

Melting point depression

The melting points of compounds may be lower than the reported values because it may contain small amounts of the impurities or solvents. Impurities in a solid cause a melting point depression because the impurity disrupts the crystal lattice energies. For example if a compound had a melting point of 55-57 °C and an impurity was introduced which had a melting point of 112 °C, the melting point of the pure compound could be reduced to 50 or 30 °C depending on the concentration of impurity mixed in with the pure compound. This is called a freezing point depression.

You may be more familiar with the freezing point depression of ice by the addition a salt. When a solution begins to freeze, the solid that forms is almost always pure solvent. Pure ice in this case. Solute particles, because of their different size and shape do not fit into the crystal lattice and interfere with the crystallization process. This interference causes the solution to freeze at a lower temperature than the pure solvent. The more concentrated the solute, the greater the interference and the lower the freezing point of the solution.

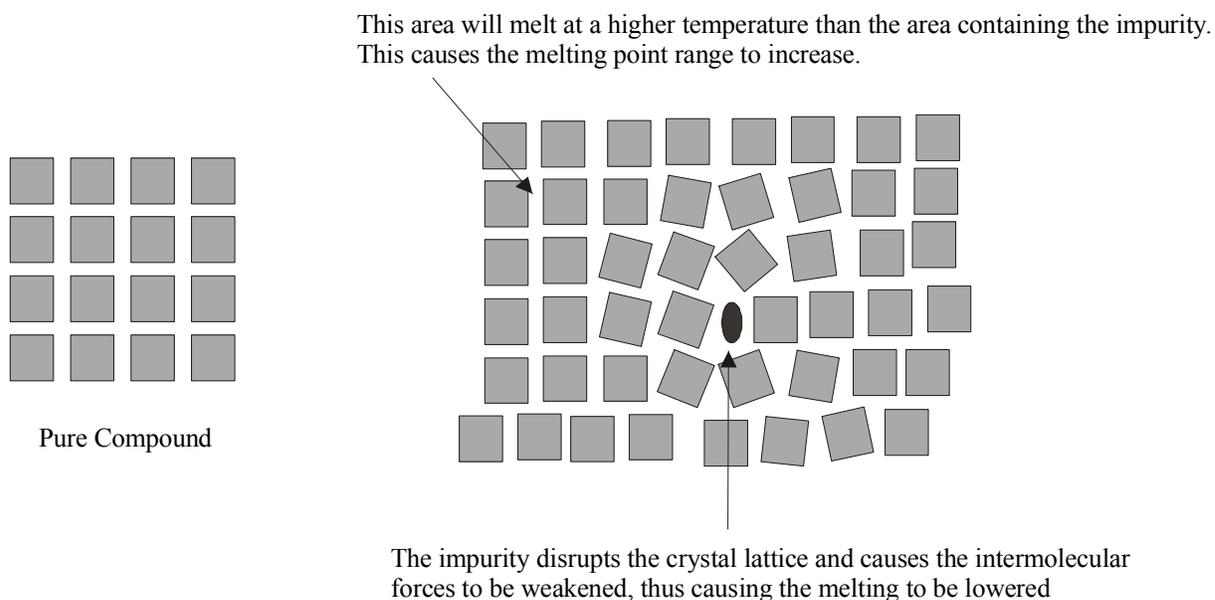
This concept can be applied to melting point (or freezing point) of a pure compound. The melting point is defined as that temperature at which the solid and liquid phases of the compound are in equilibrium at some particular pressure.

Solid Q » Liquid Q

$T^\circ = mp$

The definition implies that when the solid Q is in heterogeneous equilibrium with liquid Q at some temperature T° , the melting point, a slight increase in temperature will result in the complete conversion of solid Q to the liquid phase. Conversely, a slight decrease in temperature will result in the complete conversion of liquid Q to solid Q. Thus at the melting point of a pure crystalline material sufficient thermal energy has been introduced to begin breaking the crystal lattice. For many (but not all) pure compounds the range of temperature change, or melting range, over which this breakdown occurs will be from 0.5 to 2°C. The melting point therefore, is sometimes taken as circumstantial evidence of purity.

An impurity as stated above disrupts the crystal lattice forces and less thermal energy is needed to make the compound melt. The impurity also increases the melting point range since the compound is not homogeneous and different areas will start to melt before purer areas in the solid as shown figure below.

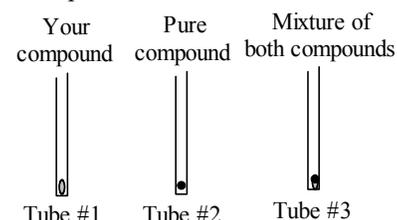


Mixed melting points.

Extending the concept of freezing point depression; if two pure compounds are mixed together they will act as an impurity to each other and the melting point of each compound will be different from the pure compounds. The melting point range will also be broad. Therefore if we have an unknown compound and mix it with potential known compounds the melting points of the mixtures will be different than the pure compounds unless the compounds are identical. It is preferential to carry out the melting point determination on a mixture and at least one pure compound simultaneously to ensure that experimental conditions for the two determinations are identical.

Procedure

Verify the identity of your unknown by doing a melting point determination with three sample tubes in the mel-temp at the same time. The first tube will contain your product, and the second will contain an authentic compound. The third will contain a mixture of your product and authentic compound. If the all three tubes melt at approximately the same temperature you have identified the compound correctly. Use a watch glass to mix the sample. Use small amounts, you do not need a lot for the mel-temp tube.

**Just for interest.**

What bench mark was used for 0°F in for old Fahrenheit scale?

Daniel Gabriel Fahrenheit and Anders Celsius both began work on their respective temperature scales in the 18th century.

A Dutch instrument maker Fahrenheit (1686-1736) built on the work of Danish astronomer Ole Romer, who spent considerable time making meteorological observations and experimenting with thermometers. During the late 1600s and early 1700s, Isaac Newton led the field in experimenting with thermometry. According to Newton 12 degrees should separate the temperature of a water ice, and salt solution from the temperature of the body. Fahrenheit believed that the thermometer he invented in 1714 had eight times the accuracy of Newton's thermometer, and therefore 96 degrees should separate these bench marks (eight times Newton's range). Using this new scale, combination of water, ice, and salt solution stayed at 0°, and body temperature registered as 96°. With these marks intact, a combination of water and ice (the freezing point of pure water) equaled 32°. Scientists later found that water boiled at 212° according to the Fahrenheit scale. After more accurate testing 98.6° became the correct body temperature that we know today.

Celsius (1701-1744), a Swedish astronomer, developed the centigrade scale a bit later in 1742. He assigned 100° to the freezing point and 0° to the boiling point of water. This scale appeared in Sweden and France, but with the numbers reversed. Celsius finally received broad recognition for his work in 1948 when his name became the official title of the temperature.

Opinion is still divided as to why one scale found favour in some parts of the world while the other was widely accepted elsewhere. Daniel Kelves, a historian of science and a professor of humanities of the California Institute of Technology, offers this theory: "Part of the reason" he says "is that the Fahrenheit system was developed first, and by a Dutchman: Holland and England enjoyed friendly relations at the time. The system later traveled to the American colonies. After the invention of the Celsius system, however, the French under Napoleon were at loggerheads with England, probably enforcing the divisions as well," he says. (Popular Science, Dec. 1997)