

# Physics

## Kinematics

$$\bar{v} = \frac{\Delta x}{\Delta t} \text{ (SI: } \frac{\text{m}}{\text{s}} \text{)}$$

$$a = \frac{\Delta v}{\Delta t} \text{ (SI: } \frac{\text{m}}{\text{s}^2} \text{)}$$

### Linear Motion

$$v = v_0 + at$$

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

$$v^2 = v_0^2 + 2ax$$

$$\bar{v} = \frac{(v_0 + v)}{2}$$

$$x = \bar{v}t$$

## Newton's Laws

$$F = ma \text{ (SI: N)}$$

### Gravity

$$F = \frac{Gm_1m_2}{r^2}$$

$$g = G\frac{M}{r^2}$$

### Circular Motion

$$a_c = \frac{v^2}{r} \text{ (SI: } \frac{\text{m}}{\text{s}^2} \text{)}$$

$$F_c = \frac{mv^2}{r} \text{ (SI: N)}$$

### Torque

$$\text{Center of Mass: } x_{\text{cm}} = \frac{\sum m_i x_i}{M}$$

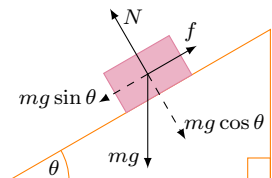
$$\text{Torque: } \tau = rF \sin \theta \text{ (SI: N}\cdot\text{m)}$$

### Mechanical Advantage

$$F_1 \cdot d_1 = F_2 \cdot d_2$$

$$\text{Mechanical Advantage: } \text{MA} = \frac{F_{\text{in}}}{F_{\text{out}}}$$

### Slopes



## Work Energy Power

$$\text{Work: } W = \int Fd \text{ (SI: J)}$$

$$\text{P: } P = \frac{W}{\Delta t} \text{ (SI: W)}$$

$$\text{KE: } K = \frac{1}{2}mv^2$$

$$\text{PE: } U = mgh$$

$$W = \Delta K = -\Delta U$$

$$E = K + U$$

### Springs

$$\text{Hooke's Law: } F = -kx$$

$$\text{Potential Energy: } U = \frac{1}{2}kx^2$$

$$\text{Frequency of Oscillation: } f = \frac{1}{2\pi} \sqrt{\frac{k}{m}}$$

### Pendulums

$$\text{Force: } F = mg \sin \theta$$

$$\text{Potential Energy: } U = mgL(1 - \cos \theta)$$

$$\text{Frequency of Oscillation: } \frac{1}{2\pi} \sqrt{\frac{g}{L}}$$

## Thermodynamics

### Thermal Expansion

$$\text{Linear: } \Delta L = \alpha L \Delta T$$

$$\text{Volume: } \Delta V = \beta V \Delta T$$

### Specific Heat

$$Q = mc\Delta T$$

$$U = Q - W$$

$$\text{Water s.h.c. : } 1 \text{ cal g}^{-1} \text{ K}^{-1} = 4.2 \text{ J g}^{-1} \text{ K}^{-1}$$

## Fluid Dynamics

$$\rho = \frac{m}{V} \text{ (SI: } \frac{\text{kg}}{\text{m}^3} \text{)}$$

$$\text{Weight} = \rho g V \text{ (SI: N)}$$

$$\text{Specific Gravity} = \frac{\rho_{\text{substance}}}{\rho_{\text{water}}}; \rho_{\text{water}} = 1000 \text{ kg m}^{-3}$$

### Pressure

$$P = \frac{F}{A} \text{ (SI: Pa)}$$

$$\text{Hydrostatic: } P_h = \rho gh$$

$$\text{Gauge: } P_g = P - P_{\text{atm}}$$

$$\text{Absolute: } \sum P$$

$$1 \text{ atm} = 760 \text{ torr} = 760 \text{ mmHg} = 10^5 \text{ Pa}$$

### Flow

$$\text{Continuity Equation: } A_1 v_1 = A_2 v_2$$

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

$$\text{Poiseuille: } Q = \frac{\pi P r^4}{8\eta l}; \eta \rightarrow \text{viscosity}$$

$$\text{Reynold's Numnber: } v_{\text{critical}} = \frac{R\eta}{2\rho r}$$

### Principles

$$\text{Archimedes: } F_{\text{buoy}} = g \cdot \rho_{\text{fluid}} \cdot V_{\text{submerged}}$$

$$\text{Pascal:}$$

$$P = \frac{F_1}{A_1} = \frac{F_2}{A_2}$$

$$A_1 d_1 = A_2 d_2$$

$$W = F_1 d_1 = F_2 d_2$$

## Electrostatics

$$\text{Coulomb's Law: } F = \frac{kq_1q_2}{r^2}; k = 9 \cdot 10^9 \text{ N} \cdot \text{m}^2 \cdot \text{C}^{-2} \text{ (SI:N)}$$

