Peter Mulhern Engineering 113 January 5, 2001

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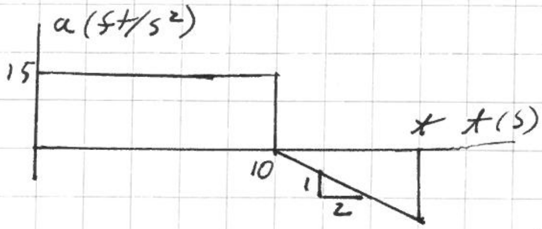
Hibbeler 8th ed: 12-64



The test car starts from rest and is subjected to a constant acceleration of $a_c = 15\ ft/s^2$ for $0 \le t \le 10 s$. The brakes are then applied, which causes a deceleration at the rate shown until the car stops. Determine the maximum speed of the car and the time t when it stops.

First, the maximum speed occurs after 10 seconds of constant acceleration.

$$v = v_0 + at$$
$$= 0 + 15(10)\ ft/s$$

$$\boxed{v_{max} = 150\ ft/s} \longleftarrow v_{max}$$

Next, finding the slope of the line from the graph to find the deceleration

$$Y - Y_1 = m(X - X_1)$$
$$\cancel{Y - Y_1 = \left(\frac{Y_2 - Y_1}{X_2 - X_1}\right)(X - X_1)}$$

here let (x_1, y_1) be $(10, 0)$ and $\cancel{(x_2, y_2)}$ the slope is $-\frac{1}{2}$

$$a - 0 = -\frac{1}{2}(t - 10)$$

Putting this into the definition of acceleration to get a formula for velocity

$$a = \frac{dv}{dt}$$

$$dv = a\,dt$$

$$\int_{150}^{0} dv = \int_{10}^{t} a\,dt$$

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continuing

$$\int_{150}^{0} dv = \int_{10}^{t} \left(-\tfrac{1}{2}\right)(t-10)\,dt$$

$$v\Big|_{150}^{0} = -\tfrac{1}{2}\left(\tfrac{t^2}{2} - 10t\right)\Big|_{10}^{t}$$

$$0 - 150 = \frac{-t^2}{4} + 5t + \frac{100}{4} - \frac{100}{2}$$

$$0 = \frac{-t^2}{4} + 5t + 125$$

Solving this quadratic equation for t and taking the positive root.

$$\boxed{t = 34.5\,s}$$

t

The car reaches a maximum speed of 150 ft/s, and comes to a stop 34.5s after it initially started to move.

Final Answer

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Problem: Hibbeler 8th ed: 12-138

A particle is moving along a circular path having a radius of 4 in such that its position as a function of time is given by $\theta = \cos 2t$, where θ is in radians and t is in seconds. Determine the magnitude of the acceleration of the particle when $\theta = 30°$

Computing the time derivatives

$r = 4\,in$ so $\dot{r} = 0$ and $\ddot{r} = 0$

$\theta = \cos 2t$

$\dot{\theta} = -2\sin 2t = -2\sqrt{1-\cos^2 2t}$

$\ddot{\theta} = -4\cos 2t$

computation of components of acceleration

$a_r = \ddot{r} - r(\dot{\theta})^2$

$= 0 - 4in\left(\cancel{-2}\sqrt{1-\cos^2 2t}\right)^2$

at $\cos 2t = \pi/6 = 30°$

$a_r = 0 - 4in\left((-2)\sqrt{1-(\tfrac{\pi}{6})^2}\right)^2$

$\boxed{a_r = -11{,}614\ in/s^2}$ ← a_r

and

$a_\theta = r\ddot{\theta} + 2\dot{r}\dot{\theta}$

$\boxed{a_\theta = (4in)(-4)(\tfrac{\pi}{6}) + 0 = -8.3775\ in/s^2}$ ← a_θ

The magnitude of the total acceleration is

$a = \sqrt{a_\theta^2 + a_r^2}$

$= \sqrt{(8.3775\ in/s^2)^2 + (11.614\ in/s^2)^2}$

$\boxed{a = 14.3\ in/s^2}$ ← a, Final Answer