NDA-CDS 1 2025

GS

LIVE

PHYSICS

WORK ENERGY POWER

CLASS 1

NAVJYOTI SIR

SSBCrack EXAMS

SSBCrack EXAMS

17 Dec 2024 Live Classes Schedule

8:00AM	17 DEC 2024 DAILY CURRENT AFFAIRS	RUBY MA'AM
9:00AM	17 DEC 2024 DAILY DEFENCE UPDATES	DIVYANSHU SIR

SSB INTERVIEW LIVE CLASSES

9:30AM	OVERVIEW OF GPE & PRACTICE	ANURADHA MA'AM

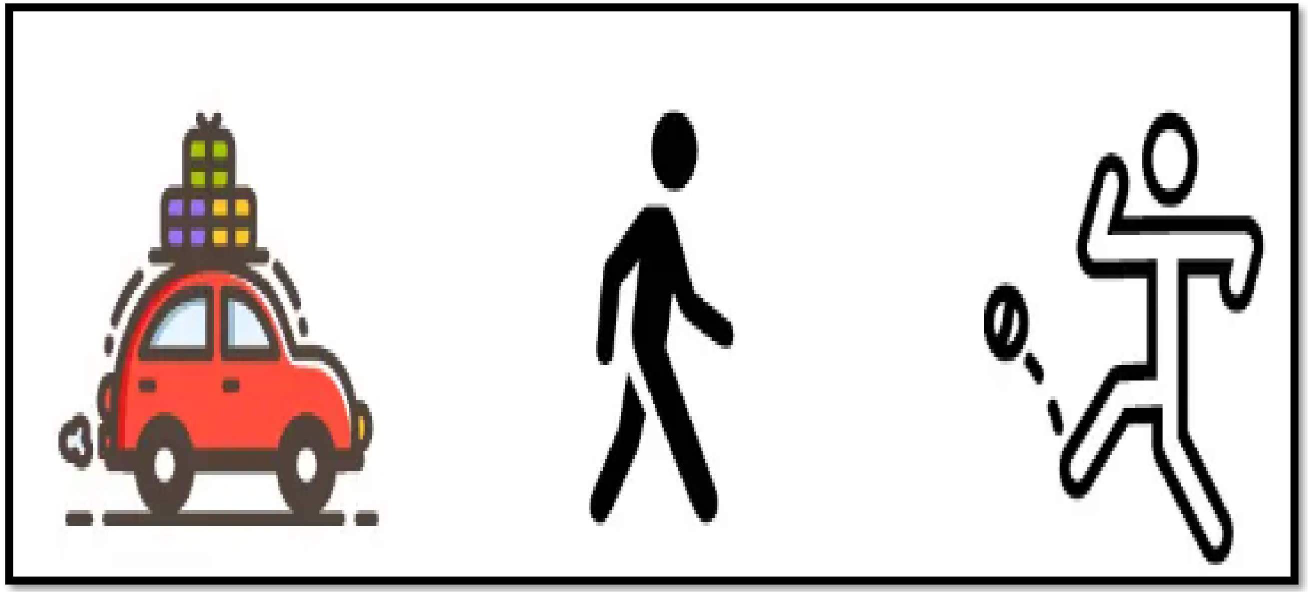
NDA 1 2025 LIVE CLASSES

1:00PM	PHYSICS - WORK ENERGY POWER - CLASS 1	NAVJYOTI SIR
4:30PM	ENGLISH - REPORTED SPEECH - CLASS 1	ANURADHA MA'AM
5:30PM	MATHS - INTEGRATION - CLASS 1	NAVJYOTI SIR

CDS 1 2025 LIVE CLASSES

1:00PM	PHYSICS - WORK ENERGY POWER - CLASS 1	NAVJYOTI SIR
4:30PM	ENGLISH - REPORTED SPEECH - CLASS 1	ANURADHA MA'AM
7:00PM	MATHS - STATISTICS - CLASS 3	NAVJYOTI SIR

WORK , ENERGY AND POWER



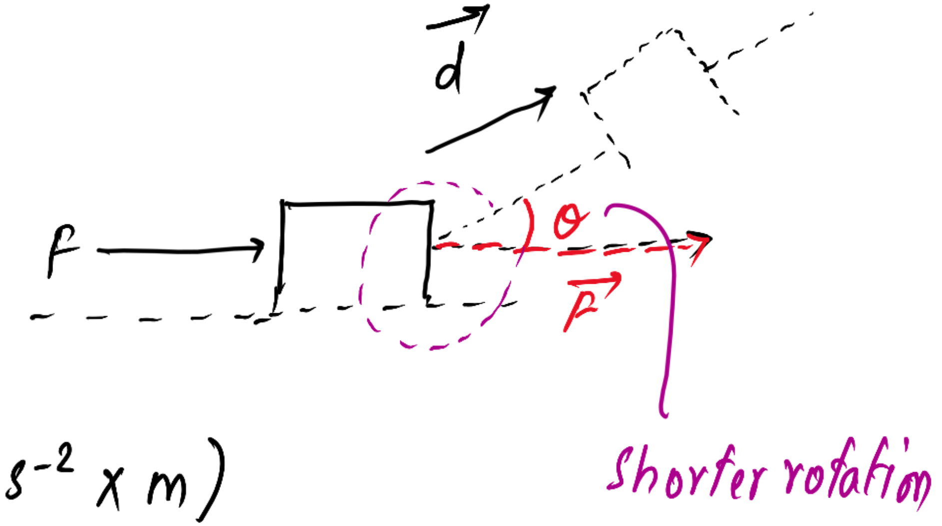
SSBCrack EXAMS

WHAT WILL WE STUDY ?

