(i) GIVEN

object

» mass, $m = 10$ kg
» EN transfer $\dot{W}_{specific} = 0.147$ kJ/kg $= 147$ J/kg
» elevation decrease $\Delta h = -50$ m
» increase in velocity from $v_1 = 15$ m/s, $v_2 = 30$ m/s
» specific internal energy decrease $\Delta U_s = -5$ kJ/kg $= -5000$ J/kg
» $g = 9.7$ m/s^2

FIND

Heat transfer $\dot{Q}$

EQN

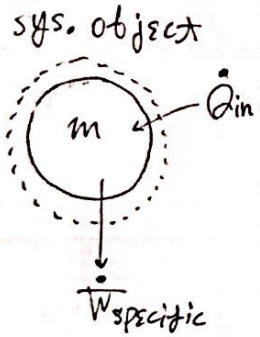
$$\left.\frac{dE}{dt}\right|_{sys} = \sum_{in} \dot{m}_{in}(h + ke + pe)_{in} - \sum_{out} \dot{m}_{out}(h + ke + pe)_{out} + \dot{Q} - \dot{W}$$

$PE = gz$, $KE = v^2/2$

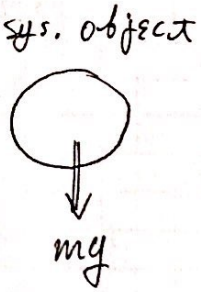
ASSUMP

* closed sys.
* no other EN loss
* Quasi equilibrium.

EFD



FBD



SOLN

$$\dot{Q} = m \cdot \Delta U_s + m \cdot \dot{W}_{specific} + \frac{1}{2} m (v_2^2 - v_1^2) + mg\Delta h$$

$$= (10\text{kg})\left(\frac{-5000\text{ J}}{\text{kg}}\right) + (10\text{kg})\left(\frac{147\text{ J}}{\text{kg}}\right) + \frac{1}{2}(10\text{kg})\left[(30^2 - 15^2)\left(\frac{\text{m}^2}{\text{s}^2}\right)\right]$$

$$+ (10\text{kg})\left(\frac{9.7\text{ m}}{\text{s}^2}\right)(-50\text{m})$$

$$= -50000\text{ J} + 1470\text{ J} + 3375\text{ J} - 4850\text{ J}$$

$$= -50005\text{ J}$$

$$\approx -50.0\text{ kJ}$$

$$\boxed{\dot{Q} = -50.0\text{ kJ}}$$