Class Nine Academic Program-2020

PHYSICS

Lecture : P-09

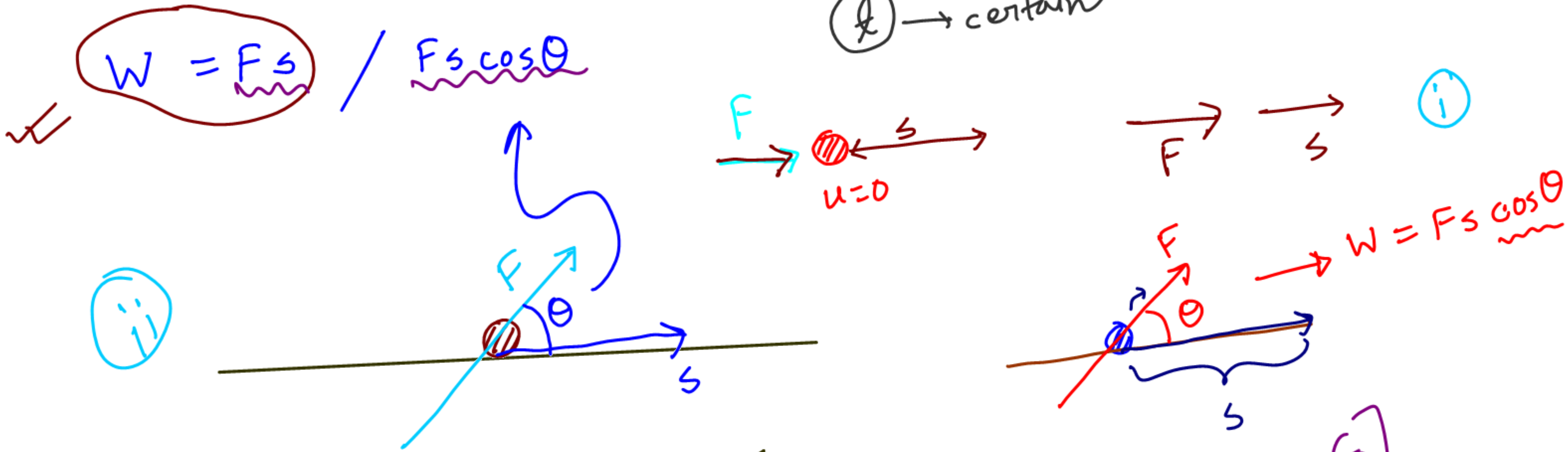
Chapter 4 : Work, Energy & Power

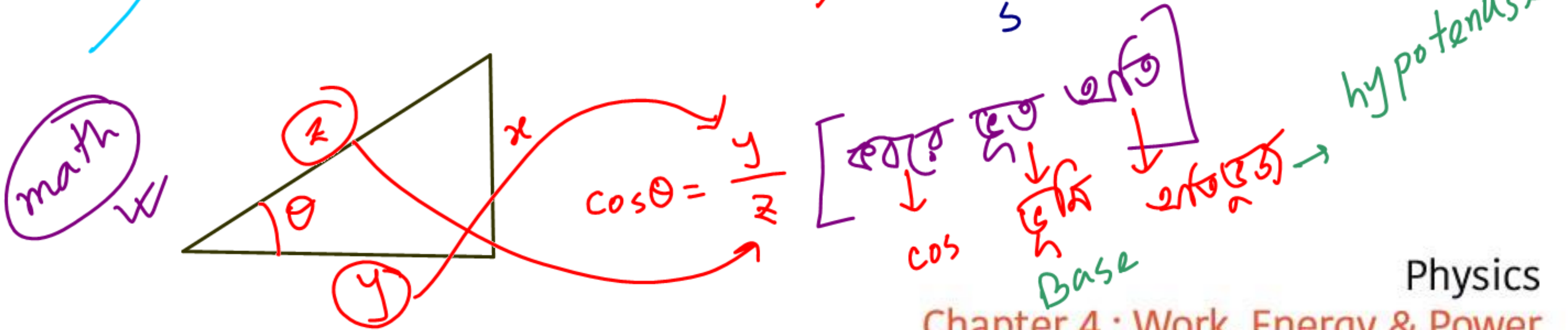
উদ্ভাস
একাডেমিক এন্ড এডমিশন কেয়ার

Work

- **Definition:**

The product of applied force on an object and the displacement or the component of displacement towards the force during the application of force is known as Work.





