# Newton’s Law

*“And shake toward you the trunk of the palm three, it will drop upon you ripe, fresh date.”*

**(Q.S. Maryam : 25)**

# What are Newton's Laws of Motion?

01

## Newton's First Law

An object at rest remains at rest, and an object in motion remains in motion at constant speed and in a straight line unless acted on by an unbalanced force.

02

## Newton's Second Law

The acceleration of an object depends on the mass of the object and the amount of force applied.

03

## Newton's Third Law

Whenever one object exerts a force on another object, the second object exerts an equal and opposite on the first.

# Newton's Law Equations And Conditions

01

## Newton' First Law

$$\sum F = 0$$

**Condition :**
At rest or
constant velocity

02

## Newton' Second Law

$$\sum F = ma$$

**Condition :**
Move or constant
acceleration

03

## Newton' Third Law

$$F_{aksi} = - F_{reaksi}$$

**Condition :**

$$\Sigma F\ ?$$

# Force in dynamics of motion

## 01

### Weight (W)

Force from gravity acting on an object with mass.

## 02

### Normal Force (N)

Force between two objects when they touch.

## 03

### Tension (T)

Force of something pulling on an object.

## 04

### Friction (f)

Force resisting sliding between surfaces.

## 05

### Centripetal Force ($F_c$)

Force on an object directed to the center of a circular path that keeps the object on the path.

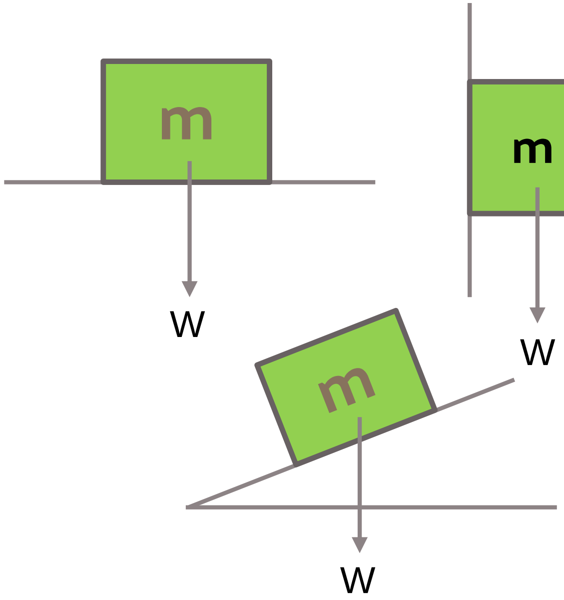
01

# Weight (W)

Force from gravity acting on an object with mass. Sometimes called force of gravity. Pulls towards the Earth (down) always.

$$W = m.g$$

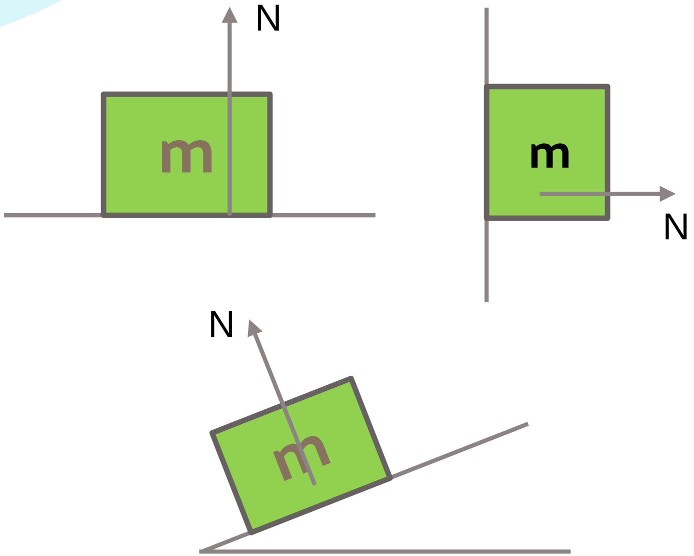
W = weight (N)
m = mass (kg)
g = gravitational acceleration (m/s$^2$)



02

# Normal Force (N)

Force between two objects when they touch. Pushes perpendicularly to the object's surface.

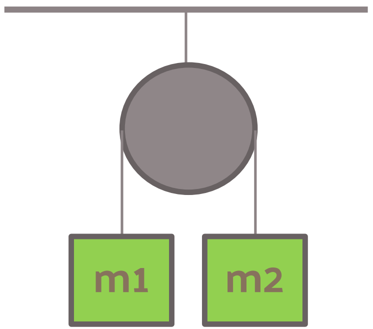


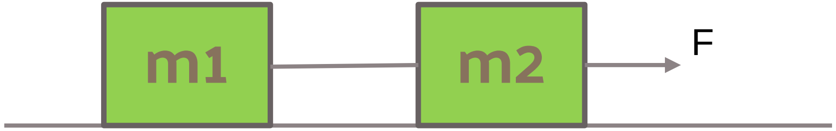

N = Normal Force (Newton)

03

# Tension (T)

Force of something pulling on an object. Can be caused by a string, rope, chain, cord, cable, or wire. Pulls along the direction of the rope on the object.



