

Name: [5 pts]

1) You are in a mountain and decide to make some tea for yourself. So you take  $m = 0.50$  kg of snow with temperature  $T = -10^\circ\text{C}$ , and put it in your pot. Your camping stove provides a power of  $P = 0.30$  kW. The latent heat for fusion of water is  $L_f = 340$  kJ/kg, and the specific heat of the snow/ice and water are  $c_i = 2.1$  kJ/(kg K) and  $c_w = 4.2$  kJ/(kg K), respectively.

a) How long you have to wait to get boiling water? [7 pts]

b) After you made the tea and pour it to your thermos, you want to drop a small piece of ice, with temperature  $T = -10^\circ\text{C}$ , to lower the tea temperature quickly, from  $T_h = 90^\circ\text{C}$  to  $T_l = 60^\circ\text{C}$ . Estimate the mass of the ice you need. [7 pts]

$$a) \quad Q_{\text{ext}} = \sum_{\alpha} Q_{\alpha}$$

$$Pt = m c_i (0^\circ\text{C} - (-10^\circ\text{C})) + m L_f + m c_w (100^\circ\text{C} - 0^\circ\text{C})$$

$$\rightarrow t = \frac{m}{P} [10 c_i + L_f + 100 c_w] = 22 \text{ min.}$$

$$b) \quad 0 = \sum_{\alpha} Q_{\alpha}$$

$$0 = m_i c_i (0^\circ\text{C} - (-10^\circ\text{C})) + m_i L_f + m_i c_w (60^\circ\text{C} - 0^\circ\text{C}) + m c_w (60^\circ\text{C} - 90^\circ\text{C})$$

$$\rightarrow m_i = m \frac{30 c_w}{10 c_i + L_f + 60 c_w} = 0.10 \text{ kg.}$$