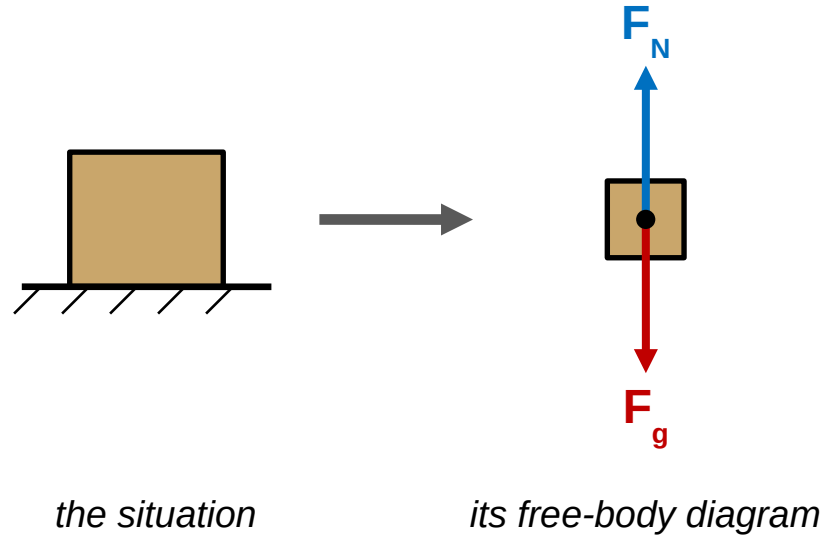


Essential Question

How can we draw all the forces on an object?

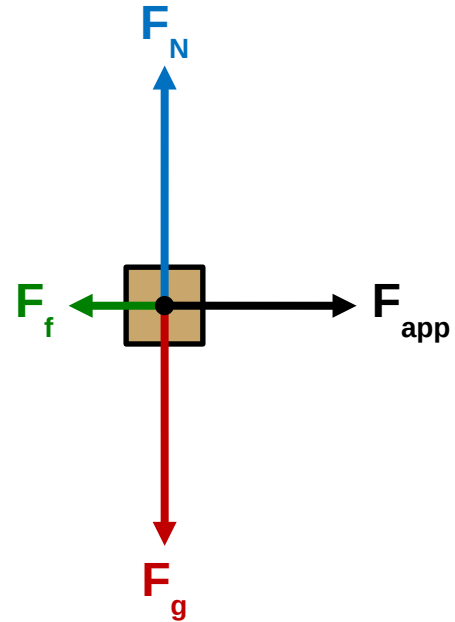
What Is a Free-Body Diagram?

- Shows every force on one object
- Object drawn as a box or dot
- Leave everything else out



Drawing Force Arrows

- Start at the object's center
- Point the way the force acts
- Longer arrow = bigger force



$F_{app} = 40\text{ N}$ is twice $F_f = 20\text{ N}$

Labeling Forces

 F_N

normal

surface pushes

 F_g

gravity

Earth pulls

 F_f

friction

surface rubs

 F_T

tension

rope pulls

 F_{app}

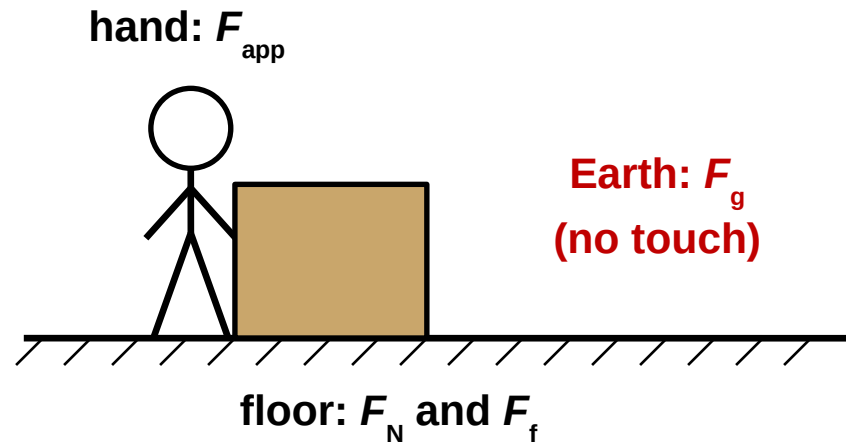
applied

push or pull

the subscript tells you which force it is

Finding Every Force

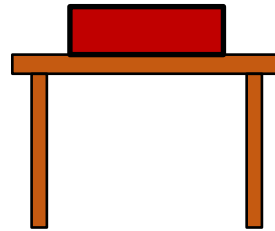
- What touches the object?
- Each touch gives a force or two
- Then add gravity



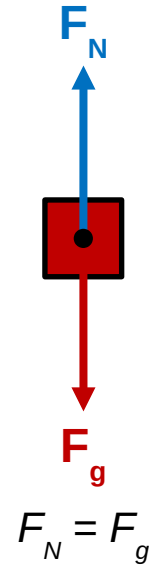
list the touches, then add gravity

At Rest

- Forces balance
- Opposite arrows are equal
- Example: book on a table

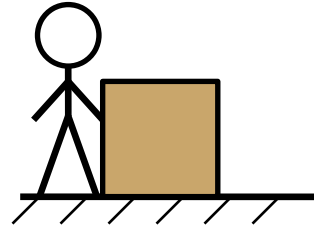


book on a table

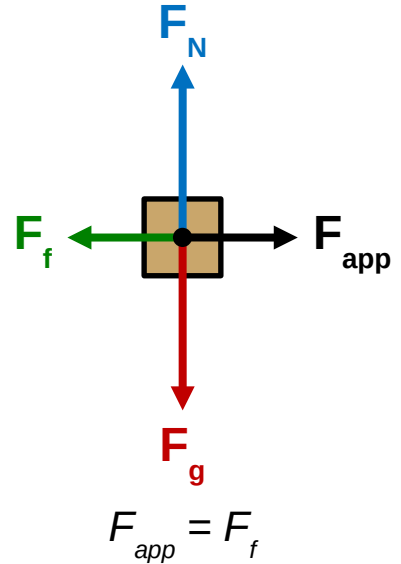


Constant Velocity

- Forces still balance
- Moving doesn't need extra force
- Example: steady push on a box

