# Newton's 2nd Law of Motion

Essential Questions:

- **How is force related to acceleration?**
- **How is mass related to acceleration?**
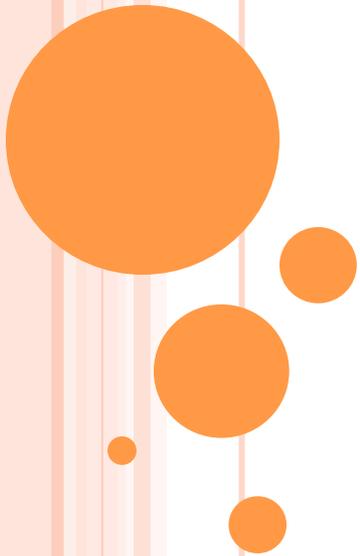
- The acceleration caused by a net force is directly proportional to the force and inversely proportional to the mass.

NEWTON'S SECOND LAW

Acceleration (m/s²) — $a = \dfrac{F}{m}$ —— Force (N)

—— Mass (kg)

- Force is *directly proportional* to acceleration.

If twice the force is applied, the acceleration is twice as great.

What it means to say
"Acceleration is proportional to force."

| Force	Mass	Acceleration
1 newton	1 kg	1 m/s²
2 newtons	1 kg	2 m/s²
0.5 newton	1 kg	0.5 m/s²
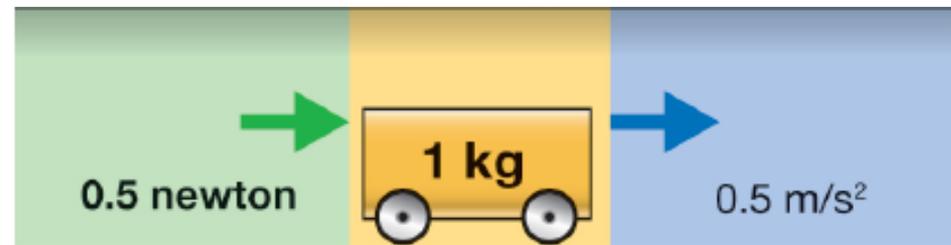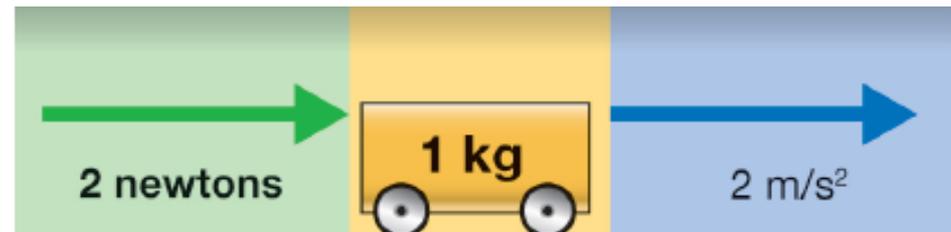
- Acceleration is inversely proportional to mass.

An object with twice the mass will have half the acceleration if the same force is applied.