Work

Work = Scalar;

W = $\vec{F}.\vec{s}$. → Dot Product = Fs$\cos\theta$

Unit: J/Nm

Dimension:

→J → Nm

→Kgm$s^{-2}m$

→Kgm^2s^{-2}

So,

[W] = [M L^2T^{-2}]

Problem

- 10N force is applied on an object for 5s and therefore displacement occurs 5m towards force. But, due to inertia of motion, the object moves 3m more. Work done =?

W = Fs

= (10 × 5)

= 50 J

a) 50 J

b) 80 J

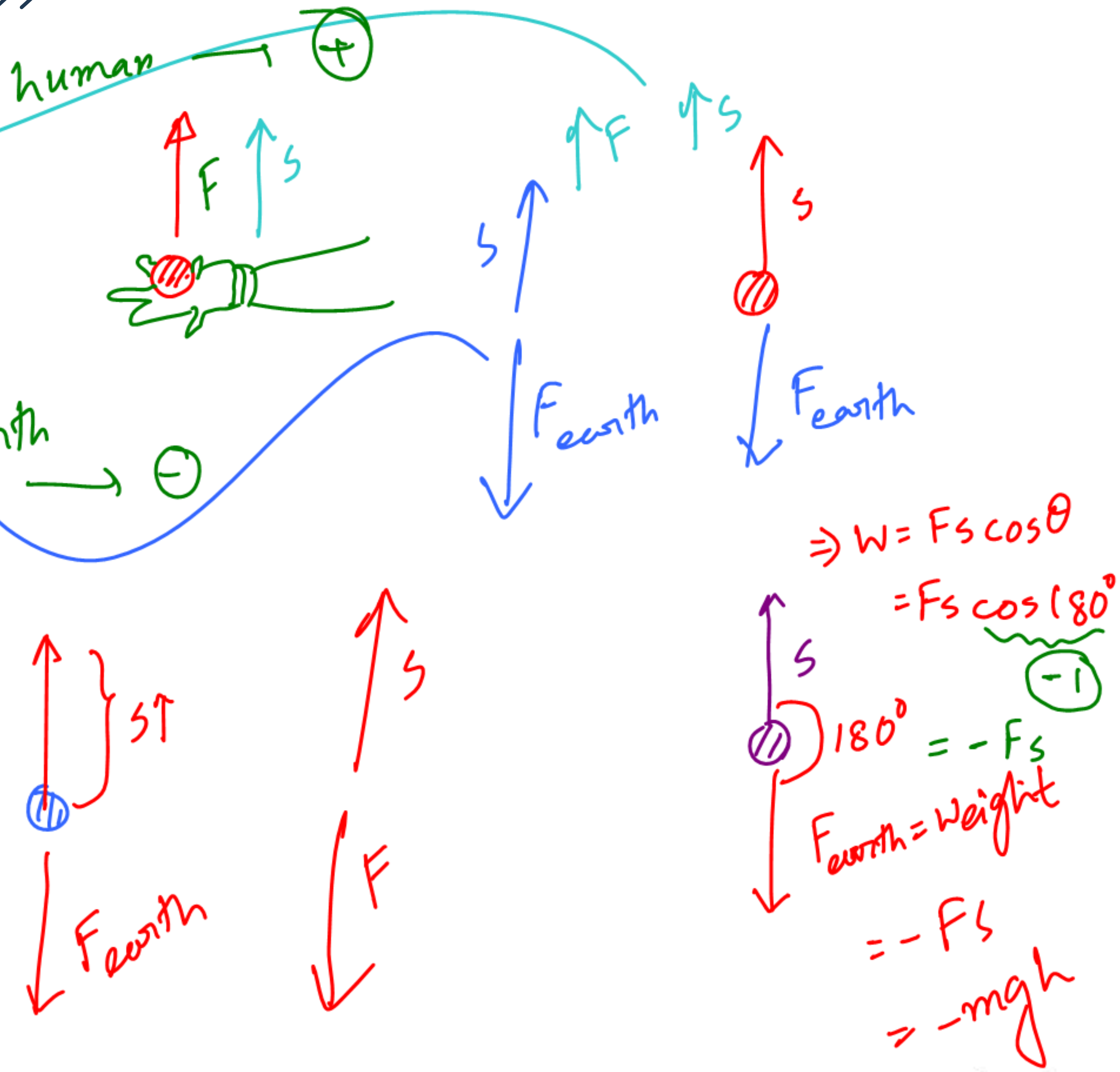
Classification of Work

- 1. Positive Work:

→ Lift up a Pen. Your work…….

- 2. Negative Work:

→ Lift up a Pen. Earth's Work…….

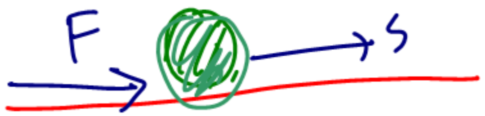


