Force Vectors

Forces are vectors. All Forces in Newtons (N)

F_{net} is the total of all forces which means to find F_{net} you must add the forces together, the resultant is Fnet.

$$\frac{F_{net}}{m} = a$$

Fg = force of gravity

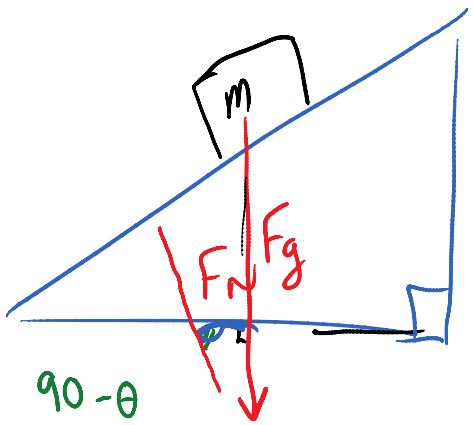
F_g = mg where m is mass in kg, g is accel due to gravity = 9.8 m/s^2 on Earth

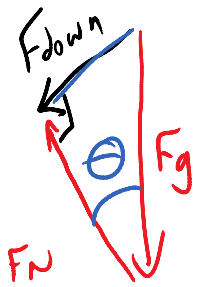
10.7
3
73°

normal force (F_n) which exerted BY A SURFACE to support an object and is ALWAYS 90° TO THE SURFACE.

$$F_N = F_g \cos\theta$$

angle of surface you are on

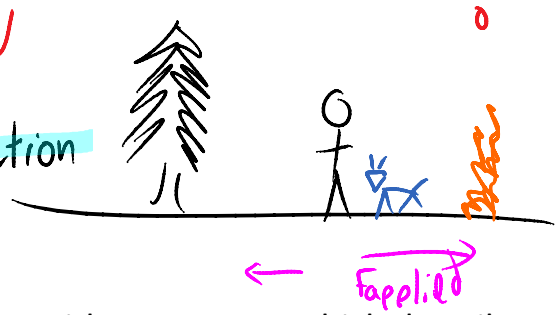




$$F_{down} = F_g \sin\theta$$

F_f = Force of friction

$F_f = \mu F_n$

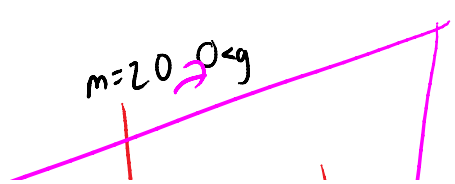


Ff = μ Fn where μ is the coefficient of friction, a unitless measure which describes how much adhesion there is between surfaces (how sticky they are). Large values of μ are close to 1 small values close to zero.

.97 .0001

+ FN = Fg
up = down

Find the normal force and
The force down slope
acting on a car on an 8°
slope if the car has mass 2000kg
also find Ff if μ = 0.10.



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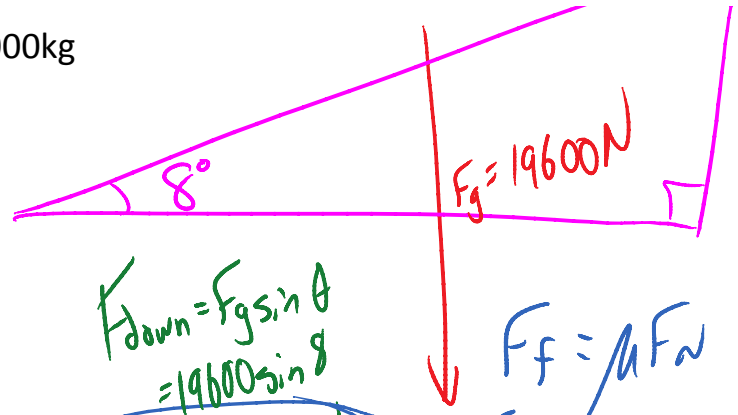


