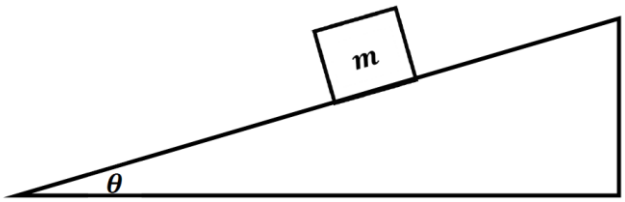
Quiz Average 4.75 **Quiz High Score** 8

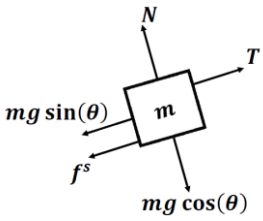
PH 220 **Quiz # 05 (10 pts)** **Name** Solution

A mass $(3.61\ \text{kg})$ is at rest on an inclined plane which makes and angle of $23.0°$ with the horizontal as shown in the sketch down below. There is a coefficient of static friction $(\mu_s = 0.691)$ between the mass and the surface of the inclined plane. You have a rope that is massless, stretchless and unbreakable that you can attach to either the upper or lower side of the mass and then pull on the rope so it is parallel to the inclined plane. What is the greatest tension force you can apply to the mass before it starts to slide on the inclined plane?



A. 8.68 N **B.** **36.3 N** **C.** 13.8 N **D.** 24.5 N

Two possible free body diagrams:

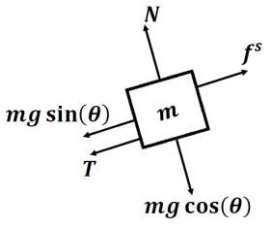


$$\sum \boldsymbol{F_\perp = N - mg\cos(\theta) = ma_\perp = 0}$$

$$\boldsymbol{N = mg\cos(\theta)}$$

$$\sum \boldsymbol{F_\parallel = T - mg\sin(\theta) - f^s = ma_\parallel = 0}$$

$$\boldsymbol{T = f^s + mg\sin(\theta)}$$



$$\sum \boldsymbol{F_\perp = N - mg\cos(\theta) = ma_\perp = 0}$$

$$\boldsymbol{N = mg\cos(\theta)}$$

$$\sum \boldsymbol{F_\parallel = T + mg\sin(\theta) - f^s = ma_\parallel = 0}$$

$$\boldsymbol{T = f^s - mg\sin(\theta)}$$

Clearly Tension is greatest up the incline so we can calculate it knowing that the static friction must be maximum.

$$\boldsymbol{T = f^s + mg\sin(\theta) = \mu_s mg\cos(\theta) + mg\sin(\theta) = mg(\mu_s\cos(\theta) + \sin(\theta))}$$

$$\boldsymbol{T = (3.61\ kg)\left(9.80\ {}^{m}/_{s^2}\right)\left((0.691)\cos(23.0°) + \sin(23.0°)\right)}$$

$$\boldsymbol{T = (35.37\ N)(1.027) = 36.3\ N}$$

So, the correct answer is B !

The Moon has an orbital speed of $1023.\ ^{m}/_{s}$ as it travels on its orbit with radius of 3.84×10^{8} m. What is the period required for the Moon to make one orbit around the Earth?

A. 1.18×10^{6} s **C.** $\mathbf{2.36 \times 10^{6}\ s}$

B. 5.97×10^{4} s **D.** 3.75×10^{5} s

$$v = \frac{2\pi R}{T}$$

$$T = \frac{2\pi R}{v} = \frac{2\pi(3.84\ x\ 10^{8}\ m)}{1023.\ ^{m}/_{s}} = 2.36\ x\ 10^{6}\ s$$

$$T = 2.36\ x\ 10^{6}\ s\ x\ \frac{h}{3600\ s}\ x\ \frac{d}{24\ h} = 27.3\ d$$

So, the correct answer is C !

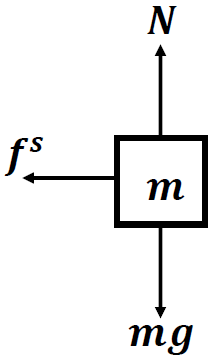
A dime ($m_{dime} = 2.27 \times 10^{-3}$ kg) is at rest on a vinyl record which is rotating with a period of 0.849 s. The dime is located a distance from the center of the vinyl record of 0.150 m. What is the minimum coefficient of static friction needed for the dime to remain at rest on the vinyl?

