Solution:

We use the following notation:

t	temperature of the final equilibrium state,
$t_0 = 0\,^\circ\mathrm{C}$	the melting point of ice under normal pressure conditions,
M_2	final mass of water,
M_3	final mass of ice,
$m_2' \leq m_2$	mass of water, which freezes to ice,
$m_3' \leq m_3$	mass of ice, which melts to water.

a) Generally, four possible processes and corresponding equilibrium states can occur:

1. $t_0 < t < t_2$, $m_2' = 0$, $m_3' = m_3$, $M_2 = m_2 + m_3$, $M_3 = 0$.
   Unknown final temperature t can be determined from the equation

$$(m_1 c_1 + m_2 c_2)(t_2 - t) = m_3 c_3 (t_0 - t_3) + m_3 l + m_3 c_2 (t - t_0)\,. \qquad (7)$$

   However, only the solution satisfying the condition $t_0 < t < t_2$ does make physical sense.

2. $t_3 < t < t_0$, $m_2' = m_2$, $m_3' = 0$, $M_2 = 0$, $M_3 = m_2 + m_3$.
   Unknown final temperature t can be determined from the equation

$$m_1 c_1 (t_2 - t) + m_2 c_2 (t_2 - t_0) + m_2 l + m_2 c_3 (t_0 - t) = m_3 c_3 (t - t_3)\,. \quad (8)$$

   However, only the solution satisfying the condition $t_3 < t < t_0$ does make physical sense.

3. $t = t_0$, $m_2' = 0$, $0 \le m_3' \le m_3$, $M_2 = m_2 + m_3'$, $M_3 = m_3 - m_3'$.
   Unknown mass m_3' can be calculated from the equation

$$(m_1 c_1 + m_2 c_2)(t_2 - t_0) = m_3 c_3 (t - t_3) + m_3' l\,. \qquad (9)$$

   However, only the solution satisfying the condition $0 \le m_3' \le m_3$ does make physical sense.

4. $t = t_0$, $0 \le m_2' \le m_2$, $m_3' = 0$, $M_2 = m_2 - m_2'$, $M_3 = m_3 + m_2'$.
   Unknown mass m_2' can be calculated from the equation

$$(m_1 c_1 + m_2 c_2)(t_2 - t_0) + m_2' l = m_3 c_3 (t_0 - t_3)\,. \qquad (10)$$

   However, only the solution satisfying the condition $0 \le m_2' \le m_2$ does make physical sense.

b) Substituting the particular values of m_1, m_2, m_3, t_2 and t_3 to equations (7), (8) and (9) one obtains solutions not making the physical sense (not satisfying the above conditions for t, respectively m_3'). The real physical process under given conditions is given by the equation (10) which yields

$$m_2' = \frac{m_3 c_3 (t_0 - t_3) - (m_1 c_1 + m_2 c_2)(t_2 - t_0)}{l}\,.$$

Substituting given numerical values one gets $m_2' = 0.11$ kg. Hence, $t = 0\,^{\circ}\mathrm{C}$, $M_2 = m_2 - m_2' = 0.89$ kg, $M_3 = m_3 + m_2' = 2.11$ kg.