$F_n = F_g \cos\theta$
$= 19600 \cos 8$
$= 19410\ N$

$F_{down} = F_g \sin\theta$
$= 19600 \sin 8$
$= 2727\ N$

$F_f = \mu F_N$
$F_f = (.1)\,19410N$
$= 1941\ N$

F_f always opposes motion! F_f will be in the opposite direction of F_{down}

Find the net force on the car ← total force

* $F_{net} = F_{down} - F_f$
$2727 + -1941$
$= 786\ N$

Find the car's acceleration

$a = \frac{F_{net}}{m} = \frac{786}{2000} = .393\ \frac{m}{s^2}$

down the ramp

ACCELERATION ON RAMPS

(9.8)

A

A cat of mass 5.0 kg is on a ramp inclined at 30°, if the coefficient of friction of 0.25 exists what Is the force down the ramp, Ff and the cat's acceleration?

μF_n

$= 25 + -10.6 = 14.4N$

$a = \frac{F_{net}}{m} = \frac{14.4}{5} = 2.88 \frac{m}{s^2}$

$= 10.6N$

$\sin 30$

① Redraw $F_{net} = F_{down} + F_f$ forces in tip to tail fashion ← $F_{net} = 0$

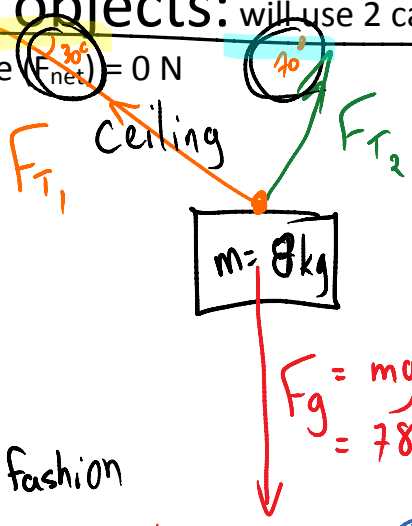
$g \cos\theta$

Coefficients of friction have high values approaching 1, (over 1 means its easier to lift the object than to slide it) low values of μ approach zero

Find the force $= 57N$

Suspended objects:

will use 2 cables (ropes) to offset the force of gravity so that The net force (F_{net}) = 0 N

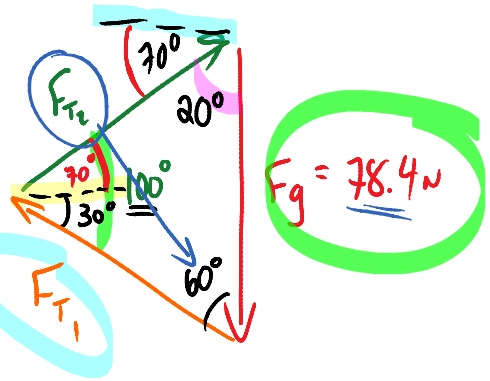


Force in ropes is called Force of Tension

F_T T

$\cos\theta$

① Redraw vectors in tip to tail fashion (you must finish where you started) $F_{net} = 0$



$- g \sin\theta$

② Sine LAW

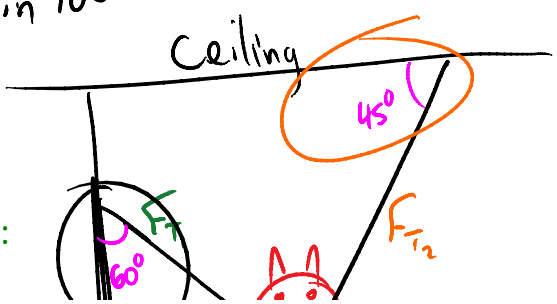
$\frac{a}{\sin A} = \frac{b}{\sin B}$

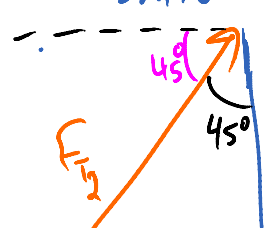
$\frac{(\sin 20)(78.4N)}{\sin 100} = F_{T_1} = 27.2N$

