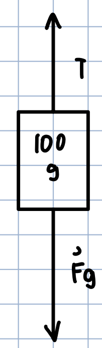
Consider a 100g stopper on a string, held up by Jeb the chihuahua

a) Find T when the stopper is stationary



$\vec{F}_{Net} = T + \vec{F}_g$

$m(0) = T + m(-g)$

$T = mg = 0.1(9.81)$

$= 0.98\ N[U]$

b) Find T if lifting string at 2m/s

$a = 0$ same as a)

c) Find T if moving string down at 2m/s

$a = 0$ same as a)

d) Find T if lifting string at 2m/s^2

$a = 2\ m/s^2\ [U]$

$\vec{F}_{Net} = T + \vec{F}_g$

$0.1(2) = T + 0.1(-9.8)$

$T = 1.18\ N[U]$

e) Find T if moving string down at 2m/s^2

$\vec{a} = 2\ m/s^2 [D]$

$\vec{F}_{Net} = T + \vec{F}_g$

$0.1(2) = T + 0.1(9.81)$

$T = 0.781\ N[U]$

f) Find T if moving string down at 15m/s^2

$\vec{a} = 15\ m/s^2\ [D]$

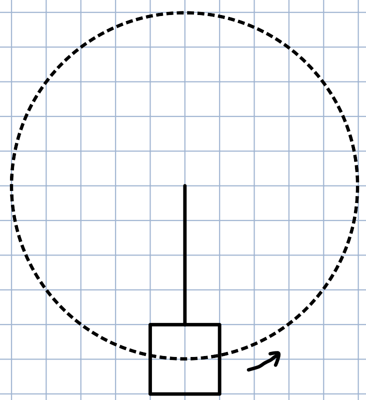
$\vec{F}_{Net} = T + \vec{F}_g$

$0.1(15) = T + 0.1(9.81)$

$T = 0.519\ N[D] = T$

Pendulum: Vertical Circle

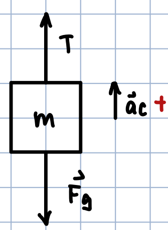
Find the tension at the bottom and top of the rotation (uniform), given the length of string and time for ten cycles



$l = R$

$T = \frac{t\ s}{10\ \text{cycles}}$

Bottom



$\vec{F}_{Net} = T + \vec{F}_g$

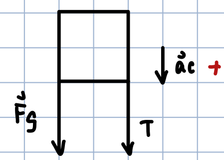
$m\vec{a}_c = T + m(-g)$

$m\left(\frac{4\pi^2 R}{T^2}\right) = T - mg$

$m\left(\frac{4\pi^2 R}{T^2}\right) + mg = T$

$m\left(\frac{4\pi^2 R}{T^2} + g\right) = T$

Top



$\vec{F}_{Net} = T + \vec{F}_g$

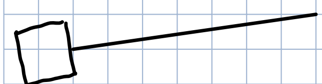
$m\vec{a}_c = T + mg$

$m\vec{a}_c - mg = T$

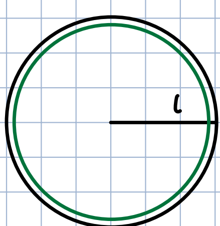
$m(\vec{a}_c - g) = T$

$m\left(\frac{4\pi^2 R}{T^2} - g\right) = T$

Pendulum: Horizontal circle



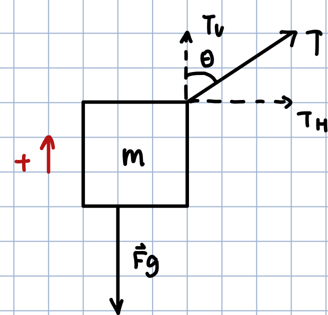
Bird's eye view:

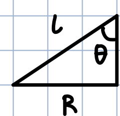


Perfectly horizontal

$l = R$

but actual $R < l$ because slight drop





Angle from vertical provided (usually)

V

$\vec{F}_{Net} = T_v + F_g$

$m(0) = T\cos\theta + m(-g)$

$mg = T\cos\theta$

$T = \frac{mg}{\cos\theta}$

sub.

