

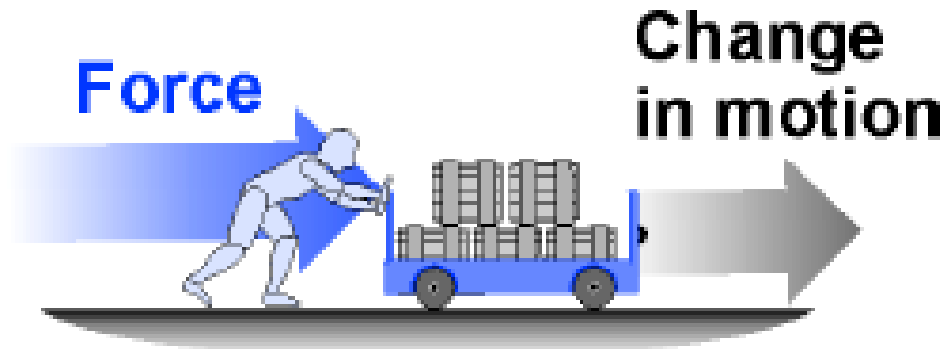


Forces and Newton's Second Law



Force

- **Force** is an action that can change motion.
 - A force is what we call a push or a pull, or any action that has the ability to change an object's motion.
 - Forces can be used to increase speed, decrease speed, or change the objects direction.

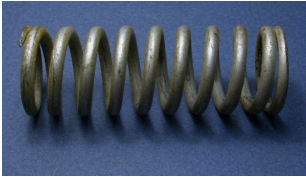


Types of Forces

Contact forces: interactions between objects that touch



applied force



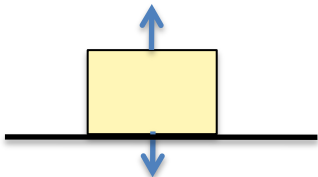
spring force



drag force



frictional force

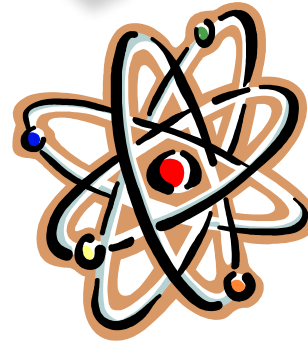


normal force

Non-contact forces: attract or repel, even from a distance



magnetic force



electric force



gravitational force

A force is a push, pull or twist

Applying a force can change an object's velocity.



What is the
scientific unit
of forces?

Newtons!

$$1 \text{ N} = 1 \text{ kg} \frac{\text{m}}{\text{s}^2}$$

Mass vs Weight

Mass is a how much matter an object contains.

Weight is the force exerted on a mass by gravity.

Mass is a constant for a body and does not change with location.

Weight is not a constant. It changes from place to place.

The kilogram is a unit of mass.

The Newton is a unit of weight.

Weight

50 kg
110 lb
490 N



Mass

50 kg
110 lb

Technically, the pound is a unit of weight but not mass!



Weight

8 kg
18 lb
82 N



What is acceleration?

Acceleration is a change in **velocity**.



Applying a force can change an object's velocity.