- Concept of Work ✓
- Energy ✓
- Kinetic and Potential Energy
- Conservation of Energy
- Power ✓
- Collisions ✓
- Levers (NDA)

CONCEPT OF WORK

- **Work done by the force is equal to the product of the force and the displacement of the object in the direction of force.**



$$W = \mathbf{F} \cdot \mathbf{s} = Fs \cos \theta$$

- **It is a Scalar Quantity. Its SI unit is Nm or Joules.**

$(kg\ ms^{-2} \times m)$

Work done by a force is zero, if

(a) body is not displaced actually, *i.e.* $\mathbf{s} = 0$. $(J \equiv kg\ m^2 s^{-2})$

(b) body is displaced perpendicular to the direction of force, *i.e.* $\theta = 90°$.

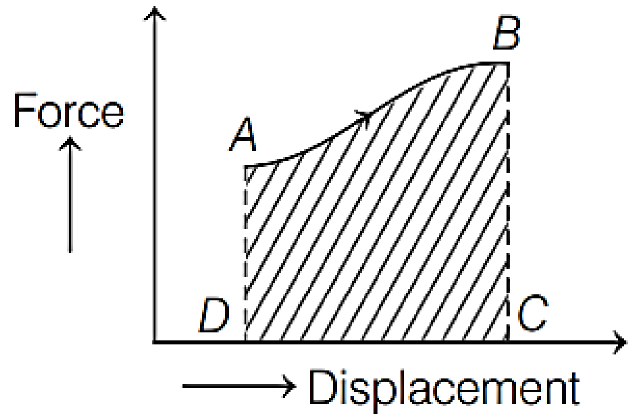
$\theta = 0^\circ$, $W = Fs(\cos 0^\circ) = +Fs$ (Positive work)

$\theta = 180^\circ$, $W = Fs(\cos 180^\circ) = Fs(-1) = -Fs$ (negative work)

$\theta = 90^\circ$, $W = Fs(\cos 90^\circ) = Fs(0) = 0$ Zero work

WORK DONE

- **Work done by a variable force F = Area under Force – Displacement graph**



Work done = Area *ABCDA*

- **Work done in displacing any body under the action of a number of forces is equal to the work done by the resultant force. In equilibrium (static or dynamic), the resultant force is zero, therefore resultant work done is zero.**

WORK DONE

- If work done by a force during a rough trip of a system is zero, then the force is <u>conservative</u> otherwise it is called non-conservative force.
- All the central forces such as Gravitational and Electrostatic Forces are conservative forces.
- Frictional force, viscous force etc are non-conservative forces.

conservative, central } Gravitational Forces, Electrostatic Forces

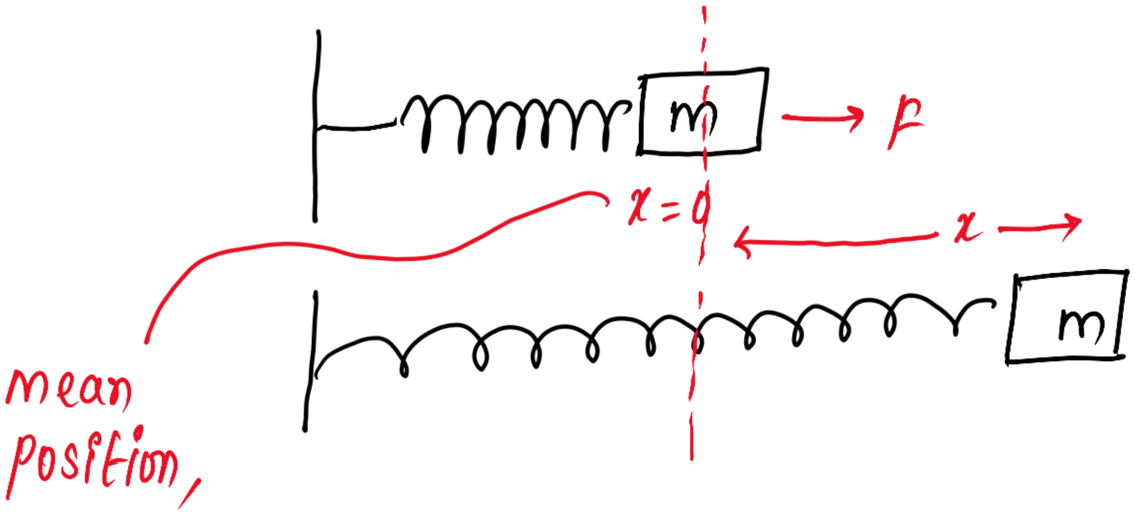
non-conservative } Friction

WORK DONE

- **Work done by the force of gravity on a particle of mass m is given by W = mgh where, g is acceleration due to gravity and h is height through which the particle is displaced.**

$w = Fs = (w)h = mgh$ — weight of particle,

- **Work done in compressing or stretching a spring is given by $W = -\frac{1}{2}kx^2$ where, k is spring constant and x is displacement from mean position.**



ENERGY

- Energy of a body is its capacity of doing work.
- It is a scalar quantity. Its SI unit is Joule.
- There are several types of energies, such as kinetic energy , potential energy, chemical energy, light energy, heat energy, sound energy, nuclear energy and electric energy etc.

