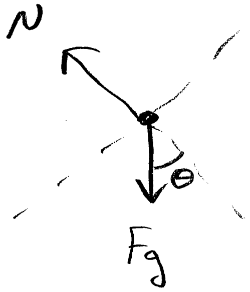
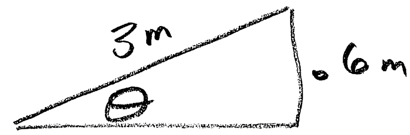
Slope Problems

(1)





$\sin\theta = \frac{.6}{3}$

$F = ma$

$F_g \sin\theta = ma$

$mg \sin\theta = ma$

$a = 9.8\left(\frac{.6}{3}\right)$

$a = 1.96\ m/s^2$ ($2.0\ m/s^2$ for $g = 10$)

$V_i = 0$

$V_f = ?$

$d = 3\ m$

$a = 1.96$

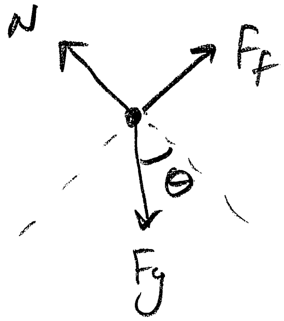
$V_f^2 = V_i^2 + 2ad$

$V_f = \sqrt{2ad}$

$= \sqrt{2(1.96)(3)}$

$= 3.4\ m/s$

(2)



x

$$-F_f + F_g \sin\theta = ma \quad (ma = 0)$$

$$F_f = F_g \sin\theta$$

y

$$N - F_g \cos\theta = ma \quad (ma = 0)$$

$$N = F_g \cos\theta$$

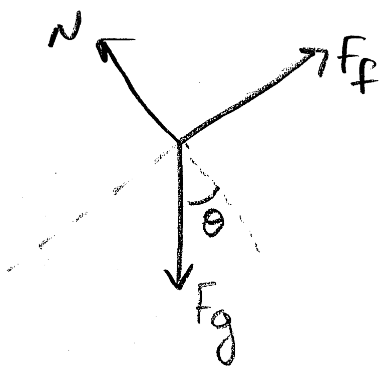
$$F_f = \mu F_N$$

$$\mu = \frac{F_f}{F_N} = \frac{F_g \sin\theta}{F_g \cos\theta} = \tan\theta$$

$$\mu = \tan(25)$$

$$\underline{\mu = 0.47}$$

(3)



x

$$-F_f + F_g \sin\theta = ma$$

$$F_f = F_g \sin\theta - ma$$

y

$$N - F_g \cos\theta = ma \quad (ma = 0)$$

$$N = F_g \cos\theta$$

$$F_f = \mu F_N$$

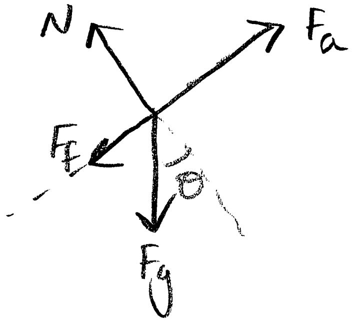
$$\mu = \frac{F_f}{F_N} = \frac{mg\sin\theta - ma}{mg\cos\theta}$$

$$= \frac{9.8 \sin 25 - 2}{9.8 \cos 25}$$

$$\mu = \underline{0.24}$$

$$= 0.25 \quad g = 10$$

(4)



x

$F_a - F_f - F_g \sin\theta = \cancel{ma}^{\,0}$

$F_f = F_a - F_g \sin\theta$

y

$N - F_g \cos\theta = \cancel{ma}^{\,0}$

$N = F_g \cos\theta$

$F_f = \mu F_N$

$$\mu = \frac{F_f}{F_N} = \frac{F_a - mg\sin\theta}{mg\cos\theta}$$

$$= \frac{90 - 10(9.8)\sin 45}{10(9.8)\cos 45}$$

$\underline{\mu = 0.30}$

$\mu = 0.27 \quad g = 10$

(5)

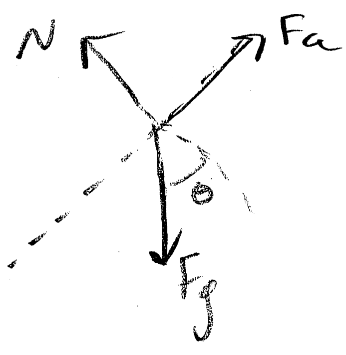
$V_i = 0$
$V_f = 21$
$t = 14s$
$a = ?$

$V_f = \cancel{V_i} + at$

$a = \frac{V_f}{t} = \frac{21}{14} = 1.5\ m/s^2$

this means that the car's engine can exert a force of $F = ma = (1100)(1.5) = 1650\ N$ and

Assume zero friction (not realistic) and constant velocity.



