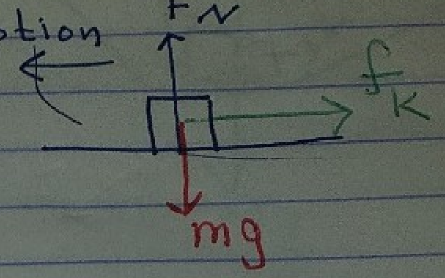
Chapter 6: Lecture Problems

(6-6) Three Forces acting on the player ($m = 79\,kg$)



mg from the earth

F_N from the surface

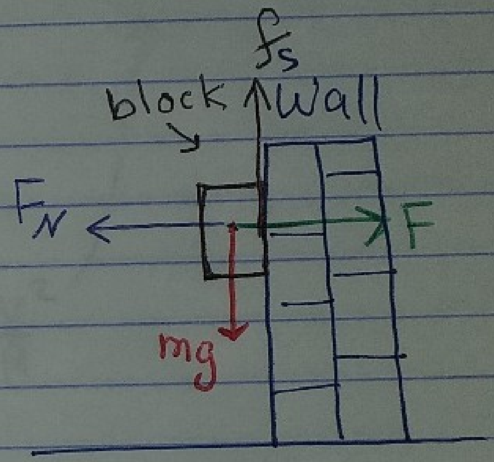
$f_k = 470N$ from the surface

$$\sum F_y = 0 \Rightarrow F_N - mg = 0 \quad F_N = mg = 774.2N$$

$$f_k = \mu_k F_N = \mu_k mg$$

$$\mu_k = \frac{f_k}{F_N} = \frac{470}{774.2} = 0.61$$

(6-19) the wall and block



$\mu_s = 0.6 \qquad \mu_k = 0.4$

4 Forces are acting on the block ($m = \frac{W}{g} = \frac{5}{9.8} = 0.51\,kg$)

$W = mg = 5N$ from earth

$F = 12N$ from external person)

F_N From the wall on the block

f : friction Force ~~Bo~~ on the block from wall.

a) Will the block move?

the block will move downward from mg if

$$mg > \mu_s F_N$$

$\sum F_x = 0$ (No motion on x-axis)

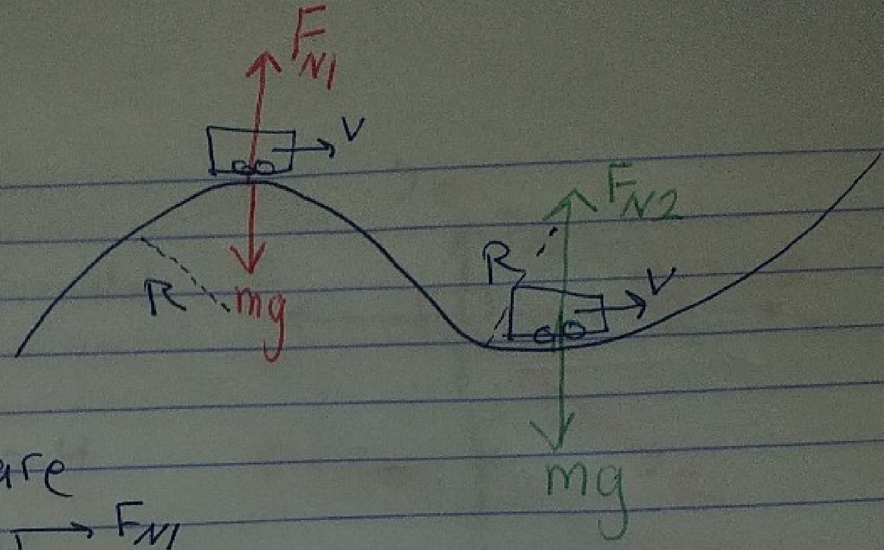
$$F - F_N = 0 \Longrightarrow F_N = F = 12N$$

$$f_{s,m} = \mu_s F_N = 0.6(12) = 7.2N$$

$mg < f_{s,max}$ the block will not move

b) 2 Forces are acting on the block From the wall $\rightarrow F_N = 12N$, $\vec{f_s} = 5N\,\hat{j}$