KINETIC ENERGY

- **The energy possessed by any object by virtue of its <u>motion.</u>**

$$K = \frac{1}{2} m v^2 = \frac{p^2}{2m}$$

$$2K = mv^2$$
$$m(2K) = m(mv^2)$$
$$2mK = m^2 v^2$$
$$2mK = (mv)^2$$
$$2mK = p^2$$
$$K = p^2/2M$$

where m = mass of the object , v is its velocity and

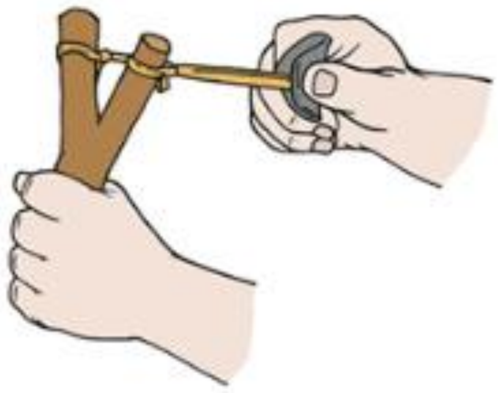
p = mv is momentum.

POTENTIAL ENERGY

- The energy possessed by any object by virtue of its position or configuration.

Roller coaster at its highest point

Apples on a tree



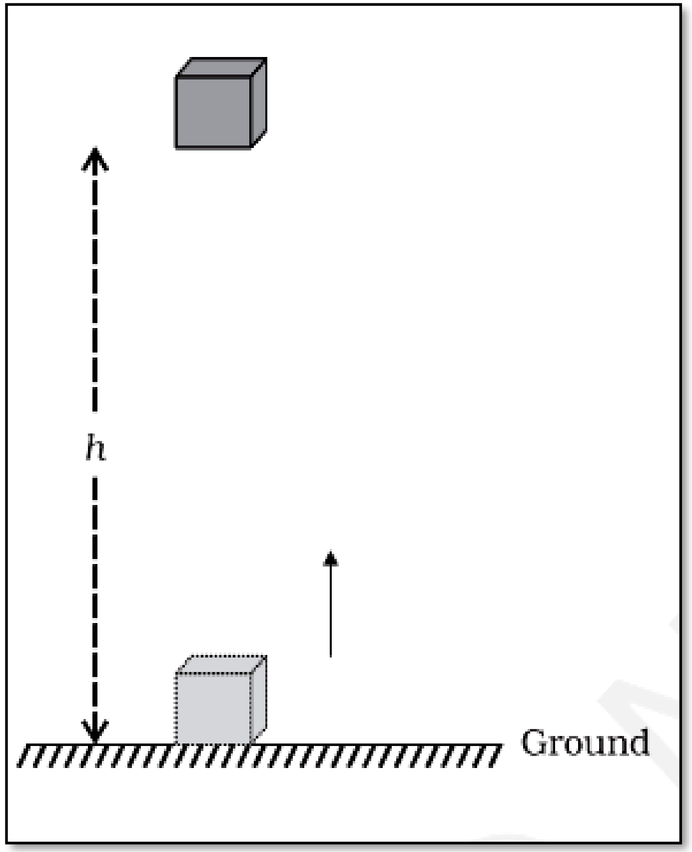
A slingshot being pulled

- Potential energy is defined only for conservative forces.

TYPES OF POTENTIAL ENERGY

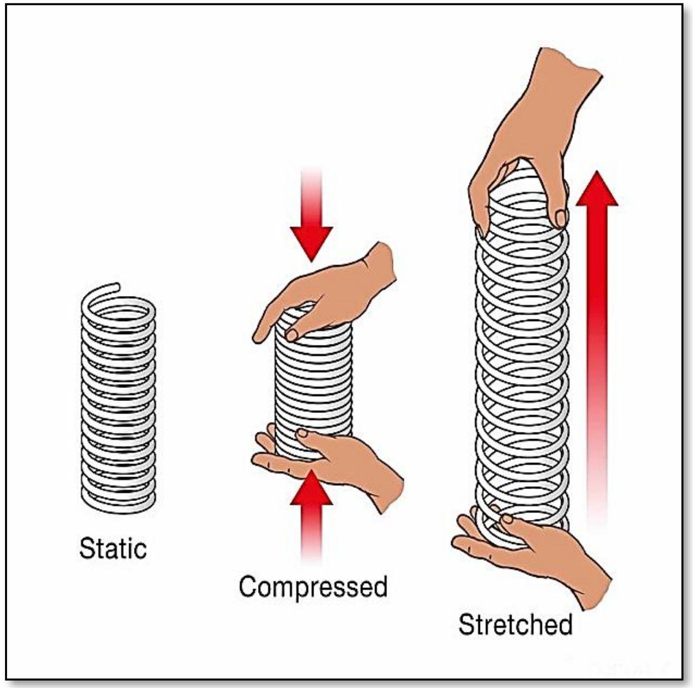
1. Gravitational Potential Energy :

