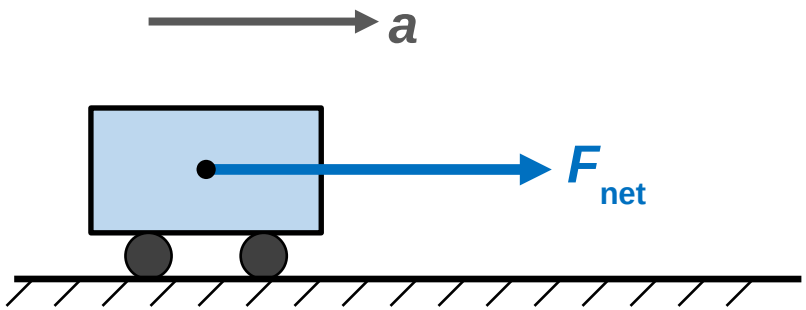
Essential Question

Why is a full shopping cart harder to speed up than an empty one?

Force Causes Acceleration

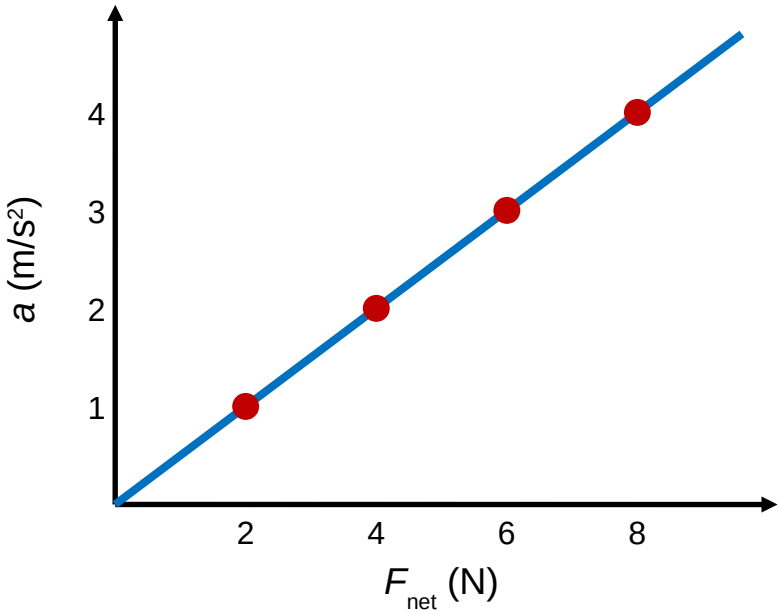
- Net force causes acceleration
- *a* points the same way as F_{net}
- No net force, no acceleration



acceleration points with the net force

Force and Acceleration

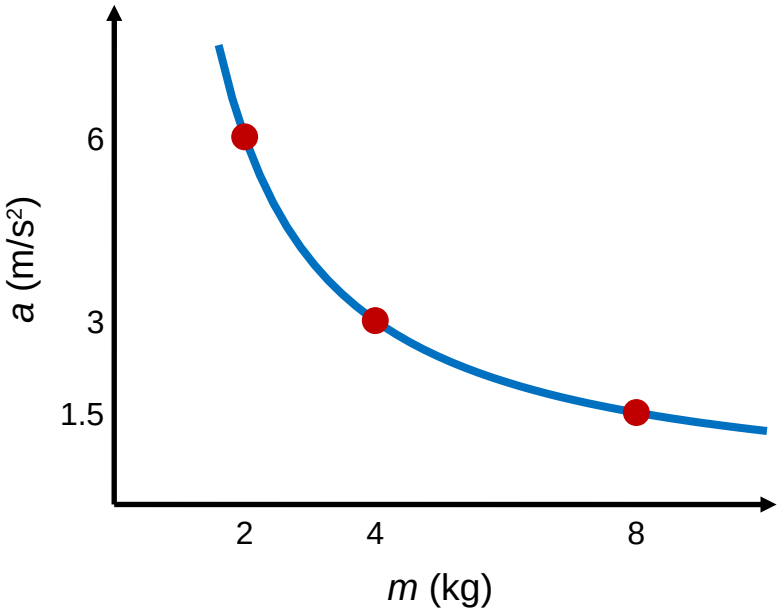
- More force, more acceleration
- Double F_{net}, double a
- Mass stays the same



straight line through the origin: direct

Mass and Acceleration

- More mass, less acceleration
- Double *m*, half the *a*
- Force stays the same



curve that drops: inverse

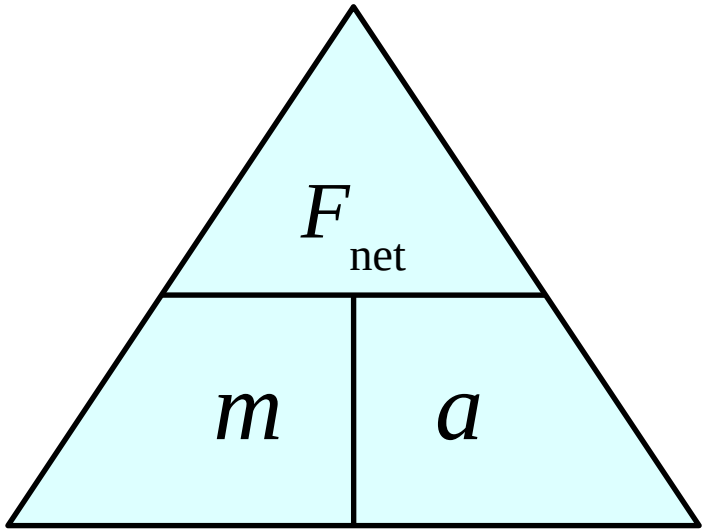
Newton's Second Law

$$a = F_{net} / m$$

a acceleration (m/s^2)	***F*** **net** net force (N)	***m*** mass (kg)

