Problem 13-08 Freezing point depression – non-electrolyte solutions

Estimate the freezing point depression of the solution of 20.3 g of 1,3,5-trichlorobenzene in 861 g of p-dioxane against the freezing point of pure p-dioxane. Choose the appropriate data:

	M /(g mol^{-1})	t_f/°C	$\Delta_{fusion}H_m$ (kJ mol^{-1})	t_b /°C	$\Delta_{vap}H_m$ (kJ mol^{-1})
p-dioxane	88.1	11.8	12.46	101.1	34.2
1,3,5-trichlorobenzene	181.4	63.45	6.5	208	42.9

[$\Delta T_f = -0.62$ K ($K_K = 4.773$ K kg mol^{-1})]

Solution:

$$K_K = \frac{\boldsymbol{R} T_{f1}^2 \cdot M_1}{\Delta_{fusion} H_1}$$

$M_1 = 88.1$ g mol^{-1}

$\Delta_{fusion}H_m = 12460$ J mol^{-1}

$T_{f1} = 11.8 + 273.15 = 284.95$ K

$$K_K = \frac{8{,}314 \cdot 284{,}95^2 \cdot 88{,}1 \cdot 10^{-3}}{12460} = 4.773 \text{ K kg mol}^{-1}$$

$m_1 = 20.15$ g , $m_2 = 838$ g

$M_2 = 181.4$ g mol^{-1}

$$\underline{m_2} = \frac{m_2}{M_2 \cdot m_1} = \frac{20.3}{181.4 \cdot 861 \cdot 10^{-3}} = 0.13 \text{ mol kg}^{-1}$$

$\Delta T_f = -K_f \cdot \underline{m_2} = -4.773 \cdot 0.13 = -0.62$ K