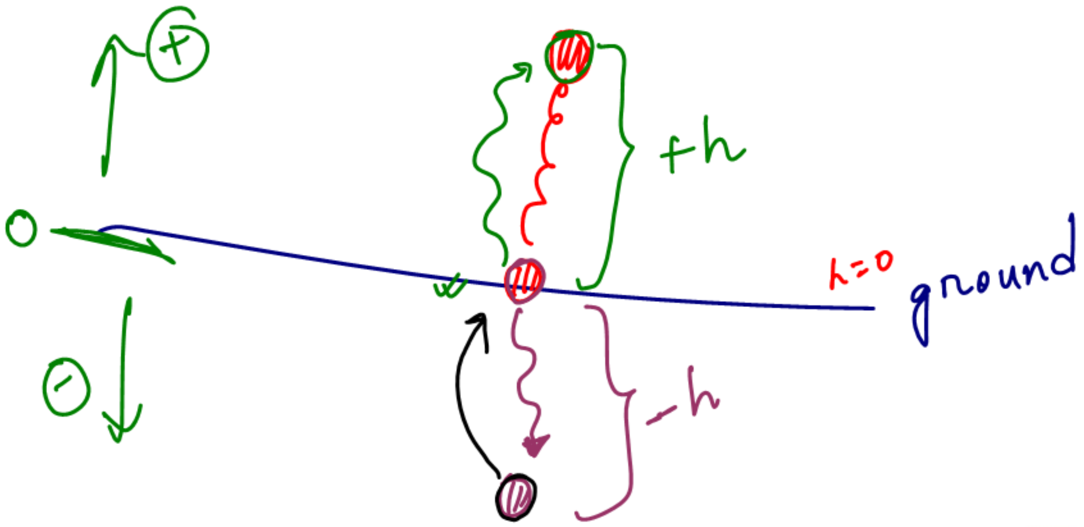
Energy

(Ability to do work is called Energy.)

Energy = Work (same)

- During Positive Work→ Giving Energy to the Object
- During Negative Work→ Taking away Energy from the Object….





Energy

Work Dore = Energy Created/ Released.

Unit: J/Nm

Dimension:

$\rightarrow J \rightarrow Nm$

$\rightarrow Kgms^{-2}m$

$\rightarrow kgm^2s^{-2}$

So,

[E] = $[ML^2T^{-2}]$

Different Forms of Energy

- **Mechanical Energy :**

(The energy that obtained due to Position, Shape & Motion of object is known as Mechanical Energy.)

