An equal mixture of two enantiomers is called a racemic mixture or racemate.

If two enantiomers rotate plane-polarized light in opposite directions, a racemate will not rotate light at all. The effects of the two enantiomers will cancel out.

- If two enantiomers are present in an unequal ratio, only part of the optical rotation will be canceled out.
- By comparing the rotation of the sample to the rotation of a pure enantiomer, the enantiomeric purity can be determined.

The "optical purity" is a comparison of the optical rotation of a pure sample of unknown stereochemistry versus the optical rotation of a sample of pure enantiomer. It is expressed as a percentage. If the sample only rotates plane-polarized light half as much as expected, the optical purity is 50%.

Optical purity also corresponds to "enantiomeric excess". If the unknown sample rotates light 50% as much as a sample of pure enantiomer, it must contain 50% enantiomeric excess; the other 50% is a racemic mixture. In other words, if the sample is 75% of one enantiomer and 25% of the other, 50% of the mixture will simply cancel out in terms of optical activity. The remaining 50% will still exert optical activity, but only half as much as if the sample were 100% of that enantiomer.

These relationships could be expressed in formulae:

\[
\text{Optical purity (op)} = \left[ \frac{\text{optical rotation of pure compound}}{\text{optical rotation of pure enantiomer}} \right] \times 100\%
\]

\[
\text{Enantiomeric excess (ee)} = \text{optical purity} \quad \text{(that is, these numbers are always the same, although they represent different things)}
\]

\[
\% \text{ major enantiomer} = \text{enantiomeric excess} + \left[ \frac{(100 - \text{enantiomeric excess})}{2} \right] = 50 + \left( \frac{\text{enantiomeric excess}}{2} \right)
\]
% minor enantiomer = 100 - % major enantiomer

**Problem SC6.1.**

The (+) enantiomer of compound A has an optical rotation of 75°. If a pure sample of compound A has an optical rotation of 50°, what is the composition of the sample?

**Problem SC6.2.**

The (+) enantiomer of compound B has an optical rotation of 50°. If a pure sample of B contains 10% of the (+) enantiomer and 90% of the (-) enantiomer, what is the optical rotation value?

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