QUIZ5- CHAPTER 20
DATE: 27/02/20

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1. A piece of iron of mass 2.00 kg at a temperature of 880 K is thrown into a large lake whose temperature is 280 K. Calculate the change in entropy of the **iron-lake system.** The specific heat of iron is 450 J/kg K.

$$\Delta S_{iron} = m c \ln\left(\frac{T_f}{T_i}\right) = 2 \times 450 \ln\left(\frac{280}{880}\right) = -1031 \frac{J}{K}$$

$$\Delta S_{lake} = -\frac{Q_{lost}}{T} = -\frac{m c \Delta T}{T} = -\frac{2 \times 450 (280-880)}{280}$$

$$= 1928 \text{ J/K}$$

$$\Delta S_{system} = 1928 - 1031 = \boxed{897 \text{ J/K}}$$

2. An ideal refrigerator has a coefficient of performance of 10. If the temperature in the room is 30 °C, what is the temperature inside the refrigerator?

$$K_C = \frac{T_L}{T_H - T_L} = 10$$

$$\Rightarrow 10(T_H - T_L) = T_L \Rightarrow 10 T_H = 11 T_L$$

$$T_L = \frac{10}{11} T_H = \frac{10}{11}(303) = \boxed{275 K}$$

$$\boxed{T_L = 2 °C}$$

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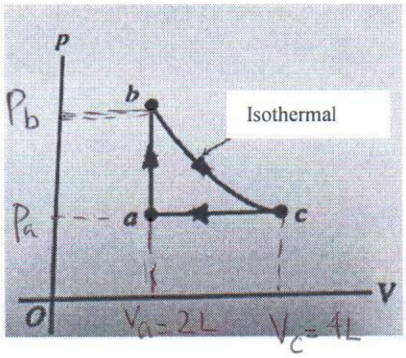
Three moles of an ideal diatomic gas are taken through the cycle *acba* as shown in the figure. The temperature of the gas in states a and b are $T_a = 300$ K and $T_b = 600$ K respectively, while the volume at a and c are 2 L and 4L, respectively.

(a) Calculate the change in entropy for the process ab.



$$\Delta S_{ab} = n\, C_v \ln\left(\frac{T_b}{T_a}\right) = n \frac{5}{2} R \ln\left(\frac{T_b}{T_a}\right)$$

$$= 3 \times \frac{5}{2} \times 8.31 \ln\left(\frac{600}{300}\right) = \boxed{43.2\ J/K}$$

(b) Calculate the change in entropy for the process bc.

$$\Delta S_{bc} = n R \ln\left(\frac{V_c}{V_b}\right) = 3 \times 8.31 \ln(2) = \boxed{17.3\ J/K}$$

(c) Calculate the change in entropy for the process ca.

$$\Delta S_{ca} = n\, C_p \ln\left(\frac{T_a}{T_c}\right) = 3 \times \frac{7}{2} \times 8.31 \ln\left(\frac{300}{600}\right)$$

$$= \boxed{-60.5\ J/K}$$

(d) Calculate the change in entropy for the cycle.

$$\Delta S_{cycle} = \Delta S_{ab} + \Delta S_{bc} + \Delta S_{ca} = 43.2 + 17.3 - 60.5$$
$$= 0$$

(e) expected result because $\Delta S_{cycle} = 0$

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1. An ideal monatomic gas of volume of 6.00 L, originally at 127 °C and pressure of 3.00 atm undergoes an isothermal expansion to 4 times the original volume. The gas is then compressed at constant pressure until it reach its original volume.
What is the net change in entropy of the gas?

$$PV = nRT \Rightarrow nR = \frac{PV}{T}$$

$$\Delta S_1 = nR\ln\left(\frac{V_f}{V_i}\right)$$

$$= \frac{P_iV_i}{T_i}\ln\left(\frac{V_f}{V_i}\right) = \frac{3\times101\times10^{3}\times6\times10^{-3}}{(127+273)}\ln(4) = 6.3\,\frac{J}{K}$$

$$\Delta S_2 = nC_p\ln\left(\frac{T_f}{T_i}\right) = n\frac{5}{2}R\ln\left(\frac{T_f}{T_i}\right) = \frac{5}{2}\frac{P_iV_i}{T_i}\ln\left(\frac{T_f}{T_i}\right)$$

$$P = \frac{nRT_i}{V_i} = \frac{nRT_f}{V_f} \Rightarrow \frac{T_f}{T_i} = \frac{V_f}{V_i} = \frac{1}{4}$$

$$\Delta S_2 = \frac{5}{2}\times\frac{3\times101\times10^{3}\times6\times10^{-3}}{(127+273)}\ln\left(\frac{1}{4}\right) = -15.8\,J/K$$

$$\Delta S_{net} = \Delta S_1 + \Delta S_2 = 6.3 - 15.8 = \boxed{-9.5\,J/K}$$

(a) Consider an ideal engine that operates between two heat reservoirs at 300 K and 600 K and absorbs 1.44×10^6 J per cycle. What is the power output of this engine if ~~it completes 10 cycles per minute~~?

$$\varepsilon_c = 1 - \frac{T_L}{T_H} = \frac{W}{Q_H} = \frac{W/t}{Q_H/t} = \frac{P}{Q_H/t}$$

$$\Rightarrow P = \frac{Q_H}{t}\left(1 - \frac{T_L}{T_H}\right) = 1.44\times10^{6}\left(1 - \frac{300}{600}\right)$$

$$= \boxed{7.2\times10^{5}\,W}$$