An open vessel contains 450 g of ice at -15°C.Heat is supplied to the vessel at a constant rate of 1,800 calories/minute.(Neglect the mass and heat effect of the vessel. Assume no heat exchange with the surroundings.)
a. After how many minutes will the ice start to melt?
b.After how many minutes will the temperature start to rise from 0°C
c.Calculate the time required for the ice to be converted to steam at 100°C?
NOTE:specific heat: ice-0.5cal/g-C°
Water-1.0cal/g-C°
steam-0.5 cal/g-C°
Hv=540 cal/g
Hf=80cal/g

Solution:

1) For the start melting of ice, it temperature have been 0 ^{0}C, than for heating 450 g of ice from -15 ^{0}C to 0 ^{0}C needs 450 × 0.5 × (0 – (-15)) = 3 375 cal of heat, which obtained during $\frac{3\,375}{1\,800} = 1.875\,\text{min} = 1\,\text{min}\,52.5\,\text{sec}$.
2) The temperature is stable at ^{0}C while all ice is melted. Then, for melting of ice it is consumed 450 × 80 = 36 000 cal of heat, which obtained during $\frac{36\,000}{1\,800} = 20\,\text{min}$. With mentioned above, the temperature start rising after 21 min 52.5 sec.
3) For converting melted ice to steam, firstly we need heat it from 0 ^{0}C to 100 ^{0}C, secondly – evaporate it at 100 ^{0}C. At the first process, melted ice consumed 450 × 1 × (100 – 0) = 45 000 cal, at the second, heated water consumed 450 × 540 = 243 000 cal. In the sum, it is consumed 288 000 cal of heat, which obtained during $\frac{288\,000}{1\,800} = 160\,\text{min}$. Then, total time is 181 min 52.5 sec.

Answer: a) 1 min 52.5 sec, b) 21 min 52.5 sec, c) 181 min 52.5 sec.