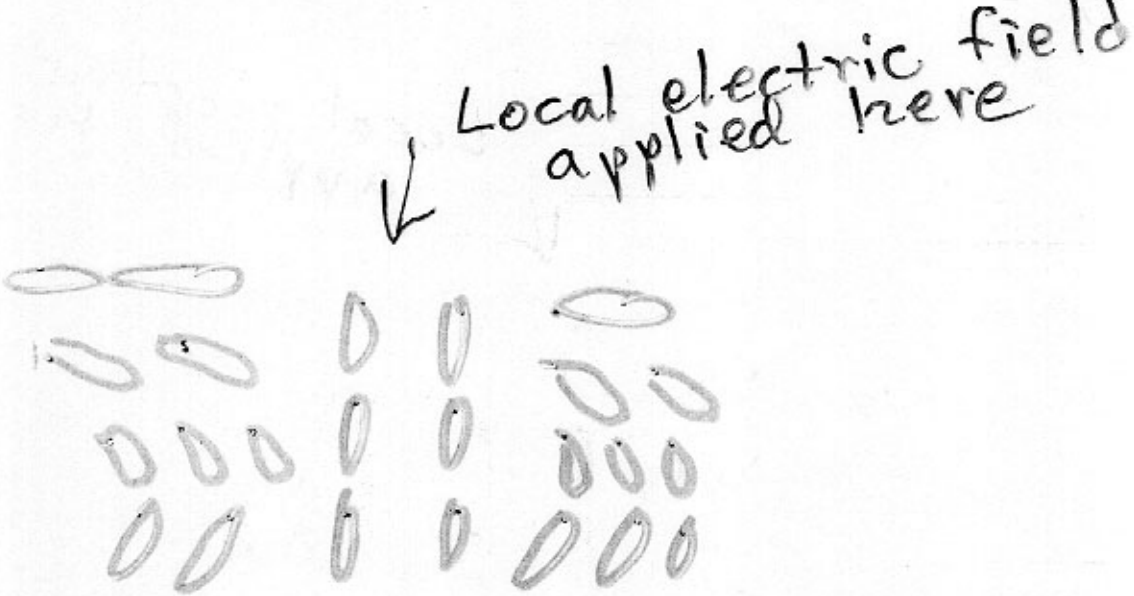
A clue: Light is a transverse wave.




polarizer
crossed
polarizer
reflector



nematic liquid crystal with a twist


Local electric field
applied here