

Temperatures within a few degrees of liquid air temperatures may be obtained by evaporating dry ice at low pressures. Dry ice (solid carbon dioxide) has a sublimation temperature of -78°C (-108°F) at atmospheric pressure. At a pressure of 1 mm hg it sublimates at -135°C or -211°F . At a pressure of 1 micron, the temperature is -166°C or -266°F . Liquid oxygen boils at -183°C .

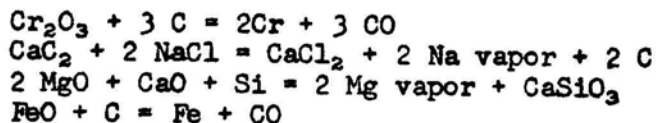
Liquid nitrogen evaporated at 1 mm hg will produce temperatures of -226°C or 47°K .

Unfortunately the heat transfer from solid carbon dioxide to an experimental chamber is quite poor and it is necessary to immerse the test object well into the crushed CO_2 and allow ample time for equilibrium.

The temperature-pressure relationship for CO_2 may be found in Handbook of Chemistry and Physics or similar reference books. Detailed information on the subject of thermodynamics may be found in a physical chemistry textbook.

Related applications

1. Distillation at low temperatures: Often a heat sensitive material may be safely distilled by using a low pressure and correspondingly low temperature. Water may be distilled at room temperature if the pressure is reduced to less than 30 mm hg. Vitamins A and D, turpentine, tar, lubricating oil, some vegetable shortenings and naphthalene are examples of products using vacuum distillation.
2. Low Temperature Chemical Reactions: The reaction $\text{NaHCO}_3 = \text{Na}_2\text{CO}_3 + \text{H}_2\text{O} + \text{CO}_2$ which normally takes place at 270°C will take place at room temperature in a vacuum of about 1 mm hg. Other reactions which take place at much lower temperatures in a vacuum are the following:



These reactions are of great commercial importance. Any reaction evolving gas or vapor will proceed at lower temperature in a vacuum.

Material for low temperature experiments

Two canning jars and lids
8" of 8 mm glass tubing closed at one end
Dry ice
Tin cans
Aluminum foil
Vacuum hose
Flake sodium hydroxide (household lye)

Assemble the system as shown in fig 2. The double walled container is made from two tin cans or paper. The two containers are held concentric by lightly crumpled aluminum foil which serves as a radiation shield. The assembly is then placed in a canning jar and supported with more aluminum foil on sides and bottom. A double foil cover is placed over the dry ice in the interior. The lid for this has a copper tube connection for exhausting and a central hole for admitting the glass cold chamber. The cold chamber is a piece of glass tube closed at one end and inserted thru a rubber stopper. A tight joint is obtained by greasing the stopper where it joins the lid.

In order to reduce the load on the pump, a trap may be installed as shown to trap the bulk of the CO_2 released. A pressure release is not necessary if the cold chamber is installed as shown. If the cold chamber is fastened to the lid, some pressure relief device should be employed.