(6-49) $m = 70\,kg$



R = radius of the hill and of th valley

① At the hill 2 Forces are acting on $m = 70\,kg$ → F_{N1}, mg

$$\Sigma F_y = m a_y$$

$$F_{N1} + -mg = m\left(\frac{-v^2}{R}\right)$$; $\frac{mv^2}{R}$ toward the center

but $F_{N1} = 0$ (From Problem)

$$\Longrightarrow \quad v^2 = Rg \quad , \quad v = \sqrt{Rg} \quad ①$$

② At the valley

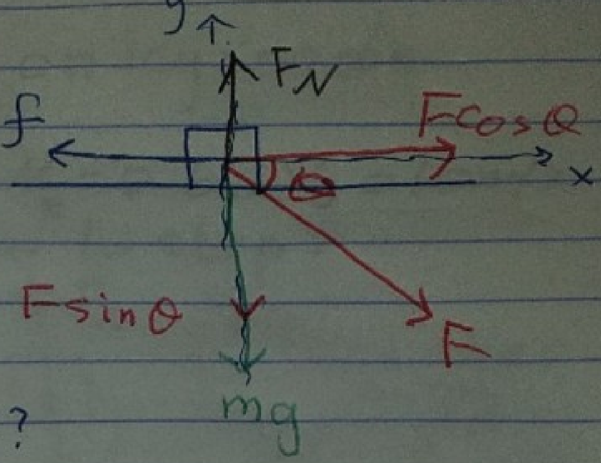
$$\Sigma F_y = m a_y \Longrightarrow F_{N2} - mg = +m\frac{v^2}{R}$$

$$F_{N2} = mg + m\frac{v^2}{R} \quad ②$$

① in ② $\quad F_{N2} = mg + \frac{m}{R}(Rg) = 2mg$

$$F_{N2} = 2(70)(9.8) = 1372\,N$$

Sample Problem 6.01:



$F = 12N$, 30° under horezontal
$m = 8\,kg$
$\theta = 30^\circ$
$\mu_s = 0.7$,, $\mu_k = 0.4$
Does the block move?
Find friction force on the block?

$\sum F_y = 0$ (No motion along y-axis) 4 Forces are acting on (m) (F, mg, F_N, f)

$F_N - mg - F\sin\theta = 0$
$F_N = mg + F\sin\theta$
$= 8(9.8) + 12\sin 30$
$= 84.4\,N$

The block will move if $F\cos\theta > f_{s,max}$

$$\left.\begin{aligned} F\cos\theta &= 12\cos 30 = 10.4\,N \\ f_{s,max} &= \mu_s F_N = (0.7)(84.4) = 59\,N \end{aligned}\right\} \Longrightarrow$$

the block will not move, It remains at rest

to find the friction force acting on the block:

$\sum F_x = 0$ (No motion)
$\overrightarrow{\quad}$
$F\cos\theta - f_s = 0 \Longrightarrow f_s = F\cos\theta$

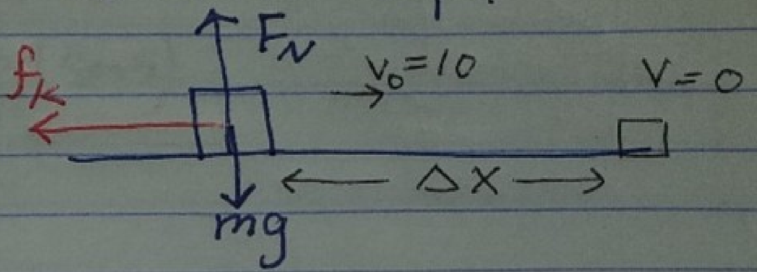
$f_s = 10.4\,N$

Sample Problem 6.02

Sliding to a stop on icy roads

a) Case 1: horizontal road $\mu_k = 0.6$, $V_0 = 10\,m/s$

Find Δx for the car to stop?



