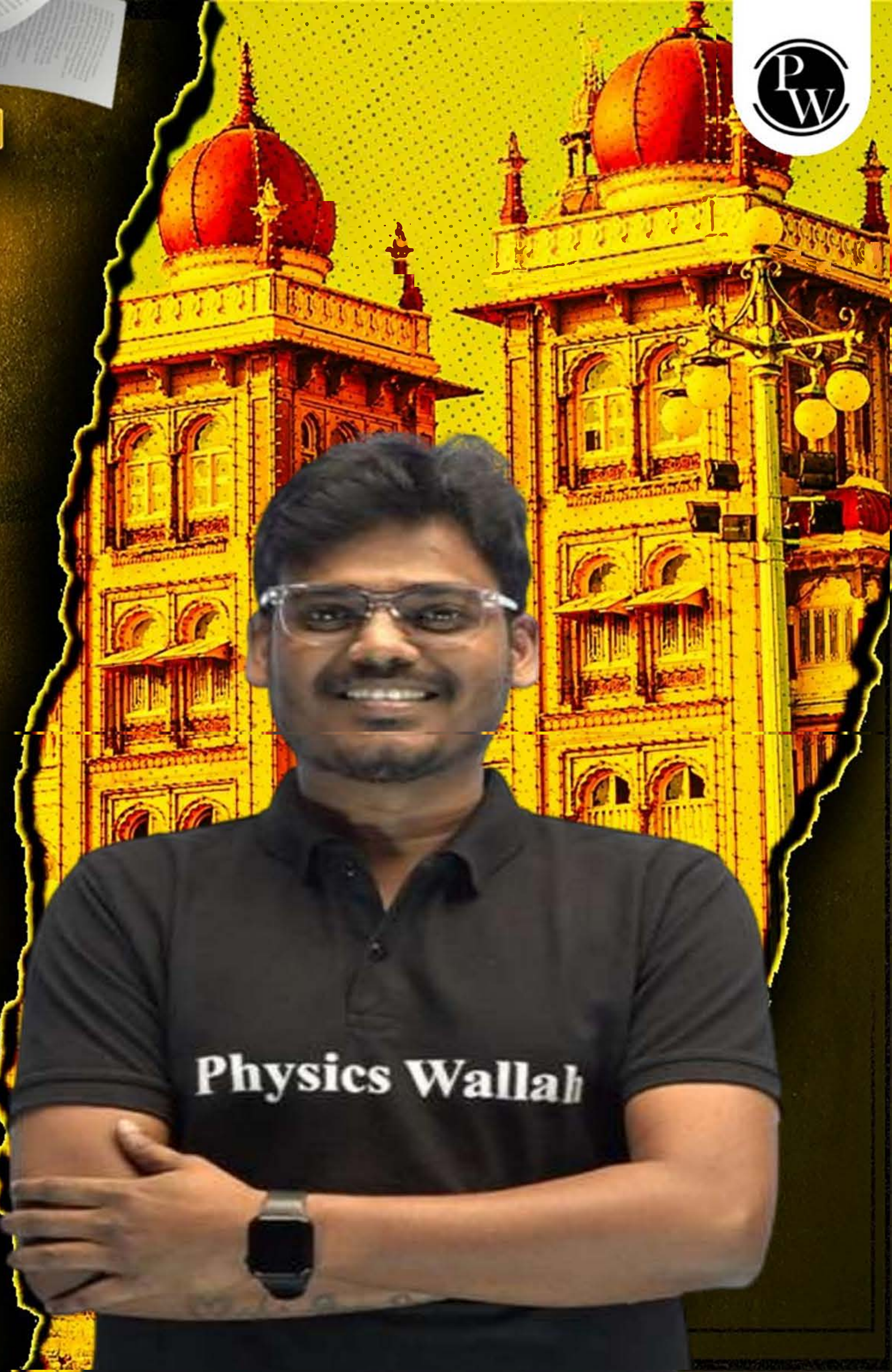
ULTIMATE KCET

CRASH COURSE 2026

Physics | Lecture :- 01

Work Energy and Power

By: AK Sir



Recap *of previous lecture*

1. INERTIA AND LAWS OF MOTION
2. LINEAR MOMENTUM AND IMPULSE
3. MOTION OF CONNECTED BODIES
4. FRICTIONS AND TYPES OF FRICTION

Topics

to be covered

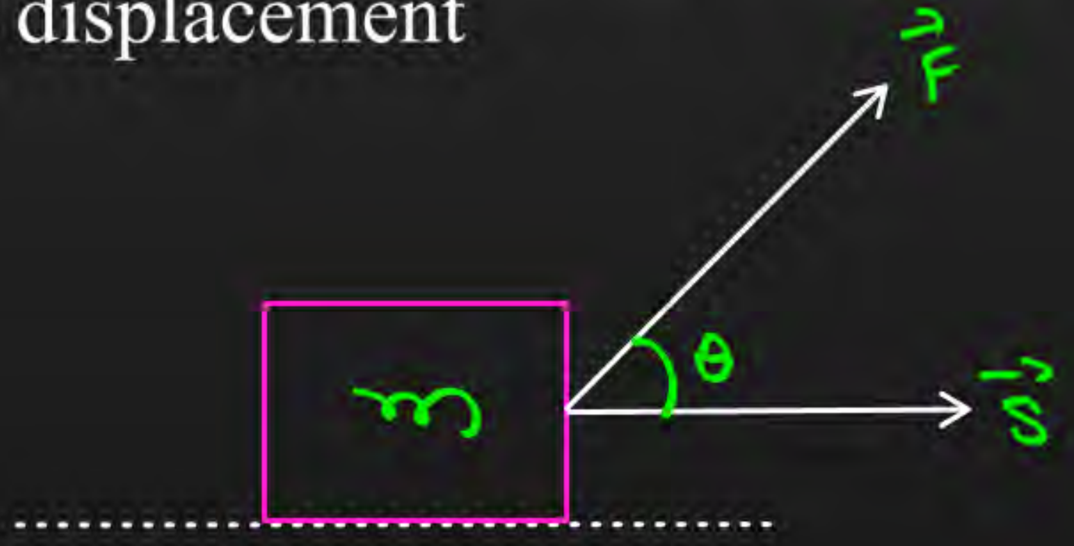
1. WORK AND ITS TYPES
2. WORK-ENERGY THEOREM
3. KINETIC ENERGY AND LINEAR MOMENTUM
4. POWER AND MCQ’s+PYQ’s

WORK

The work done by the force is defined to be the product of component of the force in the direction of the displacement and the magnitude of this displacement

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

$$W = F \cdot S \cdot \cos\theta$$



$1J = 1Nm$

$= [M^1L^1T^{-2}][L^1]$

$= [M^1L^2T^{-2}]$

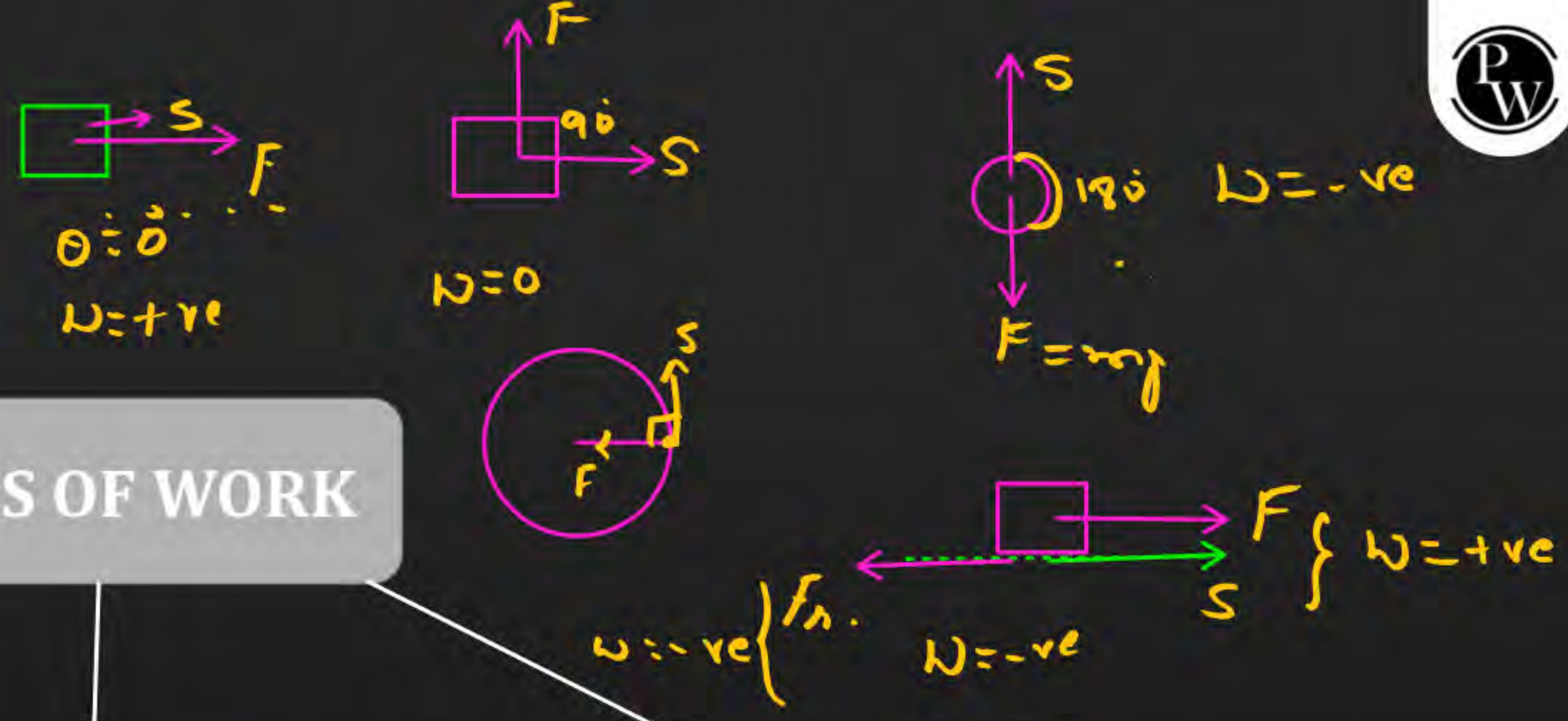
SI Unit – Nm, J

CGS Unit – erg

Quantity – Scalar

Dimensional formula - $[M^1L^2T^{-2}]$

WORK



TYPES OF WORK

$W = FS\cos\theta$

- **POSITIVE WORK**: $\theta < 90°$, $W = +FS$
- **ZERO WORK**: $\vec{S} = 0$, $\theta = 90°$, $W = 0$
- **NEGATIVE WORK**: $\theta > 90°$, $W = -FS$

