$$y' = -ky \rightarrow y' + ky = 0$$

$$y(0) = y_0 \mid y(t_h) = \frac{y_0}{2} \qquad a$$

$$IF: e^{\int k\,dt} \rightarrow e^{kt}$$

$$\therefore \cancel{\int} \cancel{\frac{d}{dt}}(y \cdot e^{kt}) \cancel{dt} = \int (0 \cdot e^{kt})\,dt$$

$$ye^{kt} = C \longrightarrow y_g = Ce^{-kt}$$

$$y_0 = Ce^{-k(0)} \rightarrow y_0 = C \rightarrow y(t) = y_0 e^{-kt}$$

$$\rightarrow y(t_h) = y_0 e^{-kt_h} \rightarrow \frac{y_0}{2} = y_0 e^{-kt_h} \rightarrow$$

$$\frac{1}{2} = y_0 e^{-kt_h} \rightarrow -kt_h = \ln\left(\frac{1}{2}\right) \rightarrow$$

$$t_h = \frac{\ln(1) - \ln(2)}{-k} \rightarrow t_h = \frac{\ln(2)}{k}$$

$$\frac{dS}{dt} = rS + d \rightarrow S' - rS = d$$

$$S(0) = S_0$$

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IF: $e^{\int -r\,dt} \rightarrow e^{-rt}$

$$\therefore \cancel{\int} \cancel{\frac{d}{dt}}\left(S \cdot e^{-rt}\right) \cancel{dt} = \int \left(d \cdot e^{-rt}\right) dt$$

$$Se^{-rt} = -\frac{d}{r} e^{-rt} + C \rightarrow$$

$$S_g = -\frac{d}{r} + Ce^{rt}$$

$$S_0 = -\frac{d}{r} + Ce^{r(0)} \rightarrow S_0 = -\frac{d}{r} + C$$

$$\rightarrow C = S_0 + \frac{d}{r} \quad \therefore$$

$$S(t) = \left(S_0 + \frac{d}{r}\right) e^{rt} - \frac{d}{r}$$