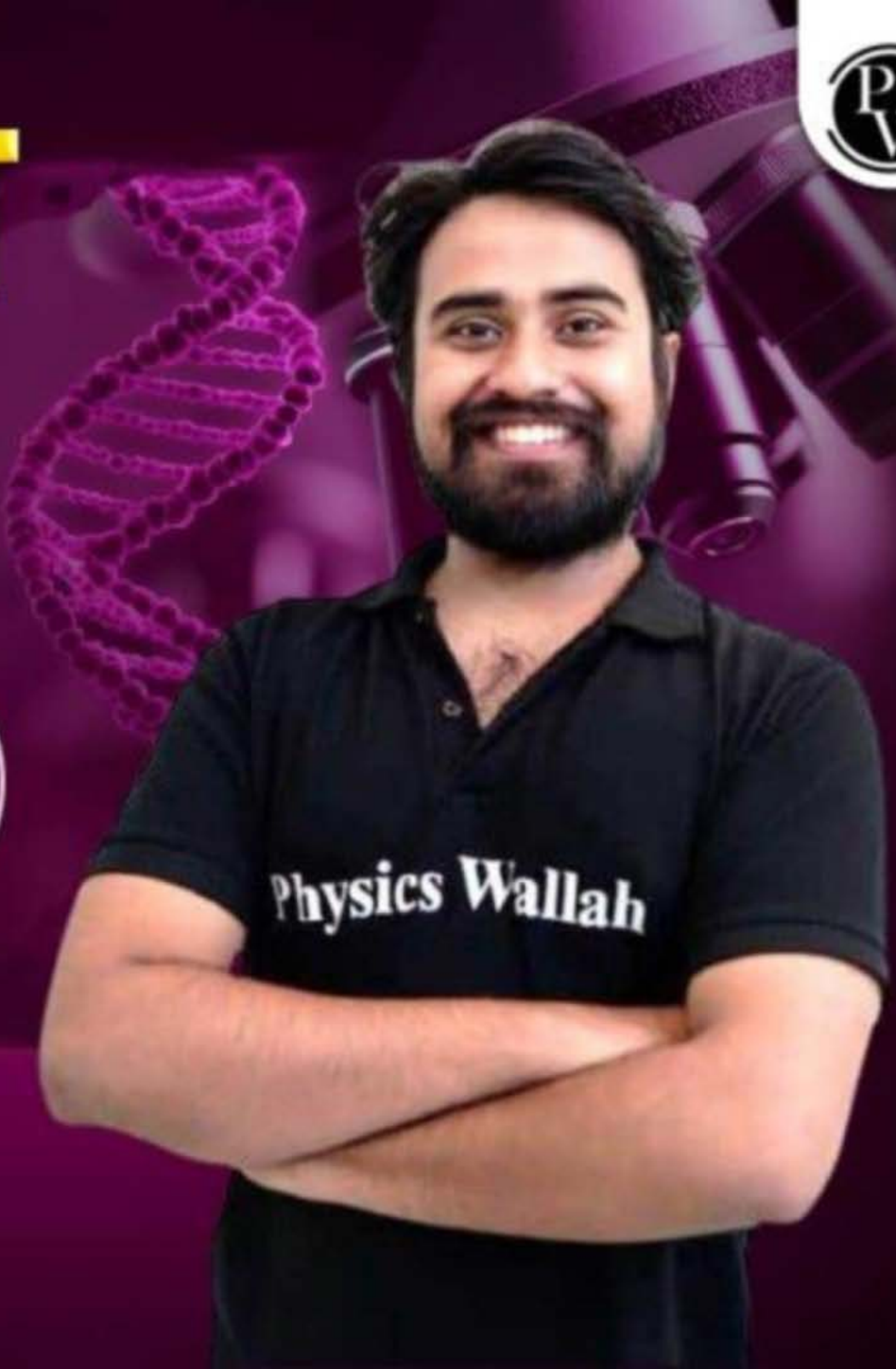
PRACHAND NEET

ONE SHOT

Physics

WORK ENERGY and POWER



By – Brofessor Dr. Aayudh

Topics *to be covered*

1. Part 1 – Basic Maths And Vectors ✓
2. Part 2 – Work Done ✓
3. Part 3 – Kinetic Energy ✓
4. Part 4 – Conservative Force ✓
5. Part 5 – Potential Energy ✓
6. Part 6 – Conservation of Mechanical Energy ✓



PRACHAND SERIES

TELEGRAM CHANNEL



NEET SYLLABUS

- Work done by a constant force and a variable force
- Kinetic and Potential energies
- Work-energy theorem
- Power
- Potential energy of spring conservation of mechanical energy
- Conservative and Non-Conservative forces
- Motion in a vertical circle

BROFESSOR ANALYSIS

Difficulty Level : EASY
Difficulty Level : MEDIUM
Difficulty Level : HARD
Difficulty Level : YODHA



