# Momentum

In Newtonian mechanics, **linear momentum**, **translational momentum**, or simply **momentum** (pl. momenta) is the product of the mass and velocity of an object. It is a vector quantity, possessing a magnitude and a direction. If $m$ is an object's mass and $\mathbf{v}$ is its velocity (also a vector quantity), then the object's momentum is:

$\mathbf{p} = m\mathbf{v}.$

### Relation to force

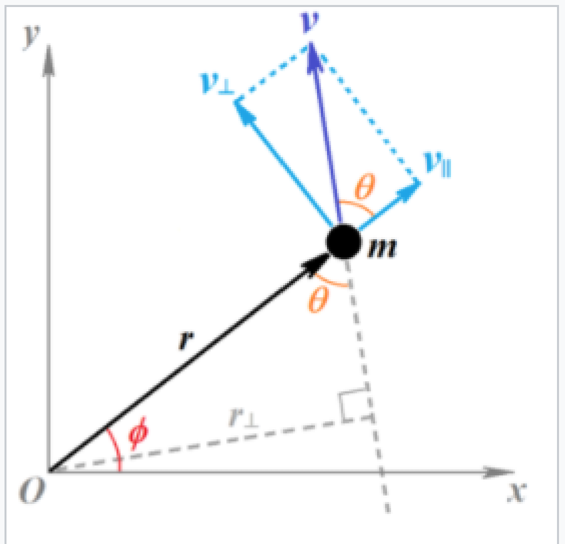
If the net force $F$ applied to a particle is constant, and is applied for :
the momentum of the particle changes by an amount

$$\Delta p = F\Delta t\,.$$

In differential form, this is Newton's second law; the rate of change o
of a particle is equal to the instantaneous force $F$ acting on it,[1]

$$F = \frac{dp}{dt}.$$

# Angular momentum




Velocity of the particle $m$ with respect to the origin $O$ can be resolved into components parallel to ($v_{\parallel}$) and perpendicular to ($v_{\perp}$) the radius vector $r$. The **angular momentum** of $m$ is proportional to the perpendicular component $v_{\perp}$ of the velocity, or equivalently, to the perpendicular distance $r_{\perp}$ from the origin.

| | |
|---|---|
| **Common symbols** | $L$ |
| **In SI base units** | kg m$^2$ s$^{-1}$ |
| **Conserved?** | yes |
| **Derivations from other quantities** | $\mathbf{L} = I\boldsymbol{\omega} = \mathbf{r} \times \mathbf{p}$ |
| **Dimension** | $\mathsf{M\,L^2T^{-1}}$ |

# Impulse (physics)

From Newton's second law, force is related to momentum $\mathbf{p}$ by

$$\mathbf{F} = \frac{d\mathbf{p}}{dt}$$

Therefore,

$$\begin{aligned}\mathbf{J} &= \int_{t_1}^{t_2} \frac{d\mathbf{p}}{dt}\,dt \\ &= \int_{\mathbf{p}_1}^{\mathbf{p}_2} d\mathbf{p} \\ &= \mathbf{p}_2 - \mathbf{p}_1 = \Delta\mathbf{p}\end{aligned}$$

# Torque

$$\boldsymbol{\tau} = \mathbf{r} \times \mathbf{F}$$

$$\tau = \|\mathbf{r}\|\,\|\mathbf{F}\| \sin\theta$$

The net torque on a body determines the rate of change of the body's angular momentum,

$$\boldsymbol{\tau} = \frac{d\mathbf{L}}{dt}$$

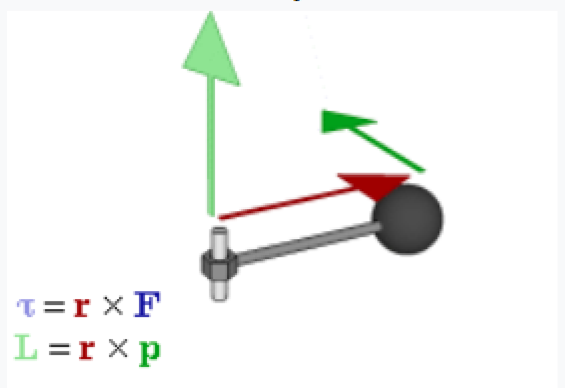
where $\mathbf{L}$ is the angular momentum vector and $t$ is time.

For the motion of a point particle,

$$\mathbf{L} = I\boldsymbol{\omega},$$

where $I$ is the moment of inertia and $\boldsymbol{\omega}$ is the orbital angular velocity pseudovector.

**Torque**




$I = F\Delta t = ma\Delta t = m\Delta V = \Delta P$ (24)

$\tau = I\alpha$

$\tau = I\alpha = r \times F$ $\quad r \times ma\Delta t = r \times m\Delta V$

$= r \times p = \Delta L$

$\tau\Delta t = \Delta L = r \times p$

$\tau\Delta t = \Delta L = I\alpha\Delta t = I\Delta\omega$

$\Rightarrow \Delta\omega = \Delta L / I$

```
void KRigidbody::ApplyImpulse(const KVector2& impulse, const KVector2& contactVector)
{
    velocity += m_invMass * impulse;
    angularVelocity += m_invI * KVector2::Cross(contactVector, impulse); // qff
        //                      ^ angular momentum
}
```