Forces in Two Dimensions

24/01/24 6:48 am

SECTION 3 Forces in Two Dimensions

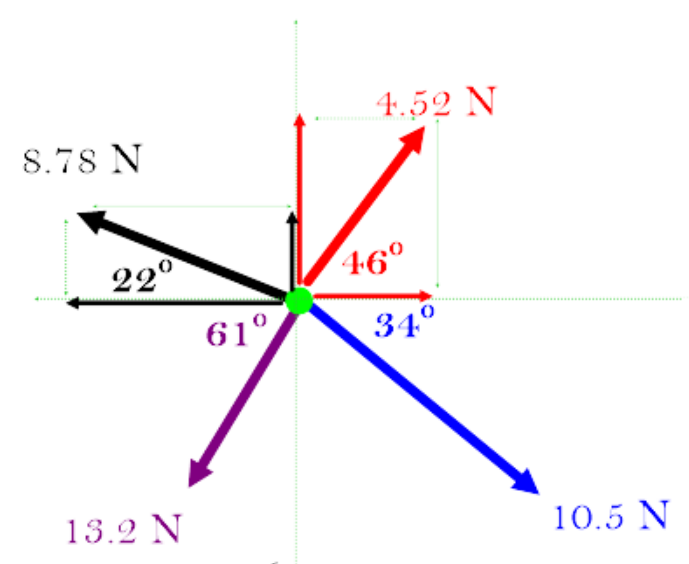
PHYSICS 4 YOU The person to the left is riding on a zip line. The tension in the rope provides the upward force necessary to balance the person's weight. If the tension in the rope increases, how would the angle the rope makes with the horizontal change?

MAIN IDEA
An object is in equilibrium if the net forces in the x-direction and in the y-direction are zero.

Essential Questions
- How can you find the force required for equilibrium?
- How do you resolve force vector components for motion along an inclined plane?

Review Vocabulary
equilibrium the condition in which the net force on an object is zero

New Vocabulary
equilibrant



Force (Magnitude) = ?

Direction (Angle) = ?

$$sin\theta = \frac{opp.}{hyp.} \qquad tan\theta = \frac{opp.}{adj.}$$

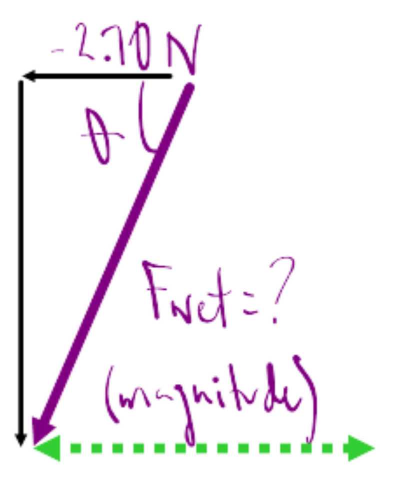
$$cos\theta = \frac{adj.}{hyp.}$$

$F_x = 4.52 \cdot \cos(46°) + 10.5\cos(34°) - 8.78\cos(22°) - 13.2\cos(61°)$

$F_x = -2.70$ N (West)

$F_y = 4.52\sin(46°) + 8.78\sin(22°) - 10.5\sin(34°) - 13.2\sin(61°)$

$F_y = -10.9$ N (South)