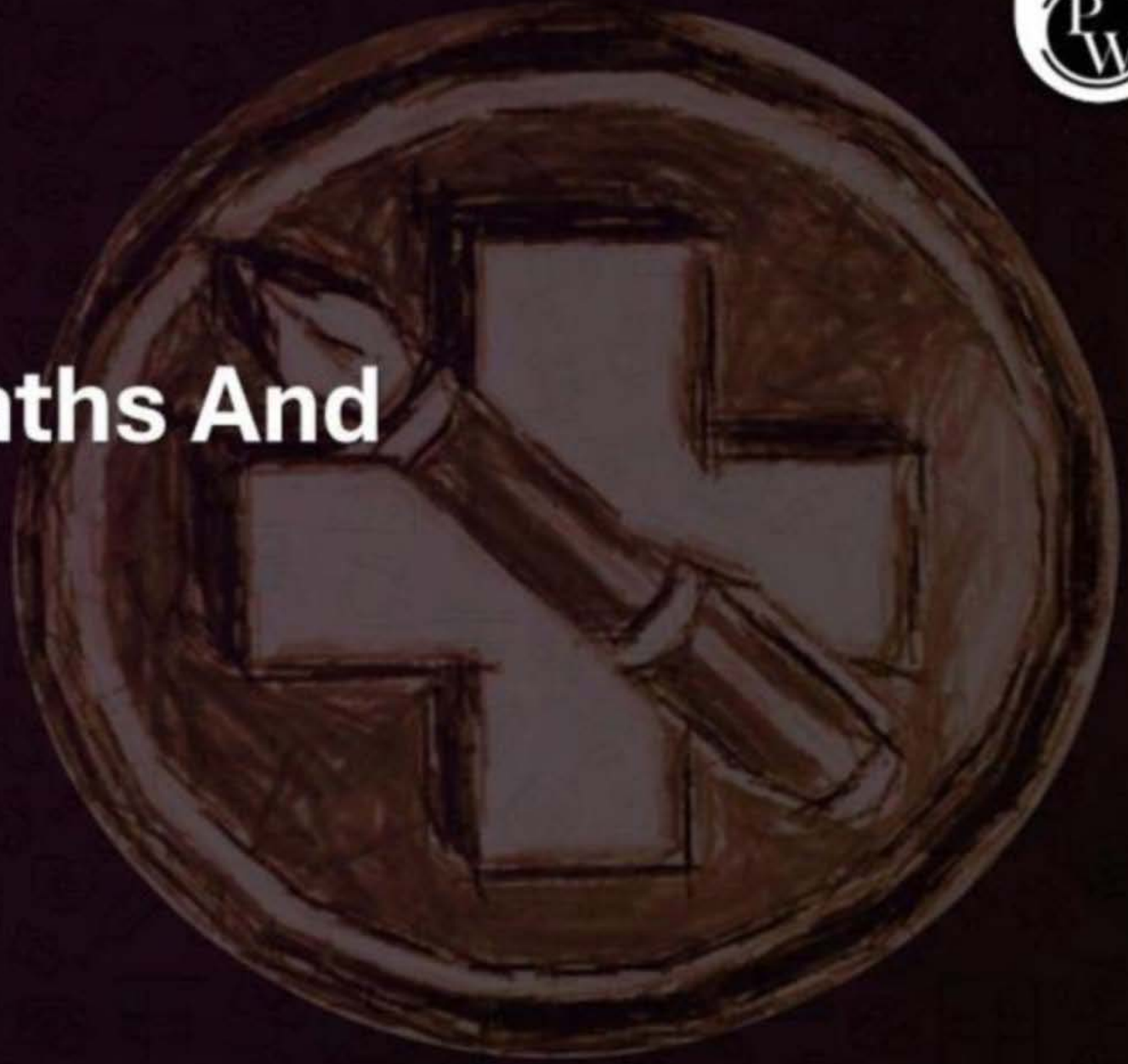


Topics *to be covered*

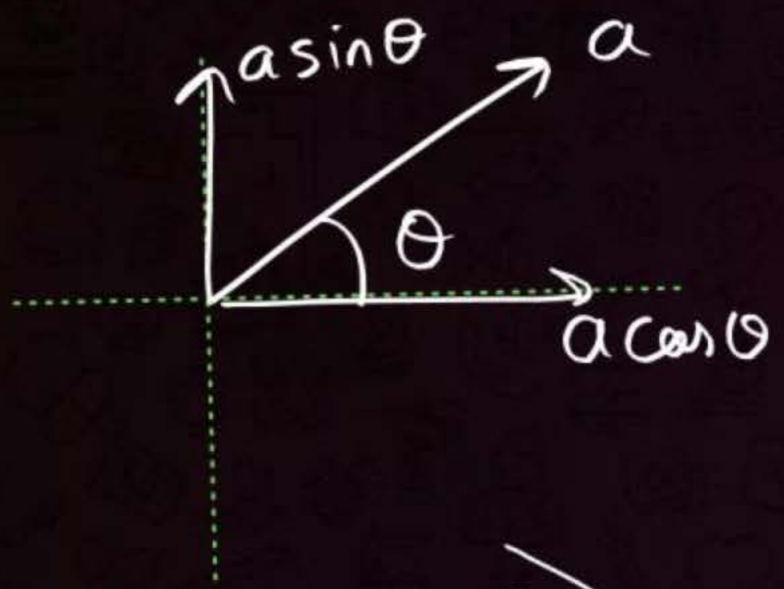
7. Part 7 – Work Energy Theorem
8. Part 8 – Power
9. Part 9 – Vertical Circular Motion
10. Part 10 – Theory and AR Questions
11. Part 11 – Revision and PUPPY POINTS

