

1. a) 1535 °C

$$b) Q = L_f \cdot m = 2.77 \cdot 10^5 \frac{\text{J}}{\text{kg}} \cdot 3.80 \text{ kg} = 1'052'600 \text{ J} = \underline{1.05 \text{ MJ}}$$

2. a) ①: solid state (warming up) – ②: melting – ③: liquid state (warming up)

b) 40 kJ

$$c) 50 \text{ °C} - (-100 \text{ °C}) = \underline{150 \text{ K}}$$

$$d) 50 \text{ °C} = 323 \text{ K}$$

$$e) 220 \text{ kJ} - 40 \text{ kJ} = \underline{180 \text{ kJ}}$$

f) 0

$$g) 320 \text{ kJ} - 220 \text{ kJ} = \underline{100 \text{ kJ}}$$

$$h) 200 \text{ °C} - 50 \text{ °C} = \underline{150 \text{ K}}$$

$$i) L_f = \frac{Q}{m} = \frac{180 \text{ kJ}}{0.632 \text{ kg}} = \underline{2.85 \cdot 10^5 \frac{\text{J}}{\text{kg}}}$$

$$j) c_{\text{solid}} = \frac{Q_{\text{solid}}}{m \cdot \Delta T_{\text{solid}}} = \frac{40 \text{ kJ}}{0.632 \text{ kg} \cdot 150 \text{ K}} = \underline{422 \frac{\text{J}}{\text{kg} \cdot \text{K}}}$$

$$k) c_{\text{liquid}} = \frac{Q_{\text{liquid}}}{m \cdot \Delta T_{\text{liquid}}} = \frac{100 \text{ kJ}}{0.632 \text{ kg} \cdot 150 \text{ K}} = \underline{1.05 \cdot 10^3 \frac{\text{J}}{\text{kg} \cdot \text{K}}}$$

3. a) 660 °C

$$b) \Delta U = c \cdot m \cdot \Delta T = 896 \frac{\text{J}}{\text{kg} \cdot \text{K}} \cdot 0.34 \text{ kg} \cdot 638 \text{ K} = 194'360 \text{ J} = \underline{194 \text{ kJ}}$$

$$c) Q_{\text{warming}} = \Delta U = \underline{194 \text{ kJ}}$$

$$d) Q_{\text{melting}} = L_f \cdot m = 3.97 \cdot 10^5 \frac{\text{J}}{\text{kg}} \cdot 0.34 \text{ kg} = \underline{135 \text{ kJ}}$$

$$e) Q_{\text{total}} = Q_{\text{warming}} + Q_{\text{melting}} = 194 \text{ kJ} + 135 \text{ kJ} = \underline{329 \text{ kJ}}$$

4. kettle:

$$Q_{\text{kettle}} = c_{\text{copper}} \cdot m_{\text{kettle}} \cdot \Delta T_{\text{kettle}} = 383 \frac{\text{J}}{\text{kg} \cdot \text{K}} \cdot 0.326 \text{ kg} \cdot 102.9 \text{ K} = 12'848 \text{ J} = 12.8 \text{ kJ}$$

Warming up the ice:

$$Q_{\text{ice}} = c_{\text{ice}} \cdot m_{\text{ice}} \cdot \Delta T_{\text{ice}} = 2.09 \cdot 10^3 \frac{\text{J}}{\text{kg} \cdot \text{K}} \cdot 0.472 \text{ kg} \cdot 19.4 \text{ K} = 19'138 \text{ J} = 19.1 \text{ kJ}$$

$$\text{Melting the ice: } Q_{\text{melting}} = L_{f(\text{ice})} \cdot m_{\text{ice}} = 3.34 \cdot 10^5 \frac{\text{J}}{\text{kg}} \cdot 0.472 \text{ kg} = 157'648 \text{ J} = 158 \text{ kJ}$$

Warming up the water: $Q_{\text{water}} = c_{\text{water}} \cdot m_{\text{water}} \cdot \Delta T_{\text{water}}$