Work

- Work done by constant force
- Work done in vector form
- Work done by variable force
- Work done by area under curve
- Work done by common force in mechanics
  - Gravitational force
  - Tension force
  - Normal reaction
  - Spring force
  - Frictional force

WORK DONE BY A CONSTANT FORCE

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

SCALAR FORM $W = F.S.\cos\theta$

QUESTION

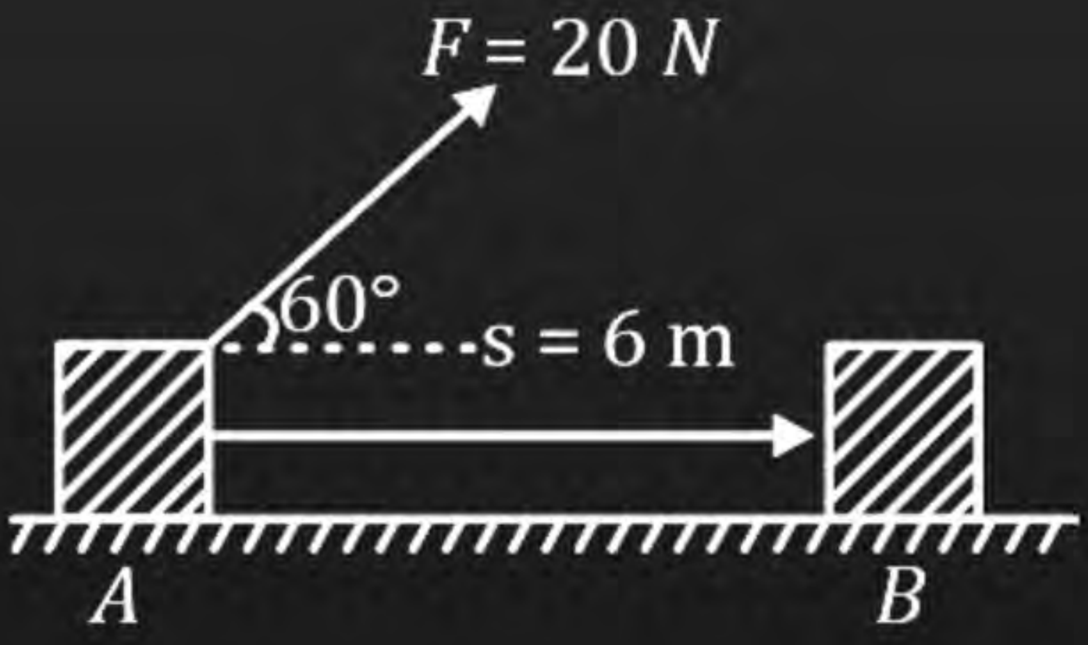
Find Workdone by force F from A to B?

$W = F \cdot S \cdot \cos\theta$

$W = 20 \times 6 \times \cos 60^\circ$

$W = 20 \times 6 \times \frac{1}{2} = 10 \times 6$

$\boxed{W = 60\,J}$



QUESTION

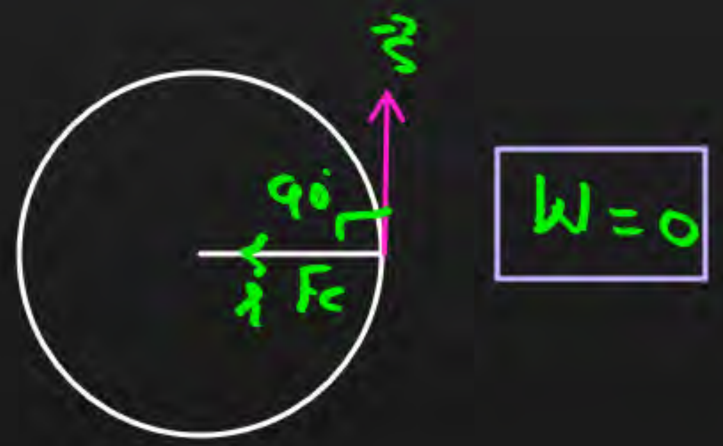
A body of mass is moving in a circle of radius r with a constant speed v. The force on the body is $\frac{mv^2}{r}$ and is r directed towards the centre. What is the work done by this force in moving the body over half the circumference of the circle?

(A) $\frac{mv^2}{\pi r^2}$

(B) Zero

(C) $\frac{mv^2}{r^2}$

(D) $\frac{\pi r^2}{mv^2}$



QUESTION

A ball of mass m moves with speed v and strikes a wall having infinite mass and it returns with same speed then the work done by the ball on the wall is

A. Zero

$\vec{s} = 0$, $W = 0$

B. mv J

C. m/v J

D. v/m J

QUESTION

A force of 10N displaces an object by 10m. If work done is 50 J then direction of force make an angle with direction of displacement:

(A) 120°

(B) 90°

(C) 60°

(D) None of these

$W = FS\cos\theta$

$50 = 10 \times 10 \times \cos\theta$

$\cos\theta = \frac{5}{10} = 0.5 = \frac{1}{2}$

$\cos\theta = \cos 60^\circ$

$\theta = 60^\circ$

QUESTION

A uniform force of $(3\hat{\imath} + \hat{\jmath})\,N$ acts on a particle of mass 2 kg. Hence, the particle is displaced from position $(2\hat{\imath} + \hat{k})\,m$ to position $(4\hat{\imath} + 3\hat{\jmath} - \hat{k})\,m$. The work done by the force on the particle is

A. 9 J

B. 6 J

C. 13 J

D. 15 J

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

$W = (3\hat{i} + \hat{j})(2\hat{i} + 3\hat{j} - 2\hat{k})$

$W = 6(1) + 3(1) + 0(1)$

$W = 6 + 3 + 0$

$W = 9\,J$

$\vec{S} = \vec{r}_2 - \vec{r}_1$

$\vec{S} = (4\hat{i} + 3\hat{j} - \hat{k}) - (2\hat{i} + \hat{k})$

$\vec{S} = 4\hat{i} + 3\hat{j} - \hat{k} - 2\hat{i} - \hat{k}$

$\vec{S} = 2\hat{i} + 3\hat{j} - 2\hat{k}$

QUESTION

$\vec{r}_1$ $\vec{r}_2$ $\vec{F}$

A particle moves from a point $(-2\hat{i} + 5\hat{j})$ to $(4\hat{j} + 3\hat{k})$ when a force of $(4\hat{i} + 3\hat{j})N$ is applied. How much work has been done by the force?

A) $8\,J$

B) $11\,J$

C) $5\,J$

D) $2\,J$

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

$W = (4\hat{i} + 3\hat{j} + 0\hat{k}) \cdot (2\hat{i} - \hat{j} + 3\hat{k})$

$W = 8(1) - 3(1) + 0(1)$

$W = 8 - 3 + 0$

$W = 5J$

$\vec{S} = \vec{r}_2 - \vec{r}_1$

$\vec{S} = (0\hat{i} + 4\hat{j} + 3\hat{k}) - (-2\hat{i} + 5\hat{j} + 0\hat{k})$

$\vec{S} = 0\hat{i} + 4\hat{j} + 3\hat{k} + 2\hat{i} - 5\hat{j} - 0\hat{k}$

$\vec{S} = 2\hat{i} - \hat{j} + 3\hat{k}$

QUESTION

A force $\vec{F} = (2\hat{\imath} + 3\hat{\jmath} + 2\hat{k})N$ acts on a particle of mass m. The particle starts from points A (1, 2,1) and moves to point B (3, 4, 3). What is the total work done by the force on the particle?

A) $14\ J$

B) $12\ J$

C) $16\ J$

D) $10\ J$

$\vec{r}_1 = 1\hat{i} + 2\hat{j} + 1\hat{k}$

$\vec{r}_2 = 3\hat{i} + 4\hat{j} + 3\hat{k}$

$\vec{S} = \vec{r}_2 - \vec{r}_1$

$\vec{S} = 3\hat{i} + 4\hat{j} + 3\hat{k} - \hat{i} - 2\hat{j} - \hat{k}$

$\vec{S} = 2\hat{i} + 2\hat{j} + 2\hat{k}$

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

$W = (2\hat{i} + 3\hat{j} + 2\hat{k})(2\hat{i} + 2\hat{j} + 2\hat{k})$

$W = 4 + 6 + 4$

$W = 14J$

QUESTION

A body of mass m is displaced from point $A(3, 1, 2)$ to point $B(4, 3, 3)$ under the effect of a force $\vec{F} = (3\hat{i} + 2\hat{j} + 4\hat{k})\, N$, calculate W.D. by the force. [H.W]

A) $57\, J$

B) $11\, J$

C) 0

D) $22\, J$

WORK DONE BY A VARAIBLE FORCE

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

$$W = \int_{S_1}^{S_2} \vec{F} \cdot d\vec{s} = \int_{S_1}^{S_2} F \cdot ds \cdot \cos\theta$$

VECTOR FORM

$$W = \int_{x_1}^{x_2} \vec{F} \cdot d\vec{x} \quad , \quad W = \int_{x_1}^{x_2} \vec{F} \cdot d\vec{x}$$

SCALAR FORM

$$W = \int_{x_1}^{x_2} F \cdot dx \cdot \cos\theta \quad , \quad W = \int_{x_1}^{x_2} F \cdot dx \cdot \cos\theta$$

AREA UNDER CURVE F-x GRAPH

W = Area under F-x Graph.