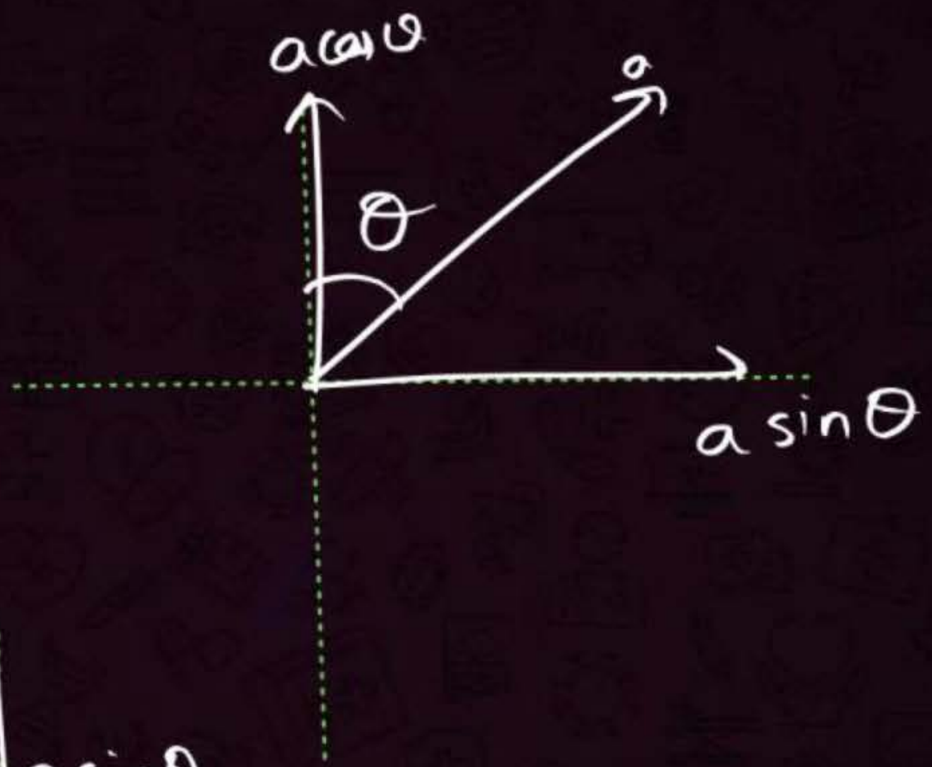


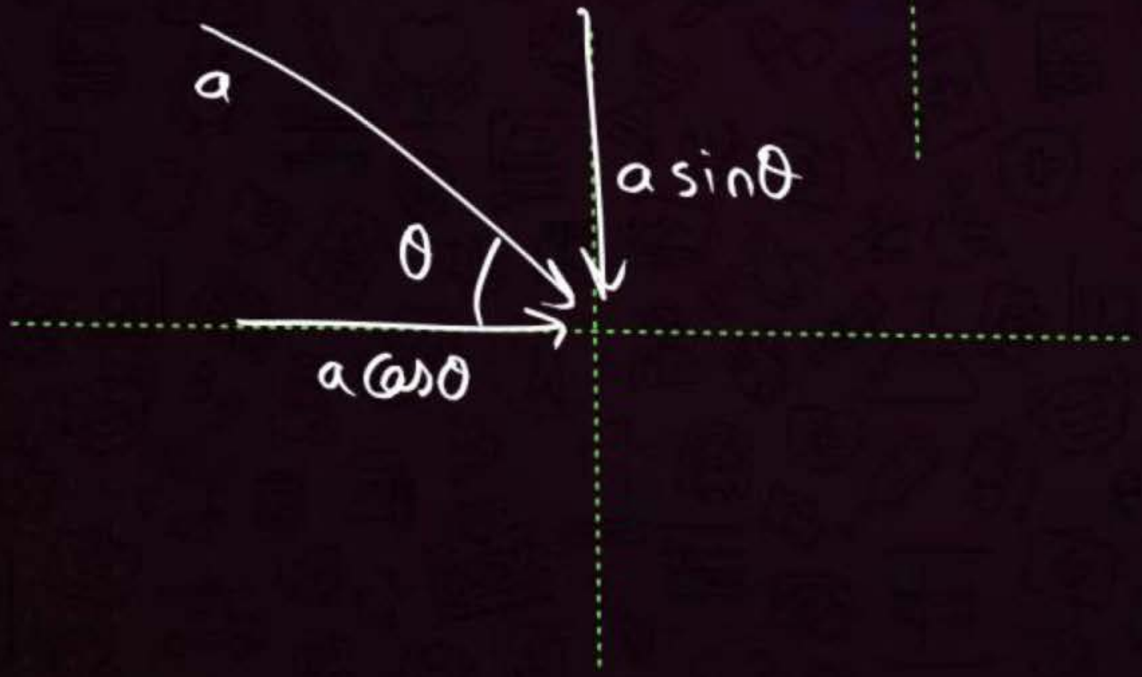
Part 1 – Basic Maths And Vectors



1.1 Component







1.2 Dot Product

$\vec{a} \cdot \vec{b} = (2\hat{i}+3\hat{j}+5\hat{k}) \cdot (2\hat{i}+\hat{j}+2\hat{k})$

$4+3+10 = 17$

Q) $(\hat{i}+2\hat{j}+\hat{k}) \cdot (2\hat{i}+\hat{j}+3\hat{k})$

$= 2+2+3 = 7$

$\vec{a} \cdot \vec{b} = ab\cos\theta$

$\vec{a} \cdot \vec{b} = 0$ → $a=0$, $b=0$, $\cos\theta = 0$, $\theta = 90°$

$\vec{a} \cdot \vec{b}$ = +ve θ is acute



$\vec{a} \cdot \vec{b}$ = -ve θ is obtuse



1.3 Differentiaiton $1/x^n$

$$\frac{d(x^n)}{dx} = n x^{n-1}$$

$$\frac{dx^{10}}{dx} = 10x^9$$

Q $\frac{dx^5}{dx} = \underline{5x^4}$ ✓

$$\frac{d}{dx}\left(\frac{1}{x^n}\right) = \frac{-n}{x^{n+1}}$$

$$\frac{d}{dx}\left(\frac{1}{x^{10}}\right) = \frac{-10}{x^{11}}$$

$$\frac{d}{dx}\left(\frac{1}{x^5}\right) = \frac{-5}{x^6}$$ ✓✓

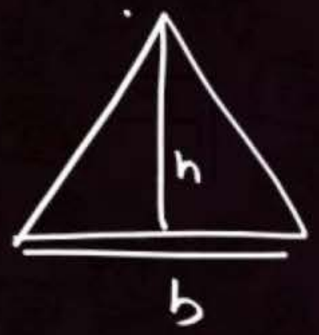
$$\frac{d(x^{3/2})}{dx} = \frac{3}{2}x^{1/2}$$