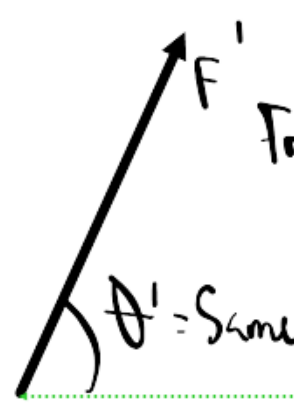


$F_{net}^2 = (-2.70)^2 + (10.9)^2$

$F_{net} = \sqrt{2.70^2 + 10.9^2}$

$\boxed{F_{net} = 11 \text{ N}}$

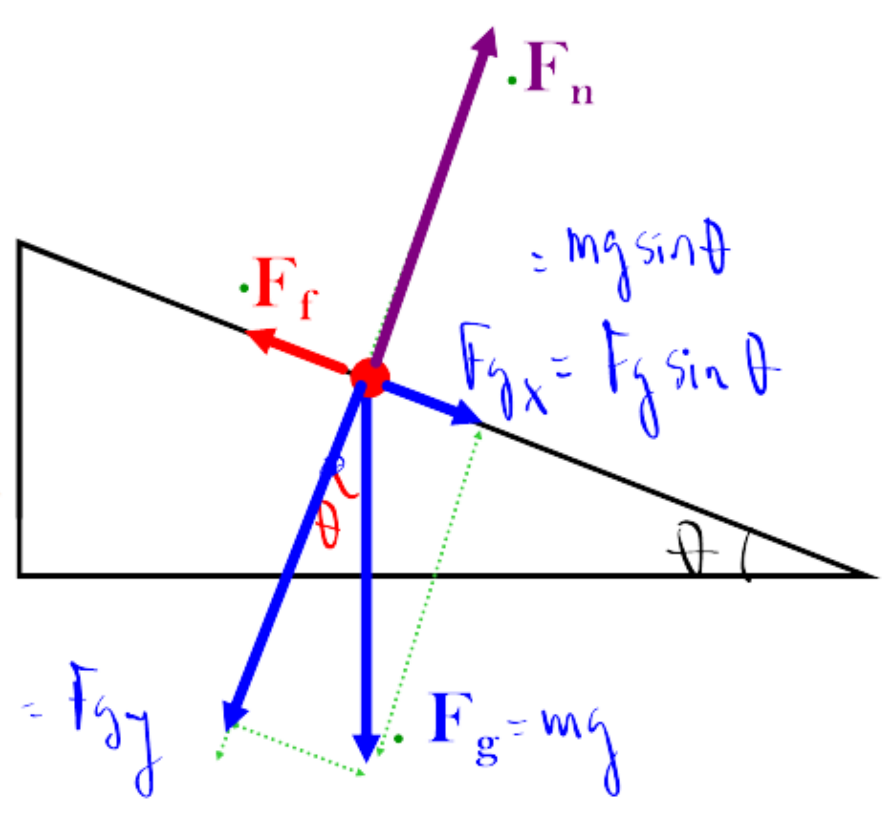
$\theta = \tan^{-1}\left(\frac{-10.9}{-2.70}\right) = 76°$ S of W



