Problems on Entropy

Q1 The change in entropy for melting 6.0 kg of a solid which melts at 27 °C is: [The latent heat of fusion of the solid is 2.5×10^4 J/kg] (Ans: $+5.0\times10^2$ J/K)

$$\Delta S = \frac{mL}{T} = \frac{6\times2.5\times10^4}{27+273} = 500\ J/K$$

Q2. An ice cube of mass 400 g at temperature of 0 °C melts to water at 0 °C. The process takes place very slowly, so it is reversible. What is the change in entropy of the ice when it has all melted. (Ans: 488 J/K)

$$\Delta S = \frac{mL}{T} = \frac{0.4\times333\times10^3}{273} = 488\ J/K$$

Q3. Liquid water having a mass of 50 grams was initially at 0 °C. Heat was added to the water so that its entropy increases by 94.0 J/K, what is the final temperature of the water?(Ans: 428 K)

$$\Delta S = mc\ln(T_f/T_i) \Rightarrow T_f = T_i\, e^{\frac{\Delta S}{mc}} = 273\, e^{\frac{94}{0.05\times4190}} = 428\ K$$

Q#4 A 5.00-kg block of copper is at 296 K. If it is heated that its entropy increases by 1.07 kJ/K, what is the final temperature? [The specific heat of copper is 386 J/(kg*K)] [A1 515 K.]

$$T_f = T_i\, e^{\frac{\Delta S}{mc}} = 1515\ K$$

Q5. Calculate the change in entropy of 1.0 kg of ice at 0.0 °C when its temperature is increased to 20.0 °C [$L_{fusion\text{-}ice}$= 333 kJ/kg; c_{water}= 4190 J/kg.K. (Ans:1.5×10^3 J/K)

$$\Delta S = \Delta S_1 + \Delta S_2 = \frac{mL}{T} + mc_w \ln\frac{T_f}{T_i} = \frac{1\times333\times10^3}{273} + 1\times4190\times\ln\left(\frac{273+20}{273}\right)$$

Q#6. One mole of an ideal gas expands reversibly and isothermally at temperature T =27 °C until its volume is doubled. The change of entropy of this gas for this process is: (Ans: 5.8 J/K)

$V_f = 2V_i$

$$\Delta S = nR\ln\frac{V_f}{V_i} = 1\times8.31\ln 2 = 5.76\ J/K$$

Q7: An ideal monatomic gas is confined to a cylinder by a piston. The piston is slowly pushed in so that the gas temperature remains at 27 degree C. During the compression, 750 J of work is done on the gas. The change in the entropy of the gas is: (Ans: -3.0 J/K) .

$$W = nRT\ln\left(\frac{V_f}{V_i}\right)$$
$$\Delta S = nR\ln\left(\frac{V_f}{V_i}\right)$$

note that W is -ve (done on gas) so S is -ve

$$\Delta S = \frac{W}{T}$$