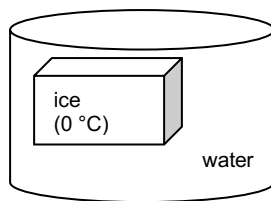
$$= 4.182 \cdot 10^3 \frac{\text{J}}{\text{kg} \cdot \text{K}} \cdot 0.472 \text{ kg} \cdot 83.5 \text{ K} = 164'821 \text{ J} = 165 \text{ kJ}$$

Total:

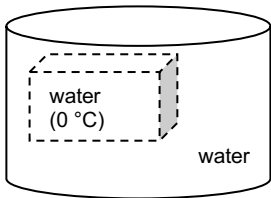
$$Q_{\text{total}} = Q_{\text{kettle}} + Q_{\text{ice}} + Q_{\text{melting}} + Q_{\text{water}} = 12.8 \text{ kJ} + 19.1 \text{ kJ} + 158 \text{ kJ} + 165 \text{ kJ} = 355 \text{ kJ}$$

$$\text{Amount of wood: } \frac{355 \text{ kJ}}{8'000 \frac{\text{kJ}}{\text{kg}}} = 0.04436 \text{ kg} = \underline{\underline{44 \text{ g}}} \text{ of wood}$$

5.



	process	temperature (goes up / goes down / no change)	heat (gain/loss)
water	<i>cools down</i>	<i>goes down</i>	<i>loss</i>
ice	<i>melts</i>	<i>no change</i>	<i>gain</i>



	process	temperature (goes up / goes down / no change)	heat (gain/loss)
water	<i>cools down</i>	<i>goes down</i>	<i>loss</i>
melted water (from ice)	<i>warms up</i>	<i>goes up</i>	<i>gain</i>

6. a) $\Delta U_{\text{water}} = c_{\text{water}} \cdot m_{\text{water}} \cdot \Delta T_{\text{water}} = 4'182 \frac{\text{J}}{\text{kg} \cdot \text{K}} \cdot 0.20 \text{ kg} \cdot 32 \text{ K} = 26'765 \text{ J} = \underline{\underline{27 \text{ kJ}}}$

b) $Q_{\text{water}} = \Delta U_{\text{water}} = \underline{\underline{27 \text{ kJ}}}$

c) $Q_{\text{ice}} = Q_{\text{water}} = \underline{\underline{27 \text{ kJ}}}$

d) $m = \frac{Q}{L_f} = \frac{27 \cdot 10^3 \text{ J}}{3.34 \cdot 10^5 \frac{\text{J}}{\text{kg}}} = 0.081 \text{ kg} = \underline{\underline{81 \text{ g}}}$

7. a) $Q_{\text{water}} = \Delta U_{\text{water}} = c_{\text{water}} \cdot m_{\text{water}} \cdot \Delta T_{\text{water}} = 4182 \frac{\text{J}}{\text{kg} \cdot \text{K}} \cdot 4.50 \text{ kg} \cdot 14 \text{ K}$
 $= 263'466 \text{ J} = \underline{263 \text{ kJ}}$

b) $Q_{\text{ice}} = Q_{\text{water}} = \underline{263 \text{ kJ}}$

c) ① ice warms up from $-5.0 \text{ }^\circ\text{C}$ to $0.0 \text{ }^\circ\text{C}$; ② ice melts at $0.0 \text{ }^\circ\text{C}$

d) $Q_{\text{ice}} = \Delta U_{\text{ice}} + Q_{\text{melting(ice)}} = c_{\text{ice}} \cdot m_{\text{ice}} \cdot \Delta T_{\text{ice}} + L_{f(\text{ice})} \cdot m_{\text{ice}} = m_{\text{ice}} \cdot (c_{\text{ice}} \cdot \Delta T_{\text{ice}} + L_{f(\text{ice})})$

$$m_{\text{ice}} = \frac{Q_{\text{ice}}}{c_{\text{ice}} \cdot \Delta T_{\text{ice}} + L_{f(\text{ice})}} = \frac{263 \cdot 10^3 \text{ J}}{2.09 \cdot 10^3 \frac{\text{J}}{\text{kg} \cdot \text{K}} \cdot 5.0 \text{ K} + 3.34 \cdot 10^5 \frac{\text{J}}{\text{kg}}} = 0.766 \text{ kg} = \underline{766 \text{ g}}$$