

# INTERMOLECULAR FORCES

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## MATERIALS NEEDED:

Iodine (approx. 1 g) (As an alternative, use tincture of iodine, available from a pharmacy)

Water, H<sub>2</sub>O

Potassium iodide, KI

Ethanol, C<sub>2</sub>H<sub>5</sub>OH Hexane, C<sub>6</sub>H<sub>14</sub>

Test tubes, 25 x 200 mm or similar (3)

Corks or stoppers to fit the test tubes

Flask, 500-mL or 1000-mL, with a cork to fit the flask.

Burner or hot plate, to heat flask.

## SAFETY PRECAUTIONS:

Wear safety goggles while performing this experiment.

Iodine is toxic. Use only small quantities. Keep containers sealed to minimize fumes.

## DISPOSAL:

Dispose of all iodine wastes in the proper receptacles for halogen wastes.

## PROCEDURE:

Add a few crystals of iodine to a large flask. Stopper. Heat the flask gently until iodine vapors can be observed.



Add a few crystals of iodine (or a few drops of tincture of iodine) to hexane in a large test tube. Note the color of the mixture.



Add a few crystals of iodine (or a few drops of tincture of iodine) to water in a large test tube. Note the color of the mixture.

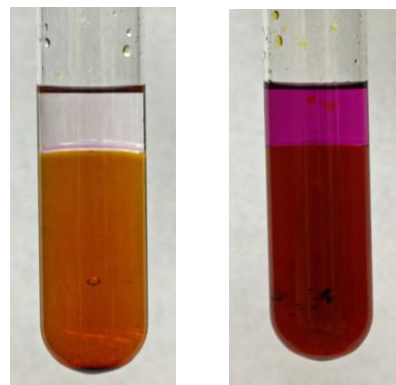


Add a few crystals of iodine (or a few drops of tincture of iodine) to ethanol in a large test tube. Note the color of the mixture.

Add a few crystals of potassium iodide to the water solution of iodine. Note the color of the solution.



Add some hexane to the KI-iodine solution, stopper, and shake gently. Note the changes that occur.



### EXPLANATION:

The iodine molecule is non-polar. In the molecular form, iodine vapors are violet. When mixed with hexane, the iodine molecules experience London dispersion forces. There is no induced polarity in the iodine molecules and they exhibit their typical violet color in the solution. (Note: The color may be pink if the iodine concentration is low.)

When mixed with either water or ethanol, the iodine molecules are subjected to polar forces, resulting in an induced polarity in the iodine molecules. This is an example of polar-induced polar (or dipole-induced dipole) intermolecular forces. The distortion of the molecular orbitals of the iodine molecules results in a yellow-brown color.

When potassium iodide is added to the solution of iodine in water, the iodine molecules are now subjected to ion-induced polar intermolecular forces. This results in a greater distortion of the molecular orbitals in the iodine molecules and the solution is now dark brown in color.

When hexane is added to the KI-iodine solution, the preference for “like-dissolves-like” is shown by the iodine partitioning to the nonpolar solvent. The hexane layer should initially be colorless or lightly pink. Gently shaking the test tube will increase the iodine concentration in the hexane layer. If the test tube is stoppered and shaken, almost all of the iodine will dissolve in the hexane layer leaving the water (or alcohol) layer almost colorless.