c_{water} = 4200 J/kgK c_{ice} = 2100 J/kgK c_{copper} = 390 J/kgK

$L_{f, ice}$ = 3.34*10^5 J/kg $L_{v, water}$ = 22.5*10^5 J/kg

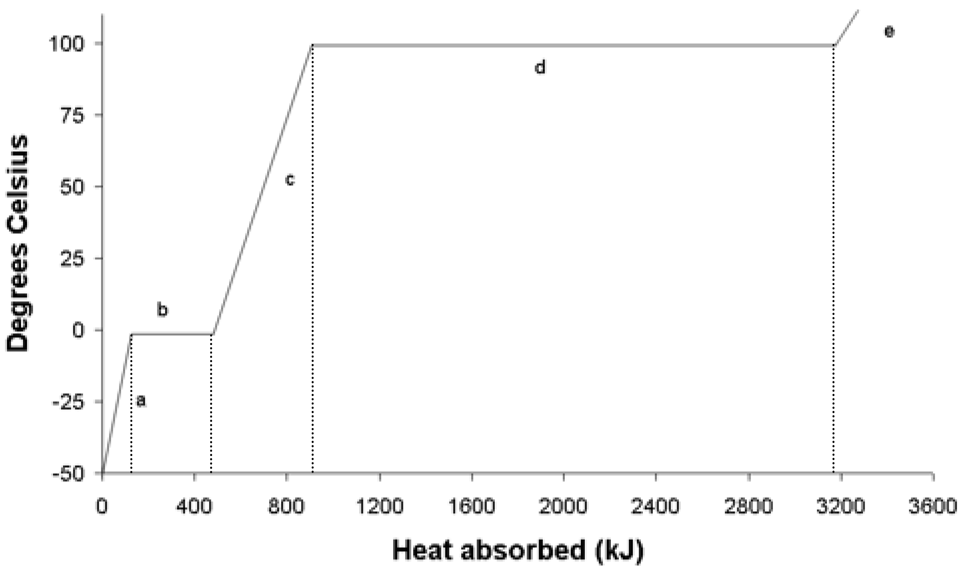
Latent heat and Specific heat capacity questions.

1. How much water at 50°C is needed to just melt 2.2 kg of ice at 0°C?

2. How much water at 32°C is needed to just melt 1.5 kg of ice at -10°C?

3. How much steam at 100° is needed to just melt 5 kg of ice at -15°C?

4. A copper cup holds some cold water at 4°C. The copper cup weighs 140g while the water weighs 80g. If 100g of hot water, at 90°C is added, what will be the final temperature of the water?



5. a)Explain where the energy is going at each section of the curve from "a" to "e"

b) Using section "b" , calculate the amount of ice used to produce the graph

c) Using section "c", calculate the amount of ice used to produce the graph

Solutions

1. How much water at 50°C is needed to just melt 2.2 kg of ice at 0°C?

$$Heat\ loss = heat\ gain$$
$$Heat\ loss\ of\ water = heat\ to\ melt\ ice$$
$$m_{water}c_{water}\Delta T = m_{ice}L_f$$
$$m_{water} * 4200 * (50 - 0) = 2.2 * 3.34 * 10^5$$
$$m_{water} = 3.50\ kg$$

2. How much water at 32°C is needed to just melt 1.5 kg of ice at -10°C?

$$Heat\ loss = heat\ gain$$
$$Heat\ loss\ of\ water = heat\ gain\ of\ ice + heat\ to\ melt\ ice$$
$$m_{water}c_{water}\Delta T = m_{ice}c_{ice}\Delta T + m_{ice}L_f$$
$$m_{water} * 4200 * (32 - 0) = 1.5 * 2300 * (0 - (-10)) + 1.5 * 3.34 * 10^5$$
$$m_{water} = 3.98\ kg$$

3. How much steam at 100° is needed to just melt 5 kg of ice at -15°C?

$$Heat\ loss = heat\ gain$$
$$Heat\ to\ condense\ steam + Heat\ loss\ of\ water = heat\ gain\ of\ ice + heat\ to\ melt\ ice$$
$$m_{steam}L_v + m_{steam}c_{water}\Delta T = m_{ice}c_{ice}\Delta T + m_{ice}L_f$$
$$m_{steam} * 22.5 * 10^5 + m_{steam} * 4200 * (100 - 0) = 5 * 2300 * (0 - (-15)) + 5 * 3.34 * 10^5$$
$$2.67 * 10^6 * m_{steam} = 1.84 * 10^6$$
$$m_{steam} = 0.69\ kg$$

4. A copper cup holds some cold water at 4°C. The copper cup weighs 140g while the water weighs 80g. If 100g of hot water, at 90°C is added, what will be the final temperature of the water?

$$Heat\ loss = heat\ gain$$
$$heat\ gain\ of\ cup + heat\ gain\ of\ cold\ water = heat\ loss\ of\ hot\ water$$
$$m_{cup}c_{cup}\Delta T + m_{cw}c_w\Delta T = m_{hw}c_w\Delta T$$
$$0.14 * 390 * (T_F - 4) + 0.08 * 4200 * (T_F - 4) = 0.1 * 4200 * (90 - T_F)$$
$$390.6T_F - 1562.4 = 37800 - 420T_F$$
$$810.6T_F = 39362.4$$
$$T_F = 48.6°C$$

5. a)Explain what is occuring at each section of the curve from "a" to "e"

a - ice particles are increasing in kinetic energy, raising temperature

b- ice particles are breaking apart and increasing in potential energy as ice melts

c- water particles are increasing in kinetic energy, raising temperature

d- water particles are breaking apart and increasing in potential energy as water vaporises

e- steam particles are increasing in kinetic energy, raising temperature

b) Using section "b" , calculate the amount of ice used to produce the graph

$\Delta Q = mL_f$
$480 - 140 = m * 3.34 * 10^5$
$m = 0.001\ kg\ (approx\ 1\ g, with\ error\ from\ reading\ graph)$

c) Using section "c", calculate the amount of ice used to produce the graph
$\Delta Q = mc\Delta T$
$920 - 480 = m * 4200 * (100 - 0)$
$m = 0.001\ kg\ (approx\ 1\ g, with\ error\ from\ reading\ graph)$