

ALL CHAPTER FORMULAS

Motion in a straightline

$$\text{Avg. Speed} = \frac{\text{Total Distance}}{\text{Total Time}}$$

$$\text{Avg. Velocity} = \frac{\text{Total Displacement}}{\text{Total Time}}$$

$$\text{Inst. Speed} = \frac{\text{very very small distance}}{\text{very very small time}}$$

$$\text{Inst. velocity} = \frac{\text{very very small displacement}}{\text{very very small time}}$$

$$\text{Avg. Acceleration} = \frac{\text{change in velocity}}{\text{time}}$$

$$V = u + at$$

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

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

Motion in a plane

$$1. \hat{A} = \frac{\vec{A}}{|\vec{A}|} \quad (\text{Unit vector})$$

$$2. R = \sqrt{A^2 + B^2 + 2AB\cos\theta} \quad (\text{resultant of 2 vectors})$$

$$3. \tan\alpha = \frac{B\sin\theta}{A+B\cos\theta} \quad (\text{angle})$$

$$4. T = \frac{2U\sin\theta}{g} \quad (\text{time of flight of projectile})$$

$$5. H = \frac{U^2\sin^2\theta}{2g} \quad (\text{max height projectile})$$

$$6. R = \frac{U^2\sin 2\theta}{g} \quad (\text{range of projectile})$$

$$7. R_{max} = \frac{U^2}{g}$$

$$8. y = x \tan\theta - \left(\frac{g}{2u^2\cos^2\theta}\right)x^2 \quad (\text{path of projectile})$$

$$9. \vec{A} \cdot \vec{B} = AB\cos\theta$$

$$10. \vec{A} \times \vec{B} = AB\sin\theta$$

$$11. \omega = \frac{d\theta}{dt} \quad (\text{angular velocity})$$

$$12. v = r\omega$$

$$13. a = \frac{v^2}{r}$$

LAWS OF MOTION

1. $P = mv$ (momentum)

2. $F = ma$ (second law)
 $F \propto \frac{dp}{dt}$

3. $I = F \times dt$ (impulse)

4. $I = \Delta p = pf - pi$
(impulse)

5. $V = -\frac{mv}{M}$ (recoil velocity)

6. $(Fs)_{max} = \mu_s N$
(Static friction)

7. $f_K = \mu_k N$ (kinetic friction)

8. $\tan\theta = \mu_s$ (angle of repose)

9. $m(g + a)$ (elevator upward)

10. $m(g - a)$ (elevator downward)

11. $V_{max} = \sqrt{\mu_s r g}$

(circular level road)

11. $V_{max} = \sqrt{\frac{rg(\mu_s + \tan\theta)}{1 - \mu_s \tan\theta}}$

(banked road maximum speed)

12. $V_{optimum} = \sqrt{rg \tan\theta}$

(banked road optimum speed)

