Mechanics


- Newton’s second law
  \[ F = ma \quad \text{or} \quad a = F/m \]
  The unit of force is the newton (N).

- Mass and Weight
  \[ W = mg \]
  Weight is a force (the force due to gravity) so the unit of weight is the newton (N).

- Velocity of an object experiencing constant acceleration
  \[ v = v_0 + at \]
  The unit of velocity is m/s.
  The unit of acceleration is m/s².

- Position (or, coordinate) of an object experiencing constant acceleration
  \[ x = x_0 + v_0t + \frac{1}{2}at^2 \]
  The unit of distance is the meter (m).

- Linear momentum
  \[ p = mv \]

- Definition of Work
  \[ W = F(\Delta x) \]
  The unit of work is the joule (J); 1 J = 1 N m.

- Kinetic energy
  \[ K = \frac{1}{2}mv^2 \]

- Gravitational potential energy
  \[ U = mgh \]
  The unit of energy is the joule (J).

- Hooke’s law for the force of a spring or elastic body,
  \[ F = -kx \]
  The potential energy is \( \frac{1}{2} kx^2 \).

- Power is energy per unit time,
  \[ p = \frac{\Delta E}{\Delta t} \]
  The unit of power is the watt (W); 1 W = 1 J/s.

- Centripetal acceleration, the acceleration of an object in uniform circular motion,
  \[ a = \frac{v^2}{r}, \text{ directed toward the center} \]

- Newton’s Theory of Universal Gravitation. The gravitational forces for two masses \( m_1 \) and \( m_2 \) are equal but opposite attractive forces with magnitude
  \[ F = \frac{Gm_1m_2}{r^2}, \text{ where } G = 6.67 \times 10^{-11} \text{ m}^3\text{ kg}^{-2}\text{ s}^{-2}. \]

- Pressure is force per unit area
  \[ p = \frac{F}{A}. \]

- The ideal gas law
  \[ p = n kT \quad \text{where } k = \text{Boltzmann constant} \]

- Bernoulli’s equation. Along a streamline of fluid flow,
  \[ p + \frac{1}{2} \rho v^2 + \rho gh = \text{a constant} \]
  For an incompressible fluid in equilibrium, \( p + \rho gh \) is constant throughout the fluid.