Subject : Physics

Class : XI

Kannada

Work Power and Energy

WORK DONE BY CONSTANT FORCE

$$W = \vec{F} \cdot \vec{S}$$

Work Done by Multiple Forces

$$W = [\Sigma \vec{F}] \cdot \vec{S}$$

$$W = \vec{F}_1 \cdot \vec{S} + \vec{F}_2 \cdot \vec{S} + \vec{F}_3 \cdot \vec{S} + \cdots \left(\because \Sigma \vec{F} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 + \cdots\right)$$

or $W = W_1 + W_2 + W_3 + \ldots$

Work Done by Variable Force

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

- Area under the force and displacement curve gives work done.

RELATION BETWEEN MOMENTUM AND KINETIC ENERGY

$K = \dfrac{p^2}{2m}$ and $P = \sqrt{2mK}$; P = linear momentum

Potential Energy

$$\int_{U_1}^{U_2} dU = -\int_{5}^{I_2} \vec{F} \cdot d\vec{r}$$

i.e. $U_f - U_i = -\int_r \vec{F} \cdot d\vec{r} = -\mathrm{W}_{\text{Conservative}}$

Conservative Force

$$\vec{F} = -\frac{dU}{dr}\hat{r}, \quad \vec{F} = -\frac{\partial U}{\partial x}\hat{i} - \frac{\partial U}{\partial y}\hat{j} - \frac{\partial U}{\partial z}\hat{k}$$

EQUILIBRIUM CONDITIONS

- Stable Equilibrium

$$F(r) = -\frac{\partial U}{\partial r} = 0; \text{ and } \frac{\partial F}{\partial r} < 0; \text{ and } \frac{\partial^2 U}{\partial r^2} > 0$$

- Unstable Equilibrium

$$F(r) = -\frac{\partial U}{\partial r} = 0; \text{ therefore } \frac{\partial F}{\partial r} > 0; \text{ and } \frac{\partial^2 U}{\partial^2} < 0$$

- Neutral Equilibrium

$$F(r) = -\frac{\partial U}{\partial r} = 0; \text{ therefore } \frac{\partial F}{\partial r} = 0; \text{ and } \frac{\partial^2 U}{\partial r^2} = 0$$

WORK-ENERGY THEOREM

$$W_{\text{All}} = \Delta K$$

$$\Rightarrow W_{\text{C}} + W_{\text{NC}} + W_{\text{Ext}} + W_{\text{Pseudo}} = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

Law of Conservation of Mechanical Energy

If the net external force acting on a system is zero, then the mechanical energy is conserved.

$$K_f + U_f = K_i + U_i$$

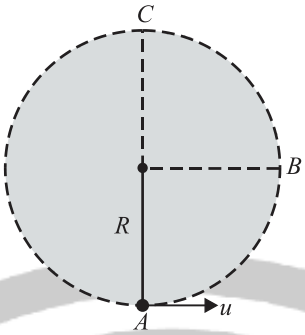
POWER

The average power delivered by an agent is given by

$$P_{\text{avg}} = \frac{W}{t}$$

$$P = \frac{d\vec{F}\cdot\vec{S}}{dt} = \vec{F}\cdot\frac{d\vec{S}}{dt} = \vec{F}\cdot\vec{v}$$

Circular Motion in Vertical Plane



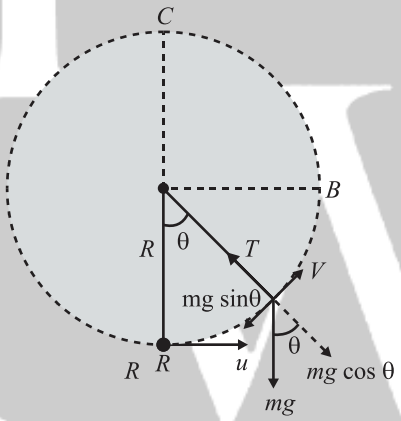
A. Condition to complete vertical circle $u \geq \sqrt{5gR}$

If $u = \sqrt{5gR}$ then Tension at C is equal to 0 and tension at A is equal to 6 mg.

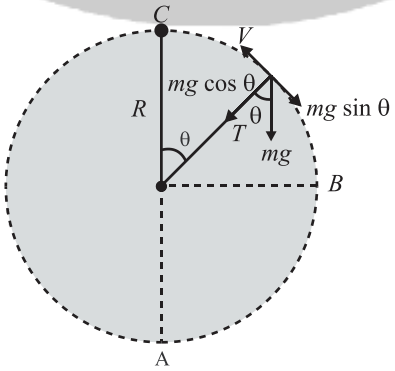
Velocity at $\underline{B}$: $v_B = \sqrt{3gR}$

Velocity at C : $v_C = \sqrt{gR}$

From A to B : $T = mg\cos\theta + \frac{mv^2}{R}$



From B to C : $T = \frac{mv^2}{R} - mg\cos\theta$



B. Condition for pendulum motion (oscillating condition)

$u \leq \sqrt{2gR}$ (in between A to B)

Velocity can be zero but T can never be zero between A and B.

