Answer on Question #43176-Physics-Molecular Physics-Thermodynamics

Calculate the required electric energy in k joules for an electric refrigerator with motor working between 30c and 5c to freeze 3kg of water at 0c the latent heat of water-ice is 80 cal/gm.

Solution

The refrigeration efficiency is

$$\eta = \frac{Q}{W} = \frac{T_2}{T_1 - T_2}.$$

Hence

$$W = Q\,\frac{T_1 - T_2}{T_2}.$$

$Q = ML$ is latent heat for $M = 3\text{kg}$ of water at $T = 0℃$ to become ice. As

$$L = 80\frac{\text{cal}}{\text{gm}} = 3.35 \cdot 10^5\,\frac{J}{kg}.$$

we find

$$W = 3.35 \cdot 10^5\,\frac{J}{kg} \cdot 3\text{kg}\frac{25K}{278.15K} = 90.3 \cdot 10^3 J = 90.3\ kJ$$

Answer: $\mathbf{90.3\ kJ}$.