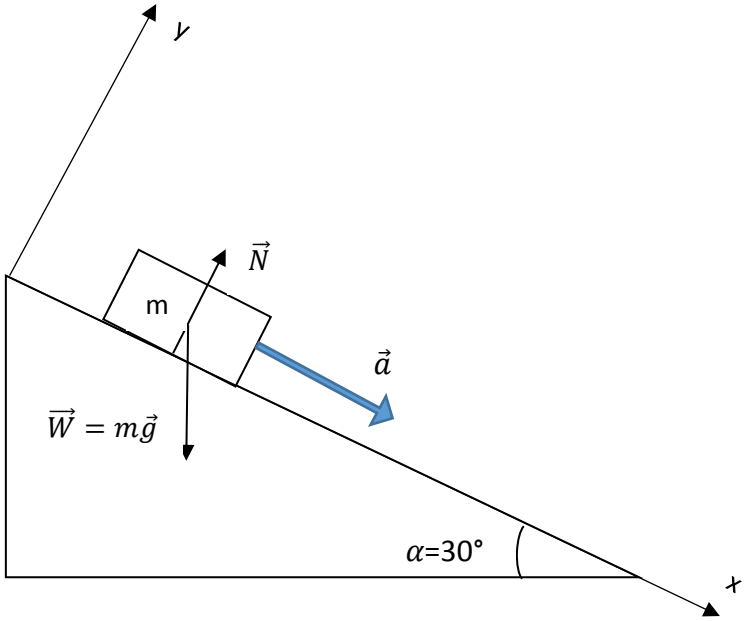
Answer on Question #79267 - Physics - Other

A 5 kg block slides down a plane inclined at 30° to horizontal. Find the acceleration of the block if the plane is frictionless.

Solution.



Let the axes of the Cartesian coordinate system have the directions shown in the figure.

Use the 2nd Newton's law:

$$\vec{F} = m\vec{a},$$

where m is the mass of an object, $\vec{F}$ is the vector sum of all the forces acting on the object, $\vec{a}$ is its acceleration.

In this case, two forces act on the block: the force of gravity (or weight) $\vec{W}$ and the normal force $\vec{N}$. The force of gravity is equal $m\vec{g}$ and directed down (g is the gravitational field strength; it is about 9.81 m/s^2 on Earth). The normal force $\vec{N}$ is perpendicular to the surface that an object contacts.

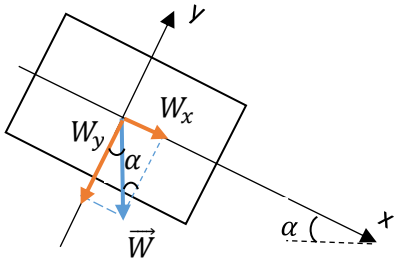
The 2nd law of Newton can be written as $\vec{W} + \vec{N} = m\vec{g} + \vec{N} = m\vec{a}$

Write the component form of Newton's second law. Note that the block moves along the x-axis, and the acceleration has only the x component.

$$\begin{cases} F_x = ma_x = ma \\ F_y = ma_y = 0 \end{cases}$$

$$F_x = W_x + N_x = mg\sin\alpha$$

$$F_y = W_y + N_y = mg\cos\alpha + N$$



To find the acceleration, we need only the equation for the x component of the resultant force.

$$mg \sin \alpha = ma$$

$$a = g \sin 30\,^\circ$$

$$a = 9.8 \frac{\text{m}}{\text{s}^2} \times\ 0.5 = 4.9 \frac{\text{m}}{\text{s}^2}$$

Answer: $a = 4.9 \frac{\text{m}}{\text{s}^2}$