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General Physics II, Quiz 7
PHYS1000AA, Class year103/2015
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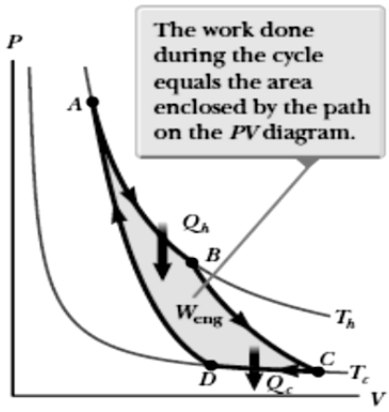
Quiz-5 Solution

1. Solution : ***(Similar to problem no.17, chap.22, text book 8th edition)***

(a)



(b) We know the efficiency of a heat engine is defined by, $e \equiv \dfrac{T_h - T_c}{T_h}\%$

By the definition we can write , the efficiency

$$80\% = \frac{T_h - T_c}{T_h} = 1 - \frac{T_c}{T_h}$$

$$\frac{T_c}{T_h} = 1 - \frac{80}{100} = 0.2$$

$$T_h = \frac{T_c}{0.2} = \frac{(400+273)K}{0.2} = 3365K$$

Here
$T_c = 673K$
$e = 80\%$

(*c*) The efficiency is also difined by

$$e \equiv \frac{W_{engine}}{|Q_h|} = \frac{\text{Work done by engine}}{\text{Amount of energy transfered}}$$

So, $W_{engine} = e \times |Q_h| = 80\% \times 500kJ$

$$W_{engine} = 400kJ$$

Now total mechanical power produced by heat engine is

$$P = \frac{W_{engine}}{t} = \frac{400kJ}{1\text{sec}} = 400kW$$

2. Solution: ***(Similar to problem no.43 and textbook reading, chap.22, text book 8th edition)***

(*a*) The entropy change for hot reservour is

$$\Delta S_h = -\frac{Q}{T_h} = \frac{-500kJ}{3365K} = -148.6 \approx -149 JK^{-1}$$

(here negative sign means heat is decayed or tranfering from hot reservour)

and similarly for cold reservour :

$$\Delta S_c = \frac{Q}{T_c} = \frac{500kJ}{673K} = 742.9 \approx 743 JK^{-1}$$

(*b*) The entropy change of the universe for this process is

$$\Delta S_{universe} = \Delta S_h + \Delta S_c = (-149 + 743) JK^{-1} = 594 JK^{-1}$$

(*c*) No , it is not possible to built a heat engine at this condition. Because if the entropy of the universe reach to maximum , the temperature will uniform / same in everywhere of universe, so no energy will be available for doing work. Even there will not be possible to conduct any physical, chemical and biological process. This is called the "heat death" of the univerese.

NB: I have given the answer only in descriptive way but you can provide your answer by mathematically/other way. If your theme is correct, so the answer will be considerable for the full score.