FIRST LAW OF THERMODYNAMICS

Internal energy

The internal energy of a given mass of gas depends on its state described by specific values of pressure, volume and temperature.

It does not depend on how this state of the gas came about

The internal energy U of a system can change through two modes of energy transfer : heat and work

ΔQ = Heat supplied to the system by the surroundings

ΔW = Work done by the system on the surroundings

ΔU = Change in internal energy of the system

First Law of Thermodynamics

The general principle of conservation of energy then implies that

$$\Delta Q = \Delta U + \Delta W$$

For isothermal expansion of an ideal gas $\Delta U = 0$

That is $\Delta \mathbf{Q} = \Delta \mathbf{W}$

Or heat supplied to the system is used up entirely by the system in doing work on the environment

If the system is a gas in a cylinder with a movable piston, the gas in moving the piston does work.

Since Force = Pressure x Area

That is

Work = Force x Distance = Pressure x Area x Distance

$$\Delta \mathbf{W} = P\,(A\,\Delta x) = \mathbf{P}\,\Delta \mathbf{V}$$

where $\Delta \mathbf{V}$ is the change in volume of the gas.

$$\Delta Q = \Delta U + \Delta W = \Delta U + P\,\Delta V$$

We see that most of the heat goes to increase the internal energy of water in transition from the liquid to the vapour phase