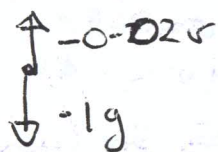


1974 Q10 DE

FORCES



$$\begin{aligned} -x &= 0 \\ t &= 0 \\ v &= 0 \end{aligned}$$

typical point  $\begin{aligned} -x &= x \\ t &= t \\ v &= v. \end{aligned}$

Signs



$$N \square \Rightarrow F = ma$$

$$\Rightarrow -1g - 0.02v = 0 \cdot \frac{dv}{dt}$$

$$\Rightarrow 98 - 2v = 10 \frac{dv}{dt}$$

$$\Rightarrow 49 - v = 5 \frac{dv}{dt}$$

$$\Rightarrow \int \frac{1}{5} dt = \int \frac{dv}{49-v}$$

Now  $\int \frac{dv}{49-v}$

Let  $u = 49 - v$   
 $du = -dv$

$$\begin{aligned} \therefore \int \frac{dv}{49-v} &= -\int \frac{du}{u} \\ &= -\ln u \\ &= -\ln(49-v) \end{aligned}$$

$$\Rightarrow \frac{t}{5} + \text{const} = -\ln(49-v)$$

$$t=0, v=0 \Rightarrow$$

$$\text{const} = -\ln 49$$

$$\therefore \frac{t}{5} - \ln 49 = -\ln(49-v)$$

$$\Rightarrow \frac{t}{5} = -\ln(49-v) + \ln 49$$

$$\Rightarrow -\frac{t}{5} = \ln(49-v) - \ln 49$$

$$\Rightarrow -\frac{t}{5} = \ln \left[ \frac{49-v}{49} \right]$$

$$\Rightarrow e^{-\frac{t}{5}} = \frac{49-v}{49}$$

$$\Rightarrow 49e^{-\frac{t}{5}} = 49 - v$$

$$\Rightarrow v = 49 - 49e^{-\frac{t}{5}}$$

$$\Rightarrow v = 49[1 - e^{-\frac{t}{5}}]$$

$$\lim_{t \rightarrow \infty} e^{-\frac{t}{5}} = 0$$

so  $\lim_{t \rightarrow \infty} v = 49[1 - 0] = 49$

Find distance travelled

$$v = 49[1 - e^{-\frac{t}{5}}] \Rightarrow \frac{dx}{dt} = 49[1 - e^{-\frac{t}{5}}]$$

$$\Rightarrow \int dx = \int 49[1 - e^{-\frac{t}{5}}] dt + \text{const}$$

$$\Rightarrow x = 49t + 5e^{-\frac{t}{5}} + \text{const}$$

$$v=0, t=0, \text{ when } x=0 \Rightarrow 0 = 0 + 5e^0 + \text{const}$$

$$\Rightarrow \text{const} = -5$$

$$\therefore \text{distance travelled in time } t, x = 49t + 5e^{-\frac{t}{5}} - 5$$