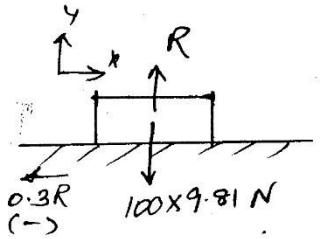
NSL (PRACTICE)

NEWTON'S SECOND LAW
(PRACTICE QUESTIONS)

(1)

(1)



$u = 10\ m/s,\ v = 0\ m/s$

BY NSL

$\Sigma F_y = 0$; $\Sigma F_x = ma$

$\therefore R = 981\ N$; $-0.3R = 100a$

$\therefore a = -2.943\ m/s^2$

$v = u - at$

$0 = 10 - (2.943)t$

$\therefore t = 3.398\ s$

$v^2 = u^2 - 2as$

$0 = (10)^2 - 2(2.943)s$

$\therefore s = 16.989\ m$

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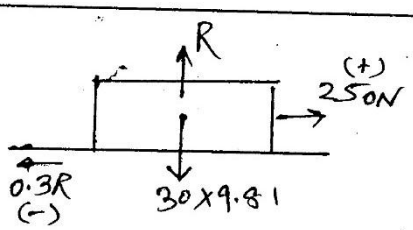
(2)(a)



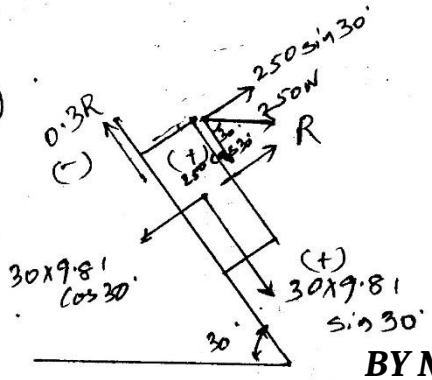
BY NSL

$\Sigma F_y = 0$; $\Sigma F_x = ma$

$R = 30 \times 9.81$; $250 - 0.3R = 30a$

$= 294.3\ N$; $\therefore a = 5.390\ m/s^2$

(b)



$\Sigma F_y = 0$

$R + 250 \sin 30 = 30 \times 9.81 \cos 30°$

$\therefore R = 129.871\ N$

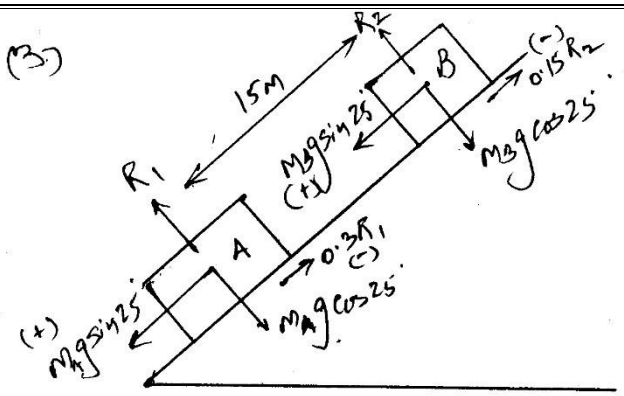
BY NSL $\Sigma F_x = ma$

$30 \times 9.81 \sin 30 + 250 \cos 30 - 0.3R = 30a$

$\therefore a = 10.823\ m/s^2$

Navlakhi's

(3)



FOR A : (2)

BY NSL

$\Sigma F_y = 0$; $\Sigma F_x = m_A a$

$R_1 = M_A g\cos25$

$M_A g\sin25 - 0.3R_1 = M_A a_1$

$\therefore a_A = 1.479\ m/s^2$

FOR B :

BY NSL

$\Sigma F_y = 0$

$R_2 = M_B g\cos25$

$\Sigma F_x = M_B a$

; $M_B g\sin25 - 0.15R_2 = M_B a_B$

$\therefore a_B = 2.812\ m/s^2$

Let A travel dist 'x' m before B collides

$\therefore$ B " " 'x+15' m " collision

$\therefore$ $s = ut + \frac{1}{2}at^2$ for A & B gives

$x = 0 + \frac{1}{2}(1.479)t^2$ & $x+15 = 0 + \frac{1}{2}(2.812)t^2$

(i) (ii)

