ASSIGNMENT 6

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Question 1:

A diesel engine performs 2200 J of mechanical work and discards 4300 J of heat each cycle.

(a) How much heat must be supplied to the engine in each cycle?
(b) What is the thermal efficiency of the engine?

Data ⇝ 2200 J of $\underline{\underline{W}}$
4300 J of Q_c/Cycle

a) $W = |Q_H| - |Q_C|$

$\Rightarrow Q_H = W + Q_C \rightsquigarrow Q_H = 4300 - 2200 = 6500\,J$

b) $e = \frac{W}{Q_H} = \frac{2200}{6500} = 0{,}338 \rightsquigarrow 33{,}8\%$

Question 2:

A room air conditioner has a coefficient of performance of 2.9 on a hot day and uses 850 W of electrical power.

(a) How many joules of heat does the air conditioner remove from the room in one minute?
(b) How many joules of heat does the air conditioner deliver to the hot outside air in one minute?
(c) Explain why your answers to parts (a) and (b) are not the same.

a) $W = P \times T = 850 \times 60s = 51000\,J$
$K = \frac{Q_c}{W} \rightsquigarrow Q_c = KW = 2{,}9 \times 51000 = 147900\,J$

b) $Q_H = Q_C + W \Rightarrow Q_H = 147900 + 51000 = 198900\,J$

c) The reason is due to <u>the law of energy</u> as in air conditioner electrical energy (W) is used to transfer heat from a cold place to a hot one.

Question 3:

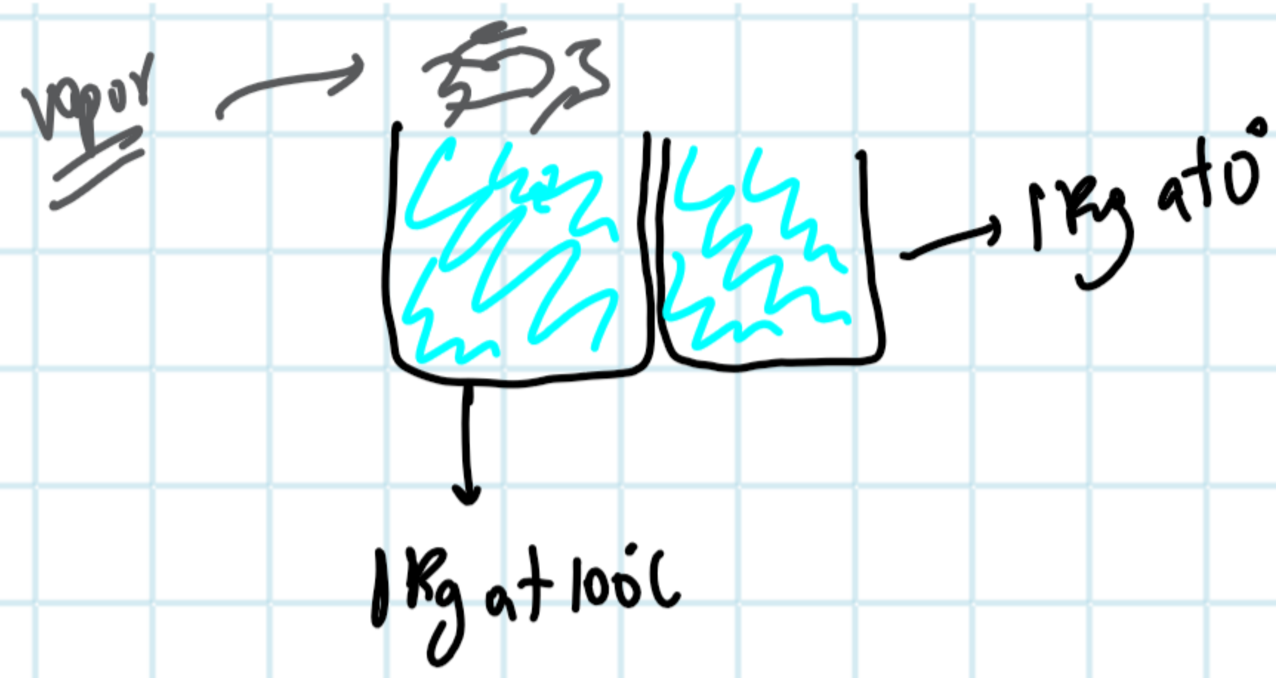
A person who has skin of surface area 1.85 m^2 and temperature 30.0^o C is resting in an insulated room where the ambient air temperature is 20.0^o C. In this state, a person gets rid of excess heat by radiation. By how much does the person change the entropy of the air in this room each second?

$P = \varepsilon \sigma A \left(T_{person}^4 - T_{air}^4\right)$
$P = 111.4\,W$

<u>Entropy</u>: $\frac{\Delta S}{t} = \frac{P}{T_{air}} = \frac{111.4}{293{,}15K} \approx 0{,}38\,J$

Question 4:

Suppose 1.00 kg of water at 100°C is placed in thermal contact with 1 kg of water at 0°C. What is the total change in entropy? Assume that the specific heat of water is constant at 4190 J/kg.K over this temperature range.



- $T_f = \dfrac{T_{cold} + T_{hot}}{2} = \dfrac{373{,}15 + 273{,}15}{2} = 323{,}15\,K$

$\Delta S_{hot} = mc \ln\left(\dfrac{T_f}{T_i}\right) = 4190 \ln\left(\dfrac{323{,}15}{373{,}15}\right) = -602{,}79\,J/K \rightsquigarrow$ loses Entropy

- $\Delta S_{cold} = mc \ln\left(\dfrac{T_f}{T_i}\right) = 4190 \ln\left(\dfrac{323{,}15}{273{,}15}\right) = 704{,}32\,J/K \rightsquigarrow$ Gain Entropy

$\Delta S_{total} = -602{,}79 + 704{,}32 = 101{,}53\,J/K$

Question 5:

What do you think about the entropy of universe, is it increasing, decreasing? Justify your statement with the help of suitable mathematical equation.

This is the central statement of the Second Law of Thermodynamics. It dictates that for any real (irreversible) process, the total entropy of the "universe" (the system plus its surroundings) must increase. While a local system's entropy can decrease (like freezing water), it does so by causing an even larger entropy increase in its surroundings.The mathematical equation is:

$$\Delta S_{universe} = \Delta S_{System} + \Delta S_{surrounding} \geq 0$$