

1. Kinematics

For all equations, the acceleration is constant.

$$s = ut + \frac{1}{2}at^2$$

$$v = u + at$$

$$v^2 = u^2 + 2as$$

$$v_{\text{avg}} = \frac{v + u}{2}$$

2. Newton's laws of motion

F = Force, a = acceleration, μ = friction coefficient

Newton's 2nd law : $F = ma$

Weight : $W = mg$

Static friction: $f_s \leq \mu_s N$

Kinetic friction: $f_k = \mu_k N$

3. Work, Energy, and Power

Work, $W = Fd \cos\theta$

Kinetic Energy: $KE = \frac{1}{2}mv^2$

Potential energy: $PE = mgh$

Conservation of energy: initial energy = final energy

Power: $P = \frac{W}{t}$

Power: $P = Fv$

4. Momentum and Collisions

MOMENTUM IS ALWAYS CONSERVED !!!

Linear Momentum: $p = mv$

Impulse = $F\Delta t = \Delta p$

5. Gravitation

Newton's law of Gravitation: $F = \frac{GMm}{r^2}$

Gravitational field: $g = \frac{GM}{r^2}$

Gravitational potential energy: $U = -\frac{GMm}{r}$

Orbital velocity: $V = \sqrt{\frac{GM}{r}}$

Escape Velocity: $V_e = \sqrt{\frac{2GM}{R}}$ where, R represents the radius of the body.

6. Fluid Mechanics

Density: $\rho = \frac{M}{V}$

Pressure: $P = \frac{F}{A}$

Hydrostatic Pressure: $P = P_0 + \rho gh$ where, P_0 = atmospheric pressure.

Buoyant Force (Archimedes' Principle): $F_b = \rho Vg$

Equation of Continuity: $A_1V_1 = A_2V_2$

Bernoulli's Equation: $P + \frac{1}{2}\rho v^2 + \rho gh = \text{constant}$

7. Thermodynamics

Thermal Expansion: $\Delta L = \alpha L_0 \Delta T$

Heat Transfer: $\Delta Q = mc\Delta T$

First law of Thermodynamics: $\Delta U = \Delta Q - \Delta W$

Ideal Gas law: $Pv = nRT$

Work done by gas: $W = p\Delta V$

When T_C = temperature of the cold reservoir and T_H = temperature of the hot reservoir

Efficiency of a Carnot Engine = $1 - \frac{T_C}{T_H}$

Coefficient of Performance (COP) of a Carnot Refrigerator = $\frac{T_C}{T_H - T_C}$

8. Waves and Oscillations

Hooke's Law : $F = -kx$

In simple harmonic motion (SMH):

- Displacement : $x = A\cos(\omega t + \phi)$

- Angular frequency : $\omega = \sqrt{\frac{k}{m}}$

- Period : $T = 2\pi \sqrt{\frac{m}{k}}$

Wave speed : $v = f\lambda$

Doppler Effect : $f' = \frac{v \pm v_o}{v \pm v_s}$

9. Optics

$$\text{Snell's Law: } n_1 \sin\theta_1 = n_2 \sin\theta_2$$

BE CAREFUL TO USE A PROPER SIGN CONVENTION!!

$$\text{Mirror Equation: } \frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

$$\text{Lens Equation: } \frac{1}{f} = \frac{1}{d_i} - \frac{1}{d_o}$$

$$\text{Magnification: } M = \left| \frac{h_i}{h_o} \right| = \left| \frac{d_i}{d_o} \right|$$

$$\text{Lens Maker's Formula: } \frac{1}{f} = (\mu - 1) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$

10. Electricity and Magnetism

$$\text{Ohm's Law: } V = IR$$

$$\text{Resistance: } R = \rho \frac{L}{A}$$

$$\text{Power: } P = VI = I^2R = \frac{V^2}{R}$$

$$\text{Capacitance: } C = \frac{Q}{V}$$

$$\text{Capacitance: } C = \frac{\epsilon_0 A}{d}$$

$$\text{Energy stored in a Capacitor: } U = \frac{1}{2} CV^2 = \frac{1}{2} QV = \frac{1}{2} \frac{Q^2}{C}$$

$$\text{Magnetic Force for a Particle} = qvB \sin\theta$$

$$\text{Magnetic Force in a Current} = BIL \sin\theta$$

$$\text{Faraday's Law: } \epsilon = -N \frac{d\Phi}{dt}$$

11.Modern Physics

Energy of a Photon: $E = hf$

Photoelectric Effect: $E = hf - \phi$

De Broglie Wavelength: $\lambda = \frac{h}{p} = \frac{h}{mv}$

Einstein's Energy mass equivalence: $E = mc^2$