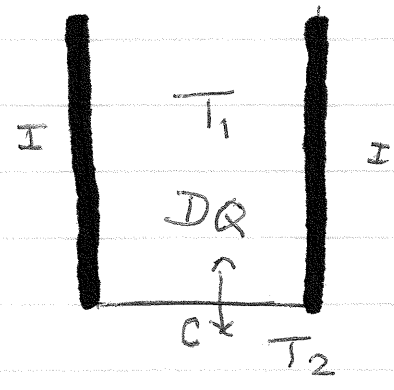# FIRST LAW OF THERMODYNAMICS.

We have learnt that if
a thermodynamic system
has a conducting boundary
(that is, it is not isolated
from its surroundings) and
its temperature T_1 is different
from that of the surroundings T_2, there will
be an exchange of Energy driven by
the temperature difference and this
energy is called heat DQ. If $T_2 > T_1$
DQ enters our system if $T_2 < T_1$, DQ leaves
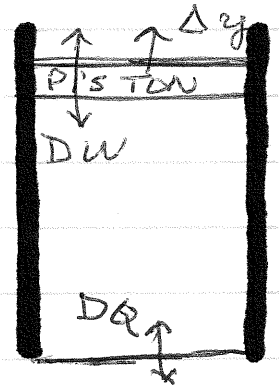our system. For liquids and solids

$$DQ = mc\Delta T \quad [\text{change of Temperature}]$$
$$DQ = mL \quad [\text{change of phase}].$$

We have also learnt that we can use
mechanical work to mimic the effects
of Heat. Indeed, $4.18\,J$ will produce
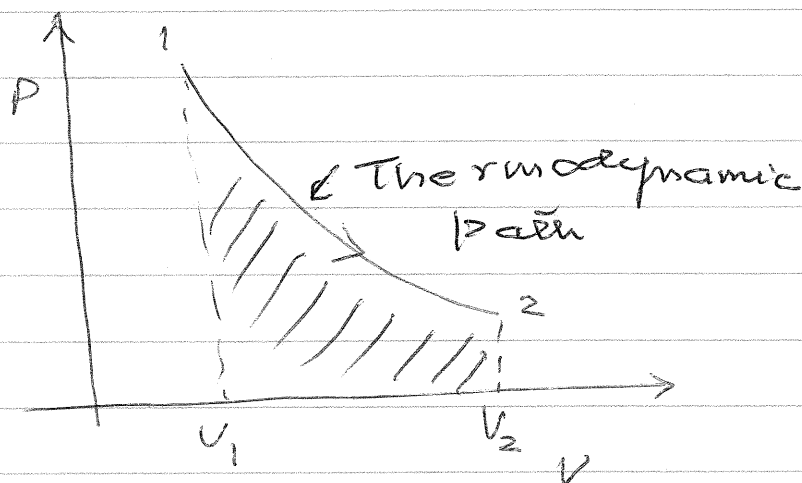same effect as transferring one Calorie
of DQ.

Consider a gas. If the
piston moves by Δy work
done is

$$\Delta W = F\Delta y = PA\Delta y = P\Delta V$$

For a finite change of volume

we get and the work done W_{1-2} is the area under the P vs V curve.

P

← Thermodynamic Path

1

2

V_1 V_2 V

Two facts stand out:
1. In the process 1-2 the work done depends on the path (Thermodynamic)
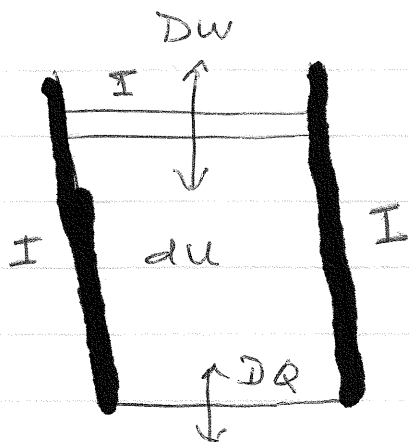2. Because work can be used to mimic DQ, the quantity of heat exchange also depends on the path

AND NOTE : DQ and DW both involve interaction of system with surroundings.
[AT for former, moving piston for latter]

The beauty is that the algebraic sum of DQ and DW, that is,

$$\pm DQ \pm DW$$

is INDEPENDENT OF THE PATH.

Recall that whenever we have a change of energy independent of the path we can define a potential so now we define a thermodynamic potential called the internal energy u

and this takes account of all the changes of energy in a thermodyn amic process. The conserv ation law for Energy then asserts that

$$\pm dU \pm DQ \pm DW \equiv 0.$$

in equivalently

Path Dependent

$$\boxed{dU = \pm DQ \pm DW}$$

Path Independent

This is the formal statement of the first LAW OF THERMODYNAMICS.

N.B. $d \rightarrow$ Path Independent Change
        $D \rightarrow$ Path Dependent Change

FOR SOLIDS/LIQUIDS DQ, DW go to change $dU = mc\Delta T$ or mL.
For an ideal gas U is a function of temperature only.
   If gas is monoatomic
$$U_{MA} = \frac{3}{2} Nk_B T. \qquad \text{(Proved in Class)}$$

   If gas is diatomic
$$U_{DA} = \frac{5}{2} Nk_B T \qquad \text{(Good near 300K).}$$

$$k_B = 1.383 \times 10^{-23} J/K.$$
T is temperature in °K.