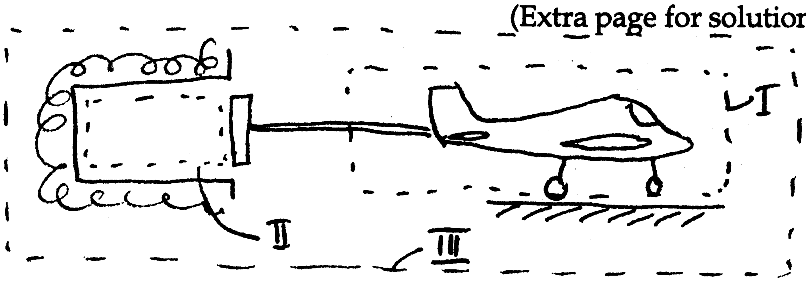
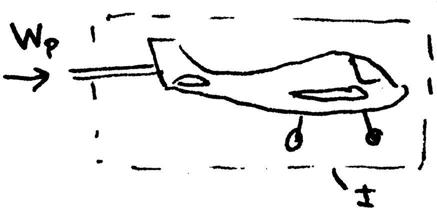
(Extra page for solutions)

a)



Assumptions:
- adiabatic processes
- rapid motion (→ NOT quasi-static), acceleration
- no friction, no interaction of a/c with surroundings
- steam is NOT ideal gas

b) Modes of energy transfer system I: adiabatic process; so work only



$\Delta E_I = -(-W_p)$ and $\Delta E_I = \Delta U_{a/c} + \Delta KE_{a/c} + \Delta PE_{a/c}$ ($\Delta U_{a/c} = 0$, $\Delta PE_{a/c} = 0$)

0 since no temp., state change of a/c

$\Delta KE_{a/c} = W_p$

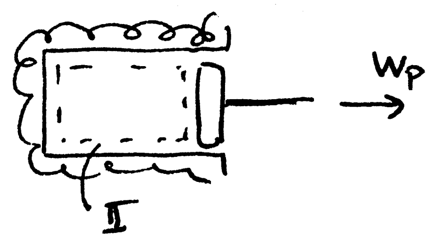
c) $\Delta E_I = \Delta KE_{a/c} = \frac{m_{a/c}}{2}(v_f^2 - v_i^2)$, no velocity at start $v_i = 0$

$\Delta E_I = \frac{m_{a/c}}{2} v_f^2$; $\Delta E_I = 5.4$ MJ , $\Delta U_{a/c} = 0$

d) Work is done by steam on the aircraft, $W_p = \Delta KE_{a/c}$

$W_p = 5.4$ MJ

e) system II:



adiabatic process

$\Delta E_{II} = -W_p$

$\Delta E_{II} = \Delta U_s + \Delta KE_s + \Delta PE_s$ ($\Delta KE_s = 0$, $\Delta PE_s = 0$)

$\Delta U_s = -W_p = -5.4$ MJ

Note: temperature of steam drops because work done by the steam

f) consider system III → no interactions with surroundings

so $\Delta E_{III} = 0$ but $\Delta E_{III} = \Delta E_I + \Delta E_{II}$ (extensive property)

↳ $= \Delta U_s = -W_p$
↳ $= \Delta KE_{a/c} = W_p$

$\Delta E_{III} = W_p - W_p = 0$ q.e.d