Force equilibrante to

$F_{net} = F'$

N of E

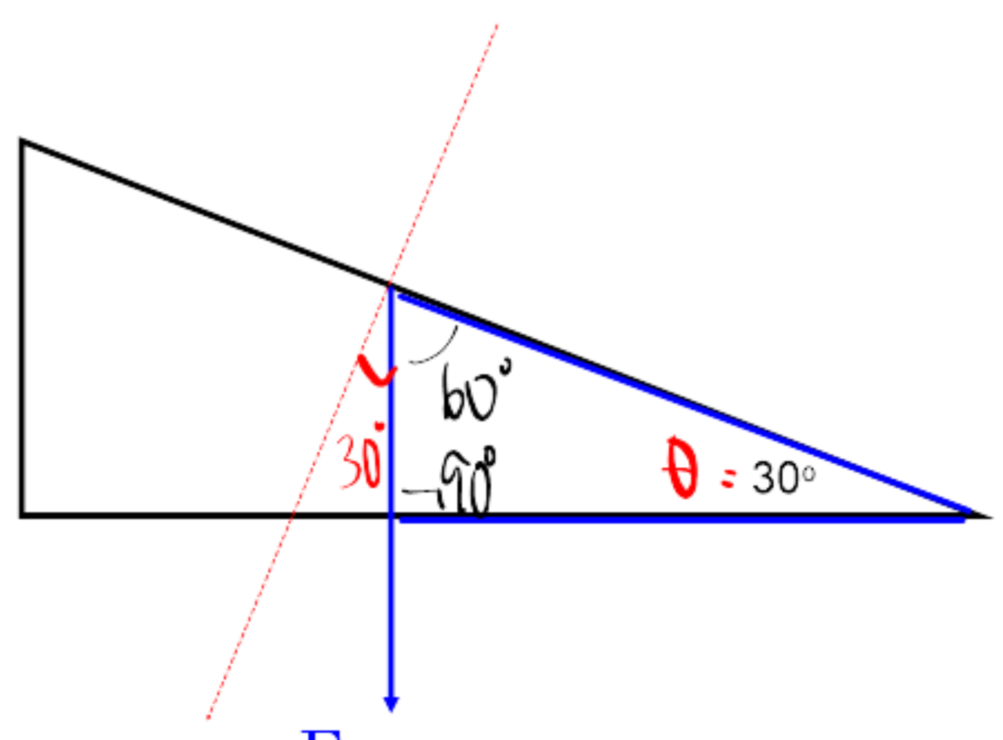


$= mg\sin\theta$

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

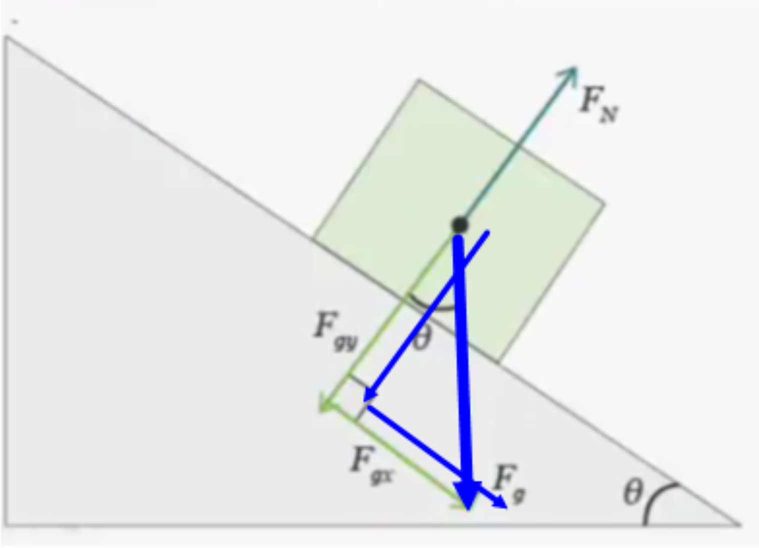
$mg\cos\theta = F_g\cos\theta = F_{gy}$

$F_g = mg$



$F_g = mg$

When an object is on an incline plane, break the force of gravity into x and y components and use trigonometry to find the magnitude of the vectors.



$F_{gx} = mg(\sin\theta)$

$F_{gy} = mg(\cos\theta)$

Section Self-Check

1. An object in _____ is motionless or moves with constant velocity.
   - equilibrium
   - B. stasis
   - C. suspended animation
   - D. constant acceleration

2. The force that puts an object in equilibrium is called the _____.
   - A. constant
   - B. coordinate
   - equilibrant
   - D. stabilizer

3. A 75-kg person on skis is going down a hill sloped at 30.0 degrees above horizontal.

   The coefficient of kinetic friction between the skis and snow is 0.15. How fast is the skier going 10.0 s after starting from rest?
   - A. 36 m/s²
   - 36 m/s
   - C. 78 m/s²
   - D. 78 m/s

4. Two forces are exerted on an object. A 43-N force acts exactly 240° and a 67-N force acts at 300°.

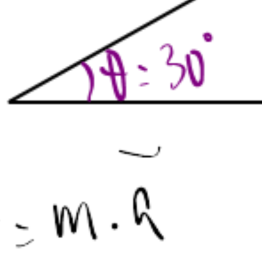
   What are the magnitude and direction of the equilibrant?
   - A. 96 N at - 83°
   - 96 N at 97°
   - C. 96 N at 7°
   - D. 84 N at 97°

5. A 475-N truck is sliding down a plane inclined at 40 above the horizontal. Calculate the magnitude of the acceleration.
   - A. 6.29 m/s
   - 6.29 m/s²
   - C. 7.51 m/s²
   - D. 62.9 m/s²

3. A 75-kg person on skis is going down a hill sloped at 30.0 degrees above horizontal. t $V_0 = 0$

The coefficient of kinetic friction between the skis and snow is 0.15. How fast is the skier going 10.0 s after starting from rest?

