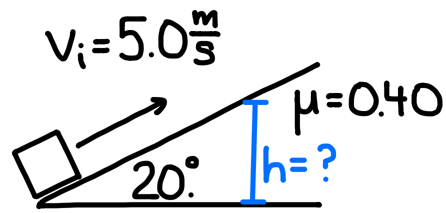
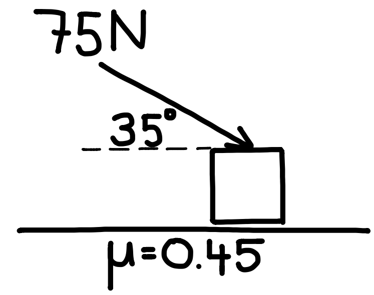
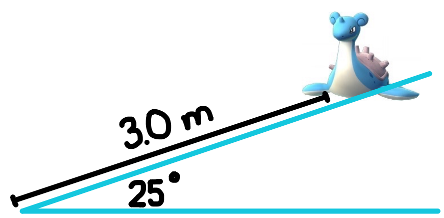
A mass is given an initial velocity of 5.0 m/s at the base of a ramp. How high up the ramp does the mass reach?

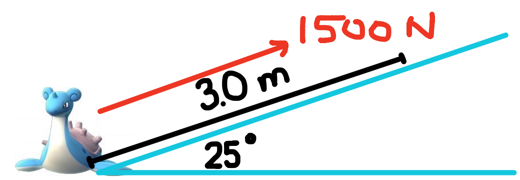


A box is pushed across a horizontal surface as shown. If the box accelerates at a rate of 1.6 m/s^2, what is the mass of the box?

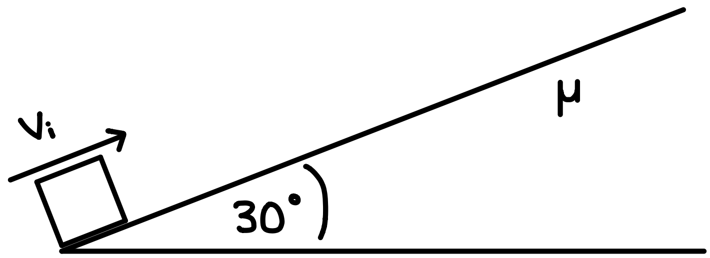


A 240 kg Lapras is sliding down an icy slope. It takes 1.4 seconds to reach the bottom.
a) What is the coefficient of friction?
b) If a 1500 N force is applied directly up the incline, how much time will it take to reach its starting point?



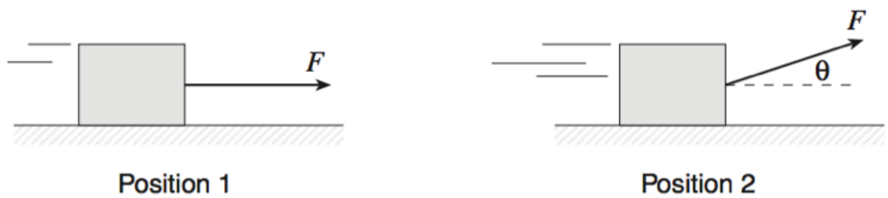


A mass is given an initial velocity at the base of a ramp.



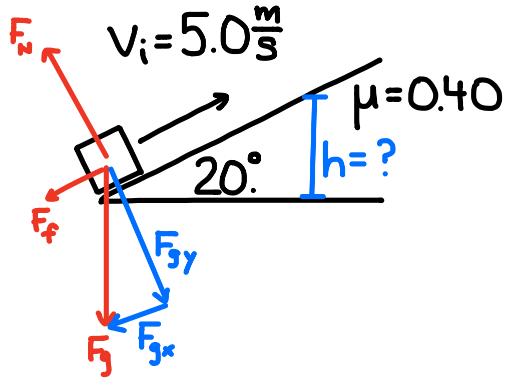
a) What values of μ would allow the block to slide back down?
b) If μ=0.50 and the time to go up and return to the starting point totals 10 seconds, what must be the initial velocity?
c) If vi=10 m/s and the time to go up and return to the starting point is 4.0 s, determine μ. *Solve using a graphing calculator.*

A crate is being accelerated across a rough concrete floor by a rope as shown in position 1 below. It is noticed that when the rope is lifted to a small angle θ as shown in position 2 the acceleration increases (*F* stays the same).



Using principles of physics, explain why this is the case.

