Solution for HW #1

17.105 (a) $M_{steam} = 0.04\,kg$ $T = 100°C$

$M_{water} = 0.2\,kg$ $T = 50°C$

heat is removed:

$Q_{steam} = M_{steam} L$

$= -0.04\,kg \times 2256 \times 10^3\,J/kg = \boxed{-9.024 \times 10^4\,J}$

The positive heat gained by water is

$Q = mC\Delta T$

$= 0.2\,kg \times 4190\,J/kg \cdot K \times (100°C - 50°C)$

$= \boxed{4.19 \times 10^4\,J}$

And the final temperature is 100°C

(b) $m = \frac{Q}{L} = \frac{4.19 \times 10^4\,J}{2.256 \times 10^6\,J/kg} = 0.0186\,kg$

H_2O: $0.0186\,kg + 0.02\,kg = \boxed{0.219\,kg}$

steam: $0.04\,kg - 0.0186\,kg = \boxed{0.0214\,kg}$

17.113 (a) When the temperature is (at) 4°C the surface of the lake cools and sink because water is most dense at 4°C. When the temp. drops below 4°C, the water at the surface becomes less dense than water below it and will not sink again. When the temp. is at 0°C the surface of lake gets freeze and remains colder than the bottom temp. And the bottom will remains at 4°C for a long time.

(b) $H = \frac{dQ}{dt} = \frac{KA(T_H - T_C)}{h}$ h: the thickness of ice

t: time

$dQ = L_f\,dm = \rho \cdot L_f\,dV = \rho \cdot L_f\,A\,dh$

$\frac{\rho \cdot L_f A\,dh}{dt} = \frac{KA(T_H - T_C)}{h} = \frac{KA\Delta T}{h}$

$dh \cdot h = \frac{K\Delta T}{\rho L_f} dt$

$\int_0^h dh \cdot h = \int_0^t \frac{K\Delta T}{\rho L_f} dt$

$\frac{1}{2} h^2 = \frac{K\Delta T\,t}{\rho L_f}$ $h = \sqrt{\frac{2K\Delta T t}{\rho L_f}}$ $h \propto \sqrt{t}$.

(c) $\Delta T = 10°C$

$$t = \frac{h^2 \rho L_f}{2 k \Delta T} = \frac{(0.25m)^2 \times (920 kg/m^3) \times (3.34 \times 10^5 J/kg)}{2 (1.6 W/m \cdot K) \cdot 10°C}$$

$$\doteq \boxed{6.0 \times 10^5 s}$$

(d) $t = \boxed{1.54 \times 10^{10} sec}$

It would not likely to occur.