04

$$f = \mu N$$

f = friction (N)
μ = coefficient of friction
N = normal force (N)

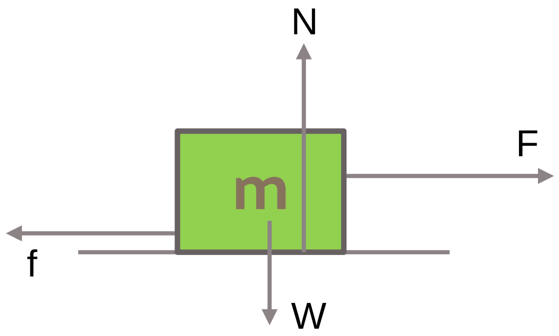
# Friction (f)

Force resisting sliding between surfaces. Pushes parallel to the contact surface and in the opposite direction of sliding.

$$f \begin{cases} f_{kinetic} = \mu_k N & \text{(move)} \\ f_{static} = \mu_s N & \text{(at rest)} \end{cases}$$

04

$$f \begin{cases} f_{kinetic} = \mu_k N & \text{(move)} \\ f_{static} = \mu_s N & \text{(at rest)} \end{cases}$$




# Friction (f)

Force resisting sliding between surfaces. Pushes parallel to the contact surface and in the opposite direction of sliding.

check whether it moves or not?

$f_s > F$ (at rest)

$f_s = F$ (precise will move)

$f_s < F$ (move)

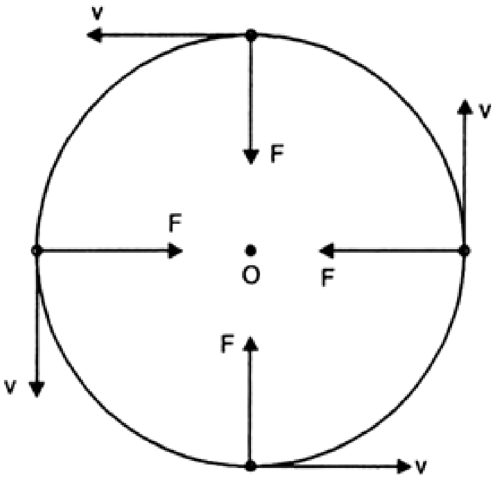
05

# Centripetal Force ($F_c$)

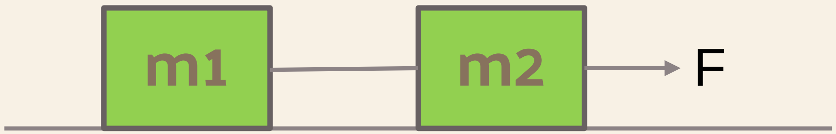
Force on an object directed to the center of a circular path that keeps the object on the path.

$$F_c = m\frac{v^2}{R} = m\omega^2 R$$

$$\boxed{v = \omega R}$$



# Application of Newton's Law




**Known :**

m1 = 2 kg
m2 = 3 kg
g = 10 m/s$^2$
F = 100 N

**Q :**

a. Acceleration ?
b. Tension ?

**Review object 1**

$$\sum F_x = ma$$

$$T = m_1 a \dots (i)$$

**Review object 2**

$$\sum F_x = ma$$

$$F - T = m_2 a \dots (ii)$$

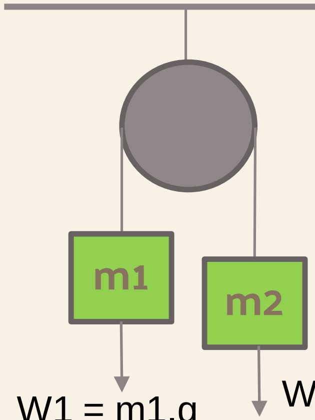
$$T = m_1 a \dots (i)$$

$$F - T = m_2 a \dots (ii)$$

$$F = (m_1 + m_2)a$$

$$a = \frac{F}{(m_1 + m_2)}$$

# Application of Newton’s Law




W1 = m1.g
= 4.10
= 40 N

W2 = m2.g
= 6.10
= 60 N

**Known :**

m1 = 4 kg
m2 = 6 kg
g = 10 m/s$^2$

**Q :**

a. Acceleration ?
b. Tension ?