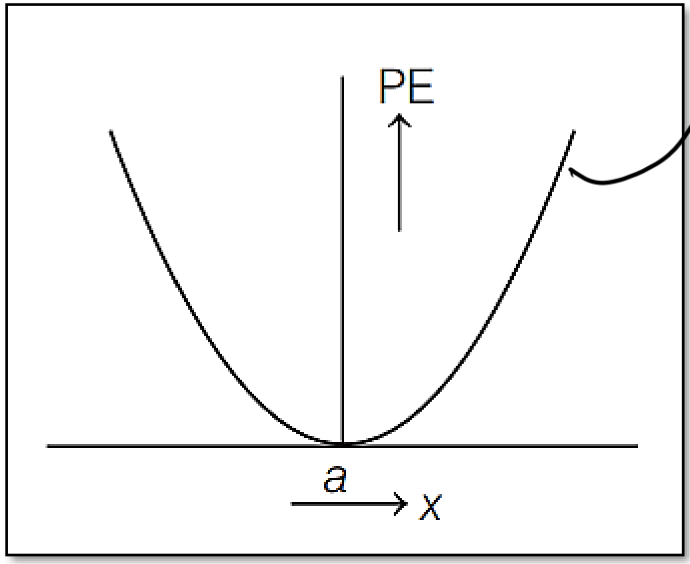
$$\text{work done, } W = \text{force} \times \text{displacement}$$
$$= mg \times h$$
$$= mgh$$



TYPES OF POTENTIAL ENERGY

2. Elastic Potential Energy :





(parabolic)

$PE \propto x^2$

as k is constant.

spring constant,

If a spring of spring constant k is stretched through a distance x,

then elastic potential energy of the spring $= \frac{1}{2}kx^2$

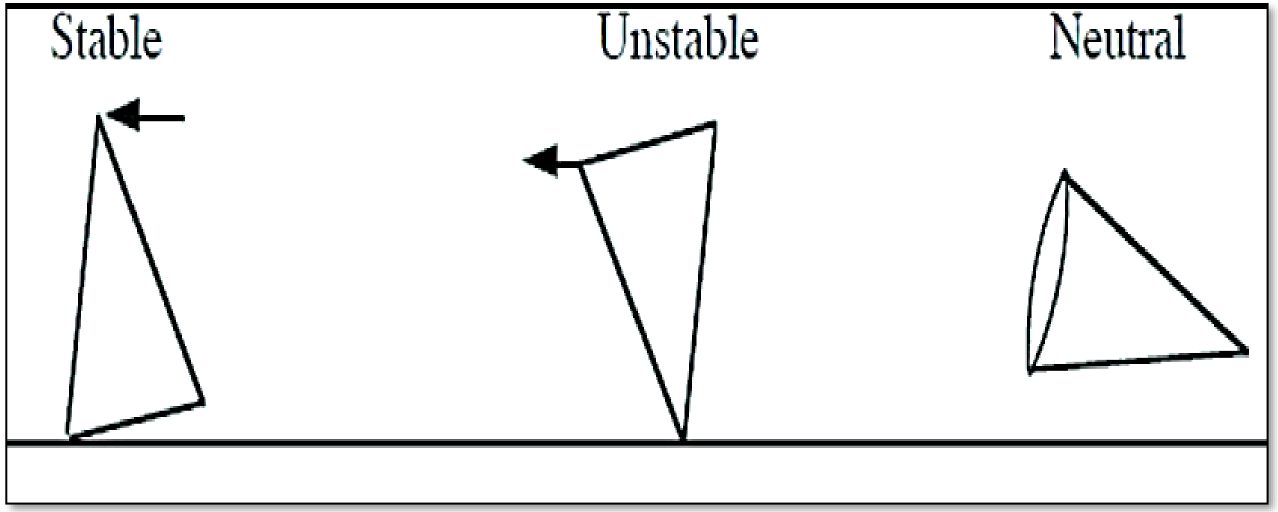
EQUILIBRIUM

- If the forces acting on an object are conservative , and the net external force on the object is zero , the object is said to be in equilibrium.

- Stable Equilibrium : An object is said to be in stable equilibrium, if on slight displacement from equilibrium position, it has the tendency to come back.
- Unstable Equilibrium : An object is said to be in unstable equilibrium, if on slight displacement from equilibrium position, it moves in the direction of displacement.

EQUILIBRIUM

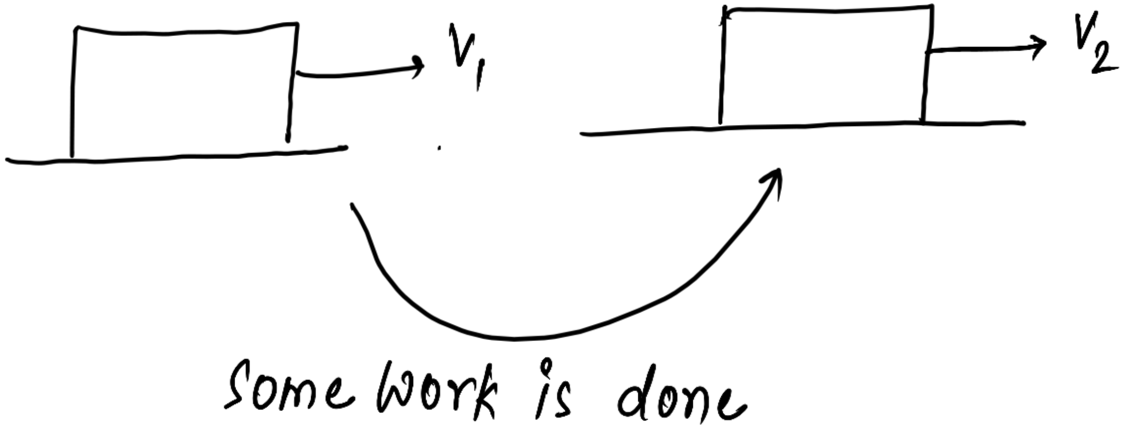
- Neutral Equilibrium : An object is said to be in neutral equilibrium, if on displacement from its equilibrium position, it has neither the tendency to move in direction of displacement nor to come back to equilibrium position.