A mass is given an initial velocity of 5.0 m/s at the base of a ramp. How high up the ramp does the mass reach?



$F_{gx} = mg \sin 20.°$

$F_{gy} = mg \cos 20.°$

$F_N = F_{gy}$

$F_N = mg \cos 20.°$

$$F_{NET} = ma$$

$$-F_{gx} - F_f = ma$$

$$-mg \sin 20.° - \mu F_N = ma$$

$$-\cancel{m}g \sin 20.° - \mu \cancel{m} g \cos 20.° = \cancel{m}a$$

$$a = -g(\sin 20.° + \mu \cos 20.°)$$

$$= -7.0354 \frac{m}{s^2}$$

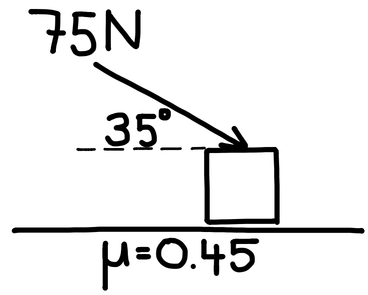
$$\cancel{v_f}^2 = v_i^2 + 2ad \quad (0)$$

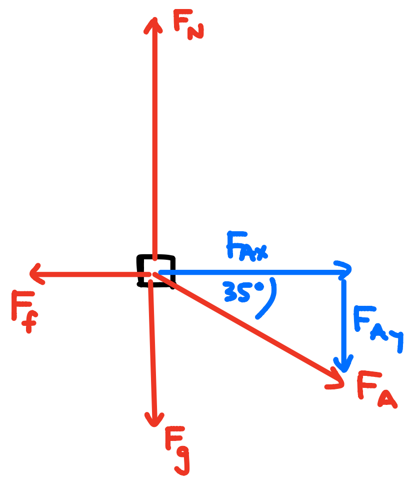
$$d = \frac{-v_i^2}{2a} = 1.7767 \text{ m}$$

$$h = d \sin 20° = 0.6077 \text{ m}$$

$$\longrightarrow 0.61 \text{ m}$$

A box is pushed across a horizontal surface as shown. If the box accelerates at a rate of 1.6 m/s^2, what is the mass of the box?





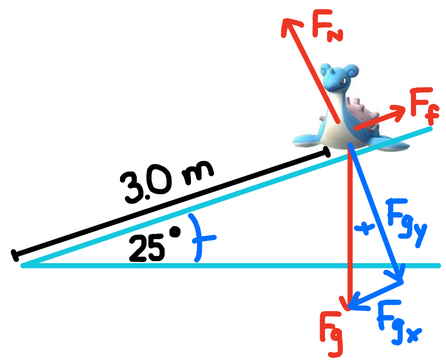
$$F_{Ax} = F_A \cos 35°$$
$$F_{Ay} = F_A \sin 35°$$

$$F_N = F_g + F_{Ay}$$
$$F_N = mg + F_A \sin 35°$$

$$F_{NET} = ma$$
$$F_{Ax} - F_f = ma$$
$$F_A \cos 35° - \mu F_N = ma$$
$$F_A \cos 35° - \mu(mg + F_A \sin 35°) = ma$$
$$F_A \cos 35° - \mu mg - \mu F_A \sin 35° = ma$$
$$F_A \cos 35° - \mu F_A \sin 35° = ma + \mu mg$$
$$F_A(\cos 35° - \mu \sin 35°) = m(a + \mu g)$$
$$m = \frac{F_A(\cos 35° - \mu \sin 35°)}{a + \mu g}$$
$$= 7.0 \text{ kg}$$

A 240 kg Lapras is sliding down an icy slope. It takes 1.4 seconds to reach the bottom.
a) What is the coefficient of friction?
b) If a 1500 N force is applied directly up the incline, how much time will it take to reach its starting point?

a)



