Exercise 7-1

Saturday, 9 May 2020 14:45

$l_c = 3.348 \cdot 10^5 \ J\,kg^{-1}$

$p = 1 \ atm$

$T = 0\,^\circ C = 273,15 \ K$

$\rho_{ice} = 917 \ kg\,m^{-3}$

$\rho_{water} = 999,84 \ kg\,m^{-3}$

$n = 1 \ kmol = 1000 \ mol$

Phase change → isothermal + isobaric

→ reversible: $dW = p\,dV$

$M_w = 2 \cdot 1,008 + 16,00 = 18,016 \ g\,mol^{-1}$

$m = M_w n = 18,016 \ kg$

$V_{ice} = \frac{m}{\rho_{ice}} = 0,0196 \ m^3$ A

$V_{water} = \frac{m}{\rho_{water}} = 0,0180 \ m^3$ B

$W = \int p\,dV = p\Delta V = 1,01 \times 10^5 \ Pa \times (0,0196 - 0,0180)\,m^3 = 164,3 \ J$

$\ldots \times (0,018 - 0,0196) = -164,9 \ J$

($1 \ atm = 1,01 \times 10^5 \ Pa$)

$-164,7 \ J$ if using $18 \ g\,mol^{-1}$

b) $dU = dQ - dW$

$dQ = l\,m = l\,M_w\,n = 3,348 \cdot 10^5 \cdot 18,016 \cdot 1 = 6,03 \cdot 10^6 \ J$

$dU = dQ - dW = 6,03 \cdot 10^6 \ J + 164,9 \ J = 6,032 \cdot 10^6 \ J$

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c) $dQ = T\,dS$

$dS = \frac{dQ}{T} = \frac{1}{T}\,dQ$

$S = \frac{1}{T} \int dQ = \frac{1}{273,15} \cdot 6,032 \cdot 10^6 = 2,208 \cdot 10^4 \ J\,K^{-1}$