WORK – ENERGY THEOREM

- **Work done by a force in displacing a body is equal to change in its kinetic energy.**

$$W = \int_{v_1}^{v_2} F \cdot ds = \frac{1}{2} m v_2^2 - \frac{1}{2} m v_1^2 = K_f - K_i = \Delta \mathrm{KE}$$

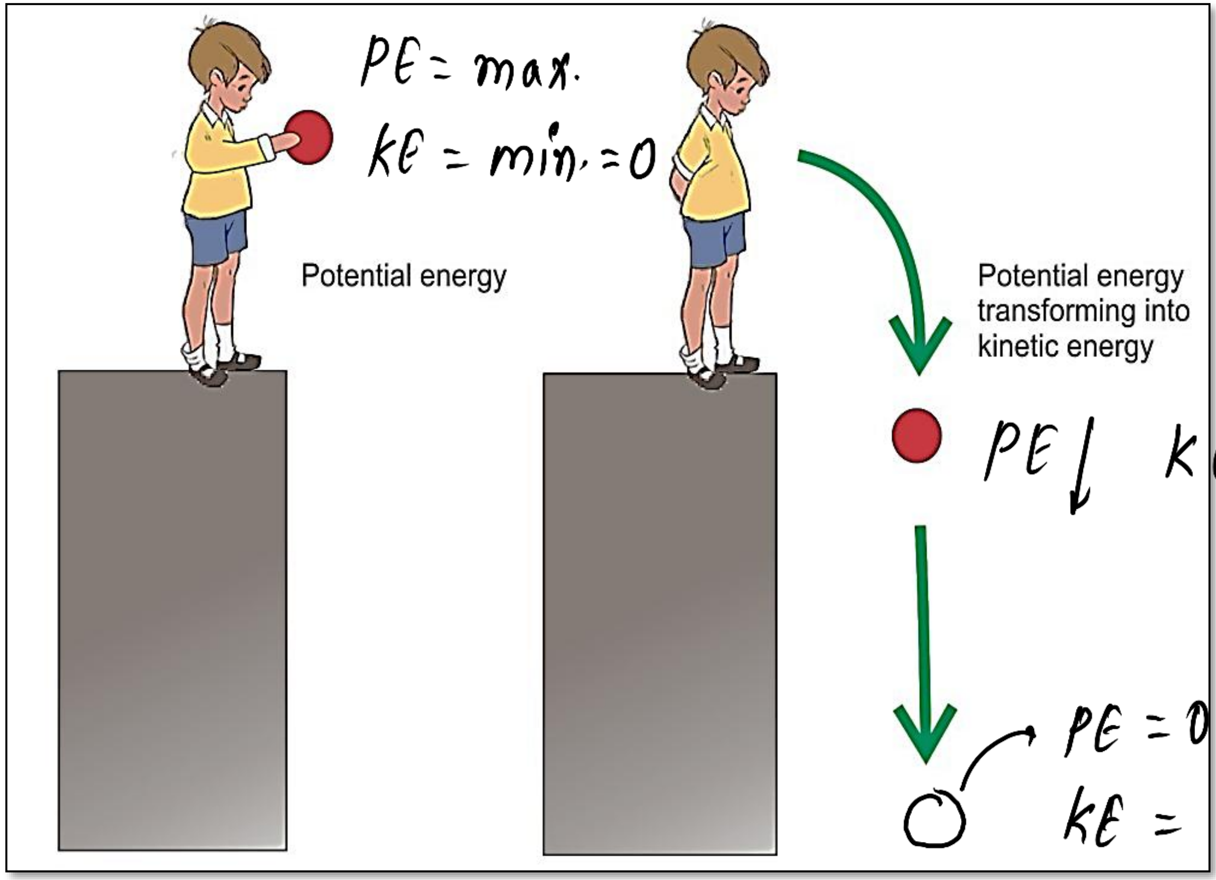


OTHER FORMS OF ENERGY

1. **Heat Energy :** A body possess heat energy due to the disorderly motion of its molecules.
2. **Chemical Energy :** Chemical energy is stored in the chemical bonds of atoms and molecules.
3. **Electrical Energy :** It is the energy which is associated with the flow of electric current.
4. **Nuclear Energy :** It is the binding energy of the nucleus of an atom.

PRINCIPLE OF CONSERVATION OF ENERGY

- **Energy can neither be created nor be destroyed, it can only be transferred from one form to another form.**
- **For conservative forces, the total <u>mechanical energy (sum of kinetic and potential energies)</u> of any object remains constant.**



$PE = mgh$

$h \downarrow \Rightarrow PE \downarrow$

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

$v \downarrow \Rightarrow KE \downarrow$ $\quad v \uparrow \Rightarrow KE \uparrow$

POWER

- The rate at which work is done by a body or energy is transferred.

$$\text{Power} = \text{Rate of doing work} = \frac{\text{Work done}}{\text{Time taken}}$$

J

s

- Power is a scalar quantity. Its SI unit is watt.
- Its other units are kilowatt and horse power.
- 1 kilowatt = 1000 watt
- 1 horse power = 746 watt

$\text{watt} \equiv Js^{-1}$

$kg\,m^2 s^{-2} \times s^{-1}$

$\text{watt} = kg\,m^2 s^{-3}$

If under a constant force **F** a body is displaced through a distance **s** in time t, then the power $P = \frac{W}{t} = \frac{\mathbf{F}\cdot\mathbf{s}}{t}$

