27 E An electron has a constant acceleration of $+3.2\ m/s^2$. At a certain instant its velocity is $+9.6\ m/s$. What is its velocity (a) 2.5 s earlier and (b) 2.5 s later?

$a = 3.2\ m/s^2$ $\qquad v = at + v_0$

$\underbrace{v(t)}_{v_0} = 9.6\ m/s$ $\qquad v = 3.2t + 9.6$

a) $t = -2.5\ s \Rightarrow v = 3.2 \times (-2.5) + 9.6 = -8 + 9.6 = 1.6\ m/s$

b) $t = +2.5\ s \Rightarrow v = 3.2 \times (2.5) + 9.6 = 8 + 9.6 = 17.6\ m/s = 18\ m/s$

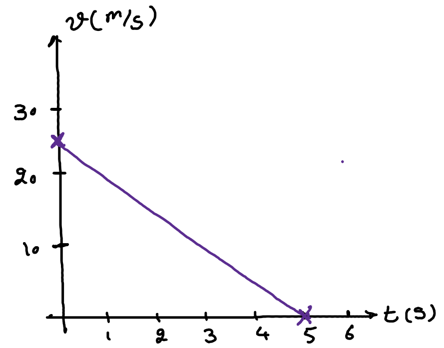
28 E On a dry road, a car with good tires may be able to brake with a constant deceleration of $4.92\ m/s^2$. (a) How long does such a car, initially traveling at $24.6\ m/s$, take to stop? (b) How far does it travel in this time? (c) Graph x versus t and v versus t for the deceleration.

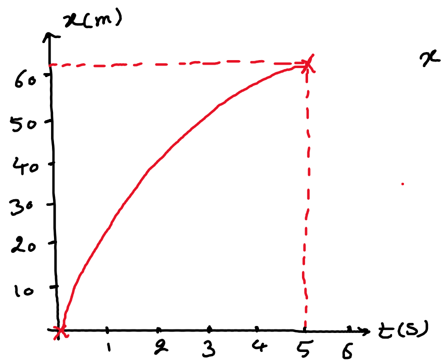
$a = -4.92\ m/s^2$

a) $v_0 = 24.6\ m/s$; $\underset{0}{\cancel{v}} = at + v_0 \Rightarrow 0 = -4.92t + 24.6 \Rightarrow t = \dfrac{24.6}{4.92} = 5.00\ s$

b) $v^2 - v_0^2 = 2a\Delta x \Rightarrow 0 - (24.6)^2 = 2 \times (-4.92)\Delta x \Rightarrow \Delta x = \dfrac{(24.6)^2}{2 \times 4.92} = 61.5\ m$

c)





$x = \frac{1}{2}at^2 + v_0 t + \underset{0}{\cancel{x_0}}$

29 E A certain elevator cab has a total run of 190 m and a maximum speed of 305 m/min, and it accelerates from rest and then back to rest at $1.22\ m/s^2$. (a) How far does the cab move while accelerating to full speed from rest? (b) How long does it take to make the nonstop 190 m run, starting and ending at rest?

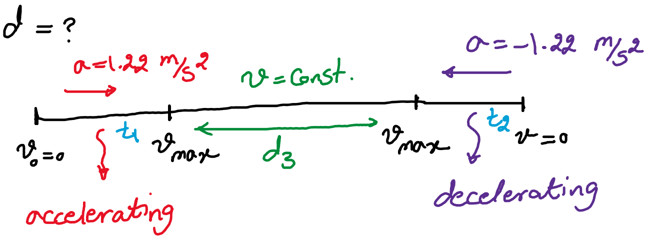
a) $v_0 = 0$

$v_{max} = 305\ m/min = 305\ \dfrac{m}{60\ s} = \dfrac{61}{12}\ m/s$

$a = 1.22\ m/s^2$ $\qquad v^2 - \underset{0}{\cancel{v_0^2}} = 2a\underbrace{\Delta x}_{d} \rightarrow d = \dfrac{\left(\frac{61}{12}\right)^2}{2 \times 1.22} = 10.59 \simeq 10.6\ m$

$d = ?$

b)



$v = at + v_0 \Rightarrow v_{max} = at_1 + 0 \rightarrow t_1 = \dfrac{v_{max}}{a} = \dfrac{\frac{61}{12}}{1.22} \simeq 4.17\ s$