### Electric Fields

$$\text{Electric Field Equation: } E = \frac{F_e}{q} = \frac{kQ}{r^2} \text{ (SI: } \frac{\text{N}}{\text{C}} \text{ or } \frac{\text{V}}{\text{M}} \text{)}$$

Electric field lines go from + to –  
+ charge moves in the same direction of the electric field  
– charge moves in the opposite direction

### Electric Dipoles

$$\text{Dipole Moment: } p = q \cdot d \text{ (SI: C}\cdot\text{m)}$$

$$F_e = qE$$

$$\sum F_e = 0$$

Dipole will realign to be parallel with an electric field

### Electrical Potential

$$\text{Voltage: } V = \frac{U}{q} \text{ (SI: V or } \frac{\text{J}}{\text{C}} \text{)}$$

$$\text{Voltage Difference: } \Delta V = \frac{W}{q} = \frac{kQ}{r} = Ed \text{ (SI: V or } \frac{\text{J}}{\text{C}} \text{)}$$

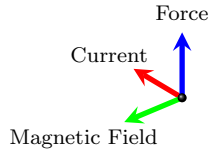
Voltage is the amount of work to move a positive test charge from infinity to some location

## Magnetism

$$F_m = Q \cdot v \cdot \beta \cdot \sin \theta; \text{ (SI: } \beta \rightarrow \text{T)}$$

$$\text{Lorentz Force: } F = F_m + F_e$$

### Right Hand Rule



### Electromagnetism

$$F_m = I \cdot L \cdot \beta \cdot \sin\theta$$

$$\text{Biot-Savart Law: } \beta = \frac{\mu_0 I}{2\pi R}$$

## Circuits

$$\text{Current: } I = \frac{Q}{\Delta t} \text{ (SI: A)}$$

$$\text{Resistance: } R = \frac{\rho L}{A}; \rho \rightarrow \text{resistivity, } A \rightarrow \text{area (SI: } \Omega \text{)}$$

$$\text{Voltage: } V = IR \text{ (SI: V)}$$

$$\text{Power: } P = IV \text{ (SI: W)}$$

$$\text{Capacitance: } C = \frac{Q}{V} \text{ (SI: F)}$$

### Resistors

$$\text{Series: } R_{eq} = R_1 + R_2 + R_3 + \dots$$

$$\text{Parallel: } \frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$$

### Capacitors

$$\text{Series: } \frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \dots$$

$$\text{Parallel: } C_{eq} = C_1 + C_2 + C_3 + \dots$$

$$\text{Energy Stored: } U = \frac{1}{2} QV = \frac{1}{2} CV^2 = \frac{1}{2} \frac{Q^2}{C}$$

$$\text{Dielectric: } C_{\text{dielectric}} = kC; k \rightarrow \text{dielectric constant}$$

## Waves

$$f = \frac{1}{T} \text{ (SI: Hz)}$$

$$v = f \cdot \lambda \text{ (SI: } \frac{\text{m}}{\text{s}} \text{)}$$

### Standing Waves

$$\text{Open Pipe \& Fixed String: } \lambda = \frac{2L}{n}; n \rightarrow 1, 2, 3, \dots$$

$$\text{Closed Pipe: } \lambda = \frac{4L}{n}; n \rightarrow 1, 3, 5, \dots$$

### Sound

$$\text{Intensity: } I = \frac{P}{A}$$

$$\text{Sound Level: } \beta = 10 \log\left(\frac{I}{I_0}\right); I_0 = 10^{-12} \text{ (SI: dB)}$$

$$\text{Doppler Effect: } f' = f \frac{v \pm v_d}{v \mp v_s}; v = 343 \frac{\text{m}}{\text{s}}$$

## Optics

### Reflection and Refraction

$$\theta_{\text{incidence}} = \theta_{\text{reflection}}$$

$$\text{Snell's Law: } n_i \sin \theta_i = n_r \sin \theta_r$$

$$\text{Index of Refraction: } n = \frac{c}{v}; c = 3 \cdot 10^8 \frac{\text{m}}{\text{s}}$$

### Mirrors and Lenses

$$\text{Focal Point: } f = \frac{1}{2} \text{ radius of curvature}$$

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

$$\text{Magnification Equation: } M = -\frac{d_i}{d_o} = \frac{h_i}{h_o}$$