Two Types:

→ Kinetic Energy

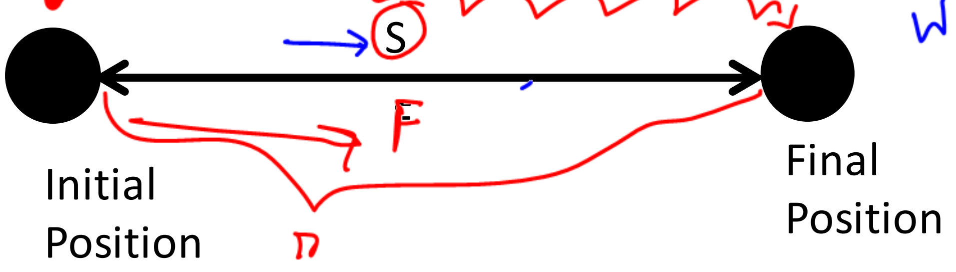
→ Potential Energy

Kinetic Energy

**The Energy due to Motion is called Kinetic Energy.

We Know,

Energy released / created = Work Done



So,

$$E_k = W = Fs$$

$$E_k = mas \ldots\ldots (i)$$

But,

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

$$\Longrightarrow v^2 = 2as \; [\because u = 0]$$

$$\Longrightarrow as = \frac{v^2}{2}$$

$$\therefore (i) \Longrightarrow$$

$$E_k = m \times \frac{v^2}{2} = \frac{1}{2} m v^2$$

$E_k = P^2 / 2m$?

Poll -01

- **If the momentum of an object becomes 2 times, then the kinetic energy will be:**
  - A) 4 times
  - B) 2 times
  - C) 1.41 times
  - D) 8 times

$E_K = \frac{p^2}{2m}$

$E_K \propto p^2$

$p \to 2$ times

$2^2 = 4$

Work-Energy Theorem

We Know,

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

Multiplying both sides by $\frac{1}{2}m \Longrightarrow$

$$\Longrightarrow \frac{1}{2}mv^2 = \frac{1}{2}mu^2 + \frac{1}{2}m \times 2as$$

$$\Longrightarrow \frac{1}{2}mv^2 - \frac{1}{2}mu^2 = mas = Fs$$

$$\Longrightarrow \boldsymbol{\frac{1}{2}mv^2 - \frac{1}{2}mu^2 = W}$$

Work –Energy Theorem.

Problem

- A force of 10N is applied on a stationary object of mass 10kg for 10s.

a) Calculate the kinetic energy after 10s.

b) Calculate the kinetic energy after 20s.

c) Calculate the kinetic energy if Force is applied for total 20s.

a) After 10s,

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

$\rightarrow v = u + at$

$= 0 + at$

$\Rightarrow v = at$

$\Rightarrow v = a \times 10 = 10a$

$= 10 \times 1$

$= 10 m/s$

$a = \frac{F}{m}$ [$F = ma$]

$= \frac{10}{10} = 1 ms^{-2}$

$E_K = \frac{1}{2} \times m \times v^2$

$= \frac{1}{2} \times 10 \times (10)^2$

$= \frac{1}{2} \times 10 \times 100$

$= 500 J$. Ans

b) 500 J

10s time → Force applied

Solution

c) $a = 1\ ms^{-2}$

$t = 20\ sec$

$\Rightarrow v = u + at$

$\Rightarrow v = 0 + 1 \times 20$

$\Rightarrow v = 20\ m/s$

$\Rightarrow v =$

$\Rightarrow E_k = \frac{1}{2} mv^2$

$= \frac{1}{2} \times 10 \times (20)^2\ J$

$= \frac{1}{2} \times 10 \times 400\ J$

$= 2000\ J$. Ans.