**Review object 1**

$$\sum F = ma$$

$$T - W_1 = m_1 a \ldots (i)$$

**Review object 2**

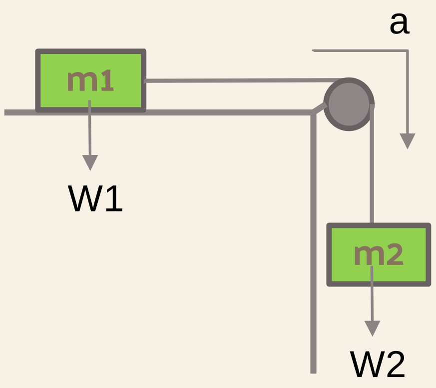
$$\sum F = ma$$

$$W_2 - T = m_2 a \ldots (ii)$$

$$T - W_1 = m_1 a \ldots (i)$$
$$W_2 - T = m_2 a \ldots (ii)$$
$$W_2 - W_1 = (m_1 + m_2) a$$

$$a = \frac{W_2 - W_1}{(m_1 + m_2)}$$

# Application of Newton's Law




**Known :**

m1 = 2 kg
m2 = 3 kg
g = 10 m/s$^2$

**Q :**

a. Acceleration ?
b. Tension ?

**Review object 1**

$$\sum F = ma$$

$$T = m_1 a \ldots (i)$$

**Review object 2**

$$\sum F = ma$$

$$W_2 - T = m_2 a \ldots (ii)$$

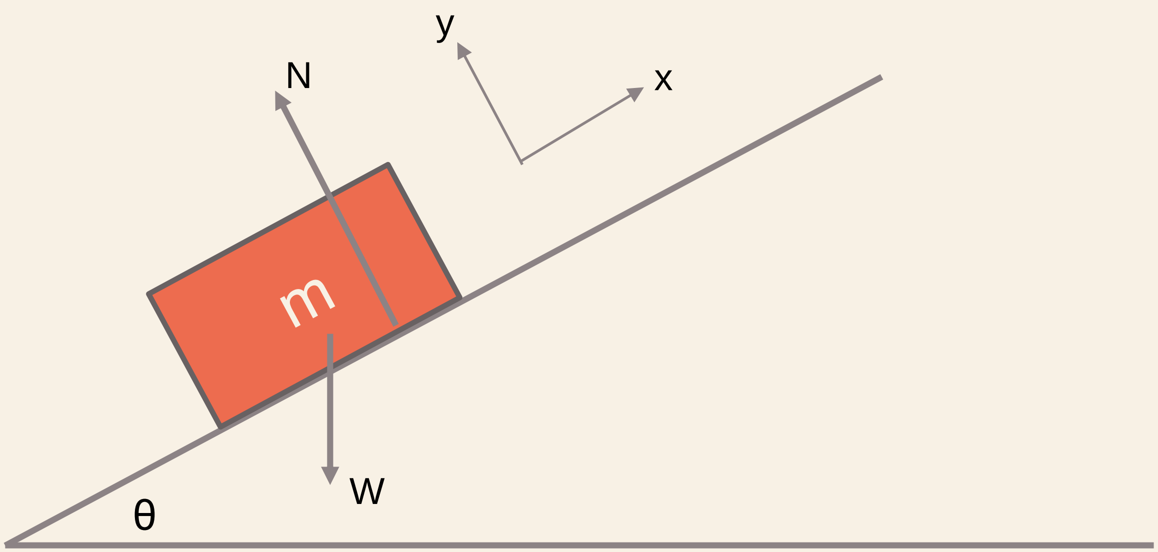
$$T = m_1 a \ldots (i)$$

$$W_2 - T = m_2 a \ldots (ii)$$

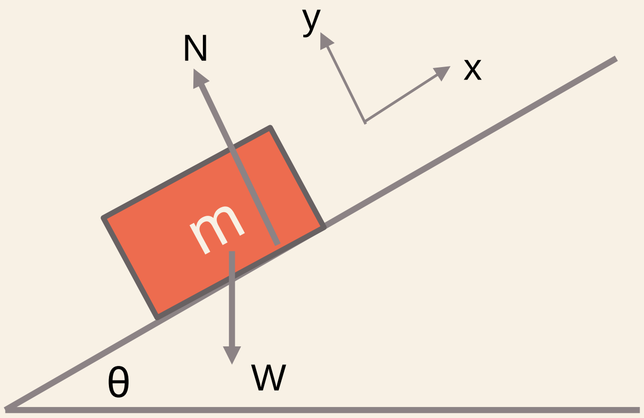
$$W_2 = (m_1 + m_2) a$$

$$a = \frac{W_2}{(m_1 + m_2)}$$

# Application of Newton's Law (Inclined Plane)



# Application of Newton's Law (Inclined Plane)




**Balanced (y axis)**

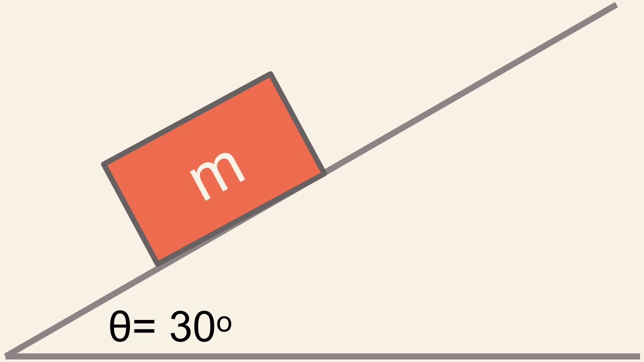
$$N = W cos\theta$$

**2nd Newton's Law (x axis)**

$$\sum F = ma$$

$$W sin\theta = ma$$
$$mg.sin\theta = ma$$
$$g\ sin\theta = a$$

# Application of Newton's Law (Inclined Plane)



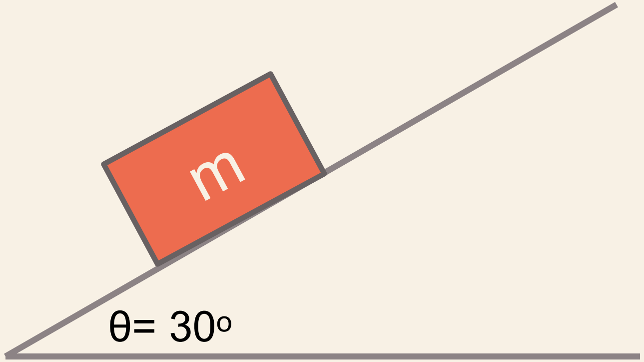

**2nd Newton's Law (x axis)**

$$W sin\theta = ma$$
$$mg.sin\theta = ma$$
$$g\ sin\theta = a$$
$$10.sin30° = a$$