(ii) ÷ (i) gives

$\frac{x+15}{x} = \frac{2.812}{1.479}$

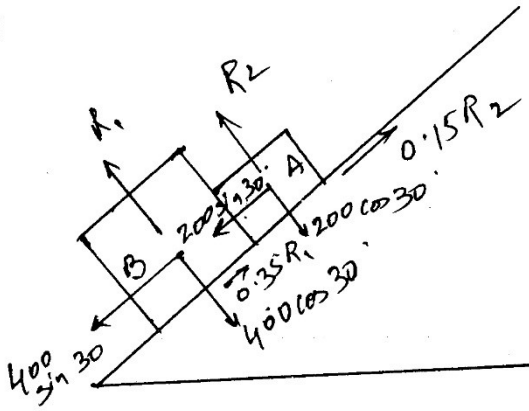
$\therefore x = 16.643\ m$

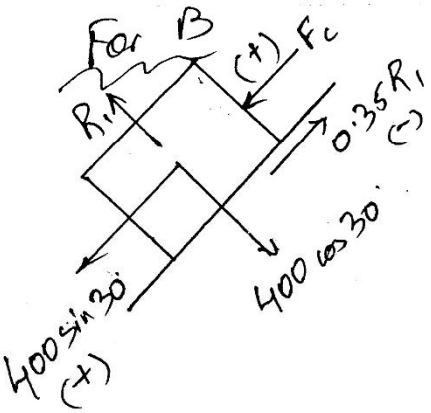
$\therefore$ B travels $x+15 = 31.643\ m$

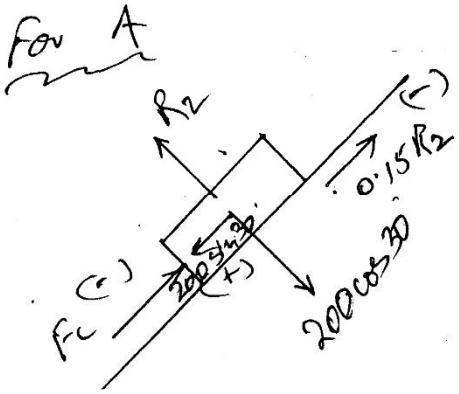
Sub in (i).

$t = 4.744\ s.$

(4)







$\Sigma F_y = 0 \;\therefore R = 400\cos 30$

$= 346.410\,N$

$\Sigma F_y = 0$

$\therefore R_2 = 200\cos 30$

$= 173.205\,N$

BY NSL

$\Sigma F_x = M_B a$

$400\sin 30 + F_c - 0.35R_1 = \frac{400}{9.81} a$

$40.775 - F_c = 78.756$ —(i)

BY NSL

$\Sigma F_x = M_A a$

$200\sin 30 - F_c - 0.15R_2 = \frac{200}{9.81} a$

$74.019 = 20.387a + F_c$ —(ii)

Solving (i) & (ii) we get

$a = 2.498\ m/s^2$

$F_c = 23.095\,N$

(5) $2x_A = 3x_B$

Diff. w.r.t. 't'

$2v_A = 3v_B$ —(ii)

Diff. w.r.t. 't'

$2a_A = 3a_B$ —(i)

$a_B = 3 m/s^2$

$\therefore a_A = \frac{3 \times 3}{2} = 4.5 m/s^2$

(4)

$u_A = 0 m/s$

$a_A = 4.5 m/s^2$

$t = 8s$

$v = u + at$

$= 0 + (4.5)(8)$

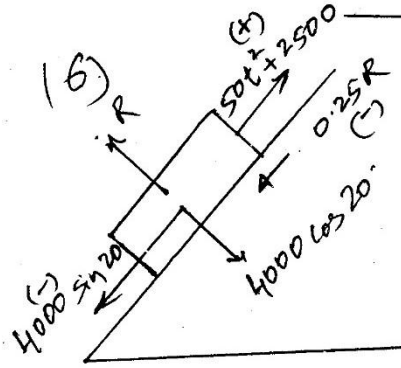
$= 36 m/s (\rightarrow)$

Sub. in (ii)

$v_B = \frac{2 \times 36}{3} = 24 m/s (\rightarrow)$

$v_{A/B} = v_A - v_B = 12 m/s (\rightarrow)$

(6)



