Given a temperature of tomatoes is lower from 18 degree Celsius to 2 degree Celsius so as to freeze tomatoes with specific heat of 50 joules.

If tomatoes weight 20kg with heat of fussion and storage temperature of 1500 k.cal and -18 degree Celsius respectively. Calculate

1. Energy required to freeze tomatoes
2. Energy required to change tomatoes from freezing point to solid
3. The energy required to lower the temperature of tomatoes from freezing temperatures to storage temperature

Solution

1. Note: specific heat is usually expressed in units j/kg×°C or cal/kg×°C, therefore it is not clear from the task the units of specific heat (50 joules), moreover this value is too small in comparison with values from other sourses:
   www.nzifst.org.nz/unitoperations/appendix7.html
   Specific heat (above freezing) 3.98 kJ/kg×°C
   Specific heat (below freezing) 2.01 kJ/kg×°C
   Latent heat of fussion 310 kJ/kg

   Also: www.tgbgroup.co>universities>file>Unfrozen Composition Data, Initial freezing point, and specific heats of Foods.pdf
   Specific heat (above freezing) 4.02 kJ/kg×K
   Specific heat (below freezing) 1.77 kJ/kg×K
   Latent heat of fussion 311 kJ/kg

   So, energy required to freeze tomatoes is:
   $Q=cm\Delta T$
   Q= 3.98 kJ/kg×°C × 20 kg ×(2°C – 18°C) = - 1273.6 kJ
   Minus shows that tomatoes give off their energy, therefore the energy required for this process is 1273.6 kJ

2. Energy required to freeze tomatoes from freezing point to solid is:
   $Q=\Delta H_{fussion} \times m$
   Q= -310 kJ/kg ×20 kg = -6200 ķJ = -1480 kcal ≈ -1500 kcal what corresponds with the value given in the task. Required energy is 6200 kJ

3. The energy required to lower the temperature of tommatoes from freezing temperatures to storage temperature:
   $Q=cm\Delta T$
   Q= 2.01 kJ/kg×°C × 20 kg × (-18-2) = -804 kJ

Required energy is 804 kJ

Answer: 1 . 1273.6 kJ

2. 6200kJ

3. 804 kJ