But $\frac{\mathbf{s}}{t} = \mathbf{v}$, uniform velocity with which body is displaced.

$$\therefore \quad P = \mathbf{F}\cdot\mathbf{v} = F\,v\cos\theta$$

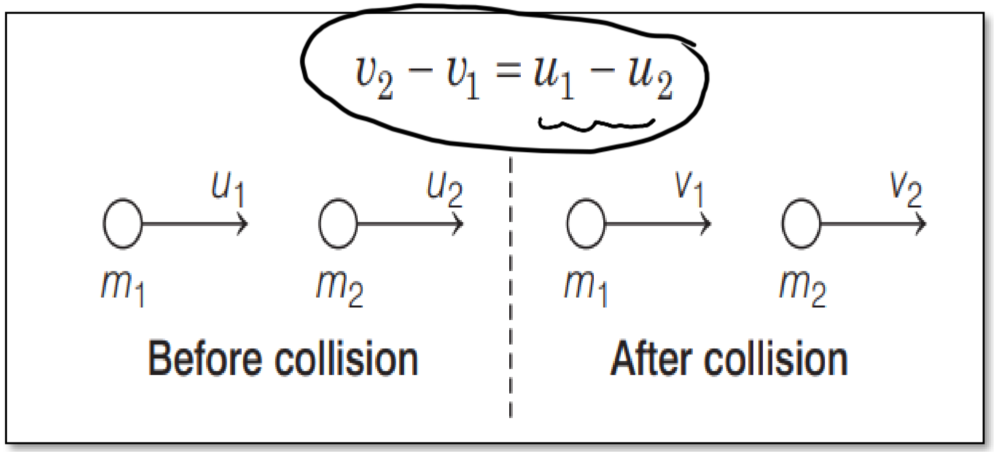
where, θ is the smaller angle between **F** and **v**.

COLLISION

- Collision between two or more particles is the interaction for a short interval of time in which they apply relatively strong forces on each other.
- There are two types of collision : Elastic and Inelastic

ELASTIC COLLISION

- The collision in which both the momentum and the kinetic energy of the system remains conserved.
- In an elastic collision, all the involved forces are conservative forces and total energy remains conserved.



conservation of momentum,

$$m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$$

conservation of kinetic energy,

$$\frac{1}{2} m_1 u_1^2 + \frac{1}{2} m_2 u_2^2 = \frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2$$

INELASTIC COLLISION

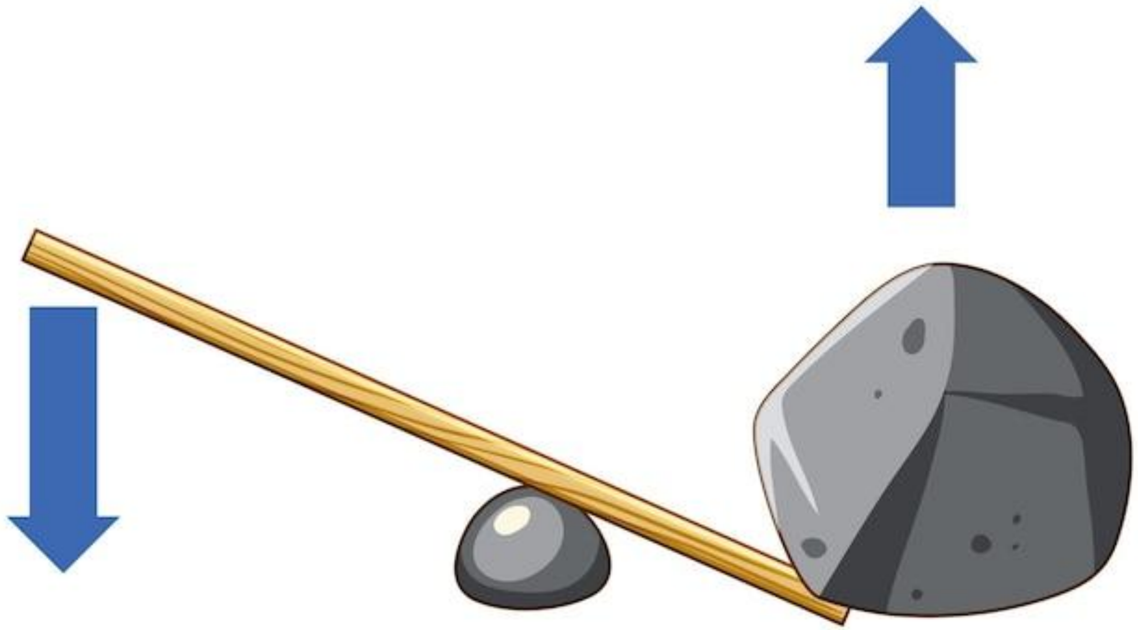
- The collision in which only the momentum remains conserved but kinetic energy does not remain conserved are called inelastic collisions.
- In an inelastic collision, some or all the involved forces are non-conservative forces.
- Total energy of the system remains conserved.

Coefficient of Restitution or Resilience (e)

- The ratio of relative velocity of separation after collision to the relative velocity of approach before collision.
- It is represented by e and it depends upon the material of the colliding bodies.
- For a perfectly elastic collision, $e = 1$
- For a perfectly inelastic collision (If after the collision two bodies stick to each other), $e = 0$
- For all other collisions, $0 < e < 1$.