$F_{T_2} = \frac{78.4 \sin 60}{\sin 100} = 68.9N$

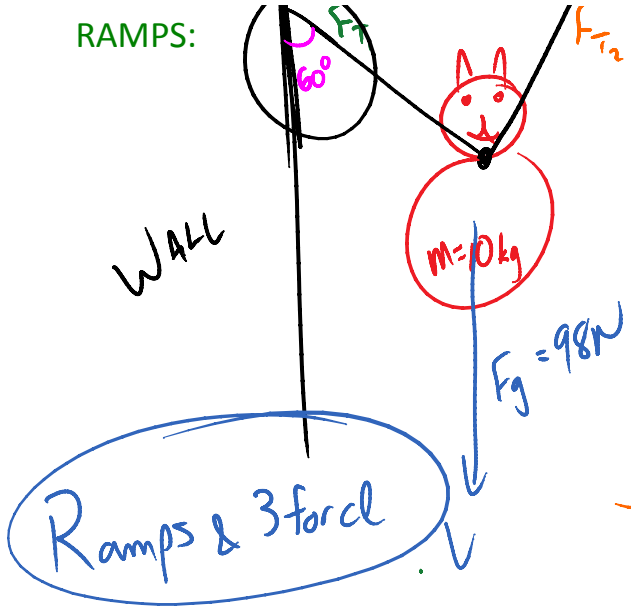
F_f *

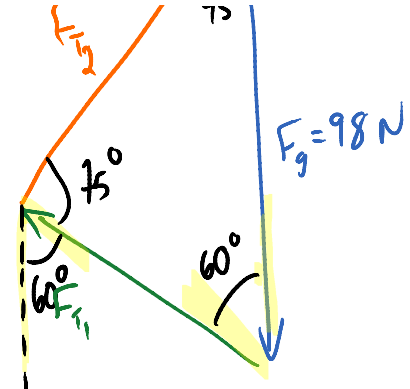
RAMPS:





RAMPS:





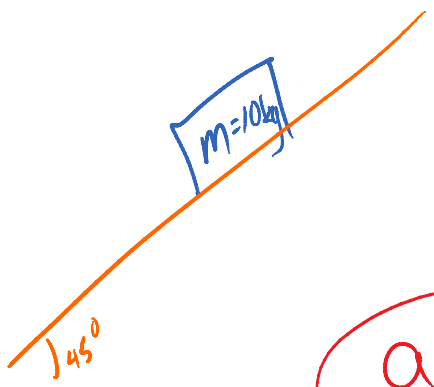
$F_{T_2} = \frac{98N \sin 60}{\sin 75} = 87.9N$

$\frac{F_{T_1}}{\cancel{\sin 45}} = \frac{98 \sin 45}{\sin 75} = 72N$

$\sin\theta$
$\sin\theta$

F_N
$\mu mg\cos\theta$
$= 38.2N$

Find the F_{down} a 45° ramp on a 10 kg mass. Then find the mass's acceleration if the ramp is frictionless.