QUESTION

A position dependent force $F = (7 - 2x + 3x^2)\,N$ acts on a small body of mass 2 kg and displaces it from $x = 0$ to $x = 5$ m. work done in joule is

(A) 35

(B) 70

(C) 135

(D) 270

$\theta = 0$

$W = \int_{x_1}^{x_2} \vec{F} \cdot d\vec{x} = \int_{x_1}^{x_2} F \cdot dx$

$W = \int_0^5 (7 - 2x + 3x^2)\,dx$

$W = \left[7x - \frac{2x^2}{2} + \frac{3x^3}{3}\right]_0^5$

$W = [(7 \times 5) - (5)^2 + (5)^3]$

$W = 35 - 25 + 125$

$W = 10 + 125 = 135\ J$

QUESTION

A force $F = 20 + 10y$ acts on a particle in y-direction, where F is in Newton and y in meter. Work done by this force move the particle from $y = 0$ to $y = 1$ m is

(A) $5\ J$

(B) $25\ J$

(C) $20\ J$

(D) $30\ J$

$\theta = 0^\circ$

$$W = \int_0^1 (20 + 10y) \cdot dy$$

$$W = \left[20y + 10\frac{y^2}{2}\right]_0^1$$

$$W = \left[20(1) + 5(1)^2\right]$$

$$W = 20 + 5$$

$$W = 25\ J$$

QUESTION

A block of mass m is placed at origin (0, 0) and a force, $F = (2x + 2)\,N$, is applied on the block so that it reaches at some other point, P (5, 0). Find the work done by the force.

(A) 35 J

(B) 30 J

(C) 15 J

(D) 21 J

$\theta = 0^\circ$

$W = \int_0^5 (2x+2)\,dx$

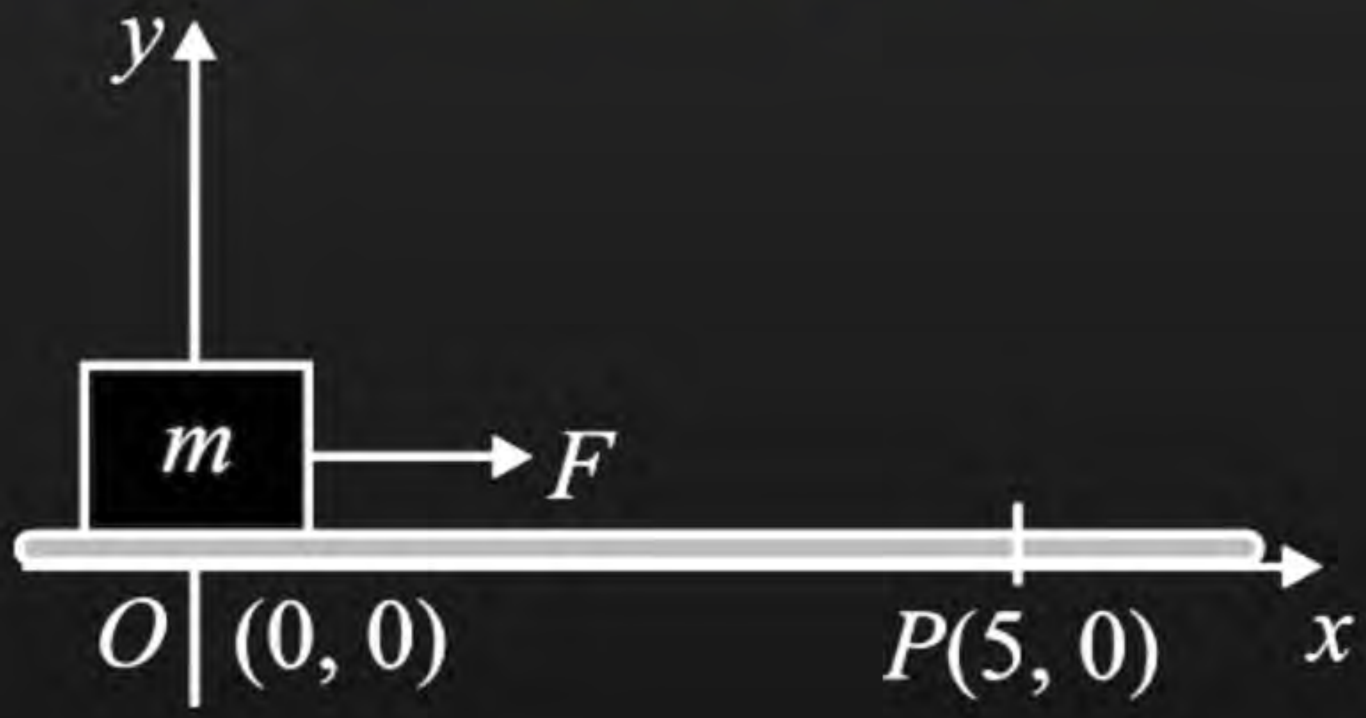
$W = \left[\frac{2x^2}{2} + 2x\right]_0^5$

$W = \left[x^2 + 2x\right]_0^5$

$W = \left[5^2 + 2(5)\right]$

$W = 25 + 10$

$W = 35\,J$



QUESTION

Force F on particle moving in a straight line varies with distance d as shown in the figure. The work done on the particle during its displacement of 12 m is.

A $21\ J$

B $26\ J$

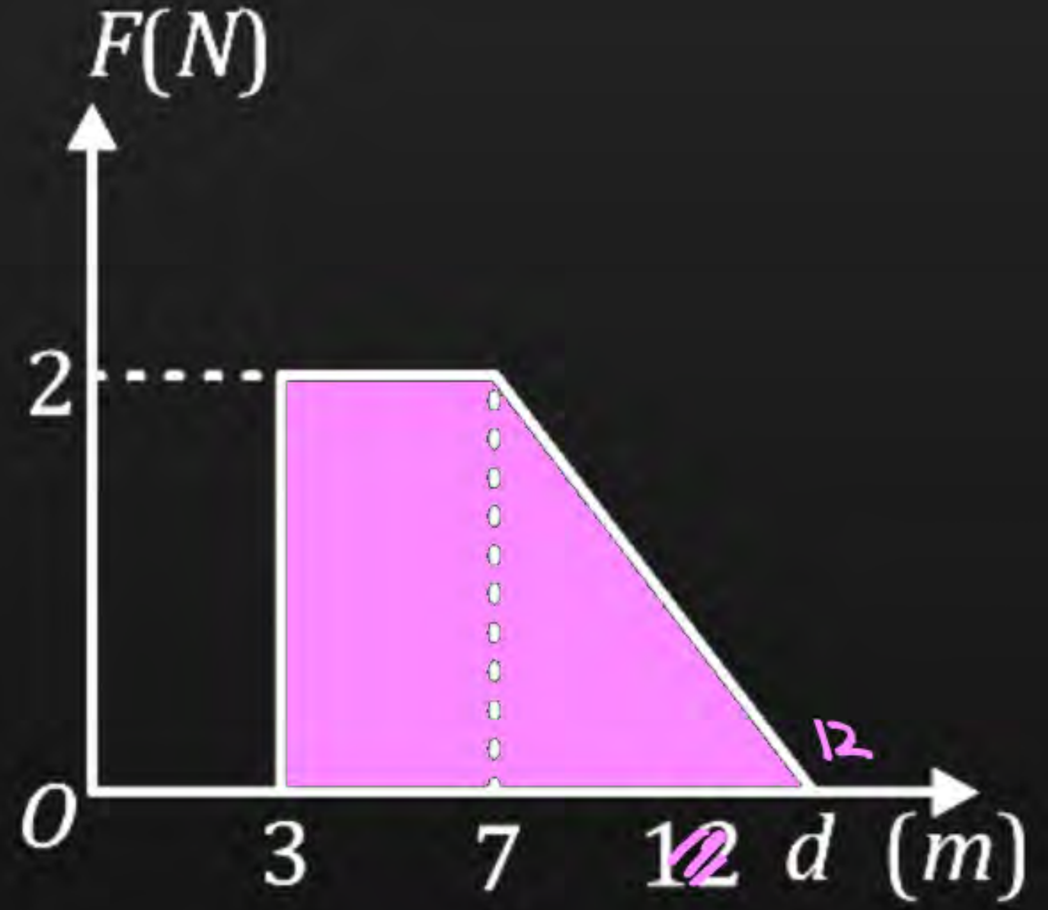
C $13\ J$

D $18\ J$

W = Area under F-d

$W = \frac{1}{2}(9+4)\times 2$

$W = 13J$



QUESTION

A force F acting on an object varies with distance x as shown here. The force is in newton and x is in meter. The work done by force in moving the object from $x = 0$ to $x = 6$ is

$$W = \frac{1}{2}(6+3) \times 3$$

$$W = \frac{9 \times 3}{2} = \frac{27}{2}$$

$$W = 13.5 J$$

(A) $4.5\ J$

(B) $13.5\ J$

(C) $9.0\ J$

(D) $18.0\ J$

WORK DONE BY A COMMON FORCES IN MECHINES

1. GRAVITATION FORCE ✓
2. TENSION FORCE ✓
3. NORMAL REACTION ✓
4. SPRING FORCE ✓
5. FRICTIONAL FORCE ✓

CONSERVATIVE FORCE & NON-CONSERVATIVE FORCE

Conservative force	Non- Conservative force
work done is independent on its path	Work done is depends upon path
Work done is zero for closed path	Work done is not zero for closed path
work done is completely recoverable	Work done is not completely recoverable
Ex: columbic force, spring force, gravitational force,	Ex: Frictional force, air resistance, viscous force

