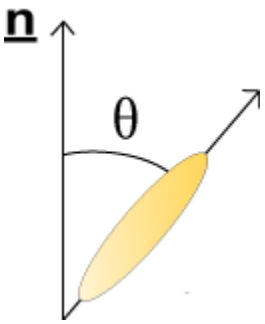
Order and disorder – molecular orientation & Position

Order and disorder – molecular orientation:

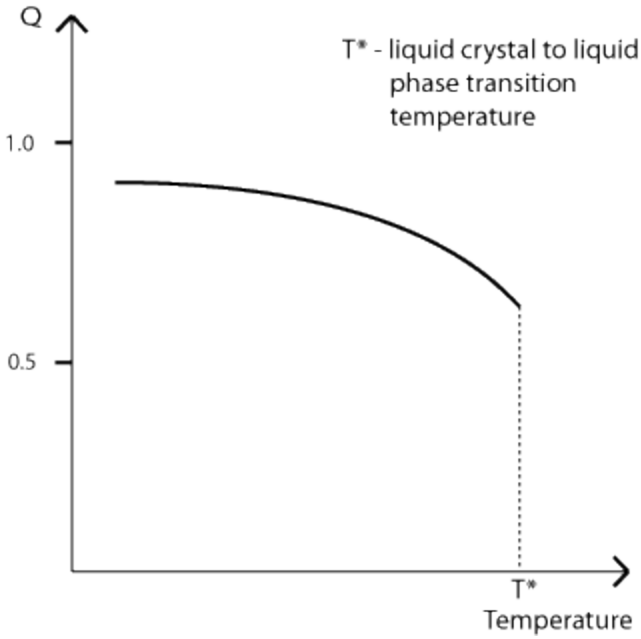
Due to their distinctive shape calamitic liquid crystal molecules undergo stronger attractive forces when arranged parallel to one another. They therefore tend to align themselves pointing along one particular direction; this is a known as the *director* vector and is given the notation **n**. The angle between individual liquid crystal molecules and the director gives an indication of the *orientational order* of the system, which can be calculated using the following formula:



$$\text{order parameter } Q = \frac{3\langle \cos^2 \theta \rangle - 1}{2}$$

When Q = 1 the liquid crystal has complete orientational order; when Q = 0 it has no orientational order and has therefore become an isotropicliquid.

For a thermotropic liquid crystal the variation of Q with temperature follows a trend similar to the one shown in the diagram below (exact values will vary):



Order and disorder – Molecular position :

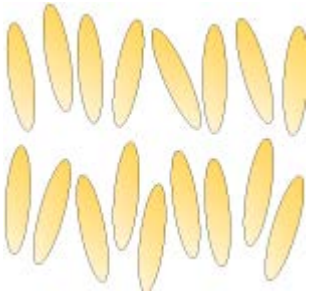
In the introduction we stated that whilst liquid crystals have high orientational order, their positional order is very low. However certain positional arrangements are possible. In general, calamitic liquid crystals can be divided into three different *mesophases*:

Nematic:

Nematic liquid crystals have *no positional order* – they only have orientational order.

Smectic:

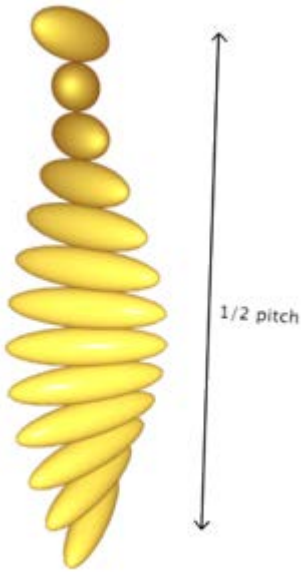
Smectic liquid crystals consist of molecules arranged into separate layers. However, there is no further positional order within the layers themselves.



Chiral Nematic:

In chiral nematic liquid crystals we see a helical structure, where the *director vector* is rotated slightly in each subsequent layer of molecules – the distance along the axis between two molecules with parallel director vectors is called the*pitch* of the liquid crystal.

Their name derives from the fact that they are easily made by mixing a nematic with a chiral substance (which does not have to be a liquid crystal itself). Historically, they were also known as *cholesteric* liquid crystals as the first molecules found to display these properties were those related to cholesterol.



As we will later see, the different degrees of positional ordering lead to very different optical properties.

Source : http://www.doitpoms.ac.uk/tlplib/liquid_crystals/order_disorder_position.php