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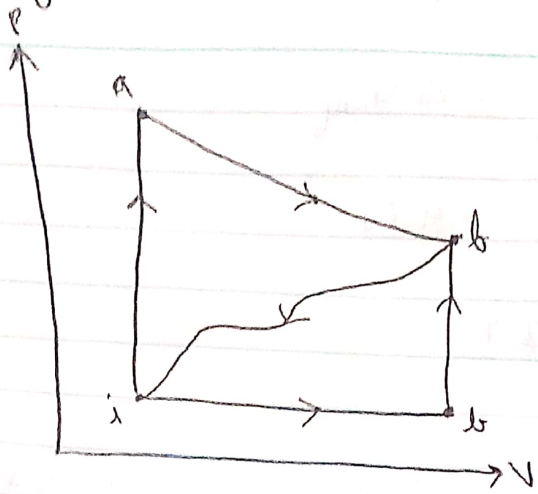
05/29/2021

PHYS-230
LAB QUIZ #14

Consider the following thermodynamic processes (iaf, ibf and fi) shown on a P-V diagram :-



We know that $W_{iaf} = 10.2\ J$, $Q_{ibf} = 19.8\ J$ & $W_{iaf} = 23.1\ J$

(a) Determine Q_{iaf}.

(b) What is the change in internal energy in the process fi, ΔU_{fi}?

(c) If $Q_{fi} = -34.7\ J$, determine W_{fi}.

(d) If $U_f = 32.3\ J$, determine U_i.

(e) If $U_B = 28.5\ J$, determine Q_{ia} and Q_{af}.

(f) If $U_A = 47.2\ J$, determine Q_{ia} & Q_{af}.

Ans:- (a) Finding ΔU for ibf from 1st law:-

$$Q_{ibf} - W_{ibf} = \Delta U_{ibf} \quad (1)$$

P.T.O

$19.8\,J - 10.2\,J = \Delta U_{ibf}$

$\Delta U_{ibf} = 9.6\,J = \Delta U_{iaf}$

Using 1st law, we have :-

$Q_{iaf} - W_{iaf} = \Delta U_{iaf}$

$Q_{iaf} - 23.1\,J = 9.6\,J$

$\therefore Q_{iaf} = 32.7\,J$

(b) Change in internal energy ΔU is a state function, so it depends on the end points, f and i.

The internal energy is calculated from point i to f, which gives 9.6 J.

$\Delta U = U_f - U_i$

$= 9.6\,J$

In this case, it is from f to i,

$\therefore \Delta U = U_i - U_f$

$= -(U_f - U_i)$

$= -9.6\,J$

(c) $Q_{fi} = -34.7\,J$

From 1st law,

$Q_{fi} - W_{fi} = \Delta U_{fi}$

$\Rightarrow -34.7\,J - W_{fi} = -9.6\,J$

$\therefore W_{fi} = -25.1\,J$

(d) From (b), we have $\Delta U = U_i - U_f = -9.6\,J$

$\Rightarrow U_i = -9.6 + 32.3\,J$

$= 22.7\,J$

(e) $Q_{net} = 19.8\,J$

$\therefore Q_{ib} + Q_{bf} = 19.8\,J \longrightarrow (1)$

$Q_{bf} - W_{bf} = \Delta U_{bf} = U_f - U_b$, volume remains constant.

$\therefore W_{bf} = 0$ (As, $W = \int P\,dV$)

$\Rightarrow Q_{bf} = U_f - U_b$

$\Rightarrow Q_{bf} = 32.3 - U_b$

$\Rightarrow Q_{bf} = 32.3 - 28.5$

$\therefore Q_{bf} = 3.8\,J$

From (1),

$Q_{ib} + 3.8 = 19.8\,J$

$Q_{ib} = 16\,J$

P.T.O

(B) $Q_{iaf} = Q_{ia} + Q_{af} = 32.7\,J \longrightarrow (2)$

For process ia,

$Q_{ia} - W_{ia} = \Delta U_{ia} = U_a - U_i$,

In this process, V is constant we have $W_{ia} = 0$.

$\therefore Q_{ia} = U_a - U_i$

$= 47.2\,J - 22.7\,J$

$\therefore Q_{ia} = 24.5\,J$

From (2),

$Q_{iaf} = 24.5 + Q_{af} = 32.7\,J$

$\therefore Q_{af} = 8.2\,J$