QUESTION

The work done against gravity in taking 10 kg. mass at 1 m height in 1 s will be:

A $49\ J$

B $98\ J$

C $196\ J$

D None of these

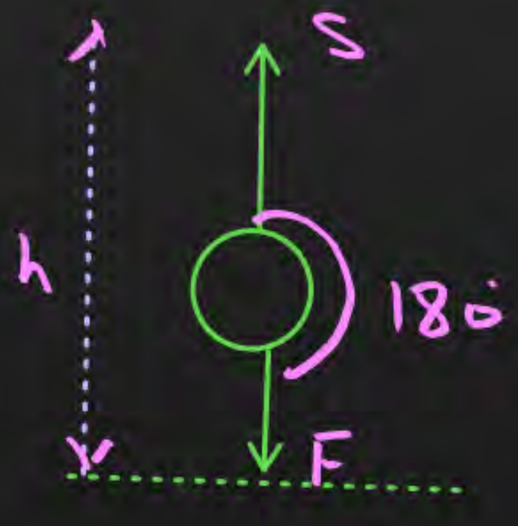
$W = F s \cos\theta$

$W = mg \cdot h \cdot \cos\theta$

$W = 10 \times 9.8 \times 1 \times \cos 180^\circ$

$W = 98 \times (-1)$

$W = -98\ J$



QUESTION

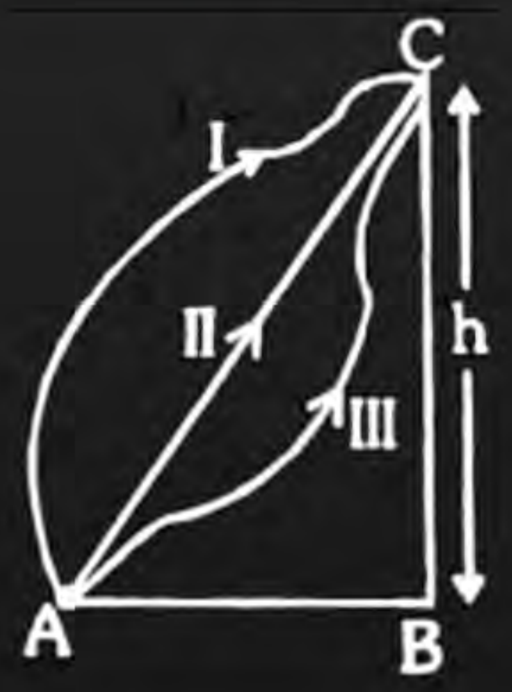
As shown in the diagram a particle is to be carried from point A to C via paths (I), (II) and (III) in gravitational field, then which of the following statements is correct:-

A. Work done is same for all the paths

B. Work done is minimum for path (II)

C. Work done is maximum for path (I)

D. None of the above



QUESTION

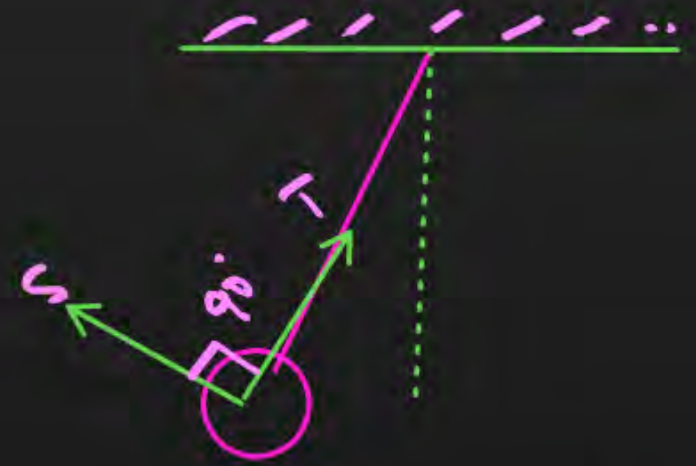
When the bob of a simple pendulum swings. The work done by tension in the string is:

(A) > 0

(B) < 0

(C) Zero

(D) Maximum



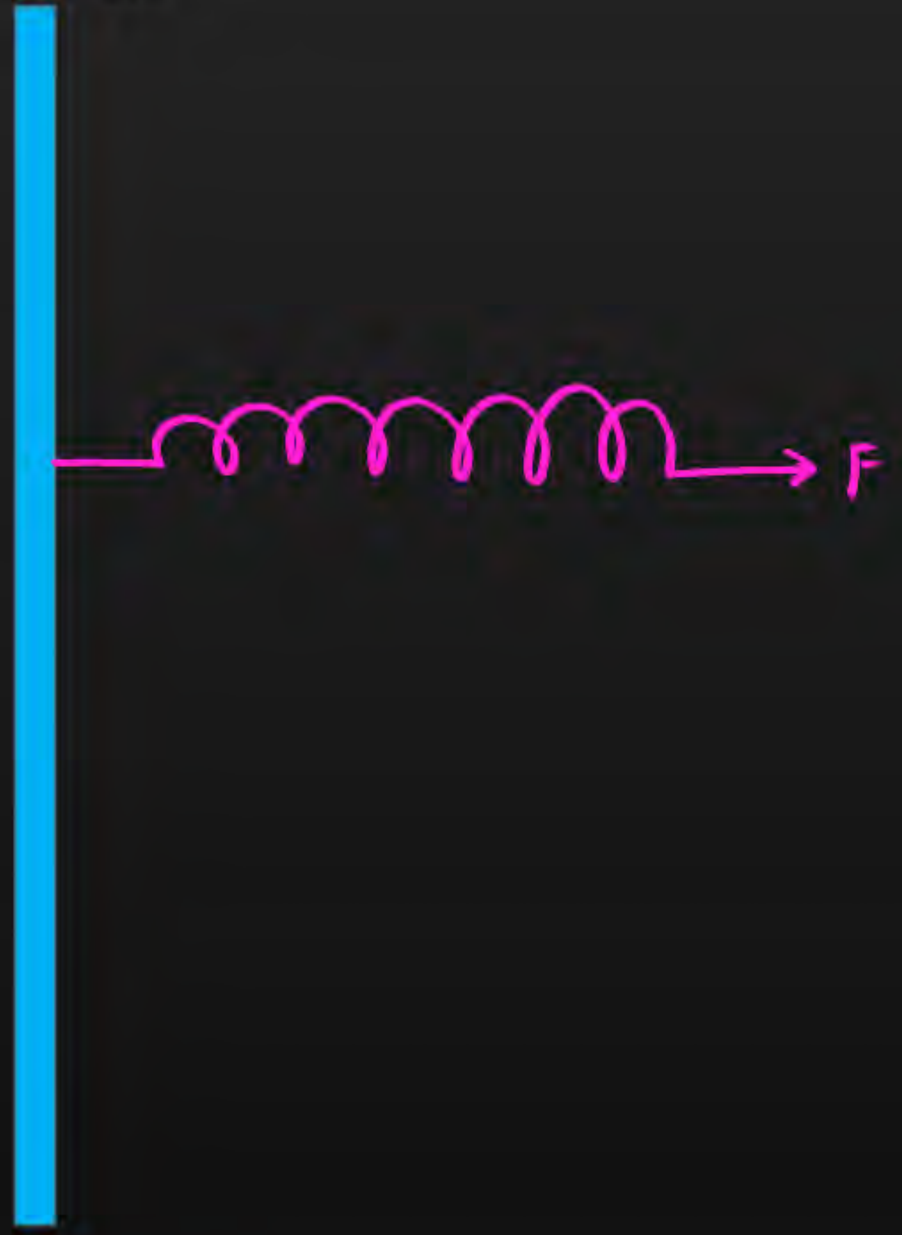
$W = F S \cos\theta$

$W = T S \cos 90^\circ$

$W = 0$

WORK DONE BY THE SPRING FORCE

Spring Force



$$W = \frac{1}{2}k\left[x_f^2 - x_i^2\right]$$

k – spring constant

QUESTION

The work done in joules in increasing the extension of a spring of stiffness 10 N/cm from 4 cm to 6 cm is:

(A) 1

(B) 10

(C) 50

(D) 100

$$W = \frac{1}{2}K\left[x_f^2 - x_i^2\right]$$

$$K = \frac{10\,N}{1\,cm}$$

$$K = \frac{10\,N}{10^{-2}\,m} = 1000\,N/m$$

$$W = \frac{1}{2}\times 1000\left[(6\times10^{-2})^2 - (4\times10^{-2})^2\right]$$

$$W = 500\left[36\times10^{-4} - 16\times10^{-4}\right]$$

$$W = 500\times 20\times10^{-4}$$

$$W = 10{,}000\times10^{-4}$$

$$W = 1\,J$$

ENERGY

Energy - the energy of a body is its capacity, For doing some work.

SI Unit – joule (J)

Quantity – scalar

Dimensional formula - $[M^1L^2T^{-2}]$

ENERGY

The energy possessed by a body by virtue of its position, configuration or motion is mechanical energy.

