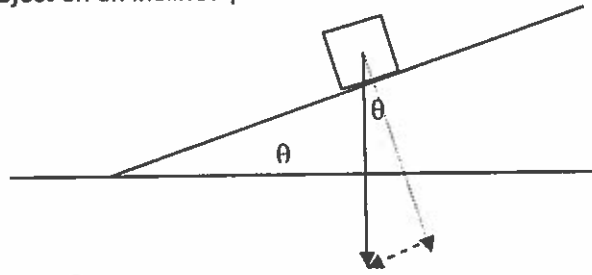


PHYSICS 12

FORCES ON AN INCLINED PLANE

- $\vec{F}_N$ ,  $\vec{F}_f$  and  $\vec{F}_g$  are acting on an object unless stated otherwise
- $\vec{F}_N$  is always perpendicular to the surface of contact ( $\perp$ )
- $\vec{F}_f$  is always parallel to the surface of contact ( $\parallel$ ) and it always opposes the motion
- $\vec{F}_g$  is always directed to the center of the Earth = strictly vertically down

Consider an object on an inclined plane:



$\vec{F}_g$  must be resolved into its two components:

1. How does the angle of the inclined plane affect the magnitude of the  $\vec{F}_{g\parallel}$  ?

2. How does the angle of the inclined plane affect the magnitude of the  $\vec{F}_{g\perp}$  ?

3. What angle of an inclined plane is desirable and reasonable in real-life situations? Give examples.

4. Consider three different inclined planes. Sketch  $\vec{F}_{g//}$  and  $\vec{F}_{g\perp}$  for three different inclined planes. How do the magnitude of  $\vec{F}_{g\perp}$  and  $\vec{F}_{g//}$  compare for the three different scenarios? At what angle is the magnitude the same? Make calculations for a 25.0-kg object.

	Scenario 1	Scenario 2	Scenario 3
Degree of inclination	15°	45°	65°
Magnitude of $\vec{F}_{g\perp}$			
Magnitude of $\vec{F}_{g//}$			
Practical use			

#### Free-Body Diagrams for objects on inclined planes:

- Object is not drawn on an angle
- The parallel and perpendicular components of the force of gravity are not drawn
- **The fact that the normal force and force of gravity vectors are NOT collinear is the indicator that the object lies on an inclined plane**
- It is a good habit to draw two diagrams; an FBD and a diagram that includes the inclined plane as well as the parallel and perpendicular components of the force of gravity

Which vector component of  $\vec{F}_g$  decides the magnitude of  $\vec{F}_N$ ?

? Which vector component of  $\vec{F}_g$  decides the magnitude of  $\vec{F}_f$ ?

? Which vector component of  $\vec{F}_g$  decides the magnitude of the object's acceleration down the inclined plane?

? What other factors affect the object's acceleration? Explain.

5. What do the magnitudes of  $\vec{F}_{net}$ ,  $\vec{F}_{g//}$ ,  $\vec{F}_f$  and  $\vec{F}_N$  relative to each other have to be in order for a stationary object to:

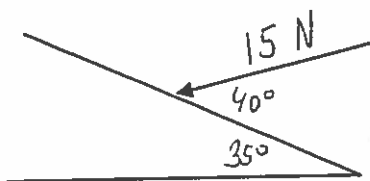
Draw FBDs that show the relative magnitude of all forces.

a) Remain at rest?

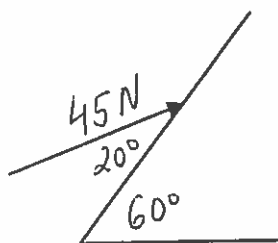
b) Start sliding down the plane?

Find components of the following forces acting on an inclined plane at an angle. One component has to be parallel (//) with the inclined plane and the other component has to be perpendicular to the surface of the inclined plane ( $\perp$ ). (Hint: Construct a right triangle that has the given vector as a hypotenuse and place the right angle at the inclined plane)

a)



b)



c) Note that  $\theta = \alpha$  whenever the force acting on the inclined plane is strictly vertical