$\sum \vec{F} = m\vec{a}$

$\sum F_y = 0$

$F_N - mg = 0$

$F_N = mg$ ①

$\sum F_x = m a_x$

$-f_k = m a_x$ ② ① in ② get

$-\mu_k mg = m a_x$, $a_x = -\mu_k g = -5.88\,m/s^2$

to find Δx:

$V_x^2 = V_{0x}^2 + 2a_x \Delta x$,

$$\Delta x = \frac{V_x^2 - V_{0x}^2}{2a_x} = \frac{0 - (10)^2}{2(-5.88)} = \boxed{8.5\,m}$$

b) Case 2: horizontal road but $\mu_k = 0.1$ find Δx for stopping

$$\Delta x = \frac{V_x^2 - V_{0x}^2}{2a_x} = \frac{(0)^2 - (10)^2}{2(-\mu_k g)} = \frac{-100}{-2(0.1)(9.8)}$$

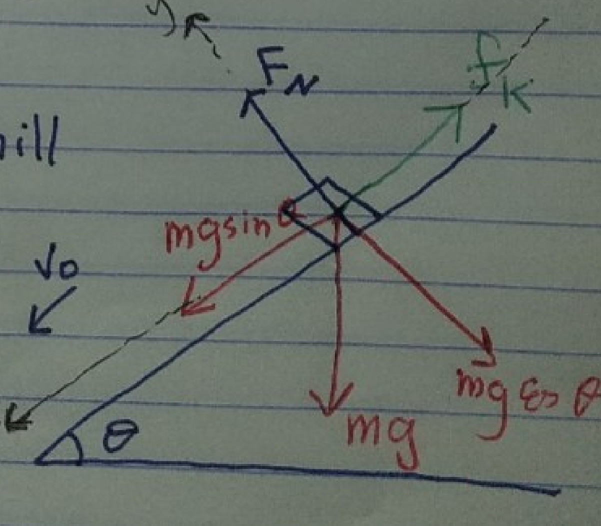
$\Delta x = 51\,m$

c) Case 3: The car is sliding an icy hill

$\theta = 5°$, $V_0 = 10\,m/s$

find Δx for stopping

$\mu_k = 0.1$



$\sum \vec{F} = m\vec{a}$

$\sum F_y = 0 \Rightarrow F_N = mg\cos\theta$ ①

$\sum F_x = m a_x$, $mg\sin\theta - f_k = m a_x$ ②

$$ma_x = mg\sin\theta - \mu_k F_n \quad , \quad ① \text{ in } ②$$

$$ma_x = mg\sin\theta - \mu_k mg\cos\theta$$

$$a_x = g\sin\theta - \mu_k g\cos\theta$$

$$= 9.8(\sin 5 - 0.1\cos 5)$$

$$a_x = -0.122 \text{ m/s}^2$$

to find ΔX

$$V_x^2 = V_{0x}^2 + 2a_x \Delta X$$

$$\Delta X = \frac{V_x^2 - V_{0x}^2}{2a_x} = \frac{0 - (10)^2}{2(-0.122)}$$

$$\Delta X = 410 \text{ m}$$

Sample Problem 6.03

Terminal speed of falling raindrop:

raindrop is a sphere
drops from height $= h = 1200m$

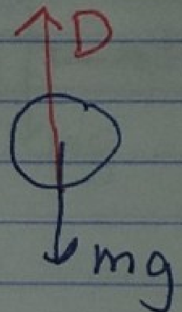
$\rho_{air} = 1.2 kg/m^3$

- radius $= R = 1.5 mm$
- $\rho_w = 1g/cm^3 = 1000 kg/m^3$
- $C = 0.6$
- Volume $= \frac{4}{3}\pi R^3 = 1.414\times10^{-8} m^3$
- mass $= \rho_w \cdot \frac{4}{3}\pi R^3 = 1.414\times10^{-5} kg$
- cross sectional Area $= \pi R^2$
  $= 7.07\times10^{-6} m^2$

a) Find the terminal speed

V_t ?

