

# Mechanics Formulae

Concepts	Formula	Units
(Average velocity) = $\frac{\text{displacement}}{\text{time change}}$	$\bar{v}_{avg} = \frac{\bar{d}}{\Delta t}$	$\left(\frac{\text{meter}}{\text{sec}}\right) = \frac{(\text{meter})}{(\text{sec})}$
Acceleration = $\frac{\text{velocity change}}{\text{time change}}$	$\bar{a} = \frac{\Delta \bar{v}}{\Delta t}$	$\frac{\text{meter}}{\text{sec}^2} = \frac{(\frac{\text{meter}}{\text{sec}})}{\text{sec}}$
(Velocity change) = (acceleration) (time change)	$\Delta \bar{v} = \bar{a} \Delta t$	$\frac{\text{meter}}{\text{sec}} = \left(\frac{\text{meter}}{\text{sec}^2}\right) (\text{sec})$
Displacement = $\left(\text{initial velocity}\right) \left(\text{time change}\right) + \frac{1}{2} (\text{acceleration}) \left(\text{time change}\right)^2$	$\bar{d} = \bar{v}_0 \Delta t + \frac{1}{2} \bar{a} \Delta t^2$	$\text{meter} = \left(\frac{\text{meter}}{\text{sec}}\right) (\text{sec}) + \left(\frac{\text{meter}}{\text{sec}^2}\right) (\text{sec}^2)$
(Horizontal displacement) = $\left(\text{horizontal velocity}\right) \left(\text{time change}\right)$	$d_x = v_x \Delta t$	$\text{meter} = \left(\frac{\text{meter}}{\text{sec}}\right) (\text{sec})$
(Vertical velocity) = $\left(\text{initial vertical velocity}\right) - \left(\text{acceleration of gravity}\right) \left(\text{time change}\right)$	$v_y = v_{0y} - g \Delta t$	$\frac{\text{meter}}{\text{sec}} = \left(\frac{\text{meter}}{\text{sec}}\right) - \left(\frac{\text{meter}}{\text{sec}^2}\right) (\text{sec})$
(Vertical displacement) = $\left(\text{initial vertical velocity}\right) \left(\text{time change}\right) - \frac{1}{2} \left(\text{acceleration of gravity}\right) \left(\text{time change}\right)^2$	$d_y = v_{0y} \Delta t - \frac{1}{2} g \Delta t^2$	$\text{meter} = \left(\frac{\text{meter}}{\text{sec}}\right) (\text{sec}) - \left(\frac{\text{meter}}{\text{sec}^2}\right) (\text{sec}^2)$
Net force = (mass)(acceleration)	$\bar{F}_{net} = m \bar{a}$	<b>newton</b> = $(\text{kg}) \left(\frac{\text{meter}}{\text{sec}^2}\right)$
Weight = (mass) (acceleration of gravity)	$\bar{F}_{weight} = m \bar{g}$	<b>newton</b> = $(\text{kg}) \left(\frac{\text{meter}}{\text{sec}^2}\right)$
Acceleration = $\frac{\text{net force}}{\text{mass}}$	$\bar{a} = \frac{\bar{F}_{net}}{m}$	$\frac{\text{meter}}{\text{sec}^2} = \left[\frac{(\frac{\text{kg} \cdot \text{meter}}{\text{sec}^2})}{\text{kg}}\right] = \frac{\text{newton}}{\text{kg}}$
Momentum = (mass)(velocity)	$\bar{p} = m \bar{v}$	$\frac{\text{kg} \cdot \text{meter}}{\text{sec}} = (\text{kg}) \left(\frac{\text{meter}}{\text{sec}}\right)$
(Total impulse) = (force) (time change) = (momentum change)	$\bar{F} \Delta t = m \Delta \bar{v} = \Delta \bar{p}$	$\text{newton} \cdot \text{sec} = \left[\left(\frac{\text{kg} \cdot \text{meter}}{\text{sec}^2}\right) (\text{sec})\right] = (\text{kg}) \left(\frac{\text{meter}}{\text{sec}}\right)$
Work = (force) • (distance)	$W = \bar{F} \cdot \bar{d}$	<b>joule</b> = (newton)(meter) = $\left[\frac{(\text{kg})(\text{meter}^2)}{\text{sec}^2}\right]$
(Gravitational potential energy) = (mass) (acceleration of gravity) (height)	$GPE = mgh$	$\text{joule} = (\text{kg}) \left(\frac{\text{meter}}{\text{sec}^2}\right) (\text{meter}) = [\text{newton} \cdot \text{meter}]$
Power = $\frac{\text{work}}{\text{time change}}$	$P = \frac{W}{\Delta t}$	<b>watt</b> = $\frac{\text{joule}}{\text{sec}}$
(Kinetic energy) = $\frac{1}{2} (\text{mass}) (\text{velocity}^2)$	$KE = \frac{1}{2} m v^2$	$\text{joule} = (\text{kg}) \left(\frac{\text{meter}}{\text{sec}}\right)^2 = \left[\frac{(\text{kg})(\text{meter}^2)}{\text{sec}^2}\right]$
(Mechanical efficiency) = $\frac{\text{work out}}{\text{energy in}}$	$\mathcal{E} = \frac{W_{out}}{E_{in}}$	[percentage] = $\frac{\text{joule}}{\text{joule}}$
(Force of gravity) = $\left(\text{gravity constant}\right) \frac{(\text{mass}_1)(\text{mass}_2)}{\text{distance}^2}$	$F = G \frac{m_1 m_2}{r^2}$	$\text{newton} = \left(\frac{(\text{newton})(\text{meter}^2)}{\text{kg}^2}\right) (\text{kg})(\text{kg}) (\text{meter})^2$
Torque = $\left(\frac{\text{lever}}{\text{length}}\right) \times (\text{force})$	$\bar{\Gamma} = \bar{r} \times \bar{F}$	$\text{newton} \cdot \text{meter} = (\text{meter})(\text{newton})$