ISP 209
Equations of Physics – Part 1

Mechanics

⊙ Newton's second law

force = mass x acceleration

$F = ma$ or $a = F/m$

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/s^2.

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

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

$x = x_0 + v_0 t + \frac{1}{2} a t^2$

The unit of distance is the meter (m).

⊙ Linear momentum

momentum = mass x velocity

$p = mv$

⊙ Definition of Work

work = force x distance

$W = F(\Delta x)$

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

⊙ Kinetic energy

= 0.5 mass x speed squared

$K = \frac{1}{2} m v^2$

⊙ Gravitational potential energy

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

$U = mgh$

The unit of energy is the joule (J).

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

restoring force = - spring constant x displacement from equilibrium

$F = -kx$

The potential energy is ½ 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,

acceleration = speed^2/radius

$a = \frac{v^2}{r}$, 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

$F = \frac{G m_1 m_2}{r^2}$, where $G = 6.67 \times 10^{-11}$ m^3 s^{-2} kg^{-1}.

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

⊙ The ideal gas law

$p = nkT$ where k = Boltzmann constant

⊙ Bernoulli's equation. Along a streamline of fluid flow,

$p + \frac{1}{2}\rho v^2 + \rho g h =$ a constant

For an incompressible fluid in equilibrium, $p+\rho gh$ is constant throughout the fluid.