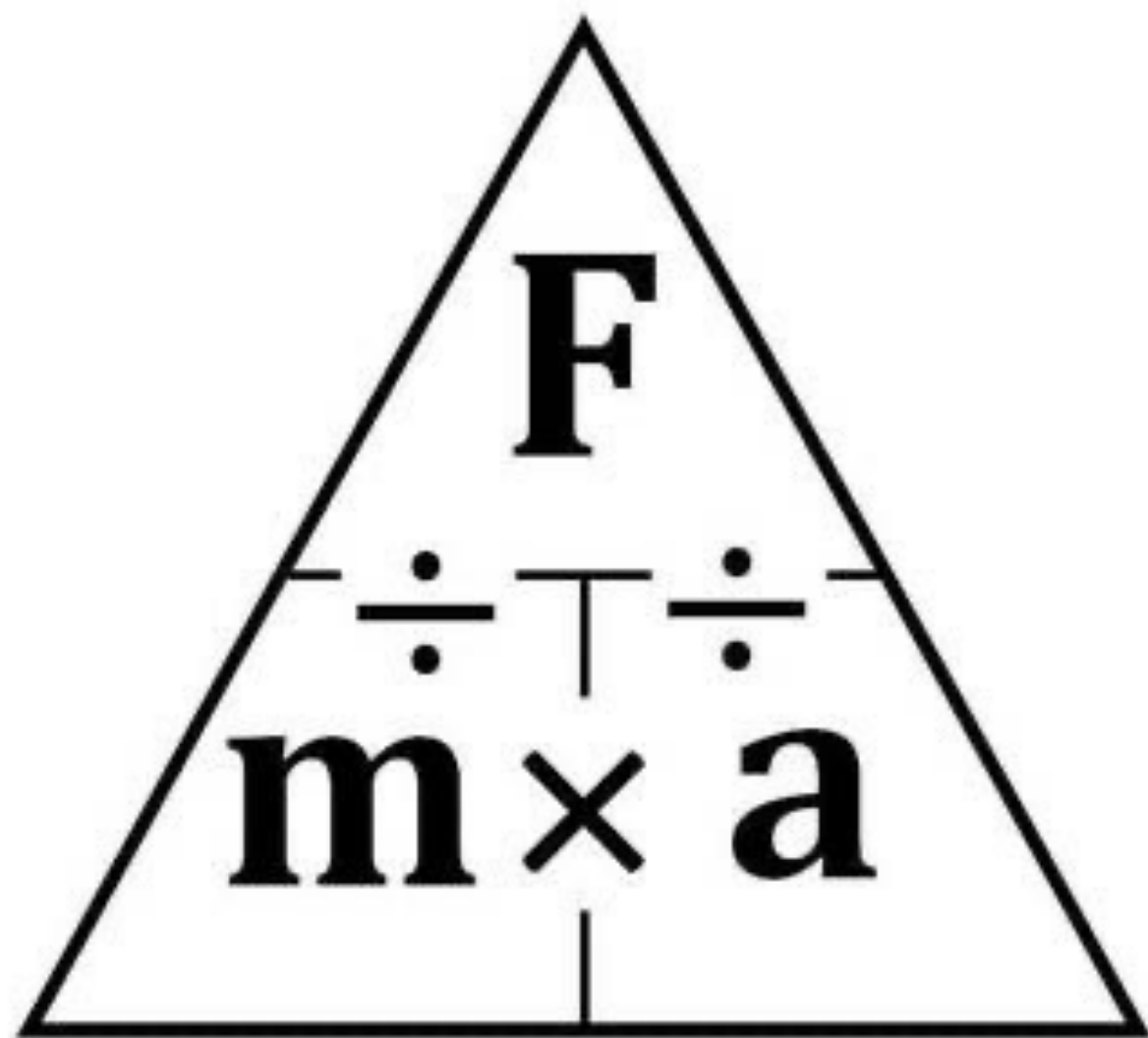
Newton's Second Law of Motion

An object's **acceleration** depends on:

- the strength of the *unbalanced force* acting on it
- the **mass** of the object

$$\text{acceleration} \rightarrow \mathbf{a} = \frac{\mathbf{F}}{\mathbf{m}} \quad \begin{array}{l} \leftarrow \text{force} \\ \leftarrow \text{mass} \end{array}$$

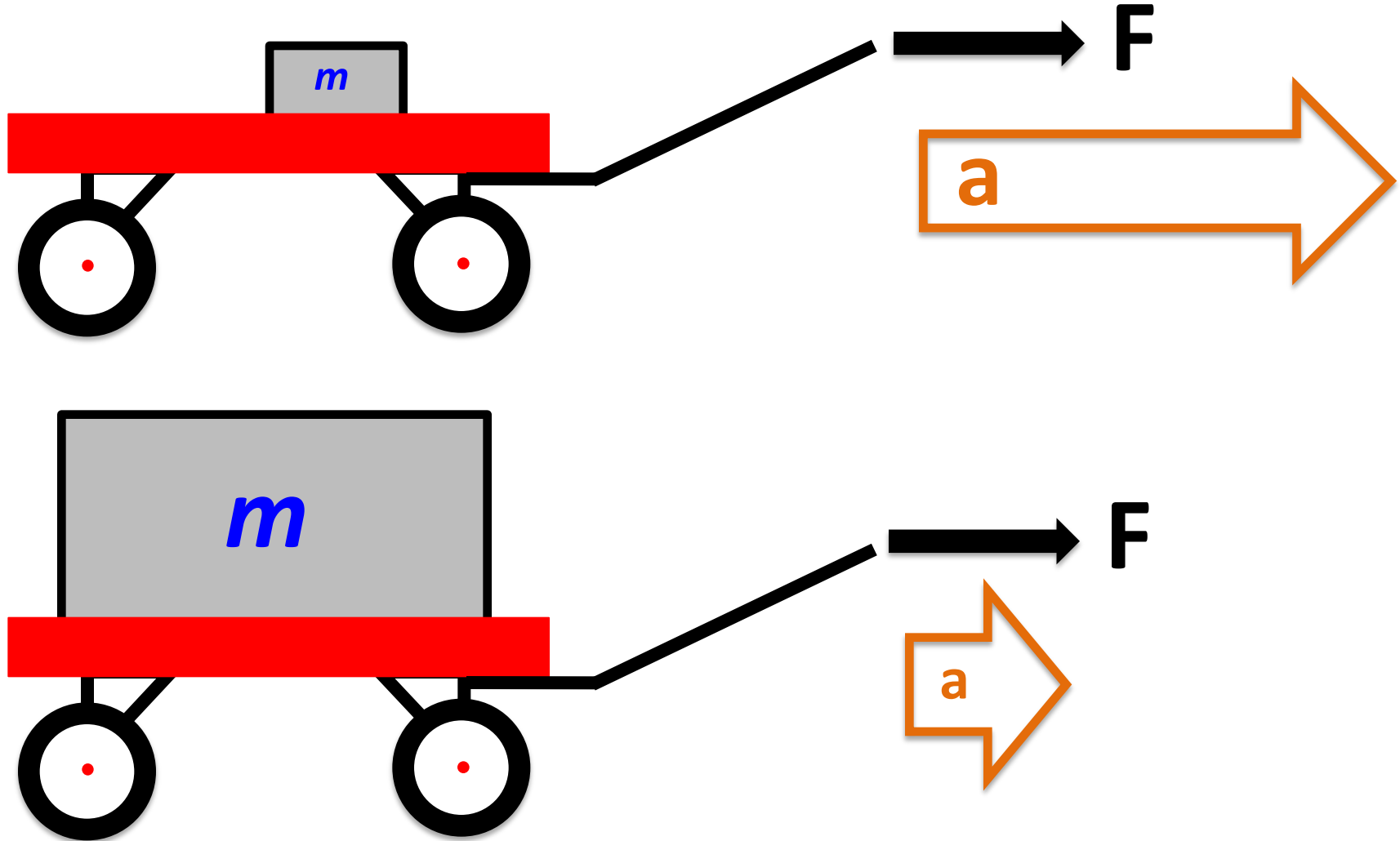
More commonly written as: $\mathbf{F} = \mathbf{ma}$



