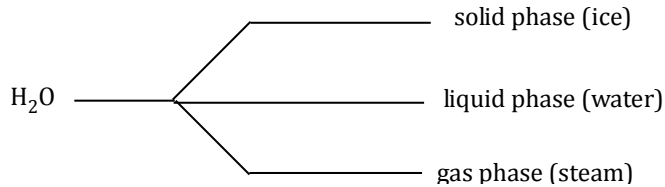## Phase Changes

Adding heat to an object does not always change the temperature of the object. Instead the heat goes into changing the phase of the object. For example from solid phase to liquid phase.

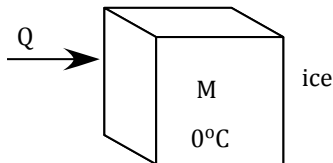*A phase describes a specific state of matter, such as solid, liquid, or gas.*

Ex.

A transition from one phase to another is called a phase change.

For a given pressure, a phase change occurs at a specific temperature.

Ex. Melting a block of ice at 0^oC.

Adding heat Q (energy) to the block of ice will not raise the temperature. Instead, the heat goes into melting the ice and thus changing the phase from solid to liquid. The remaining ice and liquid will remain at 0^oC until all the ice has melted. From this point on, any additional heat will then increase the temperature of the liquid state of water.

At normal atmospheric pressure it takes 3.34 x 10^5 J of heat to change 1 kg of ice to 1 kg of liquid water at 0^oC. This quantity is called the heat of fusion of water:

$$L_f = 3.34x10^5 \frac{J}{kg}$$ (heat of fusion of water)

Or we can say the heat required to melt a mass 'm' of ice is given by:

$$Q_{ice} = mL_{ice}$$

In general for any material of mass 'm':

$$Q = mL_f$$

L_f = Heat of fusion

The process is reversible. To freeze water at 0^oC you need to remove heat instead. Q would be negative though. Thus,

$Q = \pm mL_f$ Heat transfer in a phase change (solid ↔liquid)

For a phase transition between liquid and gas similar equation holds valid:

$Q = \pm mL_v$ Heat transfer in a phase change (liquid ↔gas)

L_v = Heat of Vaporization

$L_v = 2.256 \times 10^6$ J/kg for water

EXAMPLE