Because T is given by $T = mg\cos\theta + \frac{mv^2}{R}$

Collisions

(a) Collision is the interaction between two (or) more particles where exchange of momentum takes place.

(b) In case of collisions as the impulsive force acting during collision is internal, the total momentum of system always remains conserved.

(c) If the velocities of the colliding particles are along the same line before and after the collision then the collision is said to be one dimensional collision.

(d) In a collision, if the motion of colliding particles before and after the collision are not along the initial line of motion, then the collision is said to be oblique collision.

(e) In an oblique elastic collision, if $m_1 = m_2$ and m_2 is initially at rest, then after the collision the two masses will move in directions inclined at 90° to each other.

Coefficient of Restitution

(a) $e = \frac{\text{relative velocity of separation}}{\text{relative velocity of approach}}$

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

(b) The value of coefficient of restitution (e) is independent of masses and velocities of the colliding bodies. It depends on their materials.

(c) For a perfectly elastic collision, $e = 1$

For a perfectly inelastic collision, $e = 0$

For other collisions, e lies between 0 and 1

(d) If a body falls from a height 'h' and strikes the level ground with velocity V in time seconds and rebounds with velocity V_1 upto height h_1 in time t_1 seconds. The coefficient of restitution is given by

$e = \frac{V_1}{V}$ (or) $e = \sqrt{\frac{H_1}{H}}$ (or) $e = \frac{t_1}{t}$

For a perfectly elastic collision, $H_1 = H$

For a perfectly inelastic collision, $H_2 = 0$

For other collision, $H_1 < H$

(e) A small metal sphere falls freely from a height 'H' upon a fixed horizontal plane. If e is the coefficient of restitution, then

(i) The height to which it rebounds after n collision is $H_n = e^{2n}$ H

(ii) The velocity with which it rebounds from the ground after nth collision is $v_n = e^n v$, where v is the velocity of the sphere just before first collision.

(iii) The total distance travelled by it before it stops rebounding is $d = H\left(\frac{1+e^2}{1-e^2}\right)$

(iv) The total time taken by it to come to rest is $T = \sqrt{\frac{2H}{g}}\left(\frac{1+e}{1-e}\right)$

(f) In one dimensional semi elastic (or) inelastic collisions, linear momentum is conserved but kinetic energy of the system is not conserved.

(g) In above collisions, there is loss of kinetic energy of the system in the form of heat, sound, light etc.

(h) In one dimensional semi elastic collision relative velocity of seperation = e × realtive velocity of approach i.e., $v_2 - v_1 = e(u_1 - u_2)$

Inelastic Collisions

(a) Formulas for final velocities in case of one dimensional semi elastic collision are

$$v_1 = \left(\frac{m_1 - em_2}{m_1 + m_2}\right)u_2 + \left(\frac{1+e}{m_1 + m_2}\right)m_2u_2$$

$$v_2 = \left(\frac{m_2 - em_1}{m_1 + m_2}\right)u_2 + \left(\frac{1+e}{m_1 + m_2}\right)m_1u_1$$

(b) Loss in Kinetic energy of the system in one dimensional semi elastic collision is $\Delta E_k = \frac{1}{2}\left[\frac{m_1m_2}{m_1+m_2}\right]\left[1-e^2\right]\left[u_2-u_2\right]^2$

(c) In one dimensional perfectly inelastic collision the two particles stick together after the collision and move with common velocity.

(d) The formula for common velocity of compound body after perfectly inelastic collision is

(e) The loss of kinetic energy in a perfectly inelastic collision (e = 0) is given by $\Delta E_k = \frac{1}{2}\left[\frac{m_1m_2}{m_1+m_2}\right]\left[u_1-u_2\right]^2$

(f) In a perfectly inelastic collision, the ratio of loss of energy of the system and its initial energy, if u_2 is zero, is given by $\frac{\Delta E_k}{E_1} = \frac{m_2}{m_1+m_2}$

(g) In a perfectly inelastic collision, the ratio of final energy to initial energy, of the system, if u2 is zero, is given by $\frac{E_k}{E_1} = \frac{m_1}{m_1+m_2} \Rightarrow E_k < E_1$



PW Web/App - https://smart.link/7wwosivoicgd4
Library- https://smart.link/sdfez8ejd80if