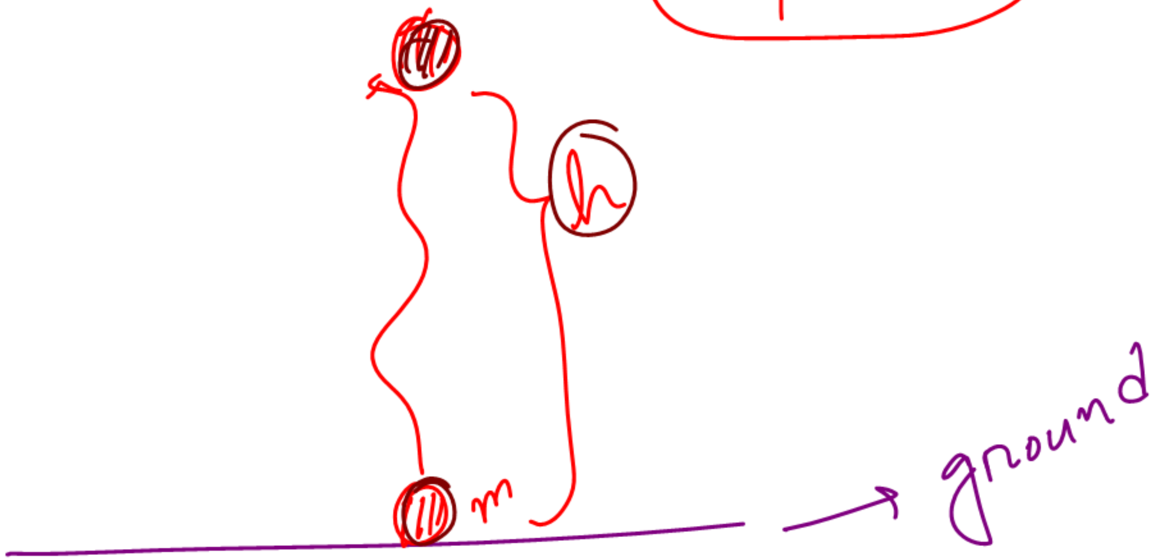
Potential Energy

**The energy that happens due to change of position & shape of an object,…… is called potential energy.

Suppose, an object mass of ‘m’ is placed on a building of ‘h’ height. Then, due to change of position, the potential energy, $E_p = mgh$.....

$E_p = W$
$= Fs$
$= mgh$

$E_p = mgh$



$E_p = mgh$

Quiz

Can Kinetic Energy be negative? → $E_k = \frac{1}{2}mv^2$ $E_p = mgh$ ↓ Fround ground