$F = {}_m a$ $F = m_a$

F

F

The same force exerted on a larger mass produces a correspondingly smaller acceleration.
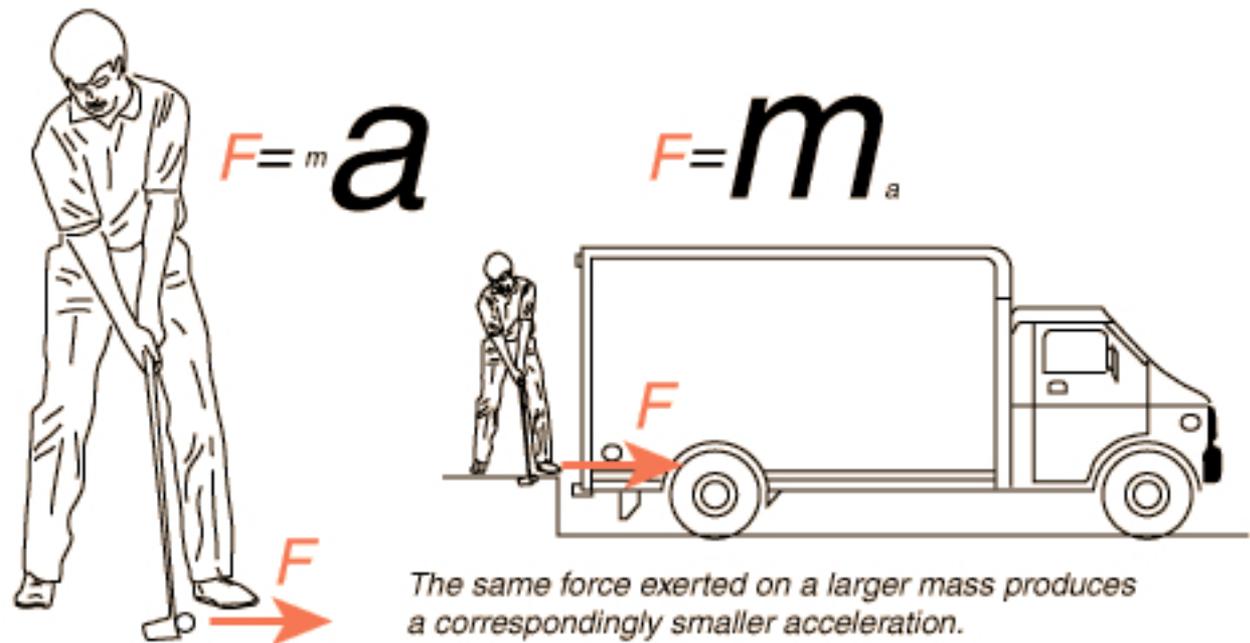
Acceleration is always in the *same direction* as the net force.

Positive force | Positive acceleration
Speed *increases*

Negative force | Negative acceleration
Speed *decreases*

Sideways force | Direction changes
Sideways acceleration

$$\frac{F}{m \times a}$$
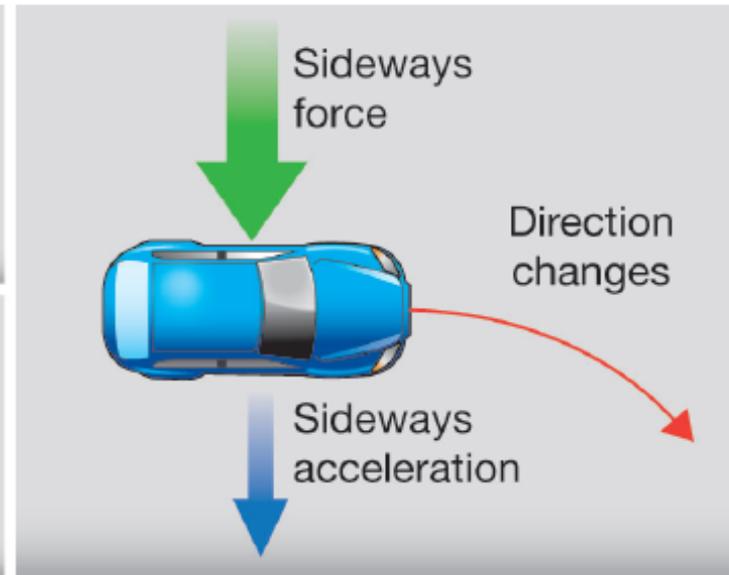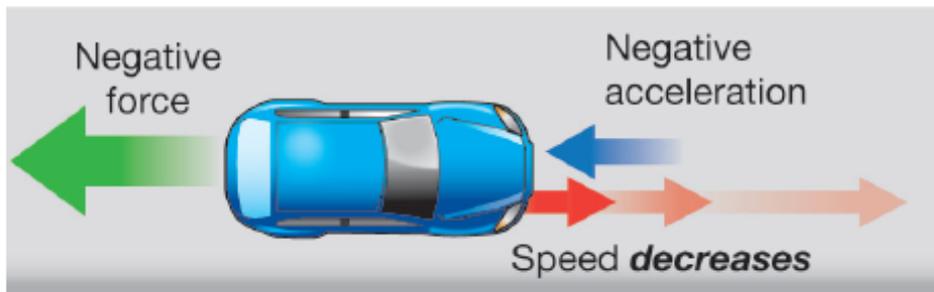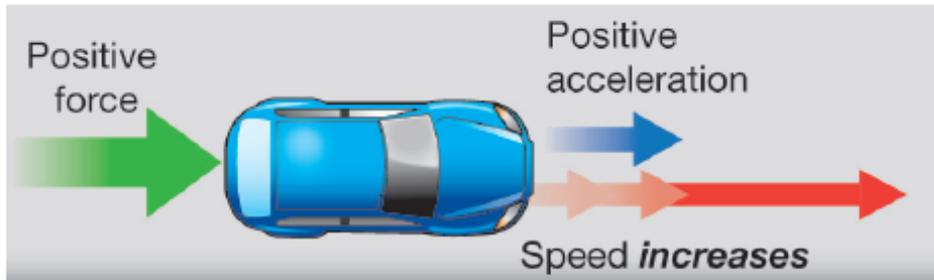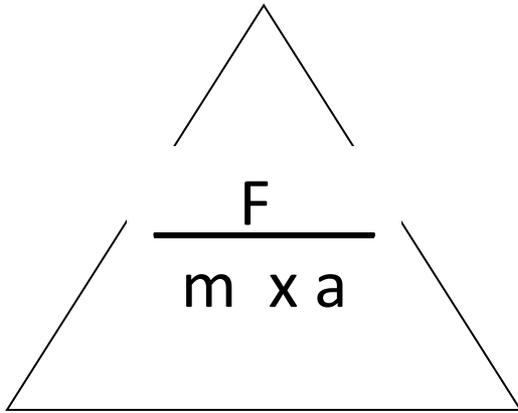
- Formula for acceleration
  - a = F/m

