Question #42883 – Physics – Molecular Physics | Thermodynamics

Question.

An electric resistance carrying electric current 2A and potential difference 50V immersed in 200g of water during 5 minutes
find
1 - the change in temperature of water at the end of time
2 - the rate of heat flow
3 - the temperature rate

Given:

$I = 2\ A$

$U = 50\ V$

$m = 200\ g = 0.2\ kg$

$t_{end} = 5\ \text{min} = 300\ s$

$c = 4200\ \dfrac{J}{kg \cdot ^\circ\text{C}}$

Find:

1) $\Delta T(t_{end}) = ?$
2) $\dfrac{Q}{t} = ?$
3) $\dfrac{dT}{dt} = ?$

Solution.

Work of the electric element is the amount of energy for the electric heating element by passing electrical current therethrough:

$$A = IU\Delta t$$

All work of electric element is used to heat water. Therefore:

$$A = Q$$

$$Q = mc\Delta T(t)$$

$$IU\Delta t = mc\Delta T(t)$$

So,

1)

$$IUt_{end} = mc\Delta T(t_{end}) \rightarrow \Delta T(t_{end}) = \frac{IUt_{end}}{mc}$$

Calculate:

$$\Delta T(t_{end}) = \frac{2 \cdot 50 \cdot 300}{0.2 \cdot 4200} = 35.7 \text{ ℃}$$

2) In our case, the rate of heat flow is the electrical power N:

$$\frac{Q}{t} = N = IU$$

Calculate:

$$\frac{Q}{t} = 2 \cdot 50 = 100\ W$$

3)

$$IU\Delta t = mc\Delta T$$

$$\frac{dT}{dt} = \frac{\Delta T}{\Delta t} = \frac{IU}{mc}$$

Calculate :

$$\frac{dT}{dt} = \frac{2 \cdot 50}{0.2 \cdot 4200} = 0.12\ \frac{\text{℃}}{s}$$

Answer.

1) the change in temperature of water at the end of time

$$\Delta T(t_{end}) = \frac{IUt_{end}}{mc} = 35.7 \text{ ℃}$$

2) the rate of heat flow

$$\frac{Q}{t} = IU = 100\ W$$

3) the temperature rate

$$\frac{dT}{dt} = \frac{IU}{mc} = 0.12\ \frac{\text{℃}}{s}$$