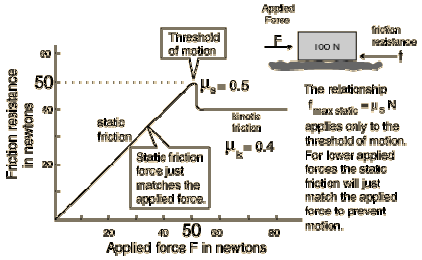
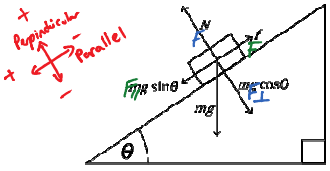
Forces at angles

September 30, 2015 2:21 PM

Frictional Force



Incline plane Problems



For Physics 12
Consider the perpindicular and parallel dimensions

Perpindular
$F_{Net} = ma$
$F_N - F_\perp = ma_\perp$
$F_N - mg\cos\theta = ma_\perp$

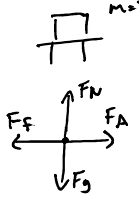
Parallel
$F_{Net} = ma$
$F_{//} - F_f = ma_{//}$
$mg\sin\theta - F_f = ma_{//}$

Sorry I'm bad at anglish.

Example:

A 20.0-kg box rests on a table and requires a minimum of 20N to overcome the static friction.

a) What is the coefficient of friction acting on this box?

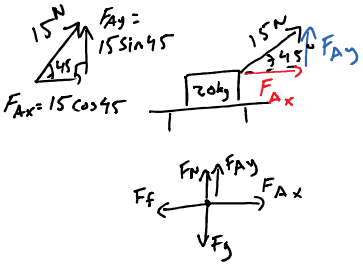


Vertical (a=0)
$F_{Net} = ma$
$F_N - F_g = 0$
$F_N = F_g$
$F_N = mg$

Horizontal (a=0)
$F_{Net} = ma$
$F_A - F_f = 0$
$F_f = F_A$
$\mu F_N = F_A$
$\mu mg = F_A$

$\mu = \frac{F_A}{mg}$
$\mu = \frac{20}{20(9.8)}$
$\mu = 0.102$

b) You apply a force of 15N at an angle of 45° above the horizontal. Does the box move?

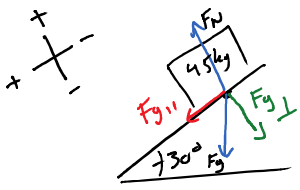


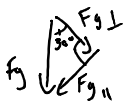
Vertical (a=0)
$F_N + F_{Ay} - F_g = ma$
$F_N = F_g - F_{Ay}$
$= mg - 15\sin45$
$= (20)(9.8) - 15\sin45$
$F_N = 185N$

Horizontal
$F_{Net} = ma$
$F_{Ax} - F_f = ma$
$15\cos45 - \mu F_N = ma$
$\frac{15\cos45 - (0.102)(185)}{20} = \frac{20a}{20}$
$-0.415 = a$

This tells us the frictional force is greater than the applied force. ∴ the object does not move

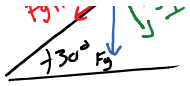
A 45kg box is on an incline plane of 30 degrees. The incline plane is frictionless. Find the acceleration





$F_{g\perp} = F_g\cos30$
$F_{g//} = F_g\sin30$

Parallel



move

Parallel

$F_{Net} = ma$

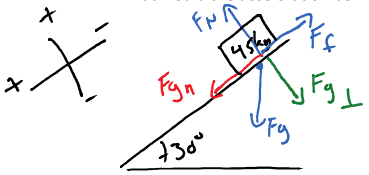
$F_g \sin 30 = ma$

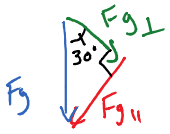
$mg \sin 30 = ma$

$g \sin 30 = a$

$4.9 m/s^2 = a$

What would the acceleration be if the coefficient of friction on the incline was 0.43?





$F_{g\perp} = F_g \cos 30$

$F_{g||} = F_g \sin 30$

$F_f = \mu F_N$

Perpendicular ($a=0$)

$F_{Net} = ma$

$F_N - F_{g\perp} = m(0)$

$F_N = F_{g\perp}$

$F_N = mg \cos\theta$

Parallel

$F_{g||} - F_f = ma$

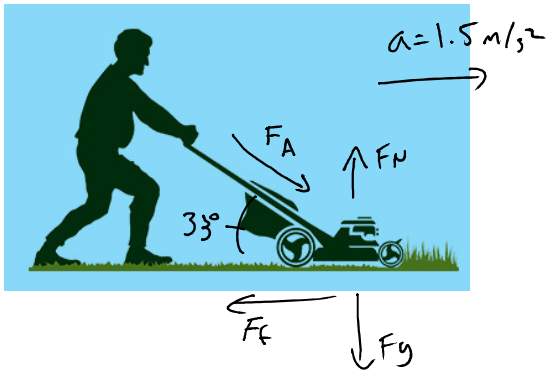
$mg \sin 30 - \mu F_N = ma$

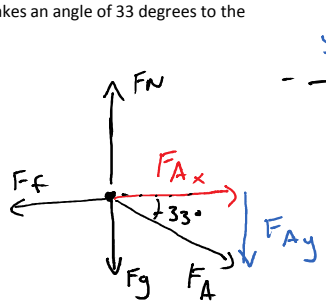
$mg \sin 30 - \mu mg \cos 30 = ma$

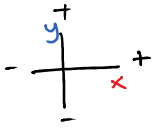
$g \sin 30 - \mu g \cos 30 = a$

$1.25 m/s^2 = a$

A man accelerates a 40kg lawn mower at a rate of 1.5m/s² in the horizontal. The coefficient of friction between the grass and the mower is 0.432. What force is the man applying to the mower if the handle makes an angle of 33 degrees to the horizontal.







$F_{Ax} = F_A \cos 33$

$F_{Ay} = F_A \sin 33$

y-direction ($a=0$)

$F_N - F_g - F_{Ay} = m(0)$

$F_N - mg - F_A \sin 33 = 0$

Eq1 $F_N = mg + F_A \sin 33$

x-direction

$F_{Ax} - F_f = ma$

$F_A \cos 33 - \mu F_N = ma$

Sub in for F_N

$F_A \cos 33 - \mu(mg + F_A \sin 33) = ma$

$F_A \cos 33 - \mu mg - \mu F_A \sin 33 = ma$

$$F_A \cos 33 - \mu mg - \mu F_A \sin 33 = ma$$

$$F_A \cos 33 - \mu F_A \sin 33 = ma + \mu mg$$

$$\frac{F_A(\cos 33 - \mu \sin 33)}{\cos 33 - \mu \sin 33} = \frac{ma + \mu mg}{\cos 33 - \mu \sin 33}$$

$$F_A = \frac{(40)(1.5) + (0.432)(40)(9.8)}{\cos 33 - (0.432)\sin 33}$$

$$F_A = 380\,N$$