

Physics formulas from Mechanics, Waves, Optics, Heat and Thermodynamics, Electricity and Magnetism and Modern Physics. Also includes the value of Physical Constants. Helps in quick revision for **CBSE, NEET, JEE Mains**, and **Advanced**.

### 0.1: Physical Constants

Speed of light	$c$	$3 \times 10^8 \text{ m/s}$
Planck constant	$h$	$6.63 \times 10^{-34} \text{ J s}$
	$hc$	$1242 \text{ eV-nm}$
Gravitation constant	$G$	$6.67 \times 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}$
Boltzmann constant	$k$	$1.38 \times 10^{-23} \text{ J/K}$
Molar gas constant	$R$	$8.314 \text{ J/(mol K)}$
Avogadro's number	$N_A$	$6.023 \times 10^{23} \text{ mol}^{-1}$
Charge of electron	$e$	$1.602 \times 10^{-19} \text{ C}$
Permeability of vacuum	$\mu_0$	$4\pi \times 10^{-7} \text{ N/A}^2$
Permittivity of vacuum	$\epsilon_0$	$8.85 \times 10^{-12} \text{ F/m}$
Coulomb constant	$\frac{1}{4\pi\epsilon_0}$	$9 \times 10^9 \text{ N m}^2/\text{C}^2$
Faraday constant	$F$	$96485 \text{ C/mol}$
Mass of electron	$m_e$	$9.1 \times 10^{-31} \text{ kg}$
Mass of proton	$m_p$	$1.6726 \times 10^{-27} \text{ kg}$
Mass of neutron	$m_n$	$1.6749 \times 10^{-27} \text{ kg}$
Atomic mass unit	$u$	$1.66 \times 10^{-27} \text{ kg}$
Atomic mass unit	$u$	$931.49 \text{ MeV}/c^2$
Stefan-Boltzmann constant	$\sigma$	$5.67 \times 10^{-8} \text{ W/(m}^2 \text{ K}^4)$
Rydberg constant	$R_\infty$	$1.097 \times 10^7 \text{ m}^{-1}$
Bohr magneton	$\mu_B$	$9.27 \times 10^{-24} \text{ J/T}$
Bohr radius	$a_0$	$0.529 \times 10^{-10} \text{ m}$
Standard atmosphere	atm	$1.01325 \times 10^5 \text{ Pa}$
Wien displacement constant	$b$	$2.9 \times 10^{-3} \text{ m K}$

## 1 MECHANICS

### 1.1: Vectors

Notation:  $\vec{a} = a_x \hat{i} + a_y \hat{j} + a_z \hat{k}$

Magnitude:  $a = |\vec{a}| = \sqrt{a_x^2 + a_y^2 + a_z^2}$

Dot product:  $\vec{a} \cdot \vec{b} = a_x b_x + a_y b_y + a_z b_z = ab \cos \theta$

Cross product:



$$\vec{a} \times \vec{b} = (a_y b_z - a_z b_y)\hat{i} + (a_z b_x - a_x b_z)\hat{j} + (a_x b_y - a_y b_x)\hat{k}$$

$$|\vec{a} \times \vec{b}| = ab \sin \theta$$

### 1.2: Kinematics

Average and Instantaneous Vel. and Accel.:

$$\vec{v}_{av} = \Delta \vec{r} / \Delta t,$$

$$\vec{v}_{inst} = d\vec{r}/dt$$

$$\vec{a}_{av} = \Delta \vec{v} / \Delta t$$

$$\vec{a}_{inst} = d\vec{v}/dt$$

Motion in a straight line with constant  $a$ :

$$v = u + at, \quad s = ut + \frac{1}{2}at^2, \quad v^2 - u^2 = 2as$$

Relative Velocity:  $\vec{v}_{A/D} = \vec{v}_A - \vec{v}_D$

Projectile Motion:



$$x = ut \cos \theta, \quad y = ut \sin \theta - \frac{1}{2}gt^2$$

$$y = x \tan \theta - \frac{g}{2u^2 \cos^2 \theta} x^2$$

$$T = \frac{2u \sin \theta}{g}, \quad R = \frac{u^2 \sin 2\theta}{g}, \quad H = \frac{u^2 \sin^2 \theta}{2g}$$

### 1.3: Newton's Laws and Friction

Linear momentum:  $\vec{p} = m\vec{v}$

Newton's first law: inertial frame.

Newton's second law:  $\vec{F} = \frac{d\vec{p}}{dt}$ ,  $\vec{F} = m\vec{a}$

Newton's third law:  $\vec{F}_{AB} = -\vec{F}_{BA}$

Frictional force:  $f_{static, max} = \mu_s N$ ,  $f_{kinetic} = \mu_k N$

Banking angle:  $\frac{v^2}{rg} = \tan \theta$ ,  $\frac{v^2}{rg} = \frac{\mu + \tan \theta}{1 - \mu \tan \theta}$

Centripetal force:  $F_c = \frac{mv^2}{r}$ ,  $a_c = \frac{v^2}{r}$

Pseudo force:  $\vec{F}_{pseudo} = -m\vec{a}_0$ ,  $F_{centrifugal} = -\frac{mv^2}{r}$

Minimum speed to complete vertical circle:

$$v_{min, bottom} = \sqrt{5gl}, \quad v_{min, top} = \sqrt{gl}$$

Conical pendulum:  $T = 2\pi \sqrt{\frac{l \cos \theta}{g}}$



### 1.4: Work, Power and Energy

Work:  $W = \vec{F} \cdot \vec{S} = FS \cos \theta$ ,  $W = \int \vec{F} \cdot d\vec{S}$

Kinetic energy:  $K = \frac{1}{2}mv^2 = \frac{p^2}{2m}$

Potential energy:  $F = -\partial U / \partial x$  for conservative forces.

$$U_{gravitational} = mgh, \quad U_{spring} = \frac{1}{2}kx^2$$

Work done by conservative forces is path independent and depends only on initial and final points:  
 $\oint \vec{F}_{conservative} \cdot d\vec{r} = 0$ .

Work-energy theorem:  $W = \Delta K$



# June 2physics 6phpaper

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