Formula Booklet

Class 11
PHYSICS

Telegram
@AirJEENEET

PHYSICAL CONSTANTS

Speed of light	c	3×10^8 m/s
Planck constant	h	6.63×10^{-34} Js
Gravitation Constant	G	6.67×10^{-11} $m^3 kg^{-1} s^{-2}$
Boltzmann constant	k	1.38×10^{-23} J/K
Molar gas Constant	R	8.314 J/(mol K)
Avogadro's number	N_A	6.023×10^{23} mol^{-1}
Permeability of vacuum	μ_0	$4\pi \times 10^{-7}$ N/A^2
Permitivity of vacuum	ε_0	8.85×10^{-12} F/m
Coulomb constant	$\frac{1}{4\pi\varepsilon_0}$	9×10^9 $N m^2/C^2$
Faraday constant	F	96485 C/mol
Mass of electron	m_e	9.1×10^{-31} Kg
Mass of proton	m_p	1.6726×10^{-27} kg
Mass of neutron	m_n	1.6749×10^{-27} kg
Atomic mass unit	u	1.66×10^{-27} kg
Stefan-Boltzmann constant	σ	5.67×10^{-8} $W/(m^2 K^4)$
Rydberg constant	R_∞	1.097×10^7 m^{-1}

Charge of electron	e	1.602×10^{-19} C
Bohr magneton	μ_B	9.27×10^{-24} J/T
Bohr Radius	a_0	0.529×10^{-10} m
Standard atmosphere	atm	1.01325×10^{5} Pa
Wien displacement constant	b	2.9×10^{-3} mk

VECTORS

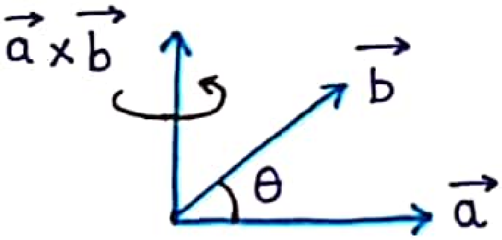
Notation : $\vec{a} = a_x\hat{i} + a_y\hat{j} + a_z\hat{k}$

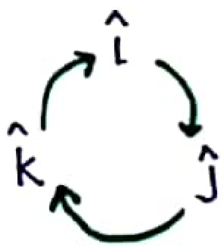
Magnitude : $a = |\vec{a}| = \sqrt{a_x^2 + a_y^2 + a_z^2}$

Dot Product ●

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

Cross Product ✖





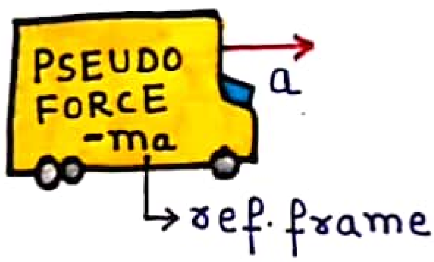
$\vec{a}\times\vec{b} = (a_y b_z - a_z b_y)\hat{i} + (a_z b_x - a_x b_z)\hat{j} + (a_x b_y - a_y b_x)\hat{k}$

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

NEWTON's Law 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 : $\vec{F}_{pseudo} = -m\vec{a}_0$

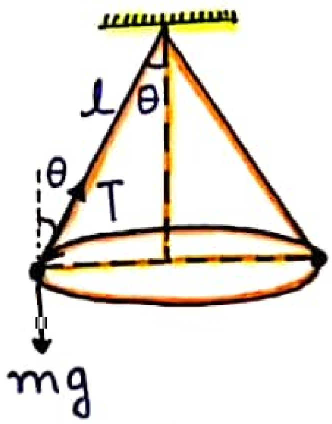


$F_{centrifugal} = -\frac{mv^2}{r}$

- Minimum speed to complete vertical circle :

  $V_{min,\,bottom} = \sqrt{5gl}$, $V_{min,\,top} = \sqrt{gl}$
- Conical pendulum :

