

Solution:

The given are $T_0 = 70^\circ\text{F}$, $T_m = 12^\circ\text{F}$, and $T = 40^\circ\text{F}$ after 30 seconds.

The formula is

$$T = T_m + (T_0 - T_m)e^{-kt}$$

Then plug in what is given, so it is

$$40 = 12 + (70 - 12)e^{-\frac{1}{2}k}$$

60 second is equal to 1 minutes, so 30 seconds of 60 seconds is $\frac{1}{2}$.

$$28 = 58e^{-.5k}$$

$$e^{-\frac{1}{2}k} = \frac{28}{58}$$

$$e^{-\frac{1}{2}k} = \frac{14}{29}$$

Take Log both side

$$\ln e^{-\frac{1}{2}k} = \ln \frac{14}{29}$$

$$-\frac{1}{2}k = \ln \frac{14}{29}$$

$$k = -2 \ln \frac{29}{14}$$

$$k = -1.4565$$

To find what the thermometer read after 2 minutes, we plug in 2 into T , so it is

$$\therefore T = 12 + 58e^{kt}$$

$$T(2) = 12 + 58e^{(-1.4565)(2)}$$

$$\boxed{T(2) = 15.15^\circ\text{F}}$$