(1) Calculate the change in entropy when 1 kg of ice at 0°c is converted into water at the same temperature. (L of ice = 0.336×10^{6} J kg^{-1})

Sol: we know that $S_2 - S_1 = (L/T)$

$$L = 0.336 \times 10^{6} \text{ J kg}^{-1}$$

$$= \frac{0.336 \times 10^{6}}{4.2} \text{ Cal kg}^{-1}$$

$$= \frac{0.336 \times 10^{6}}{4.2 \times 1000} \text{ Cal g}^{-1}$$

$$L = 80 \text{ Cal g}^{-1}$$

$$S_2 - S_1 = \frac{80}{273}$$

$$= 0.2930 \text{ Cal/K}$$

So, increase in entropy for 1 kg (= 1000 g)

$$= 1000 \times 0.2930$$

$$= 293 \text{ Cal/K}.$$

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② The efficiency of a Carnot's engine is 60%. Calculate the increase in the Temperature of the Source so that the efficiency becomes 70%.

sol: we know that $\eta = 1 - \frac{T_2}{T_1}$

$T_2 \rightarrow$ temp of sink

$T_1 \rightarrow$ Temp of source.

$\eta = \frac{60}{100} = 0.6$. then

$0.6 = 1 - \frac{T_2}{T_1}$

Then $T_2 = (1 - 0.6) T_1$

$T_2 = 0.4 T_1$

Increasing efficiency is 70%. then source ~~of the~~ be increased from T_1 to $(T_1 + x)$

then $0.7 = 1 - \frac{T_2}{(T_1 + x)}$

$\frac{T_2}{(T_1 + x)} = 1 - 0.7$

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$$\frac{T_2}{T_1+x} = 0.3$$

where $T_2 = 0.4 T_1$ then substituting above

Equation

$$\frac{0.4T_1}{T_1+x} = 0.3$$

$$0.4T_1 = 0.3 \cdot (T_1+x)$$

$$0.4T_1 = 0.3T_1 + 0.3x$$

$$0.4T_1 - 0.3T_1 = 0.3x$$

$$0.1T_1 = 0.3x$$

$$x = \frac{T_1(0.1)}{0.3}$$

(3) The efficiency of a Carnot engine is 25% on reducing the Temperature of the sink by 50% the efficiency is 50% what are the initial Temperature of the Source and sink ?

Sol:

$$\eta = 1 - \frac{T_2}{T_1}$$

$$\eta = \frac{25}{100} = 0.25$$

$$0.25 = 1 - \frac{T_2}{T_1}$$

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In second efficiency $\frac{50}{100} = \eta$

$$\eta = 0.5$$

$$0.5 = 1 - \frac{(T_2 - 50)}{T_1}$$

subtracting ~~Substituting~~ eq (2) from eq (1)

~~0.25~~

$$0.5 - 0.25 = \cancel{1} - \left(\frac{T_2 - 50}{T_1}\right) - \cancel{1} + \frac{T_2}{T_1}$$

$$0.25 = -\left(\frac{T_2 - 50}{T_1}\right) + \frac{T_2}{T_1}$$

$$= \frac{-T_2 + 50}{T_1} + \frac{T_2}{T_1}$$

$$= \frac{1}{T_1}\left(-\cancel{T_2} + 50 + \cancel{T_2}\right)$$

$$0.25 = \frac{50}{T_1}$$

$$T_1 = \frac{50}{0.25}$$

$$T_1 = 200^\circ c$$

from eq (1)

$$0.25 = 1 - \frac{T_2}{200}$$

$$\frac{T_2}{200} = 1 - 0.25$$

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$$\frac{T_2}{200} = 0.75$$

$$T_2 = 200 \times 0.75$$

$$T_2 = 150^\circ C$$

(4) The efficiency of a Carnot's Engine cycle is 1/6. if on reducing the Temp of sink ~~a~~ 65°C the efficiency becomes 1/3 find the ~~Temp~~ Temp of source and sink.

sol: we know $\eta = 1 - \frac{T_2}{T_1}$

In the first case

$$\eta = 1 - \frac{T_2}{T_1} = \frac{1}{6}$$

$$\frac{T_2}{T_1} = 1 - \frac{1}{6}$$

$$= \frac{6-1}{6}$$

$$\frac{T_2}{T_1} = \frac{5}{6} \quad \text{--- (1)}$$

Now decreasing the sink Temp at 65°C

$$T_2 = t_2 + 273$$

$$T_2' = (t_2 - 65) + 273$$

$= (t_2 + 273) - 65$

$= T_2 - 65$ then

now efficiency

$$\eta = 1 - \frac{T_2 - 65}{T_1} = \frac{1}{3}$$

$$\frac{T_2 - 65}{T_1} = 1 - \frac{1}{3}$$

$$= \frac{3-1}{3}$$

$$\frac{T_2 - 65}{T_1} = 2/3 \quad \text{—— (2)}$$

eq (2) is deviding by eq (1) then

$$\frac{\frac{T_2 - 65}{T_1}}{\frac{T_2}{T_1}} = \frac{2/3}{5/6}$$

$$\frac{T_2 - 65}{\cancel{T_1}} \times \frac{\cancel{T_1}}{T_2} = \frac{2}{\cancel{3}} \times \frac{\cancel{6}^{\,2}}{5}$$