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



KINEMATICS

Average and Instantaneous Velocity and Acceleration

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

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

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

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

Motion in a straight line with constant a

$v = u + at$

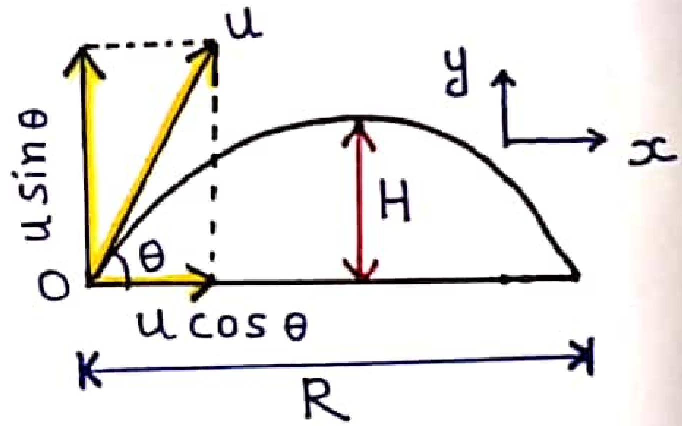
$s = ut + \frac{1}{2}at^2$

$v^2 - u^2 = 2as$

Relative Velocity

$\vec{v}_{A|B} = \vec{v}_A - \vec{v}_B$

Projectile Motion



$x = ut\cos\theta$

$y = ut\sin\theta - \frac{1}{2}gt^2$

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

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

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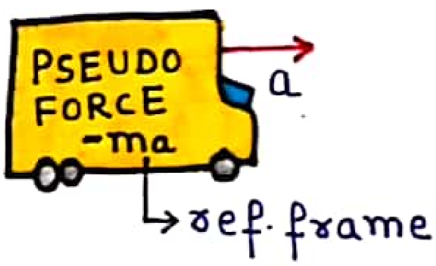

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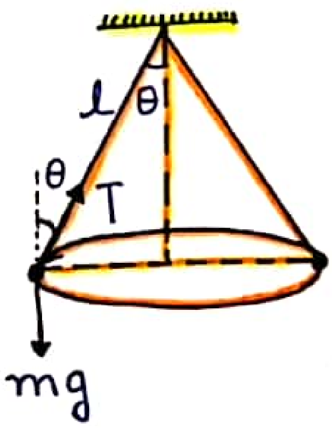


WORK, POWER & ENERGY

work = $\vec{F} \cdot \vec{s} = Fs\cos\theta$

$= \int \vec{F} \cdot d\vec{s}$

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

Potential Energy (U)

$U_g = mgh$

$U_{spring} = \frac{1}{2}kx^2$

$\vec{F} = -\frac{dU}{dx}$

K + U = Conserved $\longrightarrow$ For Conservative Forces

$\oint \vec{F} \cdot d\vec{s} = 0$ [work by a Conservative Force in a closed path]

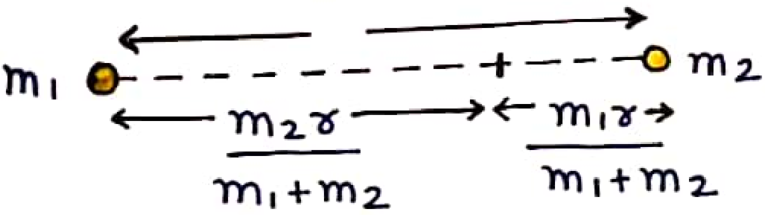
Power = $dW/dt = \vec{F} \cdot \vec{v}$

Work-Energy Theorem $W_{net} = \Delta K$

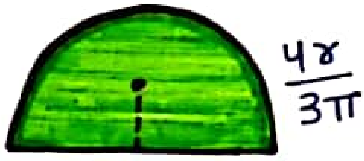
CENTER OF MASS

$$x_{cm} = \frac{\Sigma x_i m_i}{\Sigma m_i} = \frac{\int x\, dm}{\int dm}$$

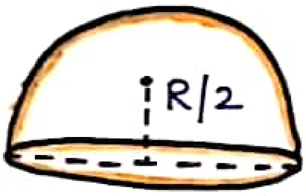
$$\vec{V}_{cm} = \frac{\Sigma m_i \vec{V}_i}{\Sigma m_i} \qquad \vec{F} = m\vec{a}_{cm}$$



