Answer on Question 49434, Physics, Molecular Physics | Thermodynamics

Question:

The Westin Stamford Hotel in Detroit is 228 m tall. Suppose a piece of ice, which initially has a temperature of 0.0 C, falls from the hotel roof and crashes to the ground. Assuming that 50.0 percent of the ice's mechanical energy during the fall and collision is absorbed by the ice and that 3.33*10^5 J is required to melt 1.00 kg of ice, calculate the fraction of the ice's mass that would melt.

Solution:

Let’s find the mechanical energy of the 1.0 kg of ice that falls from the Westin Stamford Hotel. By the law of conseration of energy we have (we write the equation when a piece of ice begins to fall from roof of a hotel):

$$E_{mech} = P.E. + K.E.$$

$$E_{mech} = mgh + 0 = 1.0kg \cdot 9.8\frac{m}{s^2} \cdot 228m = 2234.4J.$$

From the condition of question we know, that 50.0 percent of the ice's mechanical energy during the fall and collision is absorbed by the ice, so the half of the mechanical energy would be $E_{mech} \cdot 0.50 = 2234.4J \cdot 0.50 = 1117.2J$. Therefore, the fraction of the ice's mass that would melt will be:

$$\frac{E_{mech}}{E_{melt}} \cdot 100\% = \frac{1117.2J}{3.33 \cdot 10^5 J} \cdot 100\% = 0.33\%.$$

Answer:

The fraction of the ice's mass that would melt will be 0.33%.