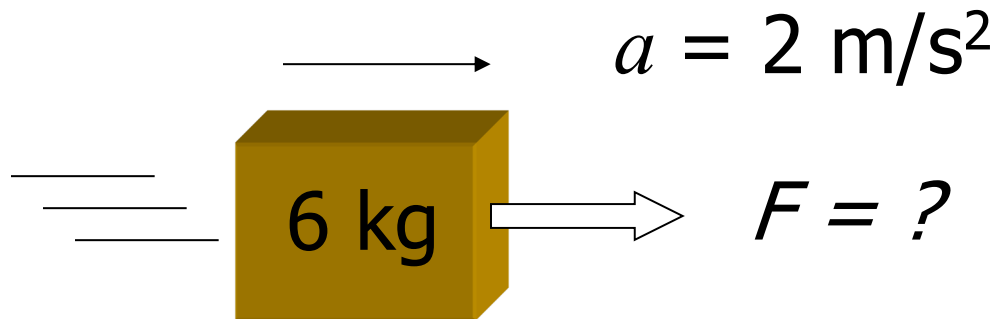
Newton's Second Law

$$F = ma$$

Pull on each wagon as hard as you can, applying the same force...



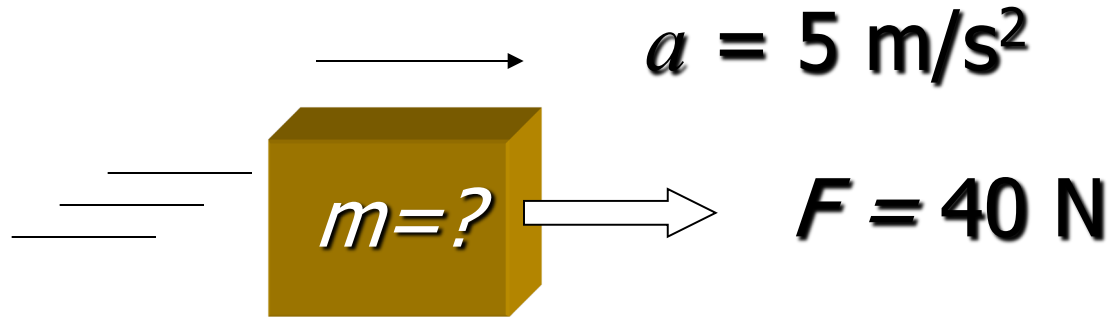
Example 1: What resultant force **F** is required to give a **6 kg** block an acceleration of **2 m/s²**?



$$F = 12 \text{ N}$$

Remember consistent units for **force**, **mass**, and **acceleration** in all problems.

Example 2: A **40N** resultant force causes a block to accelerate at **5 m/s²**. What is the mass?



$$F = ma \quad \text{or} \quad m = \frac{F}{a}$$

$$m = \frac{F}{a} = \frac{40 \text{ N}}{5 \text{ m/s}^2}$$

$$m = 8 \text{ kg}$$

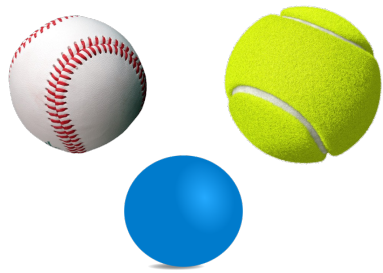
Example 3

do the math!

A car has a mass of 1000 kg. What is the acceleration produced by a force of 2000 N?



$$a = \frac{F}{m} = \frac{\boxed{}}{\boxed{}} = \frac{\boxed{}}{\boxed{}} = \boxed{}$$



F=ma Demonstration



Object	Mass (grams)	Distance (cm)
Baseball		
Ping Pong Ball		
Soft Ball		
Basketball		
Racquetball		
Golf Ball		