$$v = \frac{dx}{dt}$$

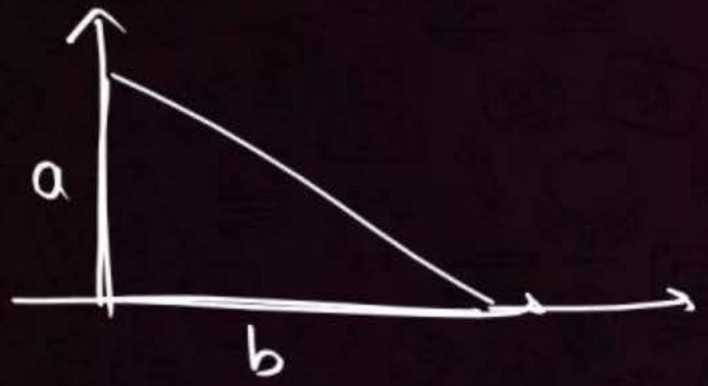
$$a = \frac{dv}{dt}$$

$$\boxed{a = \frac{v\,dv}{dx}}$$ ✓✓

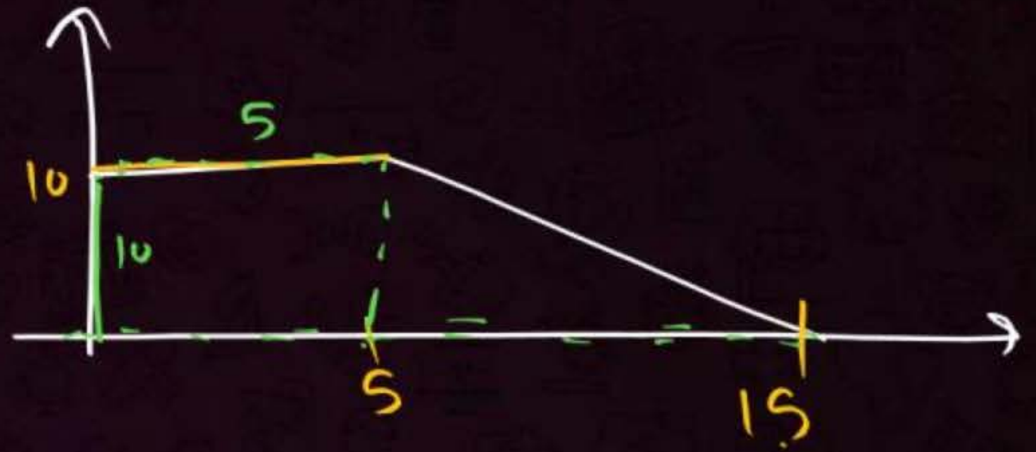
1.4 Area Trap & Triangle



$A = \frac{1}{2}bh$



$\text{Area} = \frac{1}{2}ab$



$A = \frac{1}{2}(\text{Sum parallel sides})\,h$

$= \frac{1}{2}(5+15)\,10$

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

$= 100$

Part 2 – Work Done



2.1 Work Done Direct

W = Product of Force & displacement (1xth class)

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

Scalar

Vector

W = SI unit J

$1\,J = 10^7$ erg ((4.5)

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

{ ❤ Work, Heat, Energy, Torque have same dimensions }

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

$$\boxed{W = F s \cos\theta}$$

$W = 0$

- $F = 0$
- $s = 0$
- $\cos\theta = 0$, $\theta = 90°$

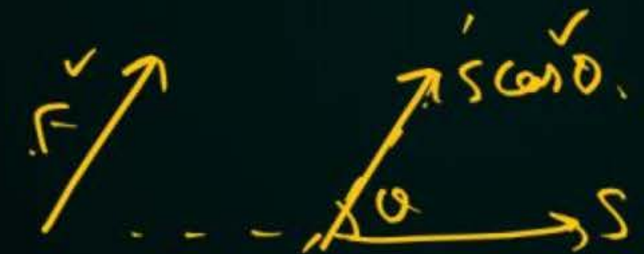
$W = +ve$ θ Acute

$W = -ve$ θ Obtuse

- $W = F s \cos\theta$
  Product of Force, displacement and cosine of angle between them.



- $W = (F\cos\theta)\, S$
  Product of displacement and component of Force along displacement



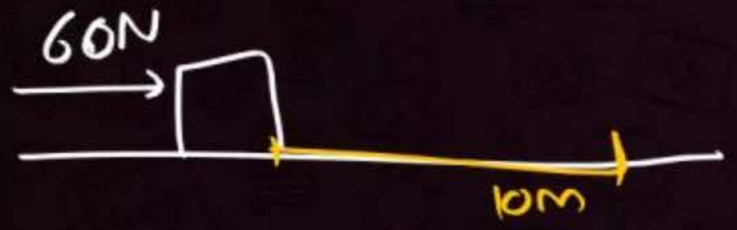
- $W = F(s\cos\theta)$
  Product of Force and component of displacement along Force

Calculate work done when

Difficulty Level : EASY

QUESTION-01

A force of 60 N is applied to displace a box by 10 m.



$W = F \cdot S = 60 \times 10 = 600\ J$

QUESTION-02

Hard

A force of 60 N is applied to a box of mass 2 kg for 10 s.

(I) $W = F \cdot S = 60$ _____

(II) $a = \frac{F}{m} = \frac{60}{2} = 30\ m/s^2$

(III) $S = \cancel{0t} + \frac{1}{2}at^2$ $\quad S = \frac{1}{\cancel{2}} \times \cancel{30}^{15} \times 10 \times 10 = 1500\ m$

(IV) $W = F \cdot S = 60 \times 1500 = 90000 = 90\ kJ$

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

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

$a = \frac{F}{m}$

$a \rightarrow$ constant

$\Delta v = \int a\,dt$

$s = \int v\,dt$

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

$v = \frac{ds}{dt}$

$a = \frac{dv}{dt}$

$F = ma$

Calculate work done when

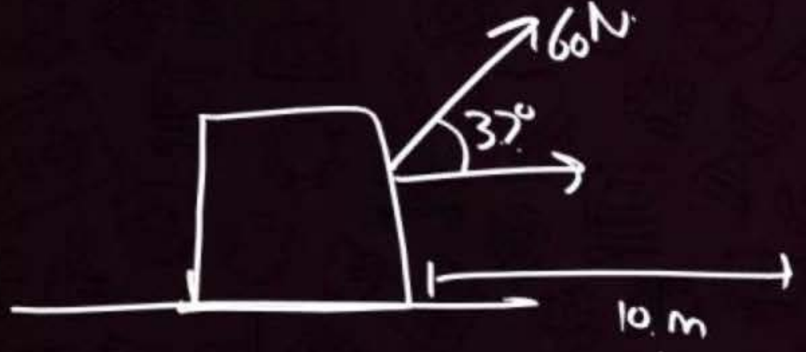
Difficulty Level : EASY

$\cos 37^\circ = 4/5$

$\cos 53^\circ = 3/5$

QUESTION-03

A force of 60 N is applied to displace a box by 10 m pulling it at an angle of 37° with the horizontal.



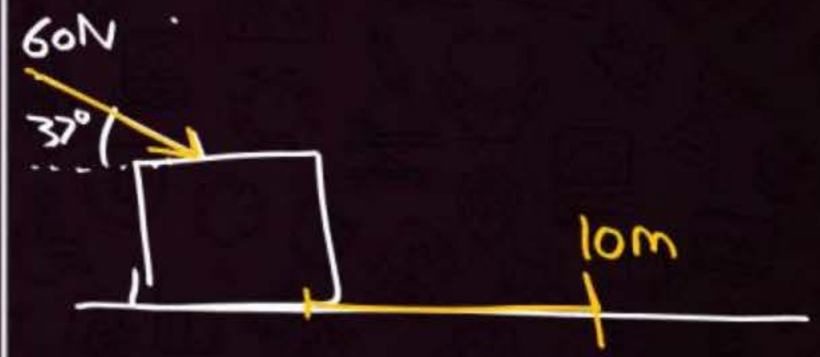
$W = FS\cos\theta = 60 \times 10 \times \frac{4}{5} =$

$= 120 \times 4$

$= 480$ J

QUESTION-04

A force of 60 N is applied to displace a box by 10 m pushing it at an angle of 37° with the horizontal.



