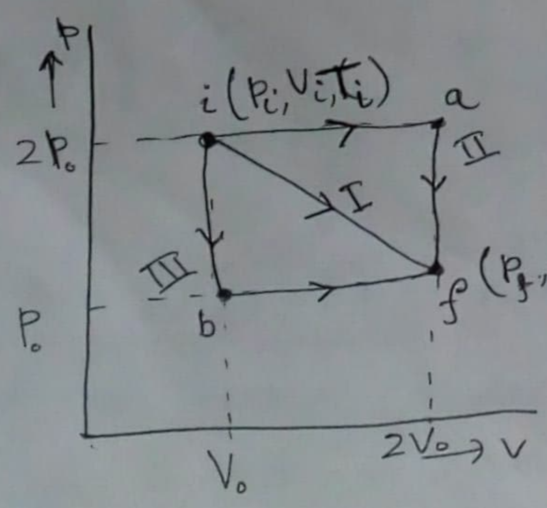
Figure (c): Here the two processes (I and II) are performed ~~consequitively Con~~ consecutively so that the system comes back to its original state (i) by forming a closed loop. Such a series of two or more processes, represented by a closed figure is called a cycle. The area under the closed figure is the difference between the areas under the curves I and II and, therefore, represents the net work done in the cycle.

$\oint p\,dV \equiv$ net work done in the cycle.

# Hydrostatic work depends on the path:




In this pV diagram:

$i \rightarrow$ initial state, $(P_i, V_i, T_i)$

$f \rightarrow$ final state, $(P_f, V_f, T_f)$.

There are many ways in which the system can move from the initial state i to the final state f. Let us consider three different paths and calculate the work done in this three processes.

**Process I (if):** work done in process I i.e., $i \to f$ (directly) is the area under the straight line if

$$= -\left[\frac{1}{2}(2V_0 - V_0)(2P_0 - P_0) + (2V_0 - V_0)(2P_0 - P_0)\right]$$

$$= -\left[\frac{1}{2}V_0P_0 + V_0P_0\right]$$

$$= -\frac{3}{2}P_0V_0.$$

'(−)' ve sign ≡ work don by the system.

**Process II (iaf):** along path II, $i \to a$ is an isobaric ($2P_0$) process, so the work done in going from i to a is $[-2P_0(2V_0 - V_0)] = -2P_0V_0$ and $a \to f$ is an isochoric process i.e., no change in volume from $a \to f$; so no work is done in going from a to f.

∴ total work in process II $= -2PV_0$

**Process III (ibf):** here $i \to b$ is isochoric process. So no work is done in going from i to b.

Then $b \to f$ is isobaric process (constant pressure $= P_0$) and change in volume $= (2V_0 - V_0) = V_0$.

∴ total work done in process (III) $= -P_0V_0$.

Here we see that though the system is moving from the same initial state i to the same final state f via three different paths, the amount of thermodynamic work done by the system are actually different.

This implies that the work done by a system depends not only on the initial and final states but also on the intermediate states, i.e., on the path of integration. In other words, the integration

$$W = -\int_{V_i}^{V_f} p\,dV$$

can not be performed until $p$ is specified as a function of $V$ using an appropriate equation of state.

* Note: Infinitesimal amount of work done ($đW$) is not an inexat differential because W is not an actual function of thermodynamic variables. Also, the total work done depends on the actual path of integration i.e., on the process.