

Equations of Physics for ISP 209

Mechanics

⊙ Newton's second law

force = mass x acceleration

$$F = ma \quad \text{or} \quad a = F/m$$

The unit of force is the Newton (N).

⊙ Mass and Weight

weight = mass x acceleration due to gravity

$$W = mg$$

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

present velocity = initial velocity
+ acceleration x time

$$v = v_0 + at$$

The unit of velocity is m/s.

The unit of acceleration is m/s².

⊙ Position (or, coordinate) of an object experiencing constant acceleration

present position = initial position
+ initial velocity x time
+ 0.5 acceleration x time
squared

$$x = x_0 + v_{t0} + \frac{1}{2}at^2$$

The unit of distance is the meter (m).

⊙ Definition of Work

work = force x distance

$$W = F(\Delta x)$$

The unit of work is the joule (J); 1 J = 1 N m.

⊙ Gravitational potential energy

gravitational potential energy
= mass x acceleration due to gravity
x height

$$U = mgh$$

The unit of energy is the joule (J).

⊙ Linear momentum

momentum = mass x velocity

$$p = mv$$

⊙ Kinetic energy

kinetic energy

= 0.5 mass x speed squared

$$K = \frac{1}{2}mv^2$$

⊙ Hooke's law for the force of a spring or elastic body,

restoring force

= - spring constant

x displacement from equilibrium

$$F = -kx$$

⊙ Centripetal acceleration, the acceleration of an object in uniform circular motion,

acceleration = speed²/radius

$$a = \frac{v^2}{r}, \text{ directed toward the center}$$

⊙ The ideal gas law

$p = nkT$ where k = 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.

⊙ 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

$$F = \frac{Gm_1m_2}{r^2}, \text{ where } G = 6.67 \times 10^{-11} \text{ m}^3 \text{ s}^{-2} \text{ kg}^{-1}.$$

⊙ 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.

⊙ Pressure is force per unit area $p = \frac{F}{A}$.