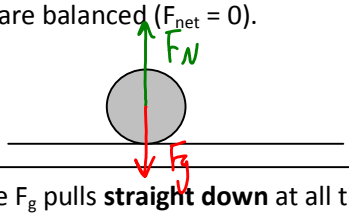
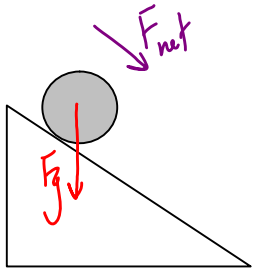
Dynamics Notes

3 – Inclines

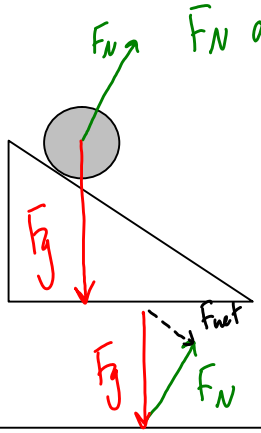
A ball sitting on a level surface will not roll because the forces on it are balanced ($F_{net} = 0$).



However, when the ball is placed on an *inclined plane* it will roll down the plane.



Although the F_g pulls **straight down** at all times...

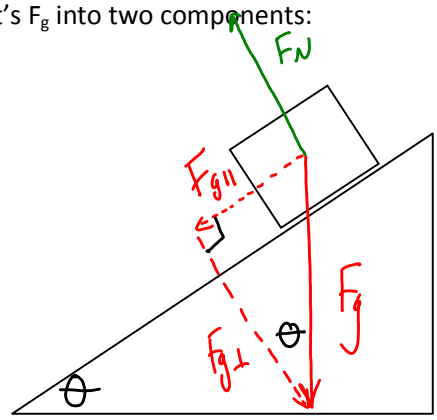


F_N does not push straight up!

F_N is always... perpendicular to surface

$F_g > F_N$

For inclined plane questions our first step should always be to resolve the object's F_g into two components:



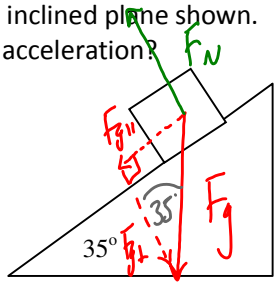
Two important things to notice:

1) Only the parallel component of F_g ($F_{g\parallel}$) pulls down the ramp.

2) The perpendicular component of F_g ($F_{g\perp}$) is equal and opposite to F_N

Ex

An 8.0 kg block slides down the frictionless inclined plane shown. What is its acceleration?



$F_{net} = F_{g\parallel} = ma$

$\sin 35° = \frac{F_{g\parallel}}{F_g}$

$F_{g\parallel} = F_g \sin 35° = mg \sin 35°$

$= (8.0)(9.8) \sin 35°$

$= 44.97\ N$

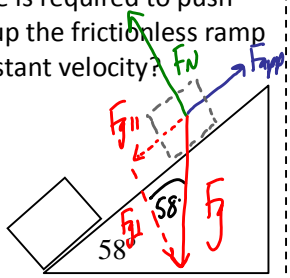
$a = \frac{F_{g\parallel}}{m} = \frac{44.97\ N}{8.0\ kg} = \boxed{5.6\ m/s^2}$

Does the mass matter?

No! Not for acceleration!

Ex

How much force is required to push an 11 kg block up the frictionless ramp shown at a constant velocity?



$a = 0$

$\therefore F_{net} = 0$

$\therefore F_{app} - F_{g\parallel} = 0$

$F_{app} = F_{g\parallel}$

$F_{g\parallel} = F_g \sin 58°$

$= mg \sin 58°$

$= (11)(9.8) \sin 58°$

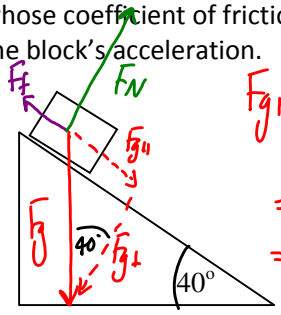
$= \boxed{91\ N}$

How about now?

Yes

Ex

A 15 kg block sits on an inclined ramp whose coefficient of friction is 0.21. Find the block's acceleration.



$F_{g\parallel} = F_g \sin 40°$

$= mg \sin 40°$

$= (15)(9.8) \sin 40°$

$= 94.49\ N$

$F_{net} = F_{g\parallel} - F_f = ma$

$F_f = \mu F_N$

$= \mu F_{g\perp}$

$= \mu F_g \cos 40°$

$= \mu mg \cos 40°$

$= (0.21)(15)(9.8) \cos 40°$

$= 23.65\ N$

$F_N = F_{g\perp}$

$a = \frac{F_{g\parallel} - F_f}{m}$

$= \frac{94.49 - 23.65}{15}$

$= \boxed{4.7\ m/s^2}$

Ok, how about now?

No! Not $\vec{a}$!