$W =$ same

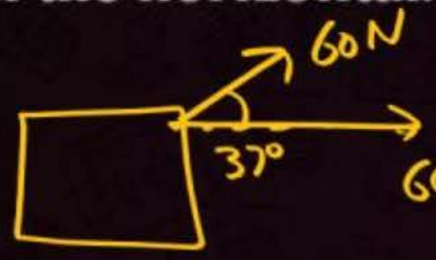
$= 480$ J

Calculate work done when

Difficulty Level : EASY

QUESTION-05

A force of 60 N is applied to a box of mass 20 kg for 10 s pulling it at an angle of 37° with the horizontal.



$60\cos 37° = 60 \times \frac{4}{5} = 12 \times 4 = 48N$



$a = \frac{F}{m} = \frac{48}{20} = 2.4 m/s^2$

$S = \frac{1}{2}at^2 = \frac{1}{2} \times 2.4 \times 10 \times 10 = 120 m$

$W = 48 \cdot 120 = 5760 J$

QUESTION-06

A force of 60 N is applied to a box of mass 20 kg for 10 s pushing it at an angle of 37° with the horizontal.

Same

$W = 5760 J$

Difficulty Level : EASY

QUESTION-07

A body moves a distance of 10 m along a straight line under the action of a 5 N force. If the work done is 25 J, then angle between the force and direction of motion of the body is: [1997]

(S) (F) (W) (θ)

1. 60°
2. 75°
3. 30°
4. 45°

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

$25 = 5 \cdot 10 \cos\theta$

$\cos\theta = \frac{25}{50} \frac{1}{2}$

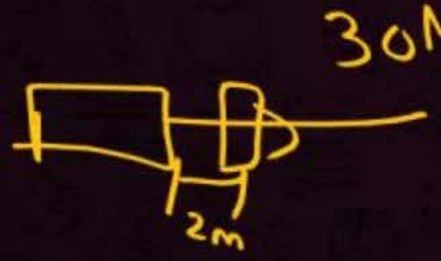
$\theta = 60^\circ$

$\cos 0^\circ = 1$
$\cos 30^\circ = \sqrt{3}/2$
$\cos 45^\circ = 1/\sqrt{2}$
$\cos 60^\circ = 1/2$
$\cos 90^\circ = 0$

Difficulty Level : EASY

QUESTION-08

In a string pulley system block of mass 10 kg is pulled up by 2 m by tension of 30 N. What is the work done by tension. [Prachand 2024]



$W = F s$

$= 30 \times 2$

$= 60 J$

2.2 Work Variable Force – F , x

$F = 2x$

$W = \int F \cdot dx = \int 2x \cdot x = 2\left[\frac{x^2}{2}\right]$

$\int x^n dx = \frac{x^{n+1}}{n+1}$

$\int x^5 dx = \frac{x^6}{6}$

$\int x^{11} dx = x^{12}/12$

$\int_2^4 x^2 dx = \left[\frac{x^3}{3}\right]_2^4 = \frac{4^3 - 2^3}{3}$ ✓

Difficulty Level : MEDIUM

QUESTION-09

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 to move the particle from $y = 0$ to $y = 1$m is

[2019]

1. 30 J
2. 5 J
3. 25 J ✓
4. 20 J

$$W = \int F \cdot dy$$

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

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

$$= 20(1-0) + 5(1^2 - 0^2)$$

$$= 20 + 5 = 25\ \text{J}$$ ✓

Difficulty Level : MEDIUM

QUESTION-10

A position dependent force, $F = (7 - 2x + 3x^2)$ N acts on a small body of mass 2 kg and displaces from $x = 0$ to $x = 5$m The work done in joule is: [1994, 92]

1. 135
2. 270
3. 35
4. 70

$$W = \int F \cdot dx$$

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

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

$$= 7 \times 5 - 5^2 + 5^3$$

$$= 35 - 25 + 125 = 135\ \text{J}$$

2.3 Work Variable Force - t

$F = t^3$ $\quad m = 2kg$

$t = 2$ to 3 sec

$a = \frac{F}{m} = \frac{t^3}{2}$

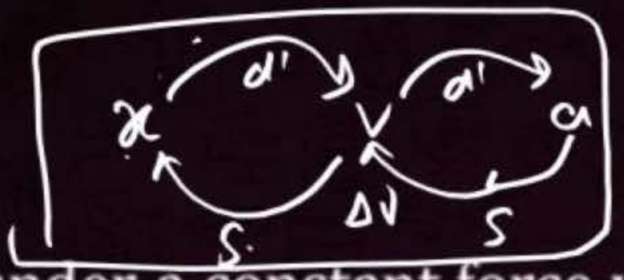
$\Delta V = \int a\,dt = \int \frac{t^3}{2}\,dt = \frac{t^4}{2 \times 4} = \frac{t^4}{8}$

$u = 0$

$v = \frac{t^4}{8}$

$S = \int v\,dt = \int \frac{t^4}{8}\,dt = \frac{t^5}{5 \times 8} = \left[\frac{t^5}{40}\right] = \frac{3^5 - 2^5}{40} = \frac{243 - 32}{40}$ ✓✓

QUESTION-11



Difficulty Level : HARD

A body of mass 3 kg is under a constant force which causes a displacement s in meters in it, given by the relation $s = (1/3)t^2$ where t is in s. Work done by the force in 2 s is:

[2006]

1. (17/3) J
2. (3/8) J
3. (8/3) J
4. (3/17) J

$s = \frac{t^2}{3}$

$v = \frac{ds}{dt} = \frac{2t}{3}$

$a = \frac{dv}{dt} = \frac{2}{3}$

$F = ma = 3 \times \frac{2}{3} N$

$t = 0$	$t = 2$
$s = \frac{0^2}{3}$	$s = \frac{2^2}{3} = \frac{4}{3}m$

$W = F \cdot S$

$= 2 \times \frac{4}{3} = \frac{8}{3} J$

QUESTION-12

Difficulty Level : ~~HARD~~ YODHA

If $x = 3 - 4t^2 + t^3$, then work done in first 4 sec will be (Mass of the particle is 3 gram): [1998]