$0 = at_2 + v_{max} \Rightarrow t_2 = \dfrac{-v_{max}}{a} = \dfrac{-61/12}{-1.22} \simeq 4.17\ s$

$$\left.\begin{matrix} d_1 = d_2 = 10.59 \\ D = 190\ m \end{matrix}\right\} \Rightarrow d_3 = 190 - 2 \times 10.59 = 168.82\ m$$

$$v_3 = \text{Const.} = \frac{61}{12}\ m/s \Rightarrow x = vt + x_0 \Rightarrow \underbrace{x - x_0}_{d_3} = v_3 t_3 \Rightarrow t_3 = \frac{168.82}{\frac{61}{12}} \simeq 33.21\ s$$

$$\Rightarrow t = t_1 + t_2 + t_3 = 2 \times 4.17 + 33.21 = 41.55\ s$$

30 E The brakes on your car can slow you at a rate of 5.2 m/s^2. (a) If you are going 137 km/h and suddenly see a state trooper, what is the minimum time in which you can get your car under the 90 km/h speed limit? (The answer reveals the futility of braking to keep your high speed from being detected with a radar or laser gun.) (b) Graph x versus t and v versus t for such a slowing.

$$a = -5.2\ m/s^2$$

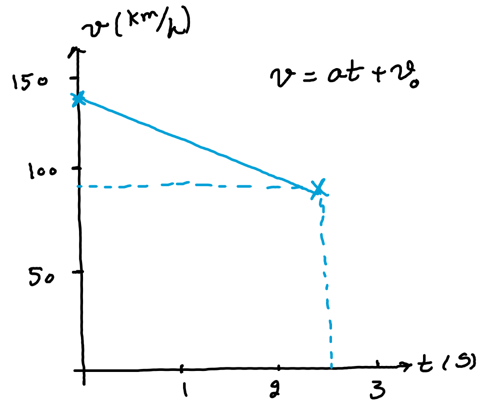
a) $v_0 = 137\ km/h = 137 \times \frac{10^3\ m}{3600\ s} \simeq 38.1\ m/s$

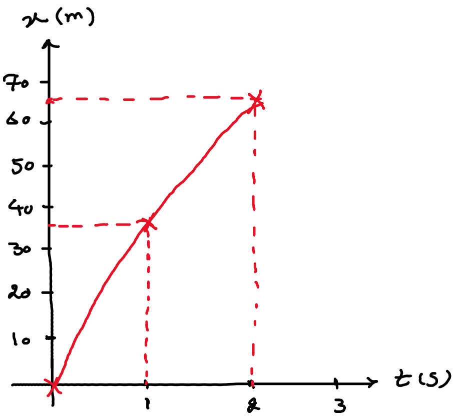
$v = 90\ km/h \simeq 25\ m/s$

$$t = ? \longrightarrow a = \frac{\Delta v}{\Delta t} = \frac{v - v_0}{t - t_0} \Rightarrow t = \frac{25 - 38.1}{-5.2} \simeq 2.5\ s$$

($t_0 = 0$)

b)





$$x = \frac{1}{2}\underset{-5.2}{a}t^2 + \underset{38}{v_0}t + x_0$$

($x_0 = 0$)

$$x = -2.6t^2 + 38t$$

$$x(t=1) = 35.4\ m$$

$$x(t=2) = 65.6\ m$$

31 E SSM Suppose a rocket ship in deep space moves with constant acceleration equal to 9.8 m/s^2, which gives the illusion of normal gravity during the flight. (a) If it starts from rest, how long will it take to acquire a speed one-tenth that of light, which travels at 3.0×10^8 m/s? (b) How far will it travel in so doing?

$$a = 9.8\ m/s^2$$

a) $v_0 = 0$

$$v = 0.1C = 0.1 \times 3.0 \times 10^8 = 3.0 \times 10^7\ m/s$$

$$t = ? \longrightarrow a = \frac{\Delta v}{\Delta t} = \frac{v - v_0}{t - t_0} \Rightarrow t = \frac{3.0 \times 10^7 - 0}{9.8} \simeq 3.1 \times 10^6\ s$$

($t_0 = 0$)

$$1\ h = 3600\ s \Rightarrow 1\ day = 24 \times 3600 = 86400\ s \longrightarrow t = \frac{3.1 \times 10^6}{86400} \simeq 35.88\ day$$

$$30\ day = 1\ month \Rightarrow t = \frac{35.88}{30} \simeq 1.2\ month$$

b) $$v^2 - v_0^2 = 2a\underbrace{\Delta x}_{d} \Rightarrow d = \frac{v^2 - v_0^2}{2a} = \frac{(3 \times 10^7)^2}{2 \times 9.8} \simeq 4.6 \times 10^{13}\ m$$