Work energy and Power

$$W = F \cdot S = F S \cos \theta$$

$$W = \int F \cdot ds$$

$$P = \sqrt{2mKE}$$

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

$$PE = mgh$$

$$E = KE + PE$$

$$K_f - K_i = \int F ds$$

$$U = \frac{1}{2} kx^2$$

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

$$P = F \cdot v$$

Elastic collision

$$U_1 - U_2 = V_2 - V_1$$

$$V_1 = \frac{m_1 - m_2}{m_1 + m_2} u_1 - \frac{2m_1}{m_1 + m_2} u_2$$

$$V_2 = \frac{m_2 - m_1}{m_1 + m_2} u_2 + \frac{2m_1}{m_1 + m_2} u_1$$

Inelastic collision

$$\Delta KE = \frac{1}{2} u_1^2 \frac{m_1 m_2}{m_1 + m_2}$$

System of particles and rotational motion

$$I = mr^2$$

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

$$I = mk^2$$

$$K = \sqrt{\frac{I}{M}}$$

$$\tau = I \alpha$$

$$\vec{\tau} = \vec{r} \times \vec{F}$$

$$\tau = r F \sin \theta$$

$$\tau = r_{\perp} F$$

$$\vec{L} = \vec{r} \times \vec{p}$$

$$L = r_{\perp} P$$

$$\tau = r p \sin \theta$$

$$L = I \omega$$

$$\vec{\tau} = \frac{d\vec{L}}{dt}$$

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

when $\vec{\tau} = 0$

L is constant

Gravitation

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

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

$$g = 9.8 \text{ m/s}^2$$

$$g_h = g \left(1 - \frac{2h}{R} \right)$$

$$g_d = g \left(1 - \frac{d}{R} \right)$$

$$V_e = \sqrt{\frac{2GM}{R}}$$

$$V_e = \sqrt{2gR}$$

$$V_o = \sqrt{\frac{GM}{R}}$$

$$V_o = \sqrt{gR}$$

$$U = -\frac{G M m}{r}$$

$$I = \frac{G M}{R^2}$$

$$V = -\frac{W}{m}$$

$$KE = \frac{GMm}{2(R+h)}$$

$$PE = -\frac{GMm}{(R+h)}$$

$$E = KE + PE$$

$$E = -\frac{GMm}{2(R+h)}$$

Mechanical properties of Solids

$$\text{Longitudinal Stress} = \frac{F}{A}$$

$$\text{Longitudinal strain} = \frac{\Delta l}{l}$$

$$\text{shearing Stress} = \frac{F}{A}$$

$$\text{Shearing strain } \theta = \frac{\Delta x}{L}$$

$$\text{Hydraulic stress} = P$$

$$\text{Hydraulic strain} = \frac{\Delta V}{V}$$

$$K = \frac{\text{stress}}{\text{strain}}$$

Young's modulus (Y)

$$Y = \frac{\text{longitudinal stress}}{\text{longitudinal strain}}$$

Shear Modulus (G)

$$G = \frac{\text{shearing stress}}{\text{shearing strain}}$$

Bulk Modulus (B)

$$B = \frac{\text{Hydraulic stress}}{\text{Volume strain}}$$

$$K = \frac{1}{B} \text{ *Compressibility*}$$

$$\sigma = \frac{\text{Lateral strain}}{\text{Longitudinal strain}} \quad \text{Poisson's ratio}$$

$$U = \frac{1}{2} \text{ Stress} \times \text{strain} \times \text{volume}$$

Elastic potential energy

$$U = \frac{1}{2} Y \times \text{strain}^2 \times \text{volume}$$

Mechanical properties of Fluids

$$\frac{F_1}{A_1} = \frac{F_2}{A_2} \quad \text{Hydraulic lift}$$

$$P_2 = P_1 + h\rho g$$

$$P = P_0 + h\rho g$$

$$R = \frac{\rho v d}{\eta} \quad \text{Reynolds number}$$

$$A_1 v_1 = A_2 v_2 \quad \text{Equation of continuity}$$

$$P + \rho g h + \frac{1}{2} \rho v^2 = \text{const} \quad \text{Bernoulli's principle}$$

$$\eta = \frac{\text{shearing stress}}{\text{strain rate}} = \frac{Fl}{Av} \quad \text{Coefficient of viscosity}$$

$$F_V = 6\pi\eta r v \quad \text{Stokes law}$$

$$v_t = \frac{2r^2 g (\rho_b - \rho_f)}{9\eta} \quad \text{Terminal velocity}$$

$$v = \sqrt{2gh} \quad \text{Velocity of efflux – open tank}$$

$$S = \frac{F}{l} = \frac{\Delta U}{\Delta A} \quad \text{Surface tension}$$

Excess pressure

$$\Delta P = \frac{2S}{R} \quad \Delta P = \frac{2S}{R} \quad \Delta P = \frac{4S}{R}$$

$$h = \frac{2S \cos \theta}{\rho g r} \quad \text{Capillary rise}$$

Thermodynamics

$$1. \Delta Q = \Delta U + \Delta W$$

(first law)

$$2. \Delta W = P \Delta V \quad (\text{work done})$$

$$3. W = nRT \ln\left(\frac{V_2}{V_1}\right)$$

(isothermal workdone)

$$4. W = 2.303nRT \log\left(\frac{V_2}{V_1}\right)$$

(isothermal workdone)

$$5. W = \frac{n}{\gamma-1} [T_1 - T_2]$$

(adiabatic workdone)

$$6. W = P \Delta V = 0$$

(isochoric workdone)

$$7. W = p (V_2 - V_1)$$

(isobaric workdone)

$$8. \eta = 1 - \frac{T_2}{T_1}$$

(Efficiency of carnot engine)

$$9. \eta = 1 - \frac{Q_2}{Q_1}$$

(Efficiency of carnot engine)