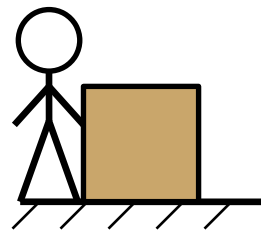


steady push

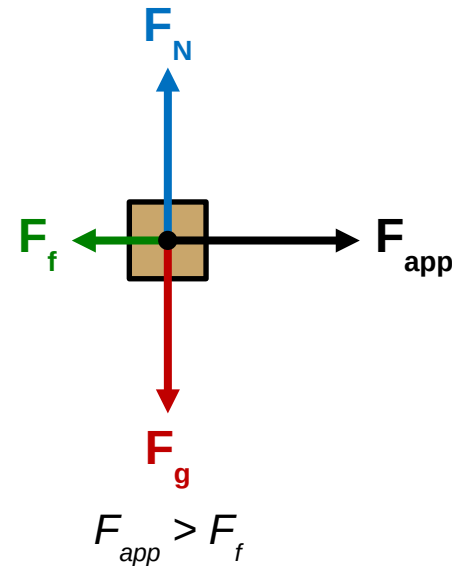


Accelerating

- Forces do not balance
- The longer arrow wins
- Speeds up in that direction

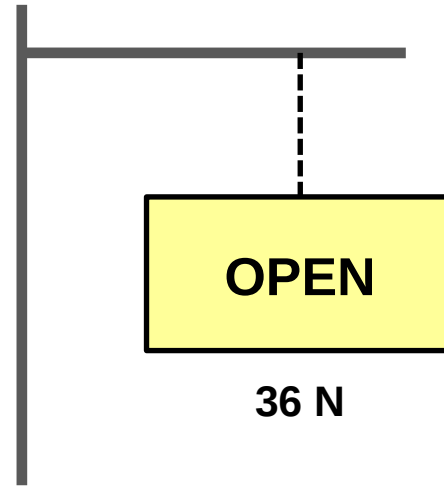


harder push



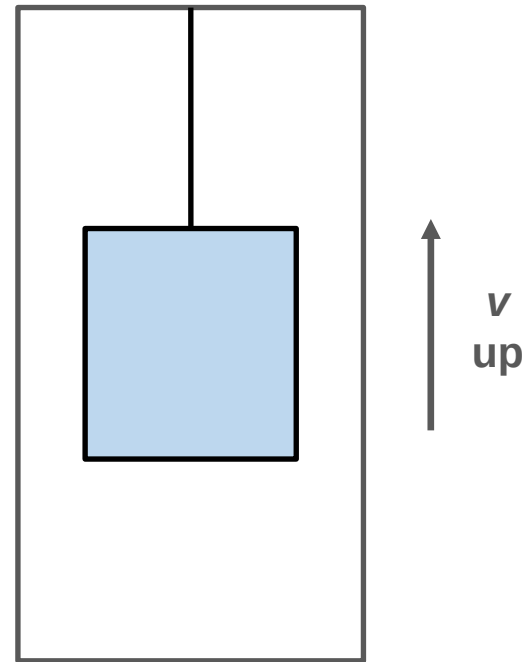
Example: Hanging Sign

A 36 N sign hangs at rest from a single chain. Draw its free-body diagram and label the size of each force.



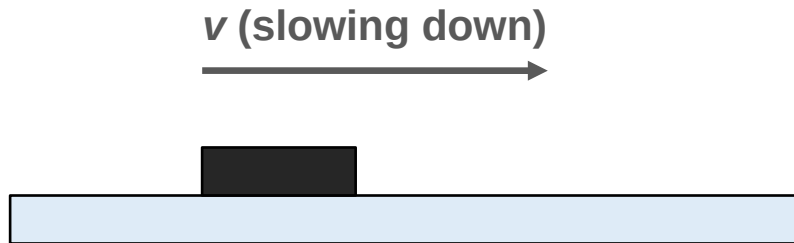
Example: Elevator Speeding Up

An elevator car is pulled up by its cable and speeds up as it rises. Draw the free-body diagram for the elevator car.



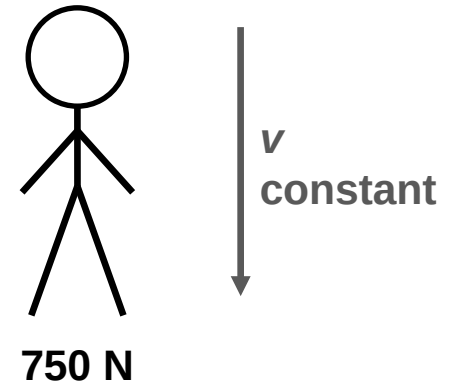
Example: Puck Sliding to a Stop

A hockey puck slides to the right across the ice and slows down. Nothing is touching it except the ice. Draw its free-body diagram.



Example: Skydiver at Constant Speed

A 750 N skydiver falls straight down at a constant speed. Draw her free-body diagram and label the size of each force.



Big Ideas

- A free-body diagram shows every force on one object
- Arrows start at the center; length shows size
- Label each arrow: F_N , F_g , F_f , F_T , F_{app}
- Equal opposite arrows: at rest or constant v