At V_t: $\sum F_y = 0$



$$D - mg = 0$$

$$\frac{1}{2} C \rho_a A V_t^2 = mg$$

$$V_t = \sqrt{\frac{2mg}{C\rho_a A}}$$

$$= \sqrt{\frac{(2)(1.414\times10^{-5})(9.8)}{(0.6)(1.2)(7.07\times10^{-6})}} = \sqrt{\frac{2.77\times10^{-4}}{5.09\times10^{-6}}}$$

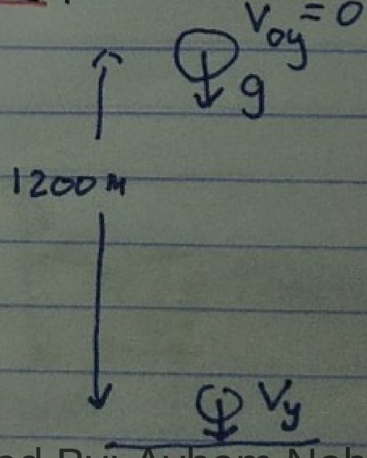
$$= 7.4 \ m/s \approx 27 km/h$$

b) What would be the drop's speed just before impact if there were no drag force?

$V_y^2 = V_{oy}^2 + 2a_y \Delta y$ (Free Falling)

$V_y^2 = 0 + 2(-9.8)(-1200)$

$V_y = 153 m/s \approx 550 km/h$



$$\vec{F}_{bw} = -12\hat{i} + 5\hat{j} \ N$$

(6-24) $m = 4.10kg$

$F = 40N$

μ_k ?

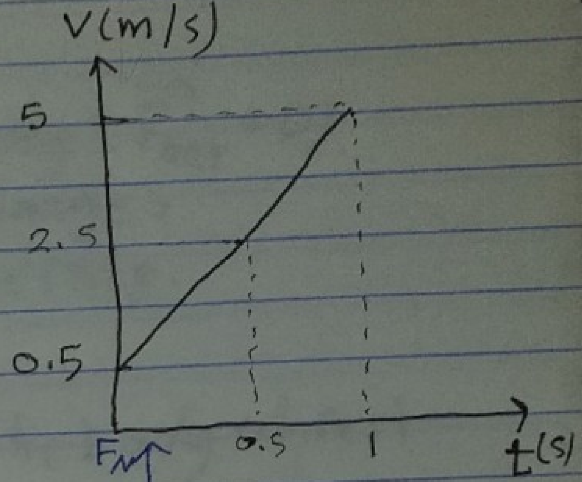
4 Forces acting on the block ($m = 4.10$ kg)

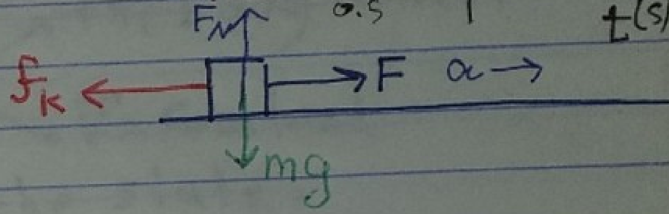
mg from earth

F_N from the surface

f_k from the surface

$F = 40N$ from external Person)





$\sum F_y = 0 \Rightarrow$

$F_N - mg = 0 \quad F_N = mg = 40.2\,N$

$\sum F_x = ma \Rightarrow F - f_k = ma$

$f_k = F - ma \quad , a = \frac{\Delta V}{\Delta t} = \frac{5-0.5}{1-0} = 4.5 m/s^2$

$f_k = 40 - 4.1(4.5) = 40 - 18.45 = 21.55N$

$\mu_k = \frac{f_k}{F_N} = \frac{21.55}{40.2} = 0.54$

(6-53) $r = 9.1m$ radius of the circular motion

$v = 16km/h = 4.4\ m/s$

What angle with vertical will be made by the loosly hanging hand straps?

loosly hanging hand has mass $= m$

it will move toward $a_c = \frac{v^2}{r}$

$\sum F_y = 0 \quad T\cos\theta - mg = 0$

$T\cos\theta = mg$ ①

$\sum F_x = ma \quad T\sin\theta = \frac{mv^2}{r}$ ②

$\frac{②}{①} \Rightarrow \tan\theta = \frac{v^2}{rg} = 0.217 \qquad \theta = 12$