$\sum F_y = 0$

$R = 4000 \cos 20$

$= 3756.770 N$

BY NSL

$\sum F_x = ma$

$50t^2 + 2500 - 0.25R - 4000 \sin 20 = \frac{4000}{9.81} a$

$192.227 + 50t^2 = 407.747 a$ —(i)

Put $t = 8s$, $\therefore a = 8.319 m/s^2$

integ (i) $a = dv/dt$

$192.227 + 50t^2 = 407.747 \frac{dv}{dt}$

$\int 192.227 dt + \int 50t^2 dt = \int 407.747 dv + c$

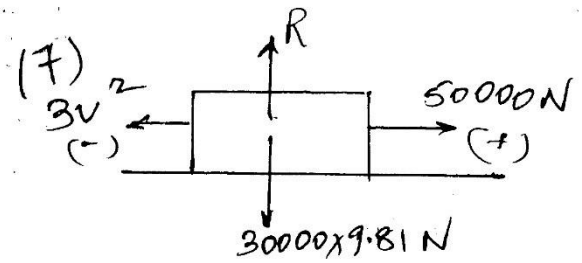
$192.227 t + 50t^3/3 = 407.747 v + c$

Put $t = 0$, $v = 1$ $\therefore c = -407.747$

$\therefore 192.227 t + 50t^3/3 = 407.747 v - 407.747$

$\therefore v|_{t=6s} = 25.7 m/s$

(7) (5)



$u = 0 \text{ m/s}$

$s = 1500 \text{ m}$

BY NSL

$$\Sigma F_x = MQ$$

$$50000 - 3v^2 = 30000\, a$$

Put $a = v\frac{dv}{dx}$

$$50000 - 3v^2 = 30000\, v\frac{dv}{dx}$$

$$\int dx = \int \frac{30000v\, dv}{50000 - 3v^2}$$

$$\int dx = \frac{-1}{2}\int \frac{-60000v\, dv}{50000 - 3v^2}$$

$$x = \frac{-10000}{2}\log_e(50000 - 3v^2) + c$$

Put $x = 0, v = 0$ $\therefore c = \frac{10000}{2}\log_e 50000$

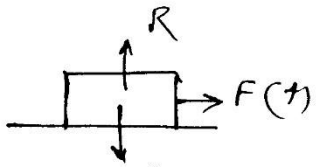
$= 54098.891$

$$\therefore x = \frac{-10000}{2}\log_e(50000 - 3v^2) + 54098.891$$

Put $x = 1500 \text{ m}$

$\therefore v = 65.724$

(6)

(a) 

$u = 0$

$m = \frac{60-0}{10-0} = 6$

$y - y_1 = m(x - x_1)$

$y - 0 = 6(x - 0)$

$y = 6x$

i.e. $F = 6t$

by NSL

$\Sigma F_x = ma$

$F = 3a$

ie $6t = 3a$ —(i)

ie $6t = 3\frac{dv}{dt}$

$\int 6t\,dt = \int 3\,dv$

ie $\frac{6t^2}{2} = 3v + c$

But $t = 0, v = 0$

$\therefore c = 0$

$\therefore 3v = 3t^2$ —(ii)

At $t = 10, v = 100\,m/s$

In (ii) put $v = \frac{dx}{dt}$

$\therefore \frac{dx}{dt} = t^2$

$\int dx = \int t^2\,dt$

$x = \frac{t^3}{3} + c$

At $t = 0, x = 0 \therefore c = 0$

$\therefore x = t^3$ —(iii)

