

# Laws of Motion Formulas

You said:



Laws of motion formulae

ChatGPT said:



Here are the key formulas from the Laws of Motion:

## 1. Newton's First Law (Law of Inertia):

- No specific formula, but it states that an object will remain at rest or move with a constant velocity unless acted upon by an external force.

## 2. Newton's Second Law (Force and Acceleration):

$$F = ma$$

Where:

- $F$  = Force
- $m$  = Mass
- $a$  = Acceleration

## 3. Newton's Third Law (Action and Reaction):

- No specific formula, but it states that for every action, there is an equal and opposite reaction.

## 4. Equation of Motion (under constant acceleration):

- $v = u + at$
- $s = ut + \frac{1}{2}at^2$
- $v^2 = u^2 + 2as$

Where:

- $u$  = Initial velocity
- $v$  = Final velocity
- $a$  = Acceleration
- $t$  = Time
- $s$  = Displacement

## 5. Momentum (Linear Momentum):

$$p = mv$$

Where:

- $p$  = Momentum
- $m$  = Mass
- $v$  = Velocity

## 6. Impulse:

$$J = F\Delta t = \Delta p$$

Where:

- $J$  = Impulse
- $F$  = Force
- $\Delta t$  = Time interval
- $\Delta p$  = Change in momentum

## 7. Force of Friction:

$$f = \mu N$$

Where:

- $f$  = Force of friction
- $\mu$  = Coefficient of friction
- $N$  = Normal force

You said:



Circular motion formulae

ChatGPT said:



Here are the key formulas for circular motion:

### 1. Angular Displacement ( $\theta$ ):

$$\theta = \frac{s}{r}$$

Where:

- $\theta$  = Angular displacement (radians)
- $s$  = Arc length
- $r$  = Radius of the circular path

### 2. Angular Velocity ( $\omega$ ):

$$\omega = \frac{\theta}{t}$$

Where:

- $\omega$  = Angular velocity (rad/s)
- $\theta$  = Angular displacement
- $t$  = Time

Alternatively:

$$\omega = \frac{2\pi}{T} = 2\pi f$$

Where:

- $T$  = Time period of one revolution
- $f$  = Frequency of revolution

### 3. Angular Acceleration ( $\alpha$ ):

$$\alpha = \frac{d\omega}{dt}$$

Where:

- $\alpha$  = Angular acceleration (rad/s<sup>2</sup>)
- $\omega$  = Angular velocity
- $t$  = Time

### 4. Tangential Velocity ( $v$ ):

$$v = r\omega$$

Where:

- $v$  = Tangential velocity
- $r$  = Radius
- $\omega$  = Angular velocity

### 5. Centripetal Acceleration ( $a_c$ ):

$$a_c = \frac{v^2}{r} = r\omega^2$$

Where:

- $a_c$  = Centripetal acceleration
- $v$  = Tangential velocity
- $r$  = Radius of the circular path
- $\omega$  = Angular velocity

### 6. Centripetal Force ( $F_c$ ):

$$F_c = \frac{mv^2}{r} = mr\omega^2$$

Where:

- $F_c$  = Centripetal force
- $m$  = Mass of the object
- $v$  = Tangential velocity
- $r$  = Radius of the circular path
- $\omega$  = Angular velocity

### 7. Tangential Acceleration ( $a_t$ ):

$$a_t = r\alpha$$

Where:

- $a_t$  = Tangential acceleration
- $r$  = Radius of the circular path
- $\alpha$  = Angular acceleration

### 8. Total Acceleration (when both centripetal and tangential acceleration are present):

$$a = \sqrt{a_c^2 + a_t^2}$$

These formulas are essential for analyzing motion along circular paths.

You said:



Banking of curves and friction formulae

ChatGPT said:



Here are the formulas related to the **banking of curves** and **friction** in circular motion:

### 1. Banking of Curves (Without Friction):

When a vehicle moves around a banked curve, the necessary centripetal force is provided by the horizontal component of the normal reaction force.

The formula for the optimum speed  $v$  at which a vehicle can take a banked curve without relying on friction is:

$$v = \sqrt{rg \tan \theta}$$

Where:

- $v$  = Optimum speed
- $r$  = Radius of the curve
- $g$  = Acceleration due to gravity
- $\theta$  = Angle of banking

### 2. Banking of Curves (With Friction):

If friction is present, the maximum speed at which a vehicle can safely negotiate the banked curve is:

$$v_{\max} = \sqrt{\frac{rg(\mu_s + \tan \theta)}{1 - \mu_s \tan \theta}}$$

Where:

- $v_{\max}$  = Maximum safe speed
- $\mu_s$  = Coefficient of static friction
- $\theta$  = Angle of banking
- $r$  = Radius of the curve
- $g$  = Acceleration due to gravity

Similarly, the minimum speed at which the vehicle can negotiate the banked curve is:

$$v_{\min} = \sqrt{\frac{rg(\tan \theta - \mu_s)}{1 + \mu_s \tan \theta}}$$

### 3. Centripetal Force with Friction:

In circular motion, if friction contributes to providing the centripetal force, the formula becomes:

$$F_c = \frac{mv^2}{r}$$

Where:

- $F_c$  = Centripetal force
- $m$  = Mass of the object
- $v$  = Velocity of the object
- $r$  = Radius of the circular path

The frictional force  $f$  also contributes to the total centripetal force:

$$f = \mu_s N$$

Where:

- $\mu_s$  = Coefficient of static friction
- $N$  = Normal force

### 4. Condition for No Skidding (Friction):

To prevent skidding in circular motion (on a flat curve), the frictional force must provide the necessary centripetal force:

$$\mu_s mg \geq \frac{mv^2}{r}$$

Solving for  $v$ , the maximum speed without skidding is:

$$v_{\max} = \sqrt{\mu_s g r}$$

Where:

- $v_{\max}$  = Maximum safe speed
- $\mu_s$  = Coefficient of static friction
- $g$  = Acceleration due to gravity
- $r$  = Radius of the curve

These equations are key in analyzing motion on banked and flat curves, considering the role of friction.

ChatGPT can make mistakes. Check important info.