



MECHANICS

VELOCITY & ACCELERATION

Rectilinear Motion



Velocity

$$v = \frac{ds}{dt} = \frac{dx}{dt}$$

$$a = \frac{dv}{dt} = \frac{d^2s}{dt^2}$$

Acceleration

$$a = \frac{dv}{dt} = \frac{d^2s}{dt^2}$$

$$v = \int a dt = at + u$$

$$s = \int v dt = \frac{1}{2}at^2 + ut + s_0$$

Circular Motion



Angular velocity

$$\omega = \frac{d\theta}{dt} = \frac{v}{r}$$

Angular acceleration

$$\alpha = \frac{d\omega}{dt} = \frac{dv}{r dt}$$

Centripetal acceleration

$$a_c = \frac{v^2}{r} = \omega^2 r$$

Centrifugal acceleration

$$a_{cf} = -\frac{v^2}{r} = -\omega^2 r$$

PARTICLE DYNAMICS

Rectilinear Motion

Center of Mass (COM)

$$x_{cm} = \frac{\sum m_i x_i}{\sum m_i}$$

$$y_{cm} = \frac{\sum m_i y_i}{\sum m_i}$$

Linear Momentum

$$p = mv$$

Force (Newton's Second Law)

$$F = \frac{dp}{dt} = ma$$

Gravitational Force

$$F_g = G \frac{m_1 m_2}{r^2}$$

$$G = 6.67 \times 10^{-11} \text{ Nm}^2/\text{kg}^2$$

Translational Equilibrium

$$\sum F = 0$$

Conservation of linear momentum

$$\sum p = \text{constant}$$

Circular Motion

Moment of Inertia

$$I = \sum m_i r_i^2$$

Angular Momentum

$$L = I\omega$$

Angular Momentum

$$L = I\omega$$

Torque

$$\tau = \frac{dL}{dt} = r \times F$$

Centrifugal Force

$$F_{cf} = -\frac{mv^2}{r} = -m\omega^2 r$$

Rotational Equilibrium

$$\sum \tau = 0$$

Conservation of angular momentum

$$\sum L = \text{constant}$$

Conservation of energy

$$\sum E = \text{constant}$$

MAGNETISM

MAGNETIC FIELD PRODUCED BY CURRENTS

System

Wire carrying current I

$$B = \frac{\mu_0 I}{2\pi r}$$

Cable of N turns, length L, carrying current I

$$B = \frac{\mu_0 N I}{L}$$

Magnetic Field Produced

Wire carrying current I

$$B = \frac{\mu_0 I}{2\pi r}$$

Cable of N turns, length L, carrying current I

$$B = \frac{\mu_0 N I}{L}$$

CURRENTS INDUCED BY MAGNETIC FIELDS

System

Wire carrying current I

$$B = \frac{\mu_0 I}{2\pi r}$$

Cable of N turns, length L, carrying current I

$$B = \frac{\mu_0 N I}{L}$$

Induced EMF

$$\mathcal{E} = -\frac{d\Phi}{dt}$$

Induced current

$$I = \frac{\mathcal{E}}{R}$$

ENERGY

Rectilinear Motion

Work (Constant Force)

$$W = Fd \cos \theta$$

Work (Gravity)

$$W = mgh$$

Kinetic energy

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

Power (Constant Force)

$$P = Fv$$

Circular Motion

Work (Constant Torque)

$$W = \tau \theta$$

Kinetic energy

$$K = \frac{1}{2}I\omega^2$$

Power (Constant Torque)

$$P = \tau \omega$$

MECHANICAL ENERGY

Displacement

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

Velocity

$$v = -A\omega \sin(\omega t + \phi)$$

Acceleration

$$a = -A\omega^2 \cos(\omega t + \phi)$$

Period

$$T = \frac{2\pi}{\omega}$$

Angular frequency

$$\omega = 2\pi f$$

Mass On Spring

Total energy

$$E = \frac{1}{2}kx^2 + \frac{1}{2}mv^2$$

Conservation of mechanical energy

$$E = \text{constant}$$

FLUID MECHANICS: LIQUIDS & GASES

Density

$$\rho = \frac{m}{V}$$

Pressure

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

Hydrostatic Pressure

$$P = P_0 + \rho gh$$

Pascal's Equation

$$P_1 = P_2$$

Continuity Equation

$$A_1 v_1 = A_2 v_2$$

Bernoulli Equation

Bernoulli Equation

$$P + \frac{1}{2}\rho v^2 + \rho gh = \text{constant}$$

Bernoulli Equation

Bernoulli Equation

$$P + \frac{1}{2}\rho v^2 + \rho gh = \text{constant}$$

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Yan Bai



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