Answer on Question #71165 – Chemistry – General Chemistry

A 0.5970 kg ice cube at -12.40°C is placed inside a chamber of steam at 365.0°C. Later, you notice that the ice cube has completely melted into a puddle of water. If the chamber initially contained 6.910 moles of steam (water) molecules before the ice is added, calculate the final temperature of the puddle once it settled to equilibrium. (Assume the chamber walls are sufficiently flexible to allow the system to remain isobaric and consider thermal losses/gains from the chamber walls as negligible)

Solution:

m(water) = 6.910 mol × 18 g/mol = 124.38 g,
m(ice) = 0.5970 kg,
c(water) = 1 cal/g · °C ,
L_f = 333000 J/kg ,
T_w = 365°C,
T_i = -12.4°C
ΔT = 365-(-12.4) = 377.4°C
The 124.38 g of water cools to -12.40°C, giving off heat:
$Q_w = m_w \times c_w \times \Delta T$ = (124.38 g)(1 cal/g ·°C)(377.4°C) = 46941,01 cal
If all of the ice melts, it absorbs heat:
$Q_i = m_{ice} \times L_f$ = (0.5970 kg)(333000 J/kg)(0.2389 cal/J) = 47493.56 cal
$Q_{lostwater} = Q_{meltice} + Q_{gained}$
$m_w \times c_w \times (T_w - T_f) = Q_i + m_{ice} \times c_w \times (T_f - T_{ice})$
$m_w \times c_w \times T_w - m_w \times c_w \times T_f = Q_i + m_{ice} \times c_w \times (T_f - 0)$
$m_w \times c_w \times T_w - Q_i = (m_{ice} \times c_w + m_w \times c_w) \times T_f$

$$T_f = \frac{m_w c_w T_w - Q_i}{m_{ice} c_w + m_w c_w} = \frac{(124{,}38g)(1cal/g\cdot^{\circ}C)(377^{\circ}C) - 47493{,}56cal}{(0{,}5970kg)(1cal/g\cdot^{\circ}C) + (124{,}38g)(1cal/g\cdot^{\circ}C)} =$$

$$= \frac{46941{,}01cal - 47493{,}56cal}{597cal/^{\circ}C + 124{,}38cal/^{\circ}C} = 0{,}766^{\circ}C$$