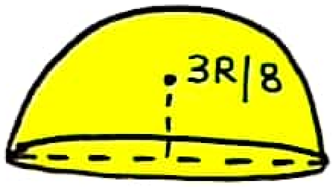
Hollow cone $= h/3$



Solid cone $= h/4$

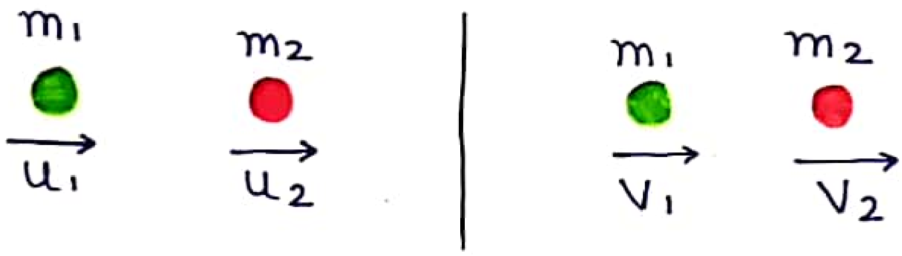


Hollow



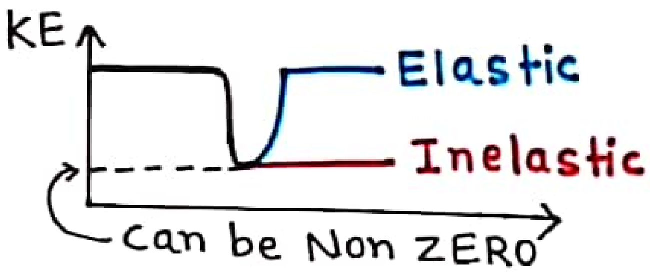
Solid

COLLISION



Momentum Conservation (Always)

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$



$$CoR = e = \frac{V_{SEPARATION}}{V_{APPROACH}}$$

$$= \frac{v_2 - v_1}{u_1 - u_2}$$

$m_1 >> m_2$

$m_1 \rightarrow$ undisturbed motion

Solve using CoR in m_1 Frame.

$m_1 = m_2$

Velocity Exchange for Elastic

Rigid body dynamics

$$\omega = \frac{\Delta\theta}{\Delta t} = \frac{d\theta}{dt} \quad \alpha = \frac{\Delta\omega}{\Delta t} = \frac{d\omega}{dt}$$

$$\boxed{\vec{V} = \vec{\omega} \times \vec{r}} \quad \boxed{\vec{a}_{tan} = \vec{\alpha} \times \vec{r}} \quad \boxed{\vec{a}_{centri} = \omega^2 r}$$

$$\theta = \omega_0 t + \frac{1}{2}\alpha t^2$$

$$\omega = \omega_0 + \alpha t$$

$$\omega^2 = \omega_0^2 + 2\alpha\theta$$

$$\vec{L} = \vec{r} \times \vec{P} = mvr_{\perp}$$

$$\tau = I\alpha = d\vec{L}/dt$$

$$\vec{\tau} = \vec{r} \times \vec{F} = r_{\perp}F = rF\sin\theta$$

EQUILIBRIUM : $F_{net} = 0 = \tau_{net}$

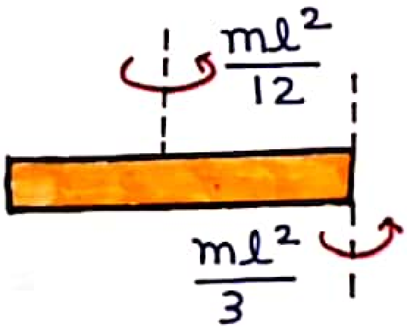
$$\omega = 2\pi f \quad T = 1/f \quad \omega = V_{\perp}/r$$