At $t = 10s$, $x = \frac{1000}{3}m$

(b) From 10s onwards

$F = -15N$

But $F = ma$

$\therefore -15 = 3a$

$\therefore a = -5\,m/s^2$

$u = 100\,m/s$

$v = 0$

$v = u - at$

$0 = 100 - 5(t)$

$t = 20s$

ie Total $= 10 + 20$

$= 30s$ from start

$s = ut - \frac{1}{2}at^2$

$= 100(20) - \frac{1}{2}(5)(20)^2$

$= 2000 - 1000$

$= 1000m$

ie $\frac{1000}{3} + 1000 = \frac{4000}{3}m$

(c) After 10s, $x = \frac{1000}{3}m$

$\therefore$ Now $x = -\frac{1000}{3}m$

$a = -5\,m/s^2$

$s = ut - \frac{1}{2}at^2$

$-\frac{1000}{3} = 100(t) - \frac{1}{2}(5)t^2$

$t = 43.094s$

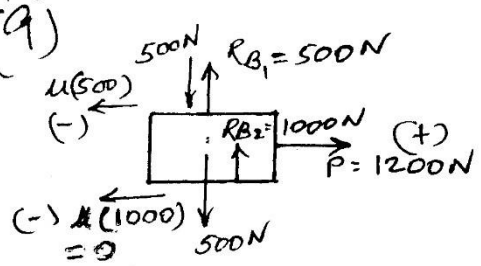
ie $10 + 43.094$

$= 53.094s$

from start.

BY NSL

(9)



$\Sigma F_x = ma$,

$1200 - \mu(500) = \frac{500}{9.81} a$ ——(i)

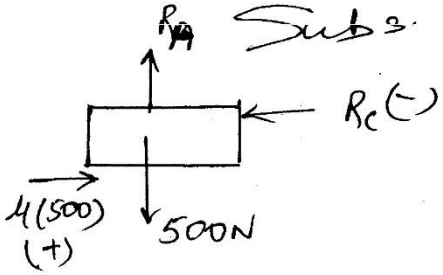
But $u = 0$, $v = 5 m/s$, $s = 0.8m$

$v^2 = u^2 + 2as$

$25 = 0 + 2a(0.8)$

$\therefore a = 15.625 m/s^2$

Subs. in (i) we get $\mu = 0.807$



$\Sigma F_x = 0$

$\mu(500) - R_C = 0$

$\therefore R_C = 403.62 N$

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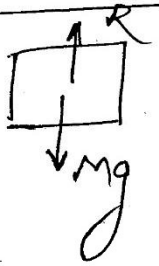
(10) $\mu R = \frac{mv^2}{r}$ $r = 90m$, $\mu = 0.35$



$\mu mg = \frac{mv^2}{r}$

$\therefore v = \sqrt{rg\mu}$

$= 17.579 m/s.$

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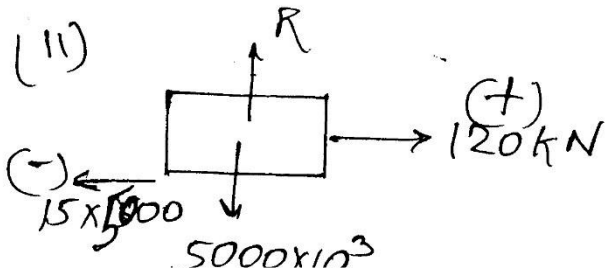
(8)

(11)



$u = 0$ m/s

$v = 90 \times \frac{5}{18} = 25$ m/s

BY NSL

$\Sigma F_x = ma$

$120 \times 10^3 - 15 \times 5000 = \frac{5000 \times 10^3 a}{9.81}$

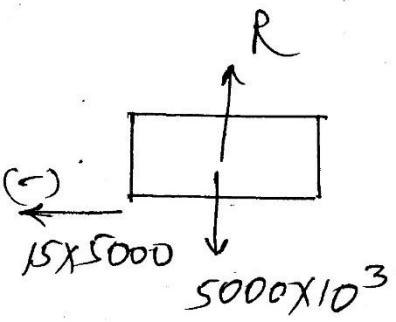
$\therefore a = 0.08829 \text{ m/s}^2$

$v = u + at$

$\therefore t = 283.158$ s

$s = ut + \frac{1}{2}at^2$

$= 3539.47$ m



$u = 25$ m/s

$v = 0$ m/s

BY NSL

$\Sigma F_x = ma$

$-15 \times 5000 = \frac{5000 \times 10^3 a}{9.81}$

$\therefore a = -0.1472 \text{ m/s}^2$

$v = u - at$

$0 = 25 - (0.1472)t$

$\therefore t = 169.837$ s

$s = ut - \frac{1}{2}at^2$

$s = 2122.962$ m

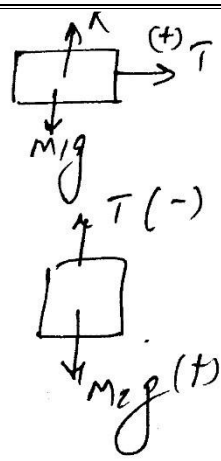
Total time = 452.995 s

Total distance = 5662.434 m.

