

② After 10 mins in Jean-Luc's room, his tea has cooled to 48°C from 100°C . The room temperature is 21°C . How much longer will it take to cool to 40°C ?

Solution: Newton's Cooling Formula: $T' = k(T - S)$

T - temp of tea

$21 = S$ - temp of room

$$\left(\frac{dT}{T-21} = k dt \right)$$

$$\ln |T-21| = kt + C$$

$$|T-21| = Ce^{kt}$$

$$T-21 = Ce^{kt}$$

$$T = Ce^{kt} + 21$$

When $t = 0$, $T = 100$

$$100 = T(0) = C + 21$$

$$79 = C \Rightarrow T = 79e^{kt} + 21$$

When $t = 10$, $T = 48$

$$48 = T(10) = 79e^{10k} + 21$$

$$27 = 79e^{10k}$$

$$\frac{1}{10} \ln\left(\frac{27}{79}\right) = k \Rightarrow T = 79 \exp\left[\frac{1}{10} \ln\left(\frac{27}{79}\right)t\right] + 21$$

Find t when $40 = T(t)$

$$40 = 79 \exp\left[\frac{1}{10} \ln\left(\frac{27}{79}\right)t\right] + 21$$

$$\ln\left(\frac{19}{79}\right) = \frac{1}{10} \ln\left(\frac{27}{79}\right)t$$

$$t = \frac{10 \ln\left(\frac{19}{79}\right)}{\ln\left(\frac{27}{79}\right)} \approx 13.273 \text{ min}$$

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So time between 48°C to 40°C is $13.273 - 10 = \boxed{3.273 \text{ mins}}$