- Formula for force
  - F=(m)(a)

- Formula for mass
  - m = F/a

○ Just give the equation

○ A boy gets pushed on a sled with a force of _____ N. The boy and the sled together have a mass of _____ kg. Ignoring friction, what is the acceleration of the boy on the sled?

○ a= F/m

- A boy gets pushed on a sled with a force of 120 N. The boy and the sled together have a mass of 60 kg. Ignoring friction, what is the acceleration of the boy on the sled?

- a= F/m
- a= 120 N/60 kg
- a = 2 m/s^2

- Just give the equation

- A rock with a mass of _____ kg is accelerating at the rate of _____ m/s² How much force does it have?

- F = (m)(a)

- A rock with a mass of 500 kg is accelerating at the rate of 2 m/s^2 How much force does it have?

- F = (m)(a)

- F= (500 kg)(2 m/s^2)
- F= 1,000 N

- Just give the equation

- A person lifts a barbell above his head with an acceleration of _____ m/s². The barbell exerts a force of _____ N. What is the mass of the barbell?

- m = F/a

- A person lifts a barbell above his head with an acceleration of 2 m/s². The barbell exerts a force of 400 N. What is the mass of the barbell?

- m = F/a
- m= 400 / 2
- m = 200 kg

- What is the force of a _____ kg sandbag in **a free fall?**

- **F = (m)(a)**

- What is the force of a 500 kg sandbag in **a free fall?**

- **F = (m)(a)**

- **F = (500 kg)(9.8 m/s^2)**

- **F = 4900 N**

WHICH CART WILL ACCELERATE MORE?

1. A cart pushed by a toddler. (The toddeler is pushing as hard as he can.)

2. The same cart pushed by a body builder. (The body builder is pushing as hard as he can

- 1. The cart pushed by the body builder
- **Why?**
- More force = more acceleration

WHEN PUSHED WITH THE SAME FORCE, WHICH CART WILL ACCELERATE MORE?

- Cart A

- Cart B

- Cart B
- **Why?**
  - Greater mass = less acceleration