$F_{gx} = mg\sin 25°$
$F_{gy} = mg\cos 25°$

$F_N = F_{gy}$
$F_N = mg\cos 25°$

$v_i = 0$

$d = \cancel{v_i t} + \frac{1}{2}at^2$

$a = \frac{2d}{t^2} = 3.0612\ \frac{m}{s^2}$

$F_{NET} = ma$

$F_{gx} - F_f = ma$

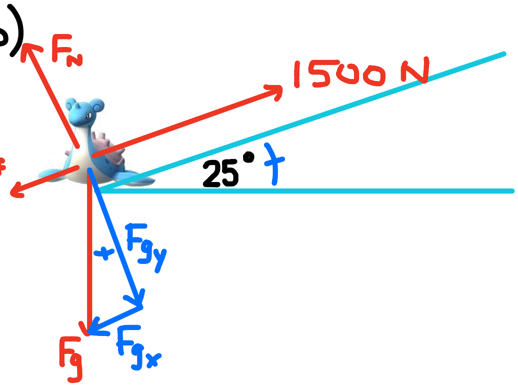
$mg\sin 25° - \mu F_N = ma$

$\cancel{m}g\sin 25° - \mu \cancel{m}g\cos 25° = \cancel{m}a$

$\mu = \frac{g\sin 25° - a}{g\cos 25°}$

$= 0.12165 \longrightarrow \boxed{0.12}$

b)



$F_{gx} = mg\sin 25°$

$F_{gy} = mg\cos 25°$

$F_N = F_{gy}$

$F_N = mg\cos 25°$

$F_{NET} = ma$

$F_A - F_{gx} - F_f = ma$

$F_A - mg\sin 25° - \mu F_N = ma$

$F_A - mg\sin 25° - \mu mg\cos 25° = ma$

$\dfrac{F_A - mg\sin 25° - \mu mg\cos 25°}{m} = a$

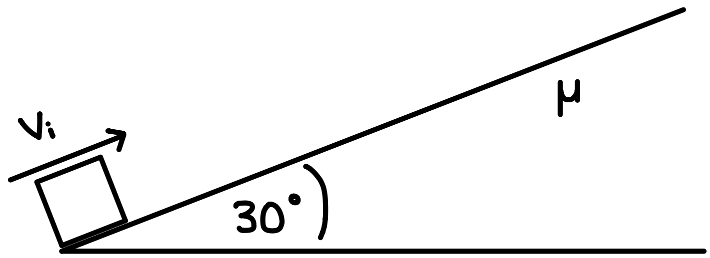
$a = 1.0279\ \frac{m}{s^2}$

$v_i = 0$

$d = \cancel{v_i t} + \frac{1}{2}at^2$

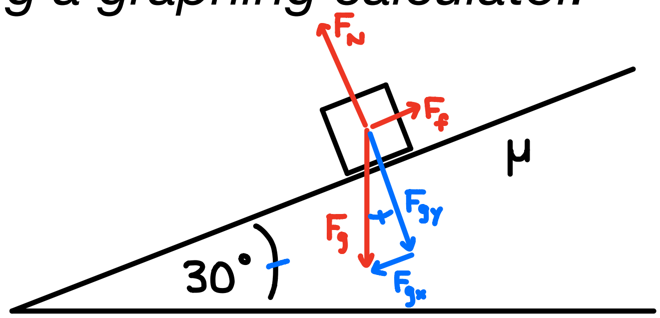
$t = \sqrt{\dfrac{2d}{a}} = 2.4\ s$

A mass is given an initial velocity at the base of a ramp.



a) What values of *μ* would allow the block to slide back down?
b) If *μ*=0.50 and the time to go up and return to the starting point totals 10 seconds, what must be the initial velocity?
c) If vi=10 m/s and the time to go up and return to the starting point is 4.0 s, determine *μ*. *Solve using a graphing calculator.*

a)



