Answer on Question #74944 Math / Calculus

A $m = 2$ kg of water is heated from 0°C to 100°C and converted into steam at the same temperature. Calculate the increase in entropy, given that specific heat of water is $c = 4.18 \times 10^3$ J kg^{-1} K^{-1} and Latent heat of vaporization is $L = 2.27 \times 10^7$ J kg^{-1}.

Solution:

The change of entropy

$$\Delta S = (\Delta S)_{\text{heating}} + (\Delta S)_{\text{vaporization}}$$

$$(\Delta S)_{\text{heating}} = \int_{T_1}^{T_2} \frac{\delta Q}{T} = \int_{T_1}^{T_2} \frac{cmdT}{T} = cm \ln \frac{T_2}{T_1} = 4.18 \times 10^3 \times 2 \times \ln \frac{373}{273} = 2.6 \times 10^3 \frac{\text{J}}{\text{K}}$$

$$(\Delta S)_{\text{vaporization}} = \frac{Q}{T_2} = \frac{Lm}{T_2} = \frac{2.27 \times 10^7 \times 2}{373} = 121.7 \times 10^3 \frac{\text{J}}{\text{K}}$$

So

$$\Delta S = 2.6 \times 10^3 \frac{\text{J}}{\text{K}} + 121.7 \times 10^3 \frac{\text{J}}{\text{K}} = 124.3 \times 10^3 \frac{\text{J}}{\text{K}} = 124.3 \frac{\text{kJ}}{\text{K}}$$

Answer: $124.3 \frac{\text{kJ}}{\text{K}}$