LEVERS

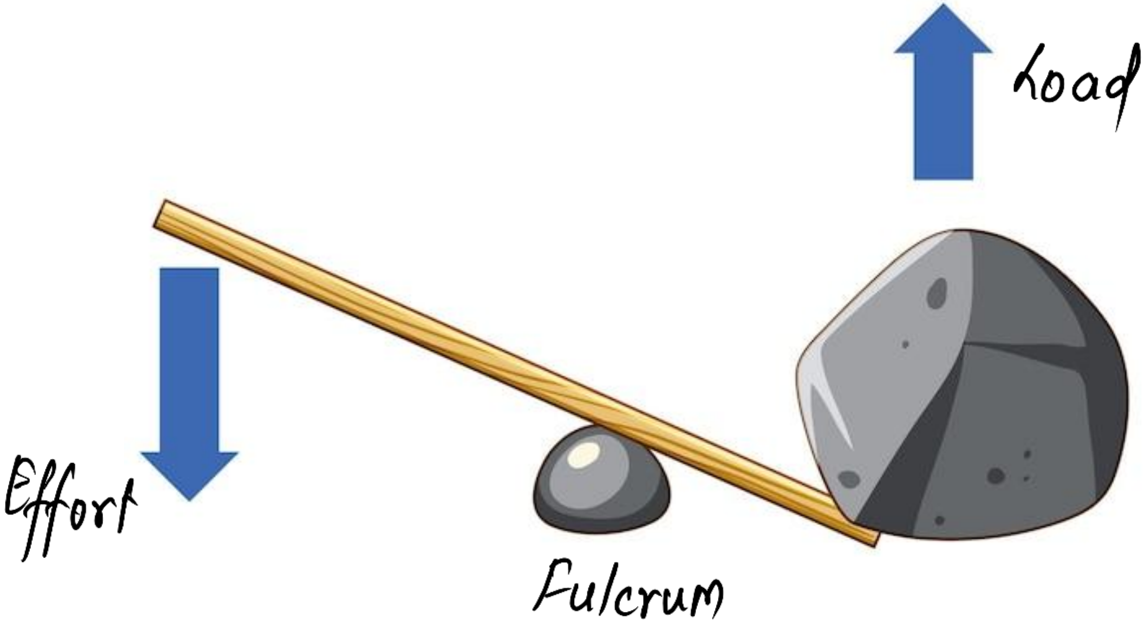
- Levers are the most basic machines which are used to do some work with minimal effort. A lever amplifies an input force to provide a greater output force, which is said to provide leverage.