positive

No

$E_k = \frac{1}{2}mv^2$ ✓

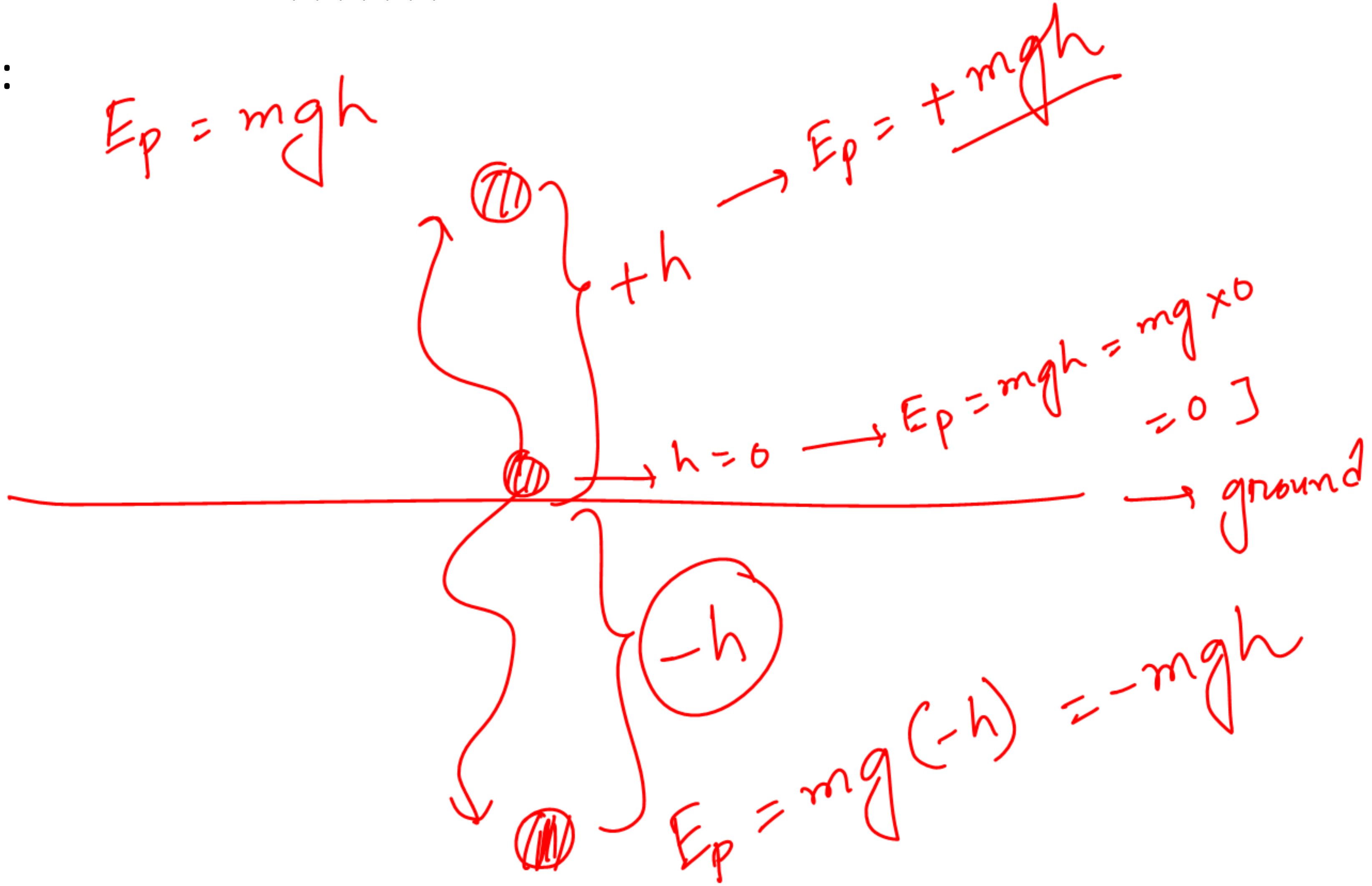
$(-5)^2 = 25$

mass

Neg

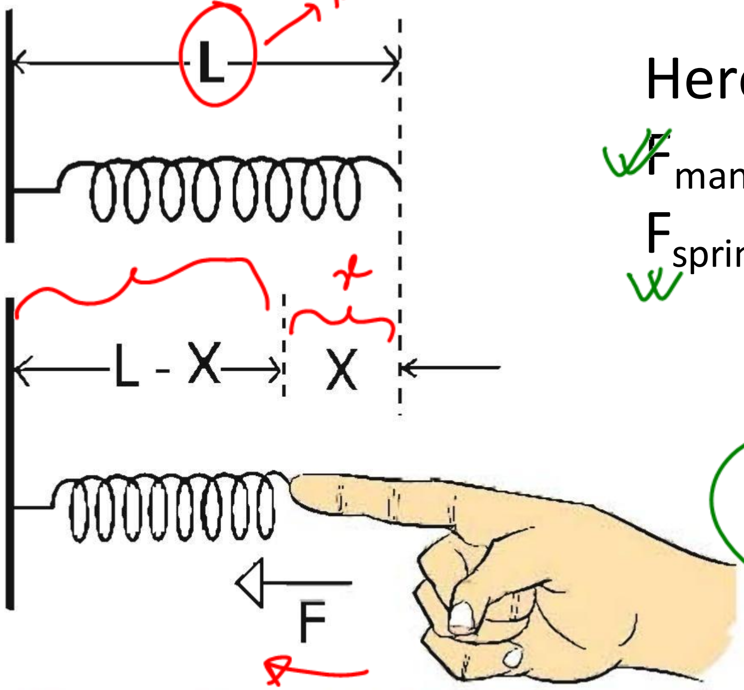
Poll - 02

- Potential energy can be:
  - A) Positive
  - B) Negative
  - C) 0
  - D) All



Spring

- For a spring, Potential Energy, **E_p= ½ Kx^2 ; K = Spring Constant , x = Expansion /Compression.**