(1) 384 mJ

(2) 168 mJ

(3) 192 mJ

(4) None of these

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

$v = -8t + 3t^2$

$a = -8 + 6t$

$F = ma =$

$F = \frac{3}{1000}(-8 + 6t)$

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

$dx = -8t + 3t^2 (dt)$

$W = \int F \cdot dx$

$= \int \frac{3}{1000}(6t - 8)(-8t + 3t^2)dt$

QUESTION-12

Difficulty Level : ~~HARD~~ YODHA

If $x = 3 - 4t^2 + t^3$, then work done in first 4 will be (Mass of the particle is 3 gram): [1998]

(1) 384 mJ

(2) 168 mJ

(3) 192 mJ

(4) None of these

(I) $x = 3 - 4t^2 + t^3$

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

$a = -8 + 6t$

(II) $F = ma = \frac{3}{1000}(6t - 8)$

(III) $dx = (3t^2 - 8t)dt$

$W = \int F \cdot dx$

$= \frac{3}{1000}(6t - 8)(3t^2 - 8t)\,dt$

$= \frac{3\times 2}{1000}\int (3t - 4)(3t^2 - 8t)\,dt$

$= \frac{6}{1000}\int [9t^3 - 24t^2 - 12t^2 + 32t]\,dt$

$= \frac{6}{1000}\int (9t^3 - 36t^2 + 32t)\,dt$

$= \frac{6}{1000}\left[\frac{9t^4}{4} - \frac{36t^3}{3} + \frac{32t^2}{2}\right]$

$= \frac{6}{1000}\left(\frac{9\times 5^4}{4} - \frac{36\times 5^3}{3} + \frac{32\times 5^2}{2}\right)$

$= \frac{7}{}$

QUESTION-12

Difficulty Level : ~~HARD~~ YODHA

If $x = 3 - 4t^2 + t^3$, then work done in first 4 will be (Mass of the particle is 3 gram): [1998]

1. 384 mJ
2. 168 mJ
3. 192 mJ
4. None of these

$W = \Delta KE$

$v = -8t + 3t^2$

$t = 0 \quad v = 0$

$t = 4 \quad v = -8 \times 4 + 3 \times 16$

$= -32 + 48$

$= 16$

$KE = \frac{1}{2}mv^2 = \frac{384\ J}{1000} = 384\ mJ$

2.4 Work Variable Force – v , x

$$a = v\frac{dv}{dx}$$

Difficulty Level : YODHA

QUESTION-13

A body of mass 0.5 kg travels in a straight line with velocity $v = kx^{3/2}$ where $k = 5\ m^{-1/2}\ s^{-1}$. The work done by the net force during its displacement from $x = 0$ to $x = 2$ m is

[NCERT Exemplar]

1. 1.5 J
2. 50 J
3. 10 J
4. 100 J

$(v = 5x^{3/2})$

$\left(\frac{dv}{dx} = \frac{3}{2} \cdot 5\, x^{1/2}\right)$

$a = v\frac{dv}{dx} = \left(5x^{3/2}\right)\left(\frac{15}{2} x^{1/2}\right)$

$\boxed{a = \frac{75}{2} x^2}$

$F = ma$

$F = \frac{1}{2} \times \frac{25}{2} x^2$

$W = \int F \cdot dx = \int_0^2 \frac{75}{4} x^2 \cdot dx$

$W = \frac{25}{4}\left[\frac{x^3}{3}\right]_0^2$

$= \frac{25}{4} \times 8 = 50$

$x^a x^b = x^{a+b}$

$\frac{x^{3/2}}{x^{1/2}} = x^{\frac{3}{2}-\frac{1}{2}} = x^{\frac{3+1}{2}} = x^{\frac{4}{2}} = x^2$

Difficulty Level : YODHA

QUESTION-13

A body of mass 0.5 kg travels in a straight line with velocity $v = kx^{3/2}$ where $k = 5\ m^{-1/2}\ s^{-1}$. The work done by the net force during its displacement from $x = 0$ to $x = 2$ m is

[NCERT Exemplar]

1. 1.5 J
2. 50 J
3. 10 J
4. 100 J

$(v = 5x^{3/2})$

$v^2 = (5x^{3/2})^2$

$v^2 = 25x^3$

$KE = \frac{1}{2}mv^2 = \frac{1}{2} \times \frac{1}{2} 25x^3$

$= \frac{25}{4}x^3$ ... 2

$\frac{25}{4} \times 8 \times 2 = 50\ J$

2.5 Work Vector

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

S dene ke tarike

- It moves By 2m is y direction $[S = 2\hat{j}]$
- It moves from (2,3,1) to (5,6,7) $[S = 3\hat{i} + 3\hat{j} + 6\hat{k}]$
- It moves by $\hat{i} + \hat{j} + \hat{k}$ $[S = \hat{i} + \hat{j} + \hat{k}]$
- It moves from $(\hat{i} + \hat{j} + \hat{k})$ to $(2\hat{i} + 3\hat{j} + 4\hat{k})$ $[S = \vec{r}_2 - \vec{r}_1 = (\hat{i} + 2\hat{j} + 3\hat{k})$

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

Calculate work done when

Difficulty Level : EASY

QUESTION-14

A force of $2\hat{i}$ N is applied on a block of mass 2 kg to move it by $3\hat{i}$ m.

$W = F \cdot s$

$= 2\hat{i} \cdot 3\hat{i} = 6$ J ✓

QUESTION-15

A force of $2\hat{i}$ N is applied on a block of mass 2 kg to move it by $3\hat{j}$ m.

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

$= 2\hat{i} \cdot 3\hat{j}$

$= 6(0) = 0$

QUESTION-16

A force of $2\hat{i} + 3\hat{j}$ N is applied on a block to move it by $5\hat{i} + 6\hat{j}$ m.

