*. (8 points) 10 g of ice at 0°C is placed into a 35 g aluminum cup filled with 50 g of water, both initially at 30°C. The mixture is thermally isolated from its environment and allowed to come to equilibrium.

a. (4 points) What is the final temperature of the mixture?

$C_w = 1.00\ cal/g\cdot K$

$C_{Al} = 0.215\ cal/g\cdot K$

$L_{w,fus} = 79.5\ cal/g$

$C_{ice} = C_w m_{ice} = 10\ cal/K$ (after melting)

$C_{w+cup} = \underbrace{C_w m_w}_{50\ cal/K} + \underbrace{C_{Al} m_{Al}}_{7.525\ cal/K} = 57.525\ cal/K$

heat out = heat in

$C_{w+cup}(T_{w+cup} - T_f) = C_{ice}(T_f - T_{ice}) + L\, m_{ice}$

$57.525(30 - T_f) = 10(T_f - 0) + 795$

$1725.75 - 795 = (10 + 57.525)T_f$

$\Rightarrow T_f = \frac{930.75\ cal}{67.525\ cal/K}(40°C) = 13.78°C$

b. (4 points) How much ice (at 0°C) should be added to bring the final temperature of the mixture down to 0°C?

$T_f = 0°C \quad m_{ice} = ?$

heat out = heat in

$57.525\ \frac{cal}{K}(30 - 0)\ C° = (79.5\ cal/g)\, m_{ice}$

$\Rightarrow m_{ice} = \frac{1725.75\ cal}{79.5\ cal/g}$ ← heat available from w+cup to melt ice

$= 21.71\ g$

An additional 11.71 g of ice must be added.

Note: any additional ice beyond the 21.71 g total will remain as ice after the mixture reaches 0°C.