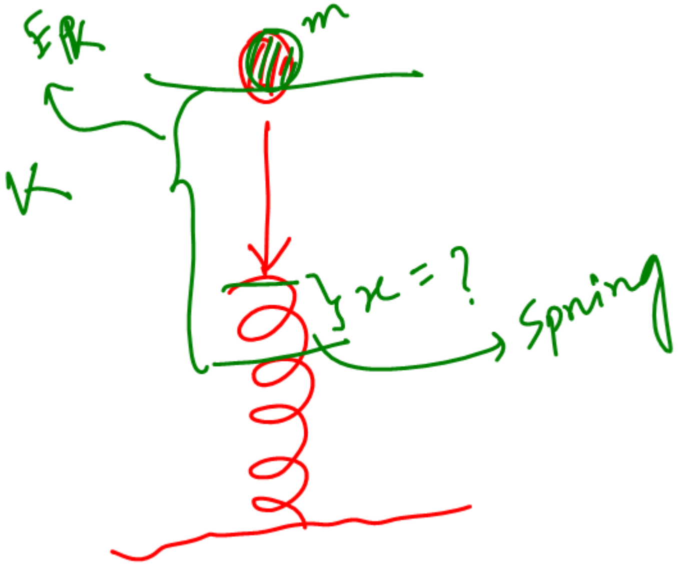
Here,

F_{man} = Human

F_{spring} = Spring

Law of Conservation of Energy

Q. A body of mass 10kg fell on a spring with a velocity of 10 m/s. If Spring Constant =100000 J/m^2 or N/m, what was the compression of the spring?



$$E_K = E_p$$

$$\Rightarrow \frac{1}{2} m v^2 = \frac{1}{2} k x^2$$

$$m v^2 = k x^2$$

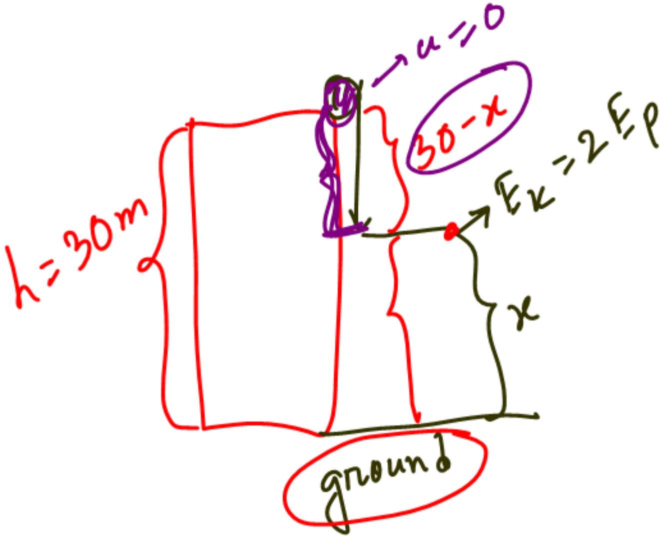
$$\Rightarrow x^2 = \frac{m v^2}{k}$$

$$\Rightarrow x = \sqrt{\frac{m v^2}{k}}$$

$\rightarrow x = 0.1m$

Problem

Q. At which height does Kinetic Energy become 2 times of Potential Energy if the object falling from 30m height?



Let, x m height from ground.

$E_p = mgh'$ (ground)

$= mg \times x$

$\Rightarrow E_p = mgx$

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

$= \frac{1}{2}m(u^2 + 2gh_1)$

$= \frac{1}{2}m \times 2gh_1$

$= \frac{1}{2} \times m \times 2g(30-x)$

$= \frac{1}{2}m\,2g(30-x)$

$E_k = mg30 - mgx$

Solution

According to Ques ⇒

$$E_k = 2E_p$$

$$\Rightarrow mg30 - mgx = 2(mgx)$$

$$\Rightarrow mg30 - mgx = 2mgx$$

$$\Rightarrow mg30 = 3mgx$$

$$\Rightarrow x = \frac{30}{3} = 10m. \text{ (From ground)}$$

Shortcut♥♥

Here, n means how many times will be Kinetic Energy of Potential Energy

Shortcut ⇒ $x = \frac{h}{n+1}$

না বুঝে মুখস্থ করার অভ্যাস
প্রতিভাকে ধ্বংস করে।