The two types of mechanical energy are

MECHANICAL ENERGY

- **KINETIC ENERGY** $K = \frac{1}{2}mv^2$
- **POTENTIAL ENERGY** $U = mgh$

WORK - KINETIC ENERGY THEOREM

Statement:

" The change in kinetic energy of a body is equal to the amount of work done on it by a constant/variable force".

$$W = \Delta K$$

$$* \quad W_c + W_{nc} + W_{ext} = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$$

QUESTION

Consider a drop of rainwater having a mass of 1 *gm* falling from a height of 1 *km*. It hits the ground with a speed of 50 *m/s*. Take 'g' constant with a value 10 m/s^2. The work done by the

(i) Gravitational force and the (ii) Resistive force of air is:

A (i) 1.25 J (ii) –8.25 J

B (i) 100 J (ii) 8.75 J

C (i) 10 J (ii) –8.75 J

D (i) –10 J (ii) –8.75 J

$u=0$

(i) $W_c = mgh\cos\theta$

$W_c = 1\times10^{-3}\times10\times1000\times(1)$

$W_c = 10J$

$W_c + W_{nc} + W_{ext} = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$

$10 + W_{nc} + 0 = \frac{1}{2}\times10^{-3}\times(50)^2 - 0$

$10 + W_{nc} = \frac{1}{2}\times10^{-3}\times2500$

$10 + W_{nc} = 1.25$

$W_{nc} = 1.25 - 10 = -8.75J$

QUESTION

A force acts on a 3.0 g particle in such a way that the position of the particle as a function of time is given by $x = 3t - 4t^2 + t^3$, where x is in metre and t in second. The work done during the first 4s is

(A) 570 mJ

(B) 450 mJ

(C) 490 mJ

(D) 528 mJ

$W = \Delta K = K_f - K_i$

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

$W = \frac{1}{2}m(v^2 - u^2)$

$W = \frac{1}{2} \times 3 \times 10^{-3}[(19)^2 - (3)^2]$

$W = 1.5 \times 10^{-3}[361 - 9]$

$W = 528 \times 10^{-3}$ J

$W = 528$ mJ

$x = 3t - 4t^2 + t^3$

$v = \frac{dx}{dt} = 3 - 8t + 3t^2$

$t = 0s$, $u = 3 - 8(0) + 3(0)^2$

$u = 3$ m/s

$t = 4s$, $v = 3 - 8(4) + 3(4)^2$

$v = 3 - 32 + 48$

$v = 19$ m/s

QUESTION

A body of mass 1 *kg* is thrown upwards with a velocity 20 ms^{-1}. It momentarily comes to rest after attaining a height of 18 *m*. How much energy is lost due to air friction? ($g = 10\ ms^{-2}$)

(A) 20 J

(B) 30 J

(C) 40 J

(D) 10 J

$\rightarrow v = 0$

$E \propto W$

$W = \Delta K$

$W_c + W_{nc} + W_{ext} = K_f - K_i$

$mgh\cos\theta + W_{nc} + 0 = 0 - \frac{1}{2}mu^2$

$1 \times 10 \times 18 \times \cos 180^\circ + W_{nc} = -\frac{1}{2} \times 1 \times (20)^2$

$-180 + W_{nc} = -200$

$W_{nc} = -200 + 180$

$W_{nc} = -20\text{J}$

QUESTION

A bullet of mass 20 g leaves a riffle at an initial speed 100 m/s and strikes a target at the same level with speed 50 m/s. The amount of work done by the resistance of air will be

[H.W]

A. 100 J

B. 25 J

C. 75 J

D. 50 J

KINETIC ENERGY AND LINEAR MOMENTUM

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

$P = mv$

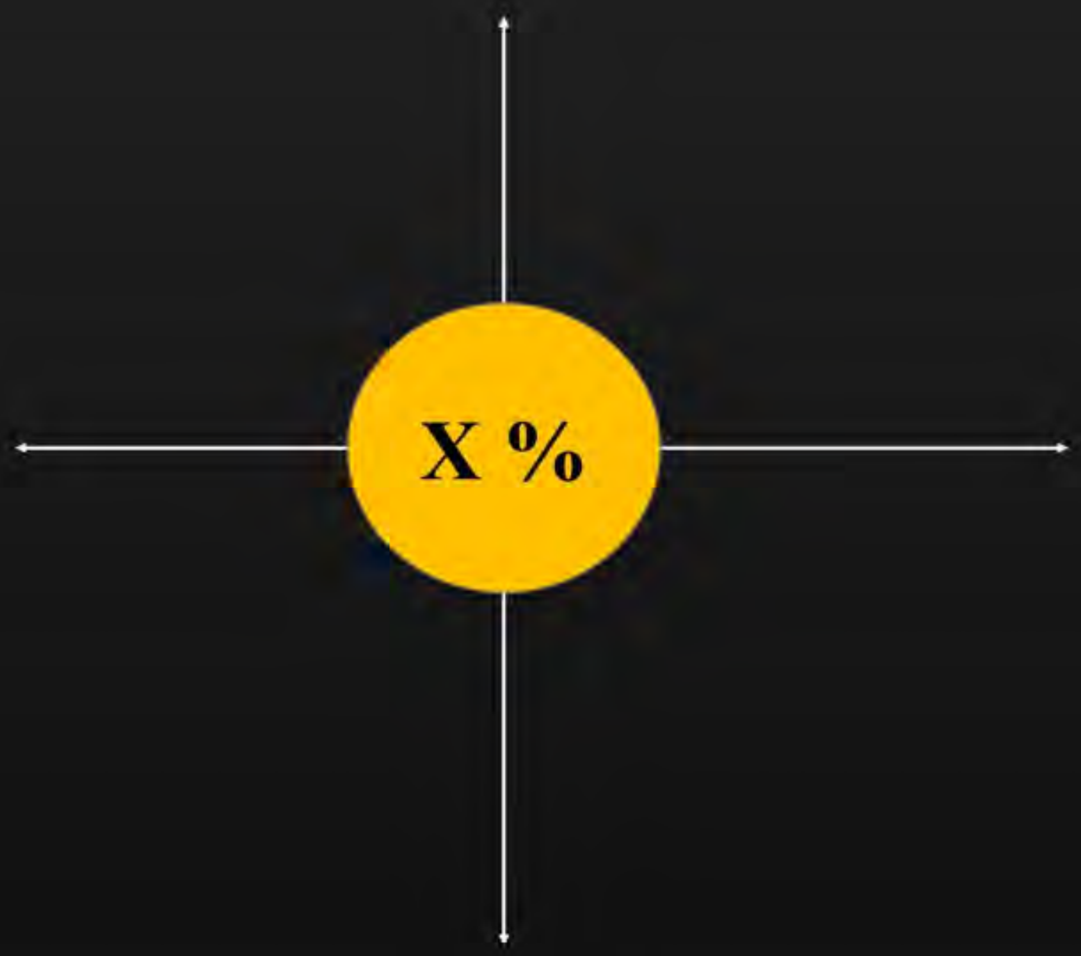
* $K = \frac{P^2}{2m}$

$P = \sqrt{2mK}$

PERCENTAGE (%) CHANGE IN P AND K.E

$$K_i = \frac{P_i^2}{2m}$$

If Percentage is $\geq 10\%$,



If momentum is increased by 10%, $P_f = P_i + \frac{10}{100} P_i$

$$P_f = P_i + 0.1 P_i = 1.1 P_i$$

$$K_f = \frac{P_f^2}{2m} = (1.1)^2 \frac{P_i^2}{2m} = 1.21 K_i = (1 + 0.21) K_i \text{ , } \quad 0.21 \times 100\% = 21\%$$

If momentum is increased by 30%, $P_f = P_i + \frac{30}{100} P_i = P_i + 0.3 P_i$

$$P_f = 1.3 P_i$$

$$K_f = \frac{P_f^2}{2m} = (1.3)^2 \frac{P_i^2}{2m} = (1.69) K_i = (1 + 0.69) K_i \quad 0.69 \times 100\% = 69\%$$

PERCENTAGE (%) CHANGE IN P AND K.E

If momentum is increased by 50%, $P_f = P_i + \frac{50}{100}P_i = P_i + 0.5P_i = 1.5P_i$

$$K_f = \frac{P_f^2}{2m} = (1.5)^2\frac{P_i^2}{2m} = (1.5)^2 K_i = 2.25K_i = (1+1.25)K_i$$

$1.25 \times 100\%$

$= 125\%$

H.W

If momentum is increased by 100%, $P_f =$

H.W

If momentum increased by 300%, $P_f =$

QUESTION

Two bodies of masses m and $4\,m$ are moving with equal K.E. The ratio of their linear momentums is

$K = \frac{P^2}{2m}$

$K_1 = K_2$

$\frac{P_1^2}{2m_1} = \frac{P_2^2}{2m_2}$

$\left(\frac{P_1}{P_2}\right)^2 = \frac{m_1}{m_2} = \frac{m}{4m} = \frac{1}{4}$

$\frac{P_1}{P_2} = \sqrt{\frac{1}{4}} = \frac{1}{2}$

(A) 4 : 1

(B) 1 : 1

(C) 1 : 2

(D) 1 : 4

QUESTION

If momentum is increased by 20%, then K.E. increases by

A 44%

B 55%

C 66%

D 77%

$$P_f = P_i + \frac{20}{100} P_i$$

$$P_f = (1.2) P_i$$

$$K_f = \frac{(1.2)^2 P_i^2}{2m} = 1.44 \times K_i$$

$$K_f = (1 + 0.44) K_i$$

$$0.44 \times 100\%$$

$$= 44\%$$

QUESTION

If the increase in the kinetic energy of a body is 22%, then the increase in the momentum will be