Max Power : $Fv = 120000 \times 25$

$= 3$ MW

(12)



$\Sigma F_x = Ma$

$T = M_1 a$ —(i)

BY NSL

$\Sigma F_y = Ma$

$M_2g - T = M_2a$

$\therefore T = M_2g - M_2a$ —(ii)

From (i) & (ii) $M_1a = M_2g - M_2a$

$\therefore a = \frac{M_2g}{M_1 + M_2}$

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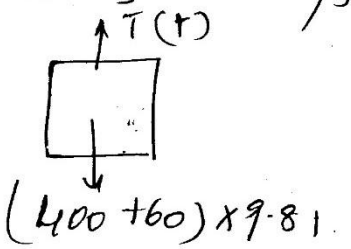
(13) $u = 0$, $v = 4\,m/s$, $s = 3m$

$v^2 = u^2 + 2as$

$16 = 0 + 2a(3)$

$a = 8/3\ m/s^2$



BY NSL

$\Sigma F_y = Ma$

$R - 60 \times 9.81 = 60a$

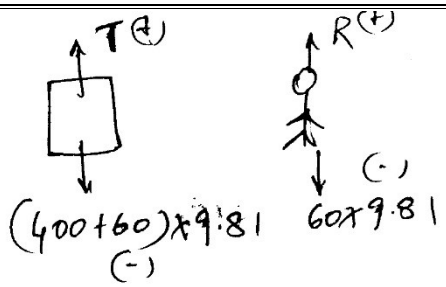
$\therefore R = 748.6N$

BY NSL

$T - 460 \times 9.81 = 460a$

$T = 5739.267N$

$\because R > mg \quad \therefore$ He feels heavy.



(b)

$u = 4\,m/s$
$v = 0\,m/s$
$t = 2s$
$v = u + at$
$\therefore a = -2\,m/s^2$

BY NSL

$\Sigma F_y = Ma$
$R - 60 \times 9.81 = 60(-2)$
$\therefore R = 468.6\,N$

$\Sigma F_y = Ma$
$T - 460 \times 9.81 = 460(-2)$
$\therefore T = 3592.6\,N.$

$R < mg$
$\therefore$ Feels light

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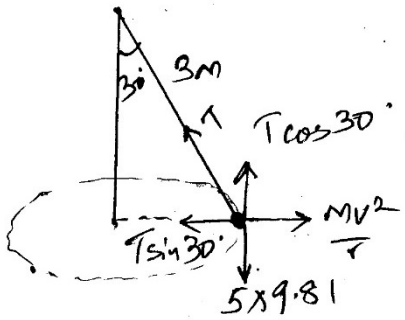
(14)



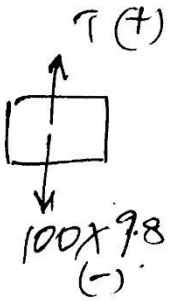
$r = 3\sin 30 = 1.5\,m$

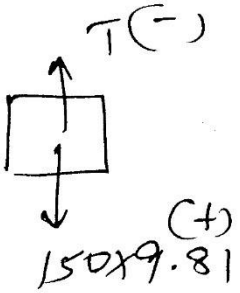
$T\cos 30° = 5 \times 9.81$
$T = 56.638\,N$

$T\sin 30° = \frac{5 \times v^2}{1.5}$
$\therefore v = 2.915\,m/s$

Navlakhi's

(15)





(11)

Navlakhi's

By NSL

$T - 100 \times 9.81 = 100a$

$\therefore T = 100a + 981$ —(i)