$10 + 18 = 28$ J

Calculate work done when

Difficulty Level : EASY

QUESTION-17

A force of $(2i+3j-k)N$ is applied on a block to move it by $(5i-6j+12k)m$

$W = 10 - 18 - 12$

$= -20J$

QUESTION-18

KODHA

$F=(3x)i+(y)jN$ is applied to move a block from (2,3) to (3,4)m.

x

$F = 3x$

$W_x = \int F\,dx$

$= \int 3x\,dx$

$= \frac{3}{2}\left[x^2\right]_2^3$

$= \frac{3}{2}(3^2-2^2)$

$= \frac{3}{2}(9-4) = \frac{15}{2}$

y

$F = y$

$W = \int F\,dy = \frac{y^2}{2}$

$W = \frac{4^2-3^2}{2} = \frac{16-9}{2}$

$W = \frac{7}{2}J$

$W = \frac{15}{2} + \frac{7}{2} = \frac{22}{2}$

$W = 11J$

QUESTION-19

HW

F=2i+3jN is applied to change position vector of a particle from r_1 to r_2 $(r_1=2i+4j, r_2=3i-2j)$

$\vec{S} = \vec{r}_2 - \vec{r}_1 = \hat{i} - 6\hat{j}$

2 - 18

$W = -16J$

QUESTION-18

$F=(3x)i+(y)jN$ is applied to move a block from (2,3) to (3,4)m.

QUESTION-18

$F=3x$

2

to 3,

$$W=\int F\cdot dx$$

$$=\int 3x\,dx=\int \frac{3x^2}{2}=\frac{3}{2}[x^2]_2^3$$

$$W=\frac{3}{2}[9-4]=\frac{3}{2}\times 5=\frac{15}{2}\,J.$$

QUESTION-18

$F=y$ $\quad y=3\text{ to }4$

$$W=\int F\cdot dy=\int y\,dy=\frac{y^2}{2}=\frac{4^2-3^2}{2}=\frac{16-9}{2}$$

$$W=7/2$$

$$W_T=W_x+W_y$$

$$=\frac{15}{2}+\frac{7}{2}=\frac{22}{2}=11\,J$$

QUESTION-20

Difficulty Level : MEDIUM

A particle moves from a point $(-\hat{i}+5\hat{j})$ 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? [2016-II]

$\vec{r_1}$ $\vec{r_2}$

$\vec{s} = \vec{r_2} - \vec{r_1}$

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

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

$\vec{F} = 4\hat{i} + 3\hat{j} + 0\hat{k}$

$W = \vec{F} \cdot \vec{s} = 4 - 3 = 1\,J$

1. 5 J
2. 2 J
3. 8 J
4. 1 J

Difficulty Level : MEDIUM

QUESTION-21

A uniform force of $(3\hat{\imath} + \hat{\jmath})$ newton acts on a particle of mass 2 kg. Hence the particle displaced from position $(2\hat{\imath} + \hat{k})$ metre to position $(4\hat{\imath} + 3\hat{\jmath} - \hat{k})$ metre. The work done by the force on the particle is: [2013]

HW

1. 15 J
2. 9 J
3. 6 J
4. 13 J

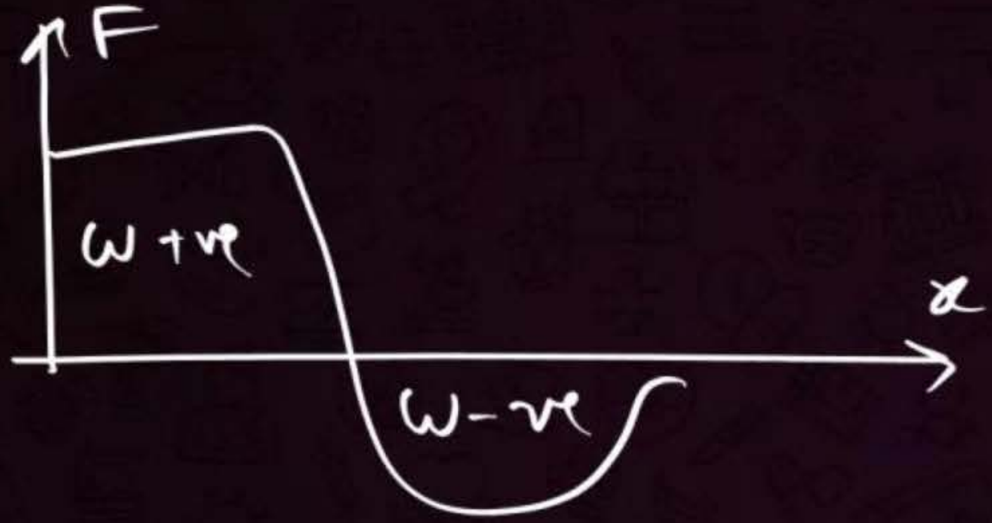
Difficulty Level : EASY

QUESTION-22

A body, constrained to move in y-direction, is subjected to a force given by overline $\vec{F} = (-2\hat{\imath} + 15\hat{\jmath} + 6\hat{k})$ N. The work done by this force in moving the body through a distance of 10 m along y-axis, is: [1994]

1. 150 J
2. 20 J
3. 190 J
4. 160 J

2.6 Work Done Using Graphs





$W = (\text{Area})\,\text{mass}$

Area of F-S $\Rightarrow$ work

(Area of a-S) $\times$ mass $\Rightarrow$ work

Difficulty Level : EASY

QUESTION-23

The area under force-displacement curve represents

[NCERT Based]

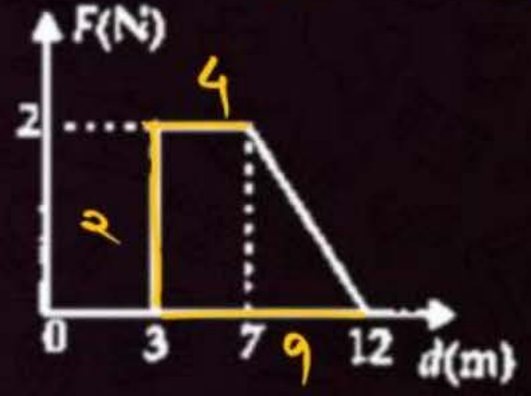
1. velocity
2. acceleration
3. impulse
4. work done

Difficulty Level : EASY

QUESTION-24

Force F on a 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:

[2011 Pre]



1. 18 J
2. 21 J
3. 26 J
4. 13 J

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

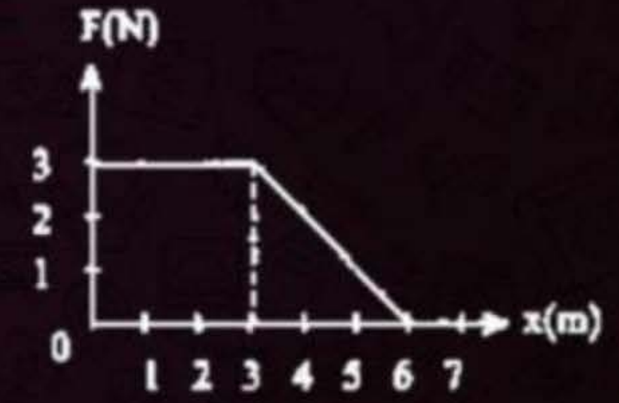
$W = 13\ J$

Difficulty Level : EASY

QUESTION-25

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

[2005]