$C_p - C_v = R$
Mayer's relation

Thermal properties of matter

$$1. \frac{C}{5} = \frac{F-32}{9}$$

$$2. K = C + 273$$

$$3. \alpha = \frac{\Delta l}{l \Delta T}$$

(Coefficient of linear expansion)

$$4. \beta = \frac{\Delta A}{A \Delta T}$$

(Coefficient of area expansion)

$$5. \gamma = \frac{\Delta V}{V \Delta T}$$

(Coefficient of volume expansion)

$$6. \beta = 2\alpha$$

$$7. \gamma = 3\alpha$$

$$8. s = \frac{\Delta Q}{m \Delta T}$$

(Specific Heat Capacity (s))

$$9. c = \frac{\Delta Q}{n \Delta T}$$

(molar Specific Heat Capacity)

$$10. L = \frac{Q}{m} \quad (\text{latent heat})$$

$$11. H = \frac{dQ}{dt} = \frac{KA \Delta T}{L}$$

(thermal conductivity)

$$12. \frac{dT}{dt} = K(T_b - T_s)$$

(newtons law of cooling)

KINETIC THEORY OF GASES

$$1. PV = nRT$$

$$2. PV = NKbT$$

$$3. P = \frac{1}{3} nm\bar{v}^2$$

(Pressure of an ideal gas)

$$4. \langle KE_{avg} \rangle = \frac{3}{2} K_b T$$

(Kinetic interpretation of temperature)

$$5. v_{rms} = \sqrt{\frac{3RT}{M}}$$

$$6. v_{rms} = \sqrt{\frac{3k_b T}{m}}$$

$$7. l = \frac{1}{\sqrt{2}\pi n d^2}$$

(mean free path)

Oscillations

Systems executing SHM

Oscillations due to spring

Restoring force

$$F = -kx$$

Acceleration

$$A = \omega^2 x$$

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

Time period

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

Frequency

$$v = \frac{1}{T}$$

Simple pendulum

$$T = 2\pi \sqrt{\frac{l}{g}}$$

Energy

Kinetic energy

$$KE = \frac{1}{2} m\omega^2(A^2 - X^2)$$

Potential energy

$$U = \frac{1}{2} m\omega^2 X^2$$

Total energy

$$E = K + U$$

$$E = \frac{1}{2} m\omega^2 A^2$$

WAVES

$$1. Y=A \sin[(kx \pm \omega t + \varphi)]$$

(general equation)

$$2. f = \frac{1}{T}$$

$$3. \omega = \frac{2\pi}{T} = 2\pi f$$

$$4. k = \frac{2\pi}{\lambda}$$

$$5. v = f\lambda$$

$$6. v = \frac{\omega}{K}$$

$$7. v = \sqrt{\frac{T}{\mu}}$$

(Speed of transverse wave on a stretched string)

$$8. v = \sqrt{\frac{Y}{\rho}} \quad (\text{solids})$$

(Speed of longitudinal wave (sound wave))

$$v = \sqrt{\frac{B}{\rho}} \quad (\text{Fluids})$$

$$9. v = \sqrt{\frac{P}{\rho}}$$

(newtons formula)

$$10. v = \sqrt{\frac{\gamma P}{\rho}}$$

(laplace correction)

$$11. \Delta v = \vartheta_1 - \vartheta_2$$

(beat frequency)

Standing wave on a stretched string

$$v_1 = \frac{V}{2L}$$

Fundamental frequency

First harmonics

$$v_2 = \frac{2V}{2L} = 2v_1$$

Second harmonics

$$v_3 = \frac{3V}{2L} = 3v_1$$

Third harmonics

Ratio = 1:2:3

Standing wave on a closed pipe

$$v_1 = \frac{V}{4L}$$

Fundamental frequency

First harmonics

$$v_3 = \frac{3V}{4L} = 3v_1$$

Third harmonics

$$v_5 = \frac{5V}{4L} = 5v_1$$

Fifth harmonics

Ratio = 1:3:5

Standing wave on an open pipe

$$v_1 = \frac{V}{2L}$$

Fundamental frequency

First harmonics

$$v_2 = \frac{2V}{2L} = 2v_1$$

Second harmonics

$$v_3 = \frac{3V}{2L} = 3v_1$$

Third harmonics

Ratio = 1:2:3