

PHYS 2350: Newton's 2nd Law

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Newton's Second Law

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

What questions are we trying to answer with this equation?

- Given all of the interactions of outside systems on an object, how is that object moving? (Acceleration, velocity, position).
- Given the motion of an object, what are the interactions that cause it to move in this way? (Find the net force, or how a specific force interacts with that object given other known forces)

Problem type 1:

Know the force, find the motion

A block with mass m slides down a inclined plane that makes an angle θ with the horizontal. What is the magnitude of the acceleration of the block as it slides down the ramp? You have consulted a table and found that this particular block has a coefficient of kinetic friction of μ_k with this ramp.

Interactions:

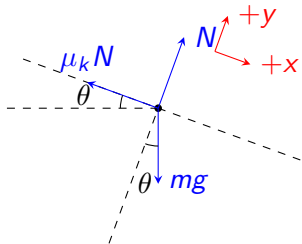
Gravity Force that the earth exerts on the block. Magnitude: mg , direction: “down”

Normal Force that the ramp exerts on the block. Magnitude: N , direction: perpendicular to the surface of the ramp.

Kinetic Friction Force that the ramp exerts on the block. Magnitude $\mu_k N$, direction: parallel to the surface of the ramp, going up the ramp.

Finding the acceleration

Draw Free Body diagram:



Set up equations of motion (Note, acceleration in y-direction is zero)

$$mg \cos \theta - \mu_k N = ma \quad (1)$$

$$N - mg \sin \theta = 0 \quad (2)$$

2 equations, 2 unknowns (N, a), let's solve!

Solve (2) for N :

$$N = mg \sin \theta$$

Plug into (1):

$$mg \cos \theta - \mu_k mg \sin \theta = ma$$

Solve for a and win:

$$a = g (\cos \theta - \mu_k \sin \theta)$$