$F_{down} = mg\sin\theta$
$= 98 \sin 45$
$= 69.3\ N$

$= kg$

$= mg$
$= 49N$

$a = \frac{F_{net}}{m} = \frac{69.3}{10} = 6.93\ \frac{m}{s^2}$

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

$a = g\sin\theta$
$= 9.8 \sin 45 = 6.93\ \frac{m}{s^2}$

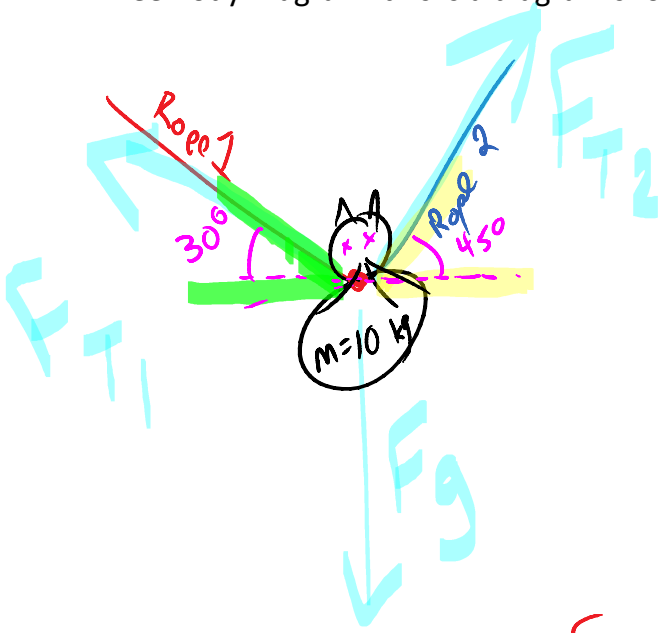
Equilibrant: a force which creates 'equilibrium' Fnet= 0N

The Force of Tension in Suspended Objects

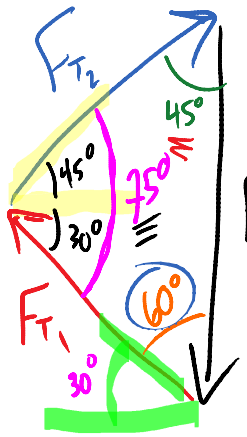
Force of Tension: a force pulling on ropes or cables
Suspended objects: the force of gravity is balanced by other forces

Static objects: these are objects at rest, all static objects have Fnet = 0 N

Free Body Diagram: this is a diagram showing all forces on an object



After drawing a diagram, Draw a new diagram with The forces in TIP to TAIL Fashion. ← last vector must end at 1st vector

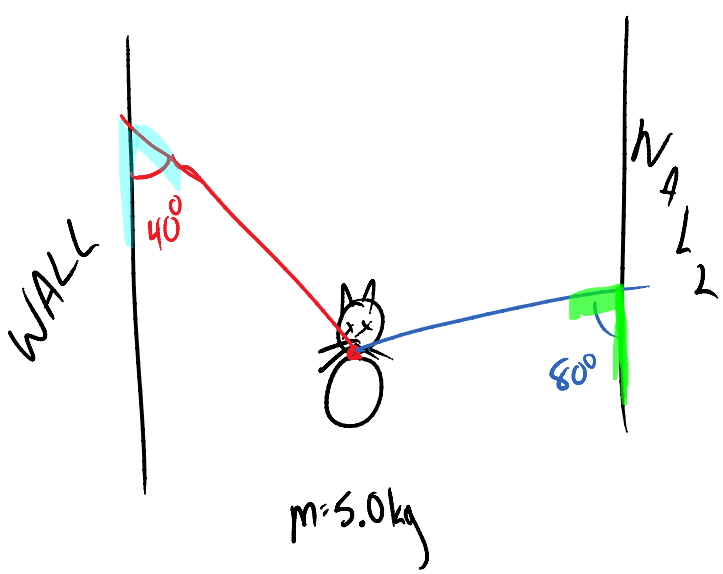


$F_g = mg$
$= 98N$

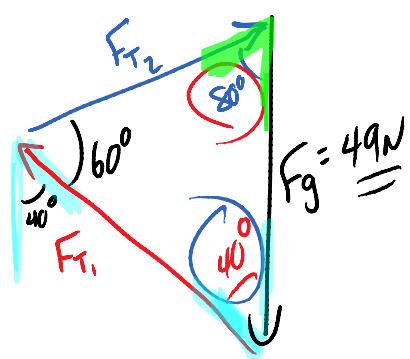
$$\frac{98}{\sin 75} = \frac{F_{T_2}}{\sin 60} \qquad \frac{98}{\sin 75} = \frac{F_{T_1}}{\sin 45}$$

$$\frac{98 \sin 60}{\sin 75} = F_{T_2} = 87.9N \qquad \frac{98 \sin 45}{\sin 75} = 71.7N = F_{T_1}$$

Find the force of tension in each cable in the diagram below:



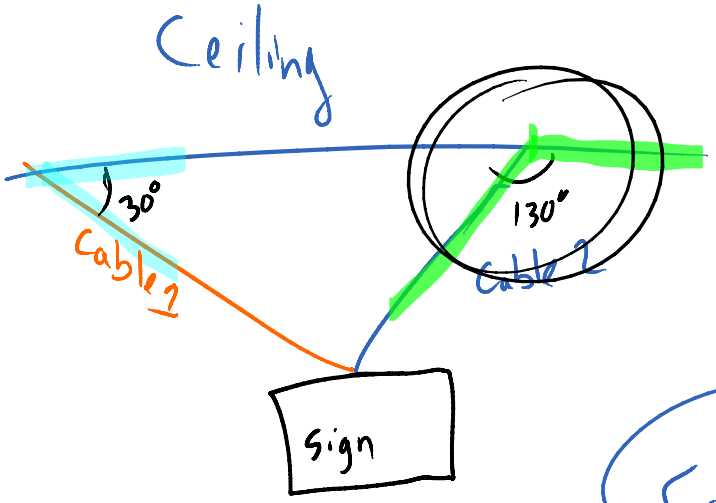
find F_T in each cable



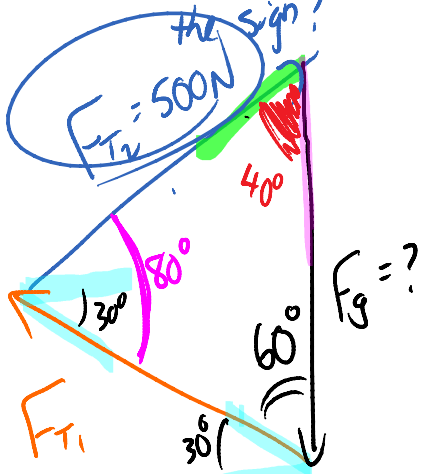
$$\frac{49}{\sin 60} = \frac{F_{T_1}}{\sin 80} \qquad \frac{49 \sin 80}{\sin 60} = F_{T_1} = 55.7N$$

$$\frac{49}{\sin 40} = \frac{F_{T_2}}{\sin 40} \qquad F_T = 36.4N$$

$$\frac{49}{\sin 60} = \frac{F_{T_2}}{\sin 40} \qquad F_{T_2} = 36.4\,N$$



If cable 2 can support a maximum force of 500N what is the maximum mass for the sign?

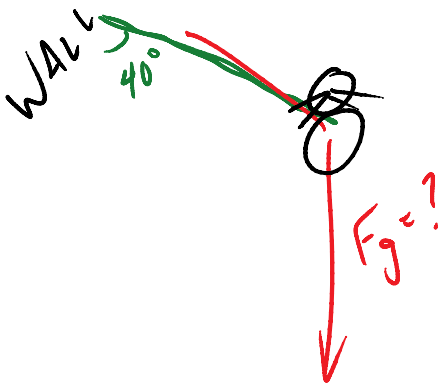


$m = ?$

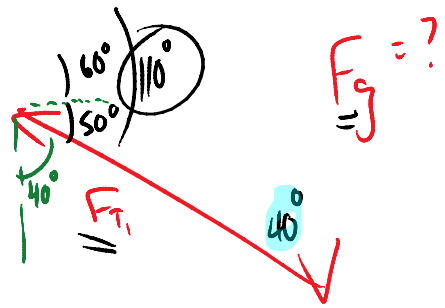
$$\frac{500\,N}{\sin 60} = \frac{F_g}{\sin 80}$$

$$\frac{500 \sin 80}{\sin 60} = F_g = 569\,N$$

$$\frac{F_g}{g} = m \qquad \frac{569}{9.8} = 58\,kg$$



What is the maximum mass of the cat?



$$\frac{F_g}{\sin 110} = \frac{100\,N}{\sin 40} \qquad F_g = \frac{100 \sin 110}{\sin 40}$$

$$F_g = 146.2\,N$$

$$F_g = m \qquad \frac{146.2}{9.8} = 14.9\,kg$$

$$\frac{F_g}{g} = m \qquad \frac{146.2}{9.8} = 14.9\,kg$$