Solving for Any Variable

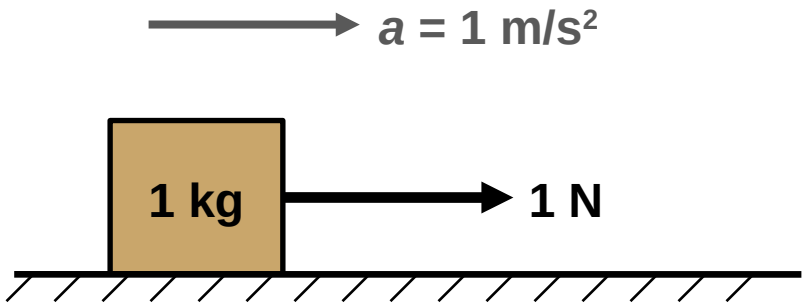
- Find a: $a = F_{net}/m$
- Find force: $F_{net} = ma$
- Find mass: $m = F_{net}/a$



cover the one you want

The Newton

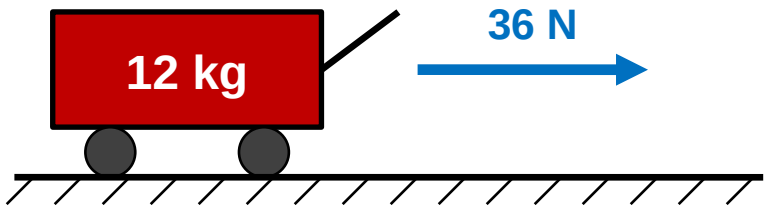
- 1 N = 1 kg·m/s^2
- Gives 1 kg an *a* of 1 m/s^2
- Units check your work



1 N on 1 kg gives 1 m/s^2

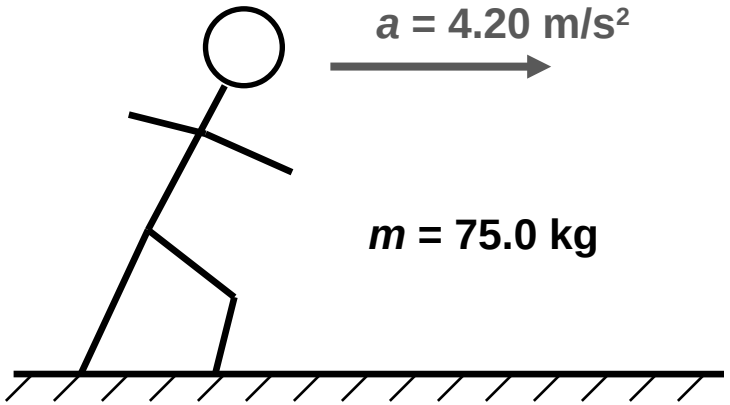
Example: Finding Acceleration

A net force of 36 N east acts on a 12 kg wagon. What is the wagon's acceleration?



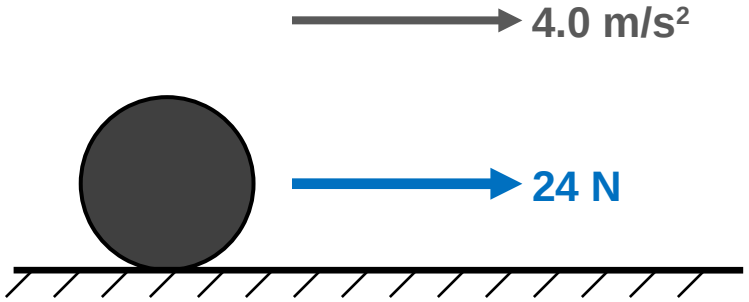
Example: Finding Net Force

A 75.0 kg sprinter accelerates out of the starting blocks at 4.20 m/s^2 forward. What net force acts on her?



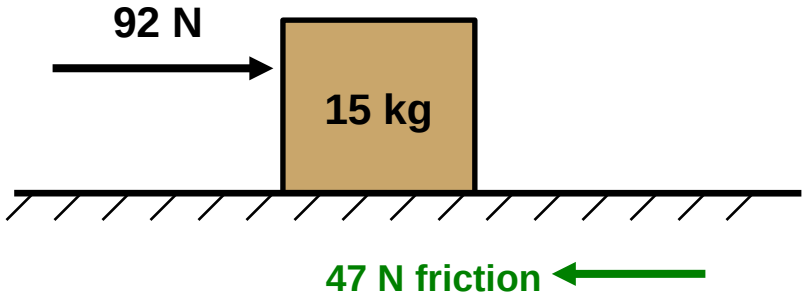
Example: Finding Mass

A net force of 24 N gives a bowling ball an acceleration of 4.0 m/s^2. What is the ball's mass?



Example: Using a Free-Body Diagram

A 15 kg box is pushed east with a 92 N force. Friction acts on it with 47 N west. What is the box's acceleration?



Newton's Second Law

Big Ideas

- A net force causes acceleration in the same direction
- $a = F_{net}/m$: more force, more a; more mass, less a
- Rearrange: $F_{net} = ma$, $m = F_{net}/a$
- 1 N = 1 kg·m/s^2