A 22%

B 44%

C 10%

D 300%

$$P = \sqrt{2mK}$$

$$P_i = \sqrt{2mK_i}$$

$$P_f = \sqrt{2mK_f}$$

$$K_f = K_i + \frac{22}{100}K_i$$

$$K_f = K_i + 0.22K_i$$

$$K_f = 1.22\,K_i$$

$$P_f = \sqrt{2m \times (1.22)K_i} = \sqrt{1.22} \times \sqrt{2mK_i}$$

$$P_f = 1.10\,P_i$$

$$P_f = (1 + 0.10)P_i$$

$0.10 \times 100\%$

$= 10\%$

QUESTION

If the momentum of body is increased by 50%, then the percentage increase in its kinetic energy is [H.W]

(A) 50%

(B) 100%

(C) 125%

(D) 200%

QUESTION

If kinetic energy o a body is increased by 300%, then percentage change in momentum will be **[H.W]**

A 100%

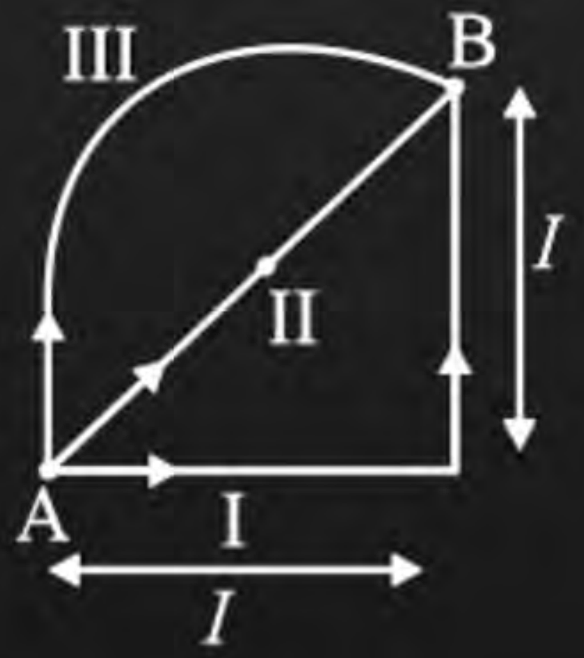
B 150%

C 265%

D 73.2%

QUESTION

If a body of mass 2 kg is moved in the conservative field from point A to B in three different paths, then work done will be



A) $W_I < W_{II} < W_{III}$

B) $W_I > W_{II} > W_{III}$

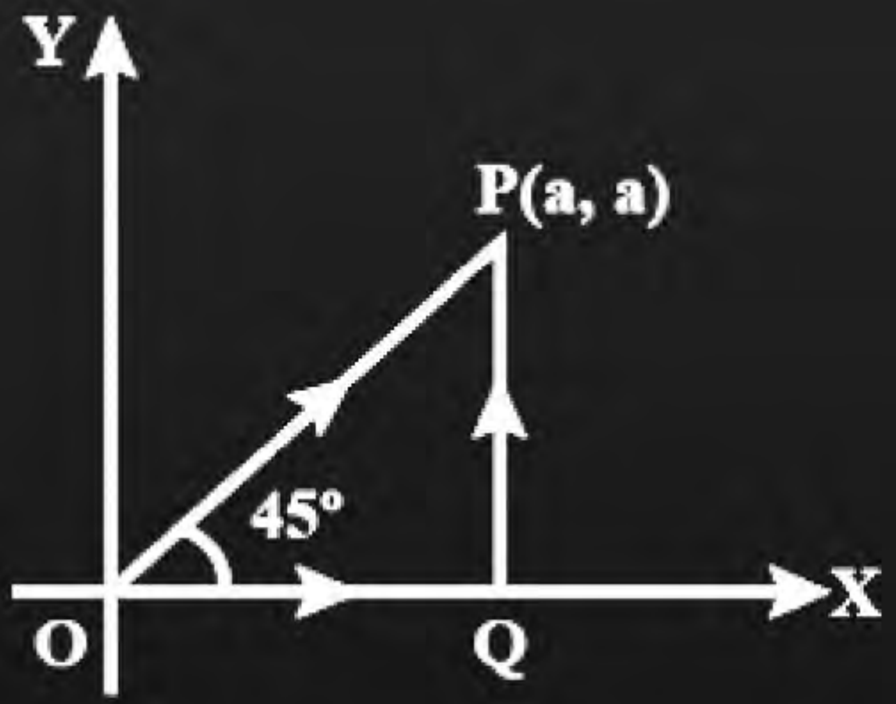
C) $W_I = W_{II} = W_{III}$

D) $W_I > W_{II} = W_{III}$

QUESTION

H.W

A particle is moved from (0, 0) to (a, a) under a force $\vec{F} = (3\hat{\imath} + 4\hat{j})$ from two paths. Path 1 is OP and path 2 is OQP. Let W_1 and W_2 be the work done by this force in these two paths. Then :



A $W_1 = W_2$

B $W_1 = 2W_2$

C $W_2 = 2W_1$

D $W_2 = 4W_1$

QUESTION

Which of the following statements is true for work done by conservative forces:-

A. It does not depend on path

B. It is equal to the difference of initial and final potential energy function

C. It can be recovered completely

D. All of the above

QUESTION

Which of the following statement is incorrect for a conservative field?

(A) Work done in going from initial to final position is equal to change in kinetic energy of the particle.

(B) Work done depends on path but not on initial and final positions.

(C) Work done does not depend on path but depends only on initial and final positions

(D) Work done on a particle in the field for a round trip is zero.

QUESTION

Which of the following is a non-conservative force:-

A. Electric force

B. Gravitational force

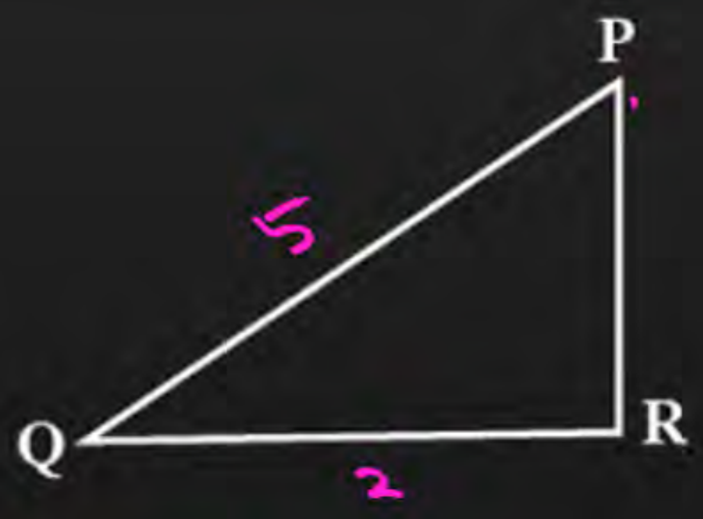
C. Spring force

D. Viscous force

QUESTION

For the path PQR, in a conservative force field, the amount of work done in carrying a body from P to Q and from Q to R are 5 Joule and 2 Joule respectively. The work done in carrying the body from P to R will be –

W = const



5+2=7J

(A) 7 J

(B) 3 J

(C) $\sqrt{21}$

(D) Zero

POTENTIAL ENERGY

P.E, U = mgh.

The energy possessed by a body by virtue of its position or rest is called potential energy.

Ex:

1. The potential energy of a wound spring of a clock is used to drive hands of the clock.
2. A stretched rubber cord
3. Due to the potential energy of the compressed spring in a loaded gun, the bullet moves with a large velocity on firing the gun.

Consider a body mass m lying on the surface of earth. Force required to lift the body is equal to its weight.

GRAVITATIONAL POTENTIAL ENERGY

Relation between work and potential energy

$W = \Delta U = U_f - U_i$ → W.D by external Force

$W = -\Delta U = -(U_f - U_i)$ → W.D by conservative force

QUESTION

If a body of mass 200 *g* falls from a height 200 m and its total P.E. is converted into K.E. at the point of contact of the body with earth surface, then what is the decrease in P.E. of the body at the contact ($g = 10\ m/s^2$)

A $200\ J$

B $400\ J$

C $600\ J$

D $900\ J$

$$W = -(U_f - U_i) = \Delta U$$

$$\Delta U = -U_f + U_i$$

$$= -mgh_2 + mgh$$

$$W = 0 + 200 \times 10^{-3} \times 10 \times 200$$

$$W = 400000 \times 10^{-3}$$

$$W = 400J = \Delta U$$

QUESTION

The decrease in the potential energy of a ball of mass 20 kg which falls from a height of 50 cm is

(A) 968 J

(B) 98 J

(C) 1980 J

(D) None of these

SPRING POTENTIAL ENERGY

$$U = W = \frac{1}{2}kx^2 = \frac{1}{2}k(x_f^2 - x_i^2)$$

$$\boxed{U = W = \frac{1}{2}k\left[x_f^2 - x_i^2\right]}$$

QUESTION

If a long spring is stretched by 0.02 m, its potential energy is U. If the spring is stretched by 0.1 m, then its potential energy will be