$$a = 10.\frac{1}{2} = 5\ \ m/s^2$$

**Known :**
m = 20 kg

**Q :**
Acceleration ?

# Application of Newton's Law (Inclined Plane)




**Known :**
m = 20 kg
$\mu = 0.2$

**Q :**
Acceleration ?

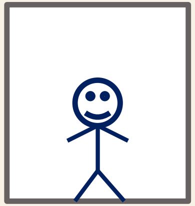
if there is friction $\mu = 0.2$
2nd Newton's Law (x axis)

$$\sum F = ma$$

$$W sin\theta - f = ma$$
$$mg.sin\theta - \mu N = ma$$
$$mg.sin\theta - \mu mgcos\theta = ma$$
$$g\ sin\theta - \mu gcos\theta = a$$
$$10.sin30° - (0.2)(10)cos30° = a$$
$$a = 10.\frac{1}{2} - 2.\frac{1}{2}\sqrt{3} = 5 - \sqrt{3}$$
$$= 5 - 1.7 \approx 3.3\ m/s^2$$

# Elevator

**the elevator doesn't move**



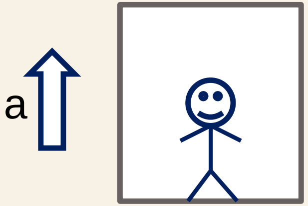
$$\sum F = 0$$

$$N - W = 0$$

$$N = W$$

$$\boxed{N = mg}$$

**the elevator is moving up**



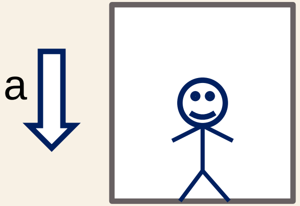

$$\sum F = ma$$

$$N - W = ma$$

$$N = ma + mg$$

$$\boxed{N = m(a + g)}$$

**the elevator is moving down**



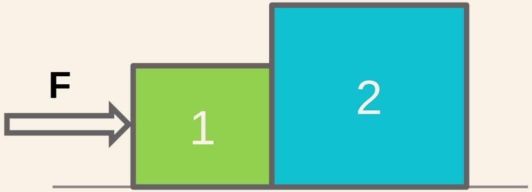

$$\sum F = ma$$

$$W - N = ma$$

$$N = mg - ma$$

$$\boxed{N = m(g - a)}$$

# Contact Force




## Review object 1

$$\sum F = ma$$

$$F - F_{21} = m_1 a \dots (i)$$

## Review object 2

$$\sum F = ma$$

$$F_{12} = m_2 a \dots (ii)$$

$$F - F_{21} = m_1 a \dots (i)$$

$$F = (m_1 + m_1) a$$

$$a = \frac{F}{(m_1 + m_2)}$$