Many pharmaceutical substances are optically active in the sense that they rotate an incident plane of polarized light to the plane of the incident light. This property is characteristic of some crystals and of many pharmaceutical liquids or solutions of solids. Where the property is possessed by a liquid or by a solute in solution, it is generally the result of the presence of one or more asymmetric centers, usually a carbon atom with four different substituents. The number of optical isomers is \( 2^n \), where \( n \) is the number of asymmetric centers. Polarimetry, the measurement of optical rotation, of a pharmaceutical article may be the only convenient means for distinguishing optically active isomers from each other and thus is an important criterion of identity and purity.

Substances that may show optical rotatory power are chiral. Those that rotate light in a clockwise direction as viewed towards the light source are dextrorotatory, or (+) optical isomers. Those that rotate light in the opposite direction are called levorotatory or (−) optical isomers. (The symbols \( D \) and \( L \), formerly used to indicate dextro- and levorotatory isomers, are no longer sanctioned owing to confusion with \( D \) and \( L \), which refer to configuration relative to \( \alpha \) glyceraldehyde. The symbols \( R \) and \( S \) and \( \alpha \) and \( \beta \) are also used to indicate configuration, the arrangement of atoms or groups of atoms in space.)

The physicochemical properties of nonsuperimposable chiral substances rotating plane polarized light in opposite directions to the same extent, enantiomers, are identical, except for this property and in their reactions with other chiral substances. Enantiomers often exhibit profound differences in pharmacology and toxicology, owing to the fact that biological receptors and enzymes themselves are chiral. Many articles from natural sources, such as amino acids, proteins, alkaloids, antibiotics, glycosides, and sugars, exist as chiral compounds. Synthesis of such compounds from nonchiral materials results in equal numbers of the enantiomers, racemates. Racemates have a net null optical rotation, and their physical properties may differ from those of the component enantiomers. Use of stereoselective or stereospecific synthetic methods or separation of racemic mixtures can be used to obtain individual optical isomers.

Measurement of optical rotation is performed using a polarimeter. The general equation used in polarimetry is:

\[
[\alpha] = \frac{1000 \alpha}{l} \\
\]

where \([\alpha]\) is the specific rotation at wavelength \( \lambda \), \( t \) is the temperature, \( \alpha \) is the observed rotation in degrees (°), \( l \) is the pathlength in decimeters, and \( c \) is the concentration of the analyte in g per 100 mL. Thus, \([\alpha]\) is 100 times the measured value, in degrees (°), for a solution containing 1 g in 100 mL, measured in a cell having a pathlength of 1.0 cm.

Optical rotation of solutions should be determined within 30 minutes of preparation. In the case of substances known to undergo racemization or mutarotation, care should be taken to standardize the time between adding the solute to the solvent and introduction of the solution into the polarimeter tube.

Angular Rotation—The reference Angular Rotation (781A) in a monograph signifies, unless otherwise directed, that the optical rotation of the neat liquid is measured in a 1.0-dm tube at 589 nm at 25°, corrected for the reading of the dry empty tube.