A. $U/5$

B. U

C. $5U$

D. $25U$

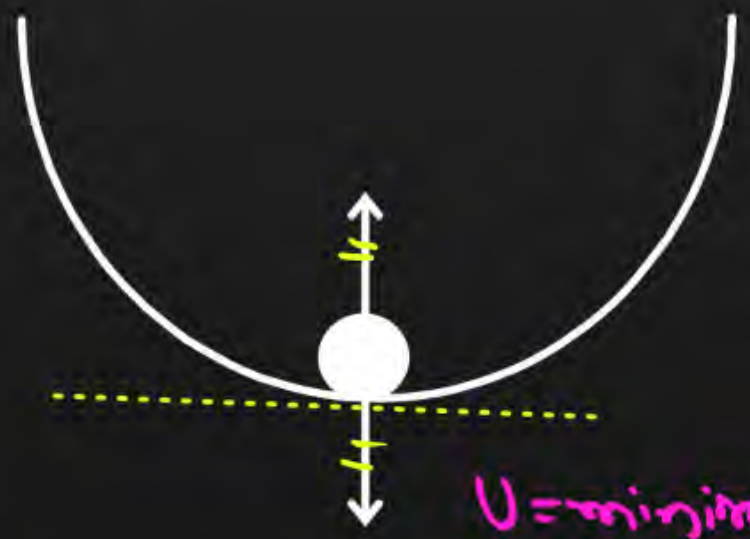
$U = \frac{1}{2}kx^2$

$\frac{U_2}{U_1} = \frac{\frac{1}{2}kx_2^2}{\frac{1}{2}kx_1^2} = \frac{(0.1)^2}{(0.02)^2}$

$\frac{U_2}{U} = 25$

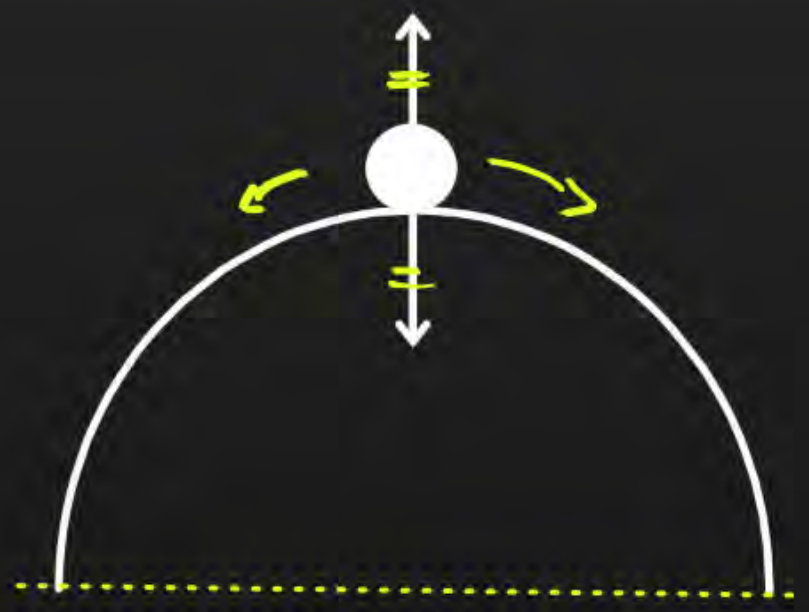
$U_2 = 25U$

CONCEPT OF EQUILIBRIUM



U = minimum

Stable equilibrium.



U = maximum.

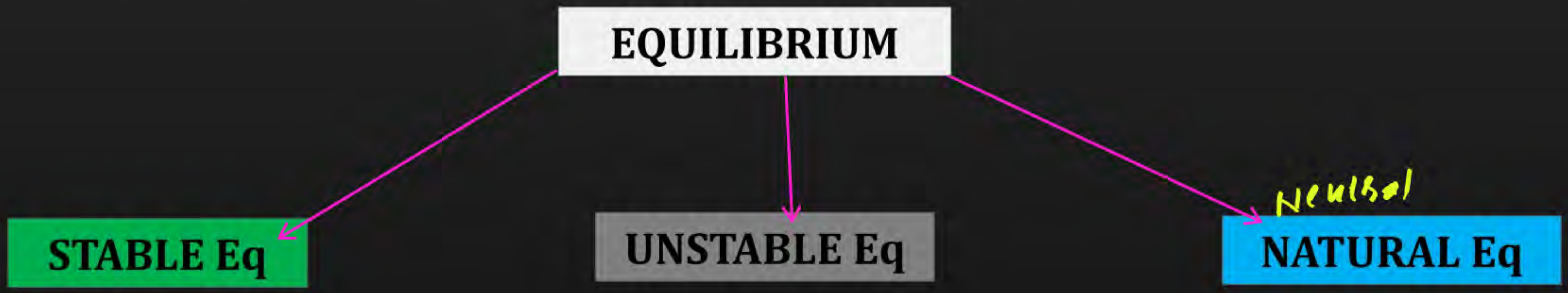
Unstable equilibrium

U = const

Neutral equilibrium.

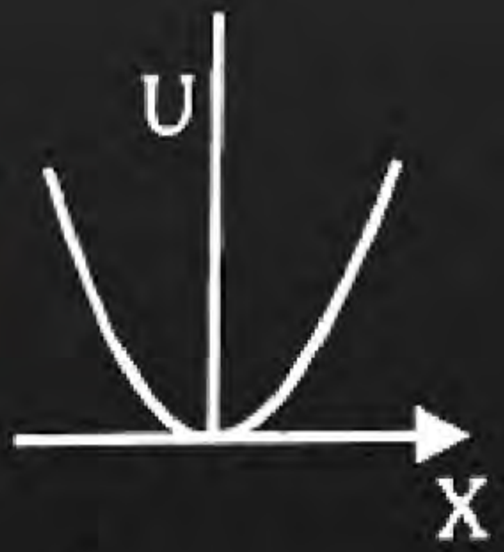
CONCEPT OF EQUILIBRIUM

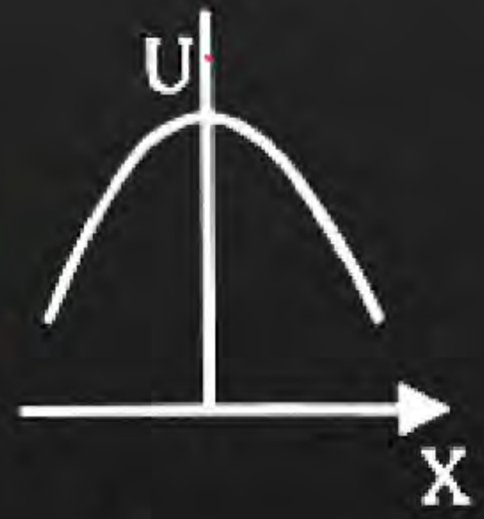
It is a state of body where net force on the body is zero, $\sum F = 0$

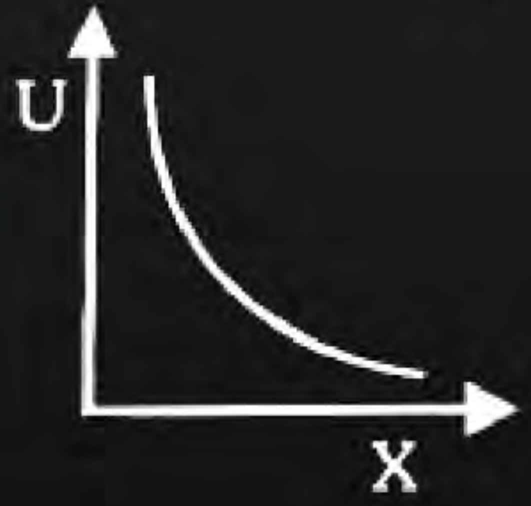


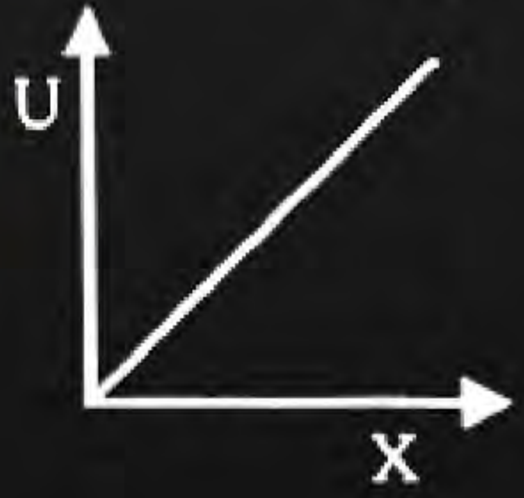
QUESTION

The graph between potential energy U and displacement X in the state of stable equilibrium will be–

(A)


(B)


(C)


(D)


QUESTION

The potential energy of a particle of mass 1 kg free to move along the x-axis is given by $U(x) = (3x^2 - 4x + 6)\ J$. Force acting on the particle at $x = 0$ is

(A) $2\hat{i}\ N$

(B) $-4\hat{i}\ N$

(C) $5\hat{i}\ N$

(D) $4\hat{i}\ N$

$F = -\frac{du}{dx}$

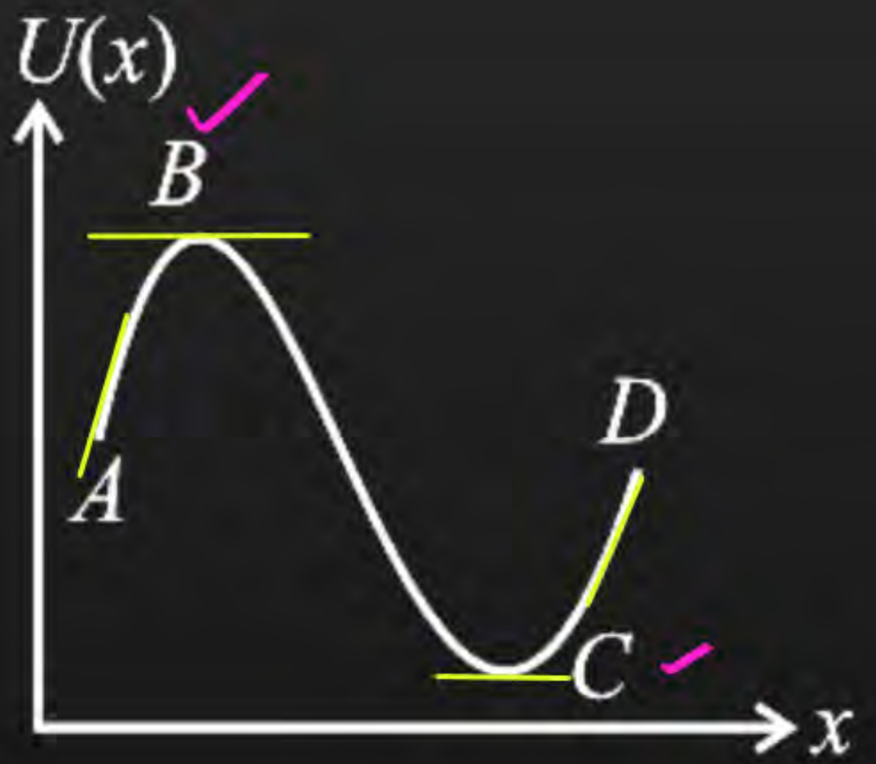
$F = -(6x - 4 + 0)$

$F = -(6x - 4)$

$x = 0,\ F = +4\ N$

QUESTION

The potential energy of a particle varies with distance x as shown in the graph. The force acting on the particle is zero at