BY NSL

$150 \times 9.81 - T = 150a$

$\therefore 150 \times 9.81 - (100a + 981) = 150a$

$\therefore a = 1.962 \text{ m/s}^2$

Subst. in (i) $T = 1177.2 \text{ N}$

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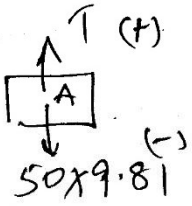
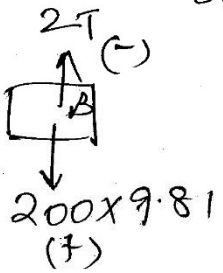
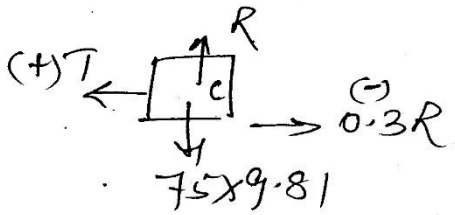
(16) $x_A + x_C = 2x_B$

Diff w.r.t 't' : $v_A + v_C = 2v_B$

" " " : $a_A + a_C = 2a_B$ —(i)







BY NSL

$T - 50 \times 9.81 = 50a_A$

$T - 50a_A = 50 \times 9.81$ —(ii)

BY NSL

$200 \times 9.81 - 2T = 200a_B$

$200a_B + 2T = 200 \times 9.81$ —(iii)

$\Sigma F_y = 0$

$\therefore R = 75 \times 9.81$

$= 735.75 \text{ N}$

$\Sigma F_x = ma$

$T - 0.3R = 75a_C$

$T - 75a_C = 220.725$ —(iv)

Solving (i), (ii) & (iii) & (iv) we get:

$T = 606.994 \text{ N}$; $a_A = 2.330 \text{ m/s}^2$

$a_B = 3.74 \text{ m/s}^2$; $a_C = 5.15 \text{ m/s}^2$

Navlakhi's

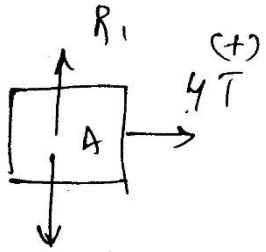
(17) $4x_A = 3x_B$

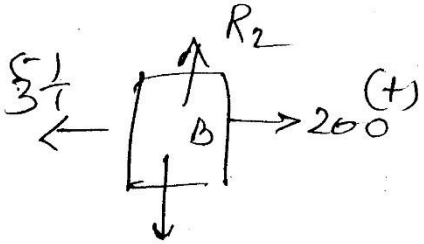
Diff wrt 't'

$4v_A = 3v_B$

$4a_A = 3a_B$ —(i)

(12)





By NSL

$\sum F_x = Ma$

$4T = 60a_A$

$T = 15a_A$ —(ii)

By NSL

$\sum F_x = Ma$ —(iii)

$200 - 3T = 40a_B$

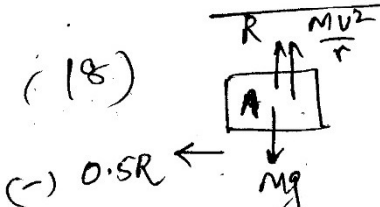
Solving (i), (ii) & (iii) we get

$T = 30.508\ N$

$a_A = 2.034\ m/s^2 \rightarrow$

$a_B = 2.712\ m/s^2 \rightarrow$

(18)



$\sum F_y = 0$

$R + \frac{MV^2}{r} = Mg$

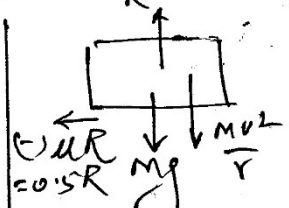
$R = M(g - \frac{V^2}{r})$

$\sum F_x = Ma$

$-0.5R = Ma$

$a = -3.343\ m/s^2$

Deceleration $= 3.343\ m/s^2$



$\sum F_y = 0$

$R = \frac{MV^2}{r} + Mg$

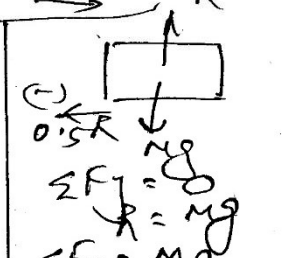
$R = M(g + V^2/r)$

$\sum F_x = Ma$

$-0.5R = Ma$

$\therefore a = -6.468\ m/s^2$

Deceleration $= 6.468\ m/s^2$



$\sum F_y = 0$

$R = Mg$

$\sum F_x = Ma$

$-0.5R = Ma$

$a = -4.905\ m/s^2$

Deceleration $= 4.905\ m/s^2$