- ~~A.~~ 36 m/s² (not units)
- 36 m/s
- C. 78 m/s²
- D. 78 m/s



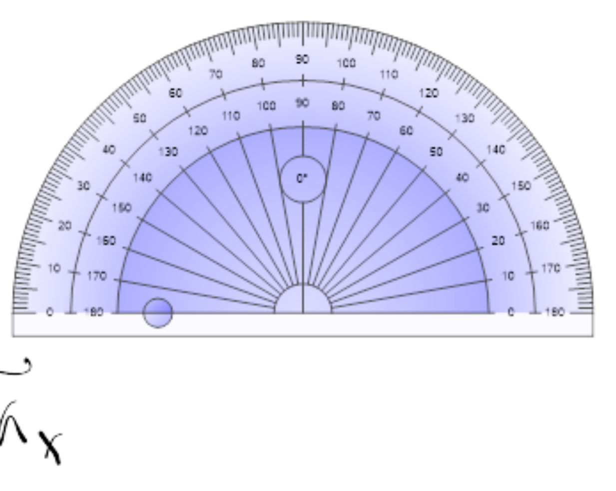
$v = ?$

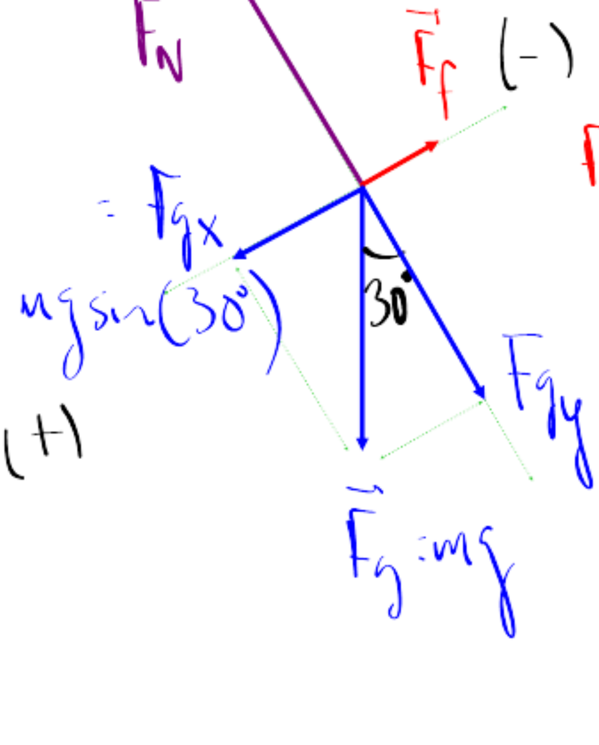
$v = v_0 + a \cdot t$

$v = 0 + a \times 10$

$a = ?$

$\vec{F}_{net} = m \cdot \vec{a}$





$F_f = \mu \cdot F_N$

$\vec{F}_{net_x} = m \cdot \vec{a}_x$

$F_{gy} = mg\cos(30°)$

$F_{gx} - F_f = m \cdot a$

$mg\sin(30°) - \mu \cdot F_N = m \cdot a$

$F_N = F_{gy} = mg\cos\theta$

$6 + 12 = 18$

$\cancel{2}\times 3 + \cancel{2}\times 6 = \cancel{2}\times 9$

$3 + 6 = 9$

$\cancel{m}g\sin(30°) - \mu \cdot \cancel{m}g\cos\theta = \cancel{m} \cdot a$

$9.8 \times \sin(30°) - 0.15 \times 9.8 \times \cos(30°) = a$

$a = 3.63 \frac{m}{s^2}$

$V = V_0 + a \cdot t = 0 + 3.63 \times 10 s$

$V = 36.3 \frac{m}{s}$