\[ \text{DE: } E = L \frac{di}{dt} + iR \rightarrow 4 = (1 - t/10) \frac{di}{dt} + .2i \text{ (for } 0 \leq t < 10) \]

Multiply by 10: \[ 40 = (10 - t) \frac{di}{dt} + 2i \]

Standard form: \[ \frac{di}{dt} + \frac{2}{10 - t} i = \frac{40}{10 - t} \]

Int. Factor: \[ \mu(t) = e^{\int \frac{2}{10 - t} dt} = e^{-2 \ln(10 - t)} = (10 - t)^{-2} \]

Multiply by \[ (10 - t)^{-2} \frac{di}{dt} + 2(10 - t)^{-3} i = \frac{40}{10 - t} (10 - t)^{-3} \]

Int. w.r.t. t: \[ (10 - t)^{-2} i = 20 (10 - t)^{-2} + C \]

So \[ i(t) = 20 + C (10 - t)^2 \]

Find C given \( i(0) = 0 \): \[ i(0) = 20 + C (10)^2 \Rightarrow C = -1 \]

So for \( 0 \leq t < 10 \) \[ i(t) = 20 - .2 (10 - t)^2 \] or \[ i(t) = 4t - .2 t^2 \]

For \( t \geq 10 \), \( i = 0 \) so the resulting equation is

\[ E = iR \rightarrow 4 = .2i \]

So that \( i = 20 \) (constant)

In summary

\[ i(t) = \begin{cases} 
4t - .2t^2, & 0 \leq t < 10 \\
20, & t \geq 10 
\end{cases} \]
Let \( t = \# \text{ hrs since noon} \) (i.e. \( t = 0 = \text{noon} \))

\[
\begin{align*}
\{ t_0 &= \# \text{ hrs before noon that it began snowing} \\
X &= \text{distance traveled by plow in feet} \\
W &= \text{width of plow in feet} \\
\Gamma &= \text{rate of snowfall in ft/hr} \\
V &= \text{rate at which plow removes snow ft}^3/\text{hr}
\end{align*}
\]

Letting \( dt \) represent an "increment" of time, \( dx \) will be the corresponding distance traveled by the plow.

The amount of snow removed by the plow in that amount of time will be:

\[
(V \text{ ft}^3/\text{hr})(dt \text{ hr}) = \boxed{Vdt \text{ ft}^3}
\]

Looked at from a different point of view, when the plow moves \( dx \) ft it will remove a rectangular "slice" as shown below

\[
\text{h being the height (depth) of snow, is a function of } t \text{ as it is snowing at a rate of } \Gamma \text{ ft/hr}
\]

As a result \( h(t) = \Gamma(t + t_0) \)

So the amount of snow removed (i.e. the volume of the rect. slice)

\[
W \cdot \Gamma(t + t_0) dx
\]

But this must equal the expression in A above.

This equality yields the DE

\[
W \Gamma(t + t_0) dx = V dt \quad \text{(Separable)}
\]
Separating variables we obtain

\[ \int \frac{rw}{V} \, dx = \int \frac{1}{t+\tau_0} \, dt \]

So that \( \frac{rw}{V} \, x = \ln(t+\tau_0) + C \)

We know \( x(0) = 0 \) \( \rightarrow \) \( 0 = \ln \tau_0 + C \) \( \rightarrow \) \( C = -\ln \tau_0 \)

So that \( \frac{rw}{V} \, x = \ln(t+\tau_0) - 2 \ln \tau_0 = \ln \frac{t+\tau_0}{\tau_0} \)

We also know \( x(1) = 2 \) \( \rightarrow \) \( x(2) = 3 \) yielding

\[
\begin{align*}
\frac{2rw}{V} &= \ln \left( \frac{1+\tau_0}{\tau_0} \right) \\
&\text{multiplied by } 3 \\
\frac{6rw}{V} &= 3 \ln \left( \frac{1+\tau_0}{\tau_0} \right) \\
\frac{3rw}{V} &= \ln \left( \frac{2+\tau_0}{\tau_0} \right) \\
&\text{multiplied by } -2 \\
\frac{-6rw}{V} &= -2 \ln \left( \frac{2+\tau_0}{\tau_0} \right)
\end{align*}
\]

Adding these equations together yields

\[
0 = \ln \left( \frac{1+\tau_0}{\tau_0} \right)^3 - \ln \left( \frac{2+\tau_0}{\tau_0} \right)^2
\]

\[
0 = \ln \left[ \frac{(1+\tau_0)^3}{\tau_0^3} \cdot \frac{\tau_0^2}{(2+\tau_0)^2} \right]
\]

Exponentiate to get

\[
1 = \frac{(\tau_0+1)^3}{\tau_0^2 (\tau_0+2)^2} \rightarrow \tau_0 (\tau_0+2)^2 = (\tau_0+1)^3
\]

\[
\Rightarrow \quad \tau_0^3 + 4\tau_0^2 + 4\tau_0 = 0 \quad \text{Solve: } \tau_0 = 0, -\frac{1}{2}, -1 \pm \sqrt{2}
\]

\[
\text{Solution: } \tau_0 = 0, -\frac{1}{2}, -1 + \sqrt{2} \approx 0.61 \text{ hr } \times 37 \text{ min.}
\]

(Ans 11:23 am)