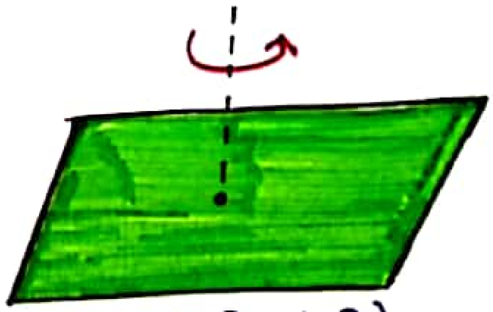
MOMENT OF INERTIA

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

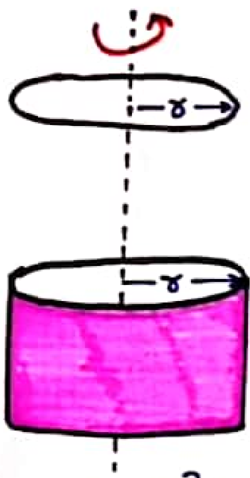
$$I = \int r^2 dm$$

$R_{GYRATION}$ $mk^2 = I$

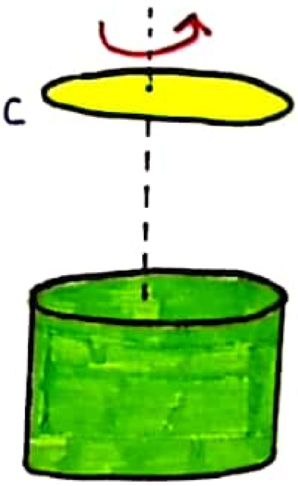




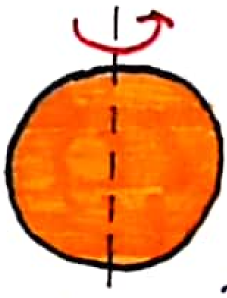
$\frac{m}{12}(a^2+b^2)$



mr^2



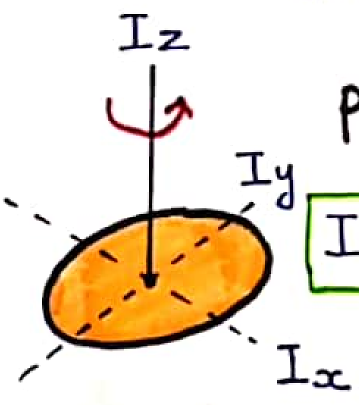
$\frac{1}{2}mr^2$



Hollow $= \frac{2}{3}mr^2$

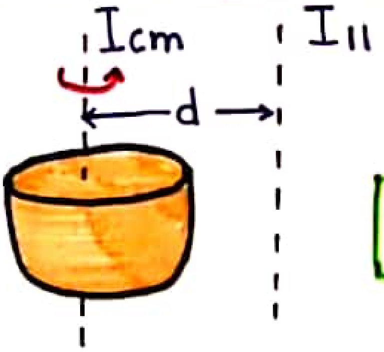
Solid $= \frac{2}{5}mr^2$

AXIS THEOREMS



Prependicular

$\boxed{I_z = I_x + I_y}$



Parallel

$$\boxed{I_{\parallel} = I_{cm} + md^2}$$

Instantaneous Axis of Rotation

$$\vec{V} = \vec{\omega} \times \vec{r}$$

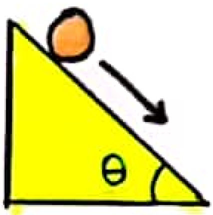
Kinetic Energy

$$K = \frac{1}{2} m v_c^2 + \frac{1}{2} I_c \omega^2$$

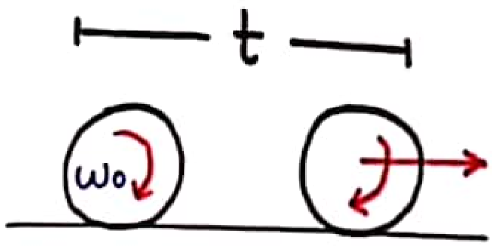
$$K = \frac{1}{2} I_H \omega^2 \text{ (About Hinge)}$$

Rolling Motion

$V = \omega r$ (no slip condition)

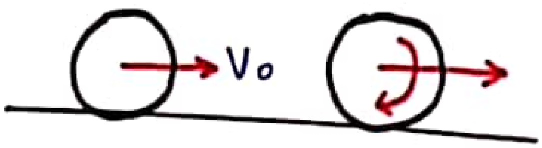


$$a = \frac{g \sin\theta}{\left[1 + \frac{I}{mr^2}\right]} \qquad V = \sqrt{\frac{2gH}{I + \frac{I}{mr^2}}}$$



Initial

$$t = \frac{r\omega_0}{\mu g\left[1 + \frac{mr^2}{I}\right]}$$



$$t = \frac{V_0}{\mu g\left[1 + \frac{mr^2}{I}\right]}$$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