PHYS 2130 Quiz #2 **Name ______________________**

Useful constants and values.

R = 8.31 J/K·mol
k = 1.38×10^{-23} J/K
$N_A = 6.022 \times 10^{23}$ (g mol)$^{-1}$
1 kcal = 4184 J

Specific Heat.

Aluminum 0.215 kcal/kg·Cº
Water 1.00 kcal/kg·Cº
Ice 0.500 kcal/kg·Cº
Copper 0.0925 kcal/kg·Cº
Glass 0.200 kcal/kg·Cº
Water Vapor 0.500 kcal/kg·Cº

Heat of Fusion
Water 80 kcal/kg

Heat of Vaporization
Water 540 kcal/kg

2.0 kg of ice at 0°C is placed in an insulated container. Next a 3.0 kg mass of aluminum at 350°C is placed into the container. Neglecting any heating of the container or of the air inside the container and assuming no heat leaking into or out of the container, what is the final temperature inside the container?

If not all the ice melts, indicate how much does. If all of the ice melts, indicate what is the final temperature of the water inside the container.

(Show all your work to get full credit.)

First find how much heat is required to melt all of the ice. Using the latent heading equation

$$Q = mL = (2.0\,kg)(80\,kcal/kg) = 160\,kcal$$

If the aluminum were to cool to the melting point of ice, it would take the following amount of heat flow

$$Q = mc\Delta t = (3.0\,kg)(0.215\,kcal/kg\cdot^{\circ}C)(0\,^{\circ}C - 350\,^{\circ}C) = -225.8\,kcal$$

Since the heat flow from the aluminum is sufficient to melt all the ice, we must calculate the final temperature of the water (melted ice) and aluminum. This gives

$$Q = 0 = Q_{melt} + \Delta Q_{Al} + \Delta Q_{H2O}$$
$$0 = m_{ice}L + m_{AL}c_{Al}\left(T - T_{Al}\right) + m_{ice}c_{H2O}\left(T - 0\right)$$
$$0 = m_{ice}L + m_{AL}c_{Al}T - m_{AL}c_{Al}T_{Al} + m_{ice}c_{H2O}T$$
$$m_{AL}c_{Al}T_{Al} - m_{ice}L = m_{AL}c_{Al}T + m_{ice}c_{H2O}T$$

$$\frac{m_{AL} c_{Al} T_{Al} - m_{ice} L}{m_{AL} c_{Al} + m_{ice} c_{H2O}} = T$$

$$T = \frac{(3.0\,kg)(0.215\,kcal/kg \cdot C)(350\,C) - (2.0\,kg)(80\,kcal/kg)}{(3.0\,kg)(0.215\,kcal/kg \cdot C) + (2.0\,kg)(1.00\,kcal/kg \cdot C)} = 24.9\,C$$

The final temperature of the system is 25°C.