1.4J: Cooling Baths

On occasion a solution may need to be cooled: to minimize evaporation of volatile liquids, induce crystallization, or to favor a certain reaction mechanism. Several cold baths are used for certain applications, with the simplest being an ice bath. When preparing an ice bath, it is important to use a mixture of ice *and* water, as an ice-water slurry has better surface contact with a flask than ice alone.

Sometimes salts are added to ice in order to create baths colder than $0^{o}C$ (freezing point depression). It is also quite common to cool a solvent with dry ice (solid CO_2) in order to achieve dramatically colder baths. In dry ice baths, dry ice is added to the solvent until a portion of dry ice remains. The most common dry ice bath is made with acetone and dry ice, and achieves a cold bath of $-78^{o}C$. Other cold baths are shown in Table 1.8.

Table 1.8: Commonly used cold baths.[9]

Cold Bath Composition	**T** (^{o}C)
36 g NaCl + 100 g ice	-10.0
75 g $NaNO_3$ + 100 g ice	-5.3
66 g NaBr + 100 g ice	-28
Acetonitrile + dry ice	-40
Acetone + dry ice	-78
Ethyl acetate + dry ice	-84
Hexane + dry ice	-95
Methanol + dry ice	-98

Ice baths can be made in Tupperware containers, beakers, or almost any container (Figure 1.57a). Baths colder than $-10^{o}C$ should be made in an insulating container or else they cannot be easily handled and will lose heat too quickly to the room. The most common cold bath container is a wide-mouthed Dewar (Figure 1.57b), which has a vacuum jacket between the bath and the exterior. An inexpensive homemade insulating bath can be made by nesting two crystallizing dishes, filling the gap with vermiculite (a packing material) and sealing the gap with silicone caulking (Figure 1.57c).

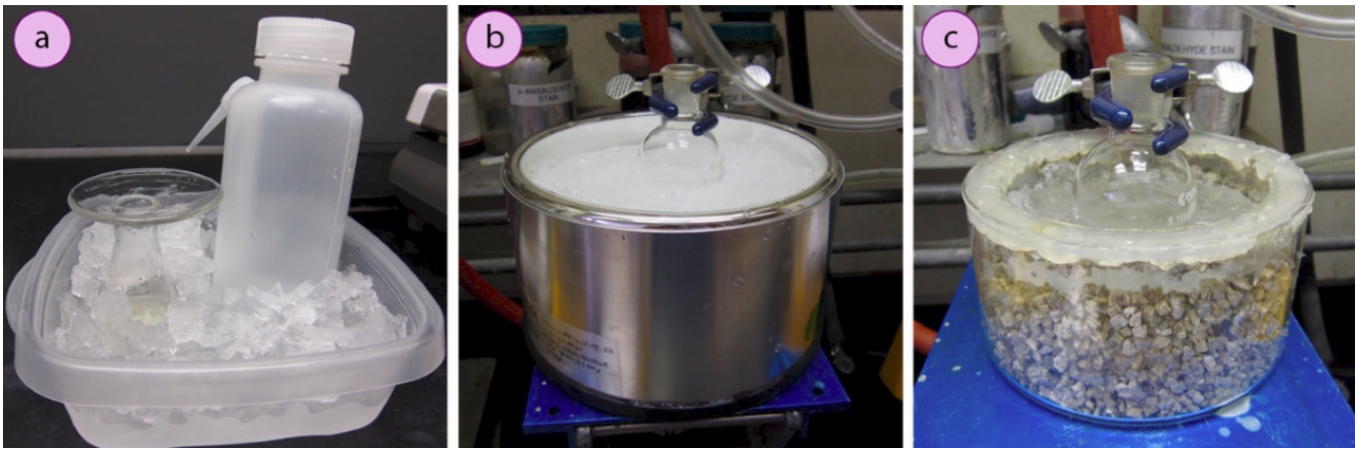

Figure 1.57: Cold baths: a) Ice-water slurry, b) a vacuum Dewar, c) a homemade insulating bath.

Safety note: Dry ice should not be handled with your bare hands or else you may get frostbite. Also avoid direct contact with baths colder than $-10^{o}C$.

[9] J. A. Dean, *Lange's Handbook of Chemistry*, 15^{th} ed., McGraw-Hill, **1999**, Sect 11.1.