A. **0.838** **B.** 0.267 **C.** 0.712 **D.** 0.018

Free Body Diagram and Sum of Forces Equations:

$$\sum F_y = N - mg = ma_y = 0$$

$$N - mg$$



$$\sum F_R = f^s = f^{s,max} = \mu_s N = \mu_s mg = m\frac{v^2}{R} = m\frac{4\pi^2 R}{T^2}$$

$$\mu_s = \frac{4\pi^2 R}{gT^2} = \frac{4\pi^2(0.150\ m)}{\left(9.80\ ^{m}/_{s^2}\right)(0.849\ s)^2} = 0.838$$

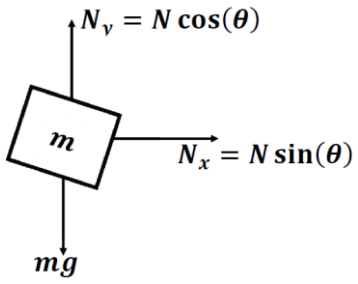
So, the correct answer is A !

A race car is going into a banked curve at the race track which is banked at an angle $\theta = 55.8°$. The radius of curvature for the curve is $424.\,\mathrm{m}$. The car and driver have a combined mass of $1340.\,\mathrm{kg}$. What is the speed with which the car can traverse this curve without the aid of any kind of friction?

A. $53.1\ {}^{\mathrm{m}}/_{\mathrm{S}}$ **B.** $\mathbf{78.2\ {}^{m}/_{s}}$ **C.** $25.0\ {}^{\mathrm{m}}/_{\mathrm{S}}$ **D.** $48.3\ {}^{\mathrm{m}}/_{\mathrm{S}}$

Free Body Diagram and Sum of Forces Equations are:

$$\sum \boldsymbol{F_y = N_y - mg = ma_y = 0}$$



$$\boldsymbol{N_y = N\cos(\theta) = mg}$$

$$\boldsymbol{N = \frac{mg}{\cos(\theta)}}$$

$$\sum \boldsymbol{F_R = N_x = N\sin((\theta)) = m\frac{v^2}{R}}$$

From this we get The banked angle formula is

$$\boldsymbol{\tan(\theta) = \frac{v^2}{Rg}}$$

Solve for speed

$$\boldsymbol{v^2 = Rg\tan(\theta)}$$

$$\boldsymbol{v = \sqrt{Rg\tan(\theta)} = \sqrt{(424.m)\left(9.80\ {}^{m}/_{s^2}\right)\tan(55.8°)} = \sqrt{6114.2\ {}^{m^2}/_{s^2}}}$$

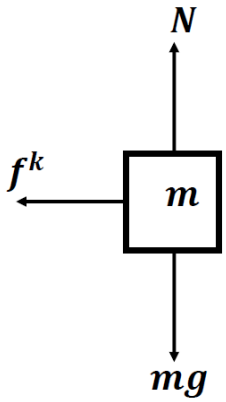
$$\boldsymbol{v = 78.2\ {}^{m}/_{s}}$$

So, the correct answer is B !

A mass is sliding with an initial speed of $13.3\ {}^{\mathrm{m}}/_{\mathrm{S}}\ (\widehat{\mathrm{North}})$ along a frictionless surface. It enters a region where a coefficient of kinetic friction greater than zero is present. After the mass has slid a distance of $24.3\ \mathrm{m}\ (\widehat{\mathrm{North}})$ the mass comes to rest. What is the value of the coefficient of kinetic friction?

A. 0.737 **B.** 0.274 **C.** **0.371** **D.** 2.70

Free Body Diagram and Sum of Forces Equations are:



$$\sum F_y = N - mg = ma_y = 0$$

$$N = mg$$

$$\sum F_x = f^k = \mu_k N = \mu_k mg = ma_x$$

$$a_x = \mu_k g$$

$$v_f^2 = 0 = v_0^2 - 2a_x x$$

$$a_x = \mu_k g = \frac{v_0^2}{2x}$$

$$\mu_k = \frac{v_0^2}{2gx} = \frac{(13.3\ {}^{m}/_{s})^2}{2\left(9.80\ {}^{m}/_{s^2}\right)(24.3\ m)} = \frac{176.89\ {}^{m^2}/_{s^2}}{476.28\ {}^{m^2}/_{s^2}} = 0.371$$

So, the correct answer is C !

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