x

$F_a - F_g \sin\theta = \cancel{ma}^{\,0}$

$F_a = F_g \sin\theta$

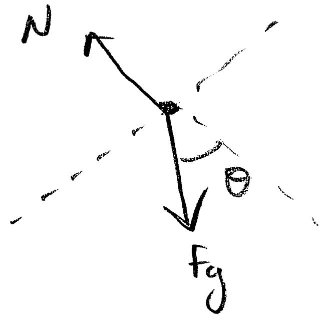
$\sin\theta = \frac{F_a}{mg}$

$\theta = \sin^{-1}\left(\frac{1650}{1100(9.8)}\right)$

$\underline{\theta = 8.8^\circ}$

$\theta = 8.6^\circ \quad g = 10$

(6)



x

$F_g \sin\theta = ma$ (down the slope is +ve)

$mg \sin\theta = ma$

$a = 9.8 \sin 10$

$a = 1.702\ m/s^2$ $a = 1.736\ m/s^2$ $g = 10$

$V_i = 0$

$V_f = ?$

$d = 3.5\ m$

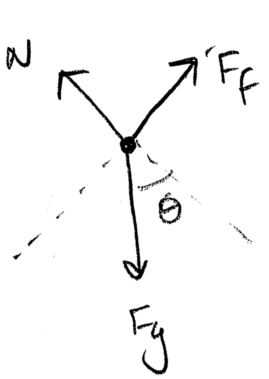
$a = 1.702\ m/s^2$

$V_f^2 = V_i^2 + 2ad$

$V_f = \sqrt{2(1.702)(3.5)}$

$V_f = 3.5\ m/s$

(7)



x

$F_f - F_g \sin\theta = ma$

y

$N - F_g \cos\theta = ma$ (0)

$N = mg\cos\theta$

$F_f = \mu F_N$

$= \mu mg \cos\theta$

if the object is stationary, then $\mu = 0.4$

and $F_f > F_g \sin\theta$

$\mu mg \cos\theta \overset{?}{=} mg \sin\theta$

$.4 \cos 30 \overset{?}{=} \sin 30$

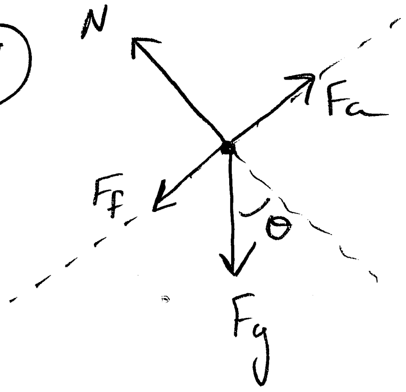
$.346 < .5$ therefore $a \neq 0$ and $\mu = 0.2$

$\mu mg \cos\theta - mg \sin\theta = ma$

$a = 9.8(.2 \cos 30 - \sin 30)$

$a = -3.2\ m/s^2$ ($3.2\ m/s^2$ down the slope)

(8)



x

$F_a - F_f - F_g \sin\theta = \cancel{ma}$ (= 0)

y

$N - F_g \cos\theta = \cancel{ma}$ (= 0)

$N = F_g \cos\theta$

$F_f = \mu F_N$

$F_f = \mu F_g \cos\theta$

$F_a - \mu F_g \cos\theta - F_g \sin\theta = 0$

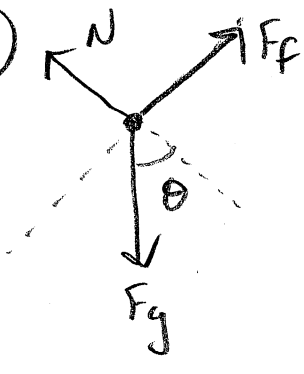
$F_a = \mu F_g \cos\theta + F_g \sin\theta$

$F_a = F_g(\mu\cos\theta + \sin\theta)$

$F_g = \dfrac{F_a}{\mu\cos\theta + \sin\theta} = \dfrac{835}{.15\cos 15 + \sin 15}$

$\underline{F_g = 2100\ N}$

(9)



x

$-F_f + F_g \sin\theta = ma$

minimum angle for sliding is when $a = 0$ and $F_f = F_g \sin\theta$

y

$N - F_g \cos\theta = \cancel{ma}$ (= 0)

$N = F_g \cos\theta$

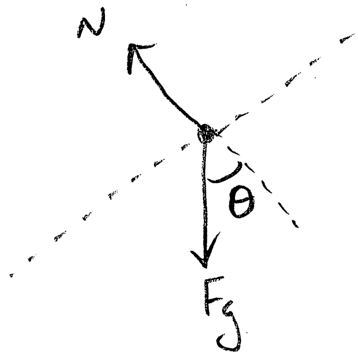
$F_f = \mu F_N$

$\cancel{F_g} \sin\theta = \mu \cancel{F_g} \cos\theta$

$\tan\theta = \mu$

$\theta = \tan^{-1}(.35) = \underline{19°}$

(10)



X

$F_g \sin\theta = ma$ (down the slope +ve)

$mg \sin\theta = ma$

$\sin\theta = \frac{a}{g}$

$v_i = 0$

$v_f = 19$ m/s

$d = 135$ m

$a = ?$

$v_f^2 = v_i^2 + 2ad$

$a = \frac{v_f^2}{2d} = \frac{(19)^2}{2(135)} = 1.337$ m/s^2

$\theta = \sin^{-1}\left(\frac{1.337}{9.8}\right)$

$\theta = 7.8^\circ$

$\theta = 7.7^\circ$ $g = 10$