A. C

B. B

C. B and C

D. A and D

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

$F = -(\text{slope}) = 0$

slope $= 0$

QUESTION

A particle is moving along the x-axis under a conservative force and its potential energy U varies with x co-ordinate as shown in the figure. Then force is positive at:

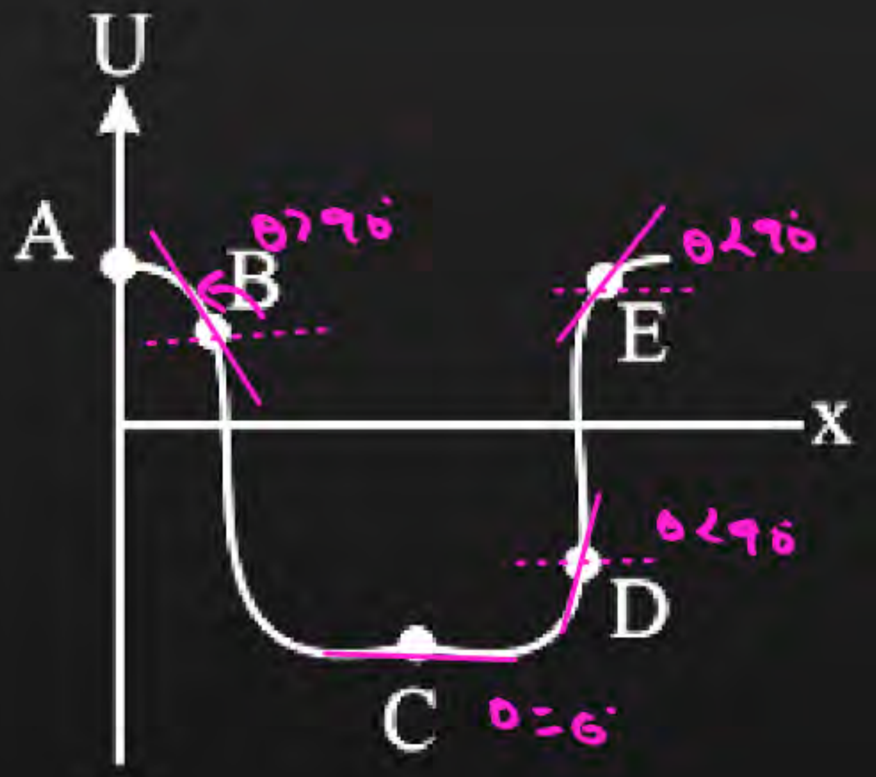
$F = -\frac{dU}{dx} = -(\text{slope})$

(A) A

(B) C, D

(C) B

(D) D, E



QUESTION

If $U = x^2 + 2y + 3z$, find the force $(\vec{F})$ corresponding to it.

$\vec{F} = F_x\hat{i} + F_y\hat{j} + F_z\hat{k}$

(A) $-2x\hat{i} - 2\hat{j} - 3\hat{k}$

(B) $-3x\hat{i} + 2\hat{j} - 3\hat{k}$

(C) $3x\hat{i} + 2\hat{j} - 3\hat{k}$

(D) $2x\hat{i} + 2\hat{j} + 3\hat{k}$

$\vec{F} = -2x\hat{i} - 2\hat{j} - 3\hat{k}$

$F_x = -\frac{dU}{dx} = -2x$

$F_y = -\frac{dU}{dy} = -2$

$F_z = -\frac{dU}{dz} = -3$

QUESTION

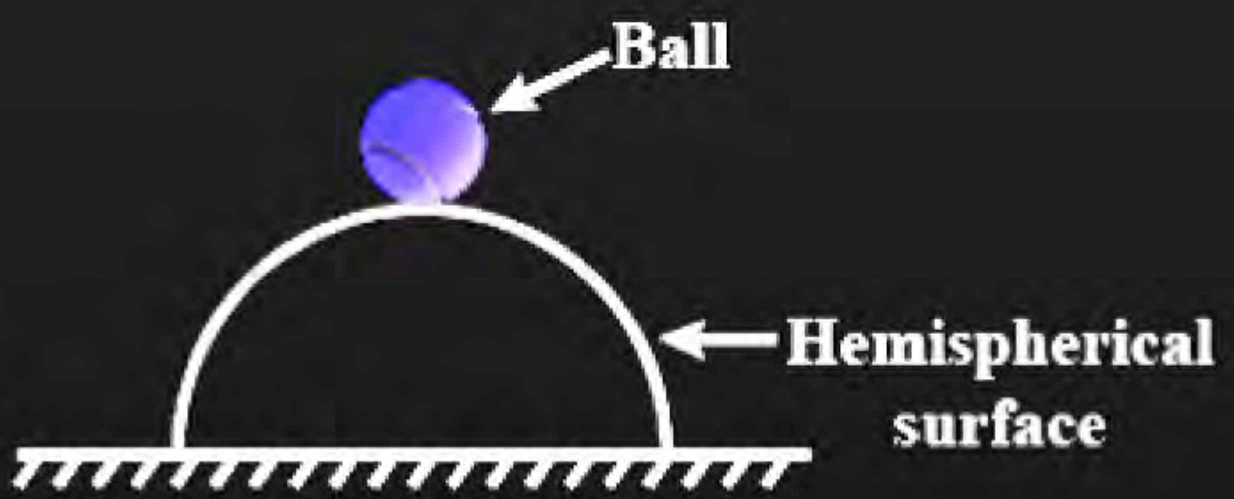
A ball is placed on the top of hemispherical bowl as shown in the figure. Which type of equilibrium can be associated with the body?

A Neutral equilibrium

B Stable equilibrium

C Unstable equilibrium

D Insufficient equilibrium



POWER

The time rate at which work is done or the ratio of the total work done to the total time taken is called power.

$$P = \frac{W}{t} = \frac{E}{t} = \frac{M^1L^2T^{-2}}{T^1} = [M^1L^2T^{-3}]$$

SI Unit – Watt (W)

1watt: power said to be 1 watt, If 1 joule of work is done in per 1 second.

Quantity – Scalar

Dimensional formula - $[M^1L^2T^{-3}]$

1H.P = 746 W

POWER

Power, P , $P = \frac{W}{t} = \frac{E}{t}$

Average Power, $P_{avg} = \frac{\Delta W}{\Delta t}$

Instantaneous Power , $P_{in} = \frac{dW}{dt}$

Power in terms of speed $P = \vec{F} \cdot \vec{V}$

$P = F \cdot V$

QUESTION

A motor boat is travelling with a speed of 3.0 m/sec. If the force on it due to water flow is 500 N, the power of the boat is

(A) 150 kW

(B) 15 kW

(C) 1.5 kW

(D) 150 W

$P = F \cdot V$

$P = 500 \times 3$

$P = 1500 W$

$P = 1.5 kW$

QUESTION

A force of $2\hat{\imath} + 3\hat{\jmath} + 4\hat{k}\ N$ acts on a body for 4 second, produces a displacement of $(3\hat{\imath} + 4\hat{\jmath} + 5\hat{k})m$. The power used is

(A) 9.5 W

(B) 7.5 W

(C) 6.5 W

(D) 4.5 W

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

$W = (2\hat{i} + 3\hat{j} + 4\hat{k})(3\hat{i} + 4\hat{j} + 5\hat{k})$

$W = 6 + 12 + 20$

$W = 38\ J$

$P = \frac{W}{t}$

$P = \frac{38}{4}$

$P = 9.5\ W$

QUESTION

The average power required to lift a 100 kg mass through a height of 50 metres in approximately 50 seconds would be

$P = \frac{W}{t} = \frac{mgh}{t} = \frac{100 \times 10 \times 50}{50} = 1000\ W$

A 50 J/s

B 5000 J/s

C 100 J/s

D 980 J/s

QUESTION

Power of a water pump is 2 kW. If g = 10m/sec^2, the amount of water it can raise in one minute to a height of 10 m is

60s

$P = \frac{mgh}{t}$

$m = \frac{Pt}{gh} = \frac{2000 \times 60}{10 \times 10} = 1200 \text{ Kg}$

$1L = 1Kg$

$m = 1200L$

(A) 2000 litre

(B) 1000 litre

(C) 100 litre

(D) 1200 litre

QUESTION

A crane lifts 300 kg weight from earth's surface up to a height of 2 m in 3 seconds. The average power generated by it will be -

(A) 1960 W

(B) 2205 W

(C) 4410 W

(D) 0 W

Thank You