H

$\vec{F}_{Net} = T_H$

$m\vec{a}_c = T\sin\theta$

$m\vec{a}_c = \frac{mg}{\cos\theta}\sin\theta$

$\boxed{\vec{a}_c} = g\tan\theta$

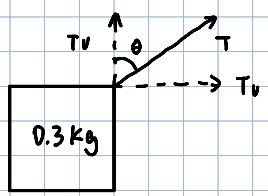
sub: $\frac{v^2}{R}$ $\frac{4\pi^2 R}{T^2}$

Pendulum: Example 1

0.3kg 4.17m/s

A 300g pendulum is spun around in a horizontal circle. If the pendulum is moving at 15km/h and makes an angle 25 degrees from the vertical, how long is the pendulum?

θ L?



V

$\vec{F}_{Net} = T_V + F_g$

$m(0) = T\cos\theta = m(-g)$

$T = \frac{mg}{\cos\theta}$

H

$\vec{F}_{Net} = T_H$

$m\vec{a}_c = T\sin\theta$

$m\vec{a}_c = \frac{mg}{\cos\theta}\sin\theta$

$\vec{a}_c = g\tan\theta$

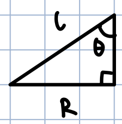
$\frac{v^2}{R} = g\tan\theta$

$R = \frac{v^2}{g\tan\theta}$

$L\sin\theta = \frac{v^2}{g\tan\theta}$

$L = \frac{v^2}{g\tan\theta\sin\theta}$

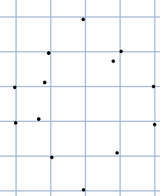
$L = 8.98\ m$



$\sin\theta = \frac{R}{L}$

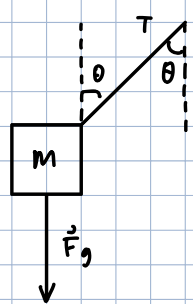
$R = L\sin\theta$

$v = 4.17 m/s$



Example 2:

A pi^R kg mass is at the end of a 3m long pendulum, moving in a horizontal circle. If the rope makes a 35 degrees angle with the vertical, how fast is the mass moving



V

$\vec{F}_{Net} = T_V + \vec{F}_g$

$0 = T\cos\theta - mg$

$T\cos\theta = mg$

$T = \frac{mg}{\cos\theta}$

H

$\vec{F}_{Net} = T_H$

$m\vec{a}_c = T\sin\theta$

$m\vec{a}_c = \frac{mg}{\cos\theta}\sin\theta$

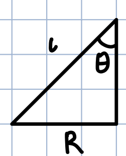
$\vec{a}_c = g\tan\theta$

$\frac{v^2}{R} = g\tan\theta$

$v = \sqrt{Rg\tan\theta}$

$= \sqrt{L\sin\theta g\tan\theta}$

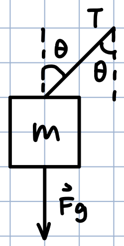
$= 3.44 m/s$



$\sin\theta = \frac{L}{R}$ $R = L\sin\theta$

Example 3:

A 2.25m long pendulum is spun in a horizontal circle. It completes 95 turns in a minute. What angle is the rope to the vertical?

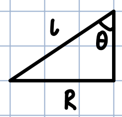


V

$$\vec{F}_{Net} = T_v + \vec{F}_g$$
$$0 = T\cos\theta - mg$$
$$T\cos\theta = mg$$
$$T = \frac{mg}{\cos\theta}$$

H

$$\vec{F}_{Net} = T_H$$
$$m\vec{a}_c = T\sin\theta$$
$$m\vec{a}_c = \frac{mg}{\cos\theta}\sin\theta$$
$$\vec{a}_c = g\frac{\sin\theta}{\cos\theta}$$
$$\frac{4\pi^2 R}{T^2} = g\frac{\sin\theta}{\cos\theta}$$
$$\frac{4\pi^2 L\sin\theta}{T^2} = g\frac{\sin\theta}{\cos\theta}$$
$$\cos\theta = \frac{gT^2}{4\pi^2 L}$$
$$\theta = \cos^{-1}\left(\frac{gT^2}{4\pi^2 L}\right)$$
$$\theta = 87.5^\circ$$



$$\sin\theta = \frac{R}{L}$$
$$R = L\sin\theta$$

$$T = \frac{60\,s}{95\ \text{cycles}}$$