$F_{gx} = mg\sin 30°$

$F_{gy} = mg\cos 30°$

$F_N = F_{gy}$

$F_N = mg\cos 30°$

BLOCK SLIDES DOWN IF

$$F_{gx} > F_f$$

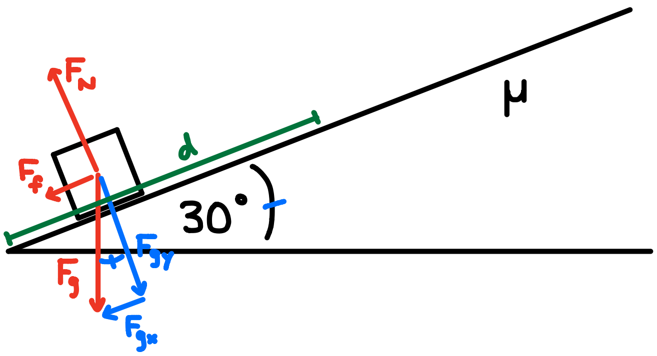
$$mg\sin 30° > \mu F_N$$

$$\cancel{mg}\sin 30° > \mu \cancel{mg}\cos 30°$$

$$\frac{\sin 30°}{\cos 30°} > \mu$$

$$\mu < \tan 30° = \frac{1}{\sqrt{3}} = 0.58$$

b) UP THE RAMP



$F_{gx} = mg\sin 30°$

$F_{gy} = mg\cos 30°$

$F_N = F_{gy}$

$F_N = mg\cos 30°$

$$F_{NET} = ma$$

$$-F_{gx} - F_f = ma$$

$$-mg\sin 30° - \mu F_N = ma$$

$$-\cancel{m}g\sin 30° - \mu \cancel{m}g\cos 30° = \cancel{m}a$$

$$a = -g(\sin 30° + \mu\cos 30°)$$

$$\cancel{v_f}^{2\,0} = v_i^2 + 2ad$$

$$d = \frac{-v_i^2}{2a}$$

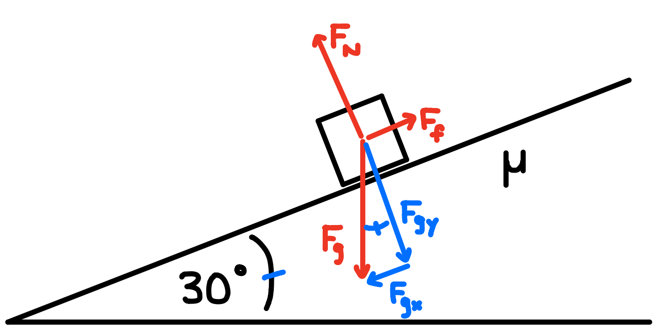
$$d = \frac{v_i^2}{2g(\sin 30° + \mu\cos 30°)}$$

$$\cancel{v_f}^{\,0} = v_i + at$$

$$t = \frac{-v_i}{a}$$

$$t_{up} = \frac{v_i}{g(\sin 30° + \mu\cos 30°)}$$

DOWN THE RAMP



$F_{gx} = mg\sin 30°$

$F_{gy} = mg\cos 30°$

$F_N = F_{gy}$

$F_N = mg\cos 30°$

$$F_{NET} = ma$$

$$F_{gx} - F_f = ma$$

$$mg\sin 30^\circ - \mu F_N = ma$$

$$\cancel{m}g\sin 30^\circ - \mu \cancel{m}g\cos 30^\circ = \cancel{m}a$$

$$a = g(\sin 30^\circ - \mu\cos 30^\circ)$$

$$d = \underbrace{v_i}_{v_i=0} t + \frac{1}{2}at^2$$

$$d = \frac{1}{2}at^2$$ FROM ABOVE (UP THE RAMP)

$$t = \sqrt{\frac{2d}{a}}$$

$$t_{DOWN} = \sqrt{\frac{\cancel{2}\left(\frac{v_i^2}{\cancel{2}g(\sin 30^\circ + \mu\cos 30^\circ)}\right)}{g(\sin 30^\circ - \mu\cos 30^\circ)}}$$

$$t_{DOWN} = \sqrt{\frac{v_i^2}{g^2(\sin 30^\circ + \mu\cos 30^\circ)(\sin 30^\circ - \mu\cos 30^\circ)}}$$

$$t_{DOWN} = \frac{v_i}{g\sqrt{\sin^2 30^\circ - \mu^2\cos^2 30^\circ}}$$

$$t_{UP} + t_{DOWN} = t_{TOTAL}$$

$$\frac{v_i}{g(\sin 30^\circ + \mu\cos 30^\circ)} + \frac{v_i}{g\sqrt{\sin^2 30^\circ - \mu^2\cos^2 30^\circ}} = t_{TOTAL}$$

$$\frac{v_i}{g}\left(\frac{1}{\sin 30^\circ + \mu\cos 30^\circ} + \frac{1}{\sqrt{\sin^2 30^\circ - \mu^2\cos^2 30^\circ}}\right) = t_{TOTAL}$$