$$\frac{T_2 - 65}{T_2} = \frac{4}{5}$$

$$T_2 - 65 = \frac{4T_2}{5}$$

$$5(T_2 - 65) = 4T_2$$

$$5T_2 - 325 = 4T_2$$

$$5T_2 - 4T_2 = 325$$

$$T_2 = 325$$

$$T_1 = T_2 \times \frac{6}{5}$$

$$= \frac{325 \times 6}{5}$$

$$T_1 = 390 \cdot K$$

In the first case source Temp $T_1 = 390$ K

and sink Temp $T_2 = 325$ K.

(5) Calculate the change in melting point of ice under a pressure of 100 atmospheres [density of ice = 0.917 gm/cc, $L_i = 336$ J/gm]

Sol: Here ~~[illegible]~~ 1 kcal kg^{-1} = 4.1867 J/gm

then $336 \text{ J/gm} = \frac{336}{4.1867}$

$= 80 \text{ kcal} \cdot kg^{-1}$

then $L = 80 \text{ kcal} \cdot kg^{-1}$

and density of ice = 920 kg m^{-3}

[$\rho = 0.917$ g/cc]

Then $T = 273$ K, $L = 80$ kcal. kg^{-1}, and

density of ice = 920 kg m^{-3}.

$dP = (100-1)$

$= 99$

$= 99 \times 76 \times 13.6 \times 980$ dyne/cm^2

$v_2 = 1$

$v_1 = \frac{1}{\rho} = \frac{1}{0.917}$

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$$v_2 - v_1 = \left(1 - \frac{1}{0.917}\right)$$

$$= -0.091 \ cm^3$$

$$dT = ?$$

$$\frac{dP}{dT} = \frac{LJ}{T(v_2 - v_1)}$$

$$dP = \frac{LJ}{T(v_2 - v_1)} \cdot dT$$

$$dT = \frac{T(v_2 - v_1) \times dP}{LJ}$$

$$= \frac{99 \times 76 \times 13.6 \times 980 \times 273 \times (-0.091)}{80 \times 4.2 \times 10^7}$$

$$dT = -0.7326$$

Change in melting Point $= 0.7326\,°C$.

(6) Deduce the change in the boiling point of water when the pressure is changed 1 cm of mercury ($L_s = 20268 \times 10^6$ J/kg). Volume of 1 kg water $= 10^{-3}$. and volume of 1 kg steam = 1.

Sol: $\frac{dP}{dT} = \frac{L}{T(V_2 - V_1)}$

$V_1 = 10^{-3}\ m^3$

$V_2 = 1.674\ m^3$

$T = 273 + 100$

$= 373\ K$

and $dP = 1$ cm of mercury $= 10^{-2} \times 13.6 \times 10^3 \times 9.8$

$dP = 1332.8\ N/m^2$

$\frac{1332.8}{dT} = \frac{22.68 \times 10^5}{373 \times (1.674 - 0.001)}$

$dT = \frac{1332.8 \times 373 \times (1.674 - 0.001)}{22.68 \times 10^5}$

boiling point. $dT = 0.368$ K.

(7). Calculate the maximum amount of heat lost per second by radiation by a sphere 10 cm in diameter at a temperature of 227°c when placed in an enclosure at 27°c.

($\sigma = 5.67 \times 10^{-8}$ w/m^{2}k^4)

Sol: According to stefan's law

$$E = \sigma (T^4 - T_0^4)$$

The net rate of loss of heat (Q) by the ~~total~~ surface area ($4\pi r^2$) of the sphere is given by

$$Q = E \times (4\pi r^2)$$

$$= \sigma (T^4 - T_0^4)(4\pi r^2)$$

Here $\sigma = 5.67 \times 10^{-8}$ w/m^{2}k^4

$T = 227°c$

$= (227 + 273)$ k

$= 500$ k

$T_0 = 27°c$

$= (27 + 273)$

$= 300$ k

and $r = 5 \times 10^{-2}$ m

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$Q = (5.67 \times 10^{-8})\left[(500)^4 - (300)^4\right] 4 \times 3.14 (5\times$

$= 98.83$ J/sec

$= 96.83$ watt.

(8) A body at 1500 k emitts maximum energy at a wavelength 20,000 A°. If the Sun emitts maximum energy at a wavelength 5500 A° what would be the Temperature of the Sun?

Sol: According to wien's displacement law

$$\lambda_m T = \text{Constant}$$

$$\lambda_m T = \lambda_m' T'$$

$$T' = \frac{\lambda_m T}{\lambda_m'}$$

$$= \frac{20000 \times 1500}{5500}$$

$$= 5454 \text{ K}$$

(9) Calcula

from the

$S = 1.34$

distance

and ste

Sol: The

He

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