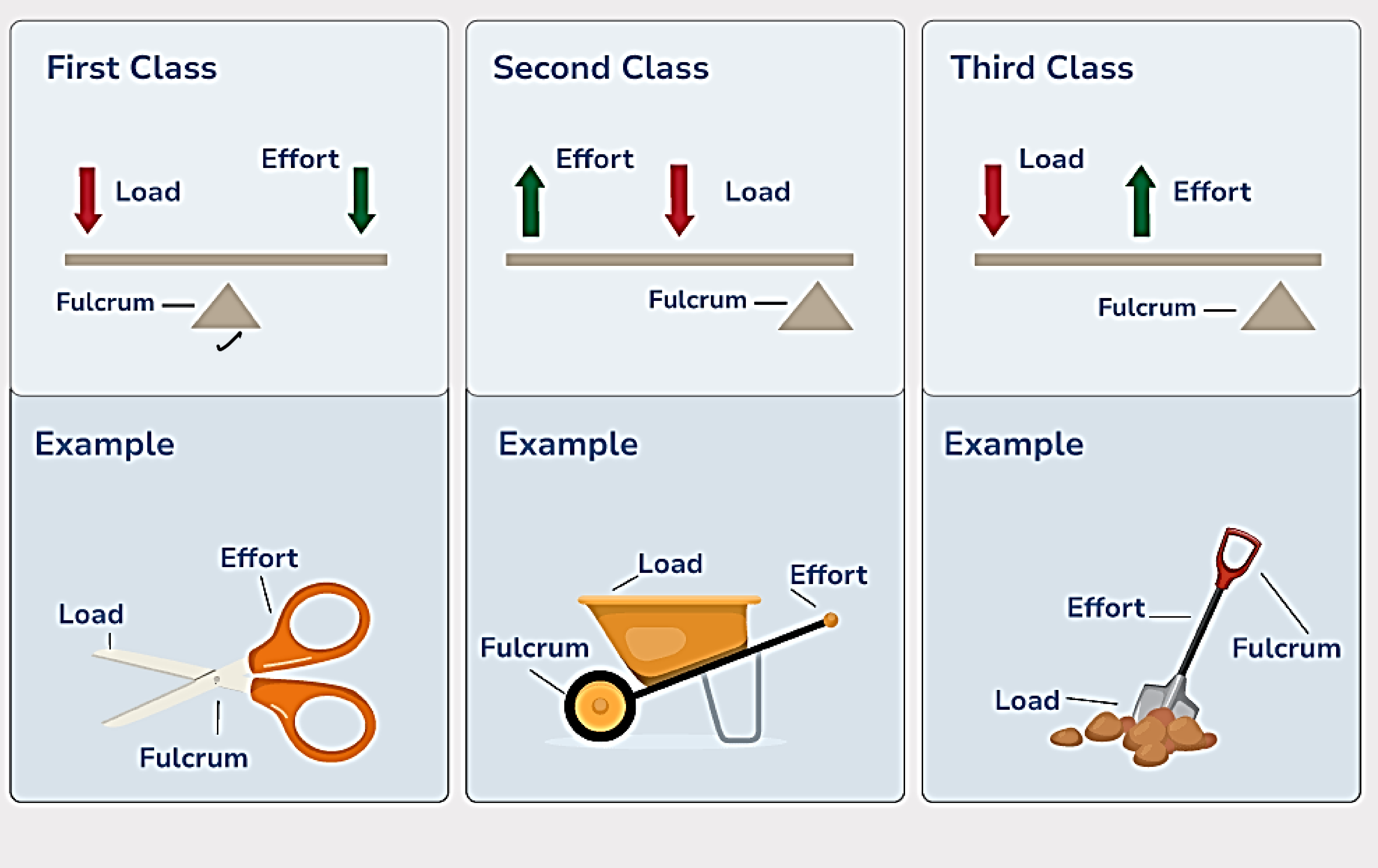
LEVERS

- **Load (L): Load is a resistive force that has to be overpowered by simple machines. The S.I. unit of Load is Newton (N).**
- **Effort (E): Effort is the external force used to pull off a load on a simple machine. The S.I. unit of effort is Newton (N).**
- **Pivot: It is the support given at a point.**

Or Fulcrum

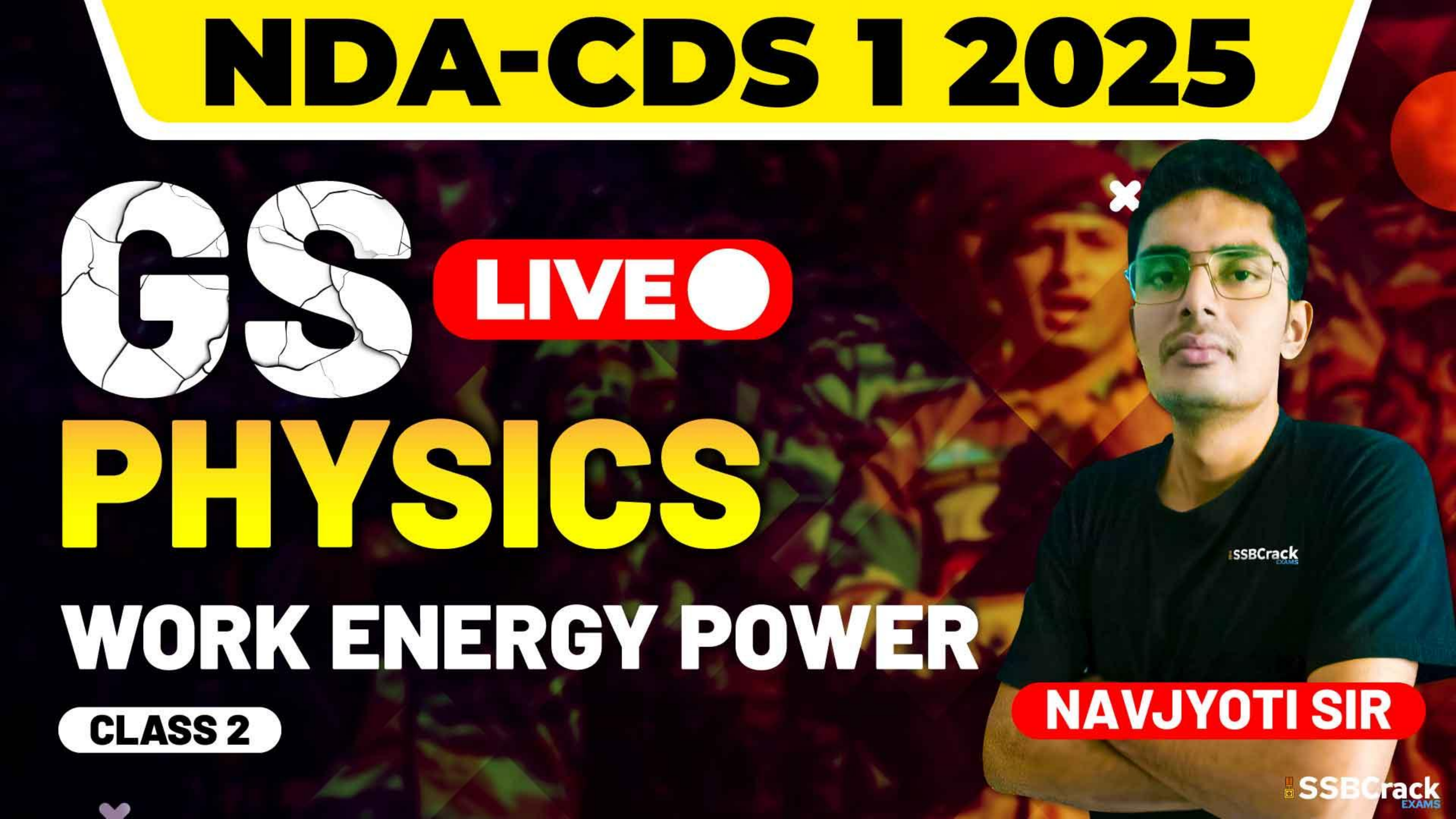


TYPES OF LEVERS



SUMMARY

- Concept of Work
- Energy
- Kinetic and Potential Energy
- Work Energy Theorem
- Conservation of Energy
- Power
- Collisions
- Levers


NDA-CDS 1 2025
GS
LIVE
PHYSICS
WORK ENERGY POWER
CLASS 2
NAVJYOTI SIR
SSBCrack
SSBCrack EXAMS