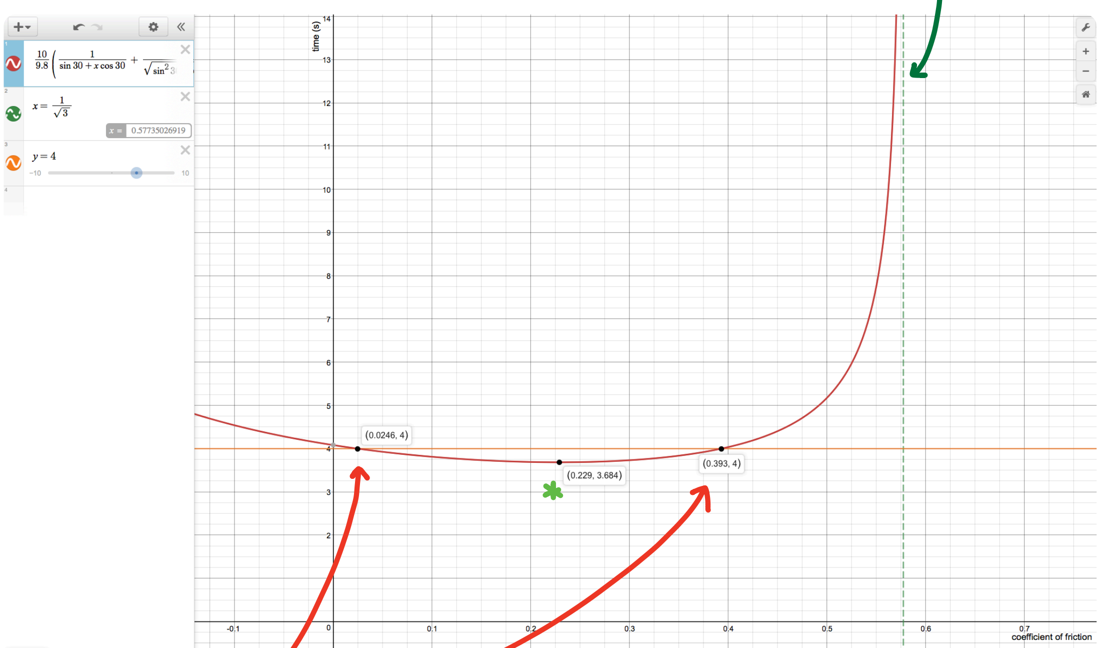
$$v_i = \frac{g\,t_{TOTAL}}{\dfrac{1}{\sin 30^\circ + \mu \cos 30^\circ} + \dfrac{1}{\sqrt{\sin^2 30^\circ - \mu^2 \cos^2 30^\circ}}} = 19.323 \ \tfrac{m}{s}$$

$\rightarrow \boxed{19 \ \tfrac{m}{s}}$

c) t_{TOTAL} VS. μ IS SHOWN BELOW (FROM b)

$$\frac{v_i}{g}\left(\frac{1}{\sin 30^\circ + \mu \cos 30^\circ} + \frac{1}{\sqrt{\sin^2 30^\circ - \mu^2 \cos^2 30^\circ}}\right) = t_{TOTAL}$$

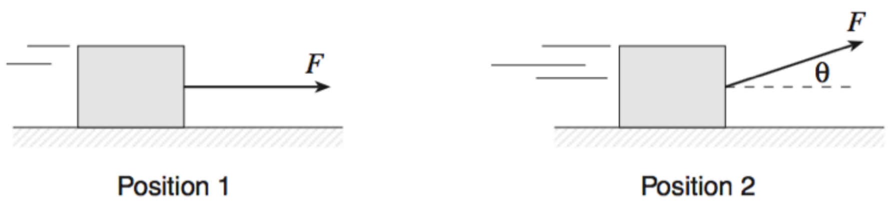
$\mu = \frac{1}{\sqrt{3}}$, MAX μ WHICH ALLOWS BLOCK TO SLIDE BACK DOWN



$t_{TOTAL} = 4.0$ s WHEN $\mu = 0.0246$ OR $\mu = 0.393$

* A MINIMUM OF 3.684 s IS TAKEN WHEN $\mu = 0.229$

A crate is being accelerated across a rough concrete floor by a rope as shown in position 1 below. It is noticed that when the rope is lifted to a small angle *θ* as shown in position 2 the acceleration increases (*F* stays the same).



Using principles of physics, explain why this is the case.

ACCORDING TO NEWTON'S SECOND LAW, ACCELERATION IS DIRECTLY PROPORTIONAL TO THE NET FORCE AND INVERSELY PROPORTIONAL TO THE MASS.

BY LIFTING THE ROPE, THE FORCE F IN POSITION 2 HAS A VERTICAL COMPONENT WHICH BALANCES A PORTION OF F_g, LEAVING F_N AND THEREFORE F_f REDUCED.

AS THE HORIZONTAL COMPONENT OF F HAS CHANGED VERY LITTLE FROM POSITION 1 TO POSITION 2, F_{NET} AND THEREFORE ACCELERATION HAVE BEEN INCREASED.