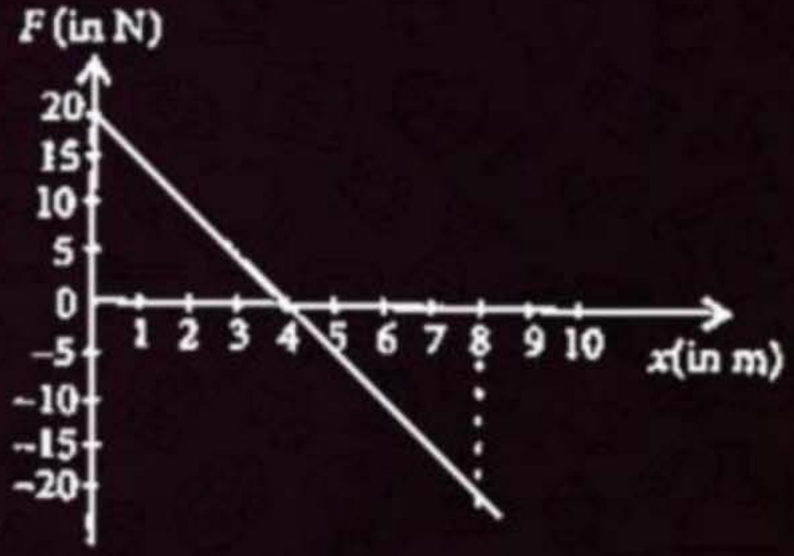
1. 10.5 J
2. 13.5 J
3. 8.5 J
4. 6.5 J

Difficulty Level : MEDIUM

QUESTION-26

A force F acting on an object varies with distance x as shown in the figure. The work done by the force in moving the object from $x = 0$ to $x = 8\ m$ is

[NCERT Based]



1. zero J
2. 80 J
3. −40 J
4. 40 J

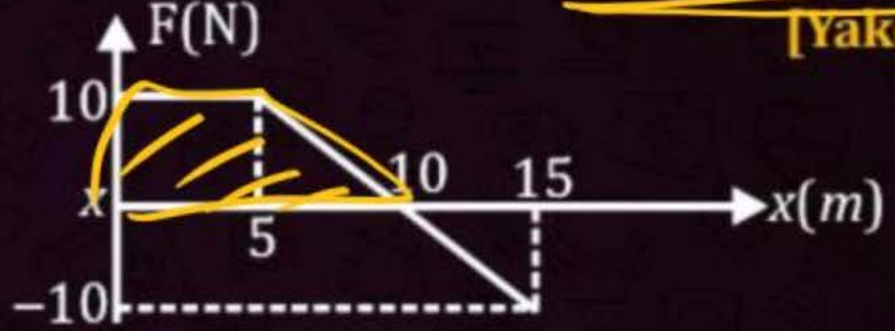
Difficulty Level : MEDIUM

QUESTION-27

A horizontal force F is used to pull a box placed on a floor. Variation in the force with position coordinate x measured along the floor is shown in the graph. Calculate the work done by the force in moving the box from $x = 0$ to $x = 10$ m.

[Yakeen 3.0]





Difficulty Level : HARD

QUESTION-28

Figure gives the acceleration of a 2.0 kg body as it moves from rest along x axis while a variable force acts on it form $x = 0$ m to $x = 9$ m. The work done by the force on the body when it reaches

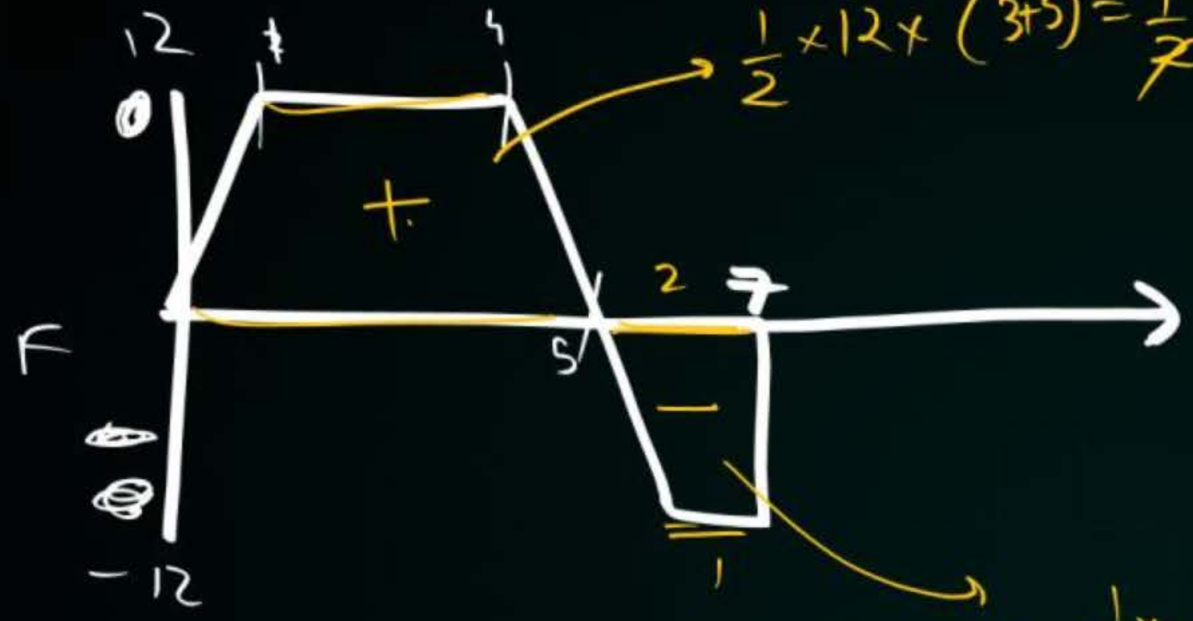
(i) $x = 4$ m and

(ii) $x = 7$ m shall be as given

[Yakeen 3.0]



1. 21 J and 33 J respectively
2. 21 J and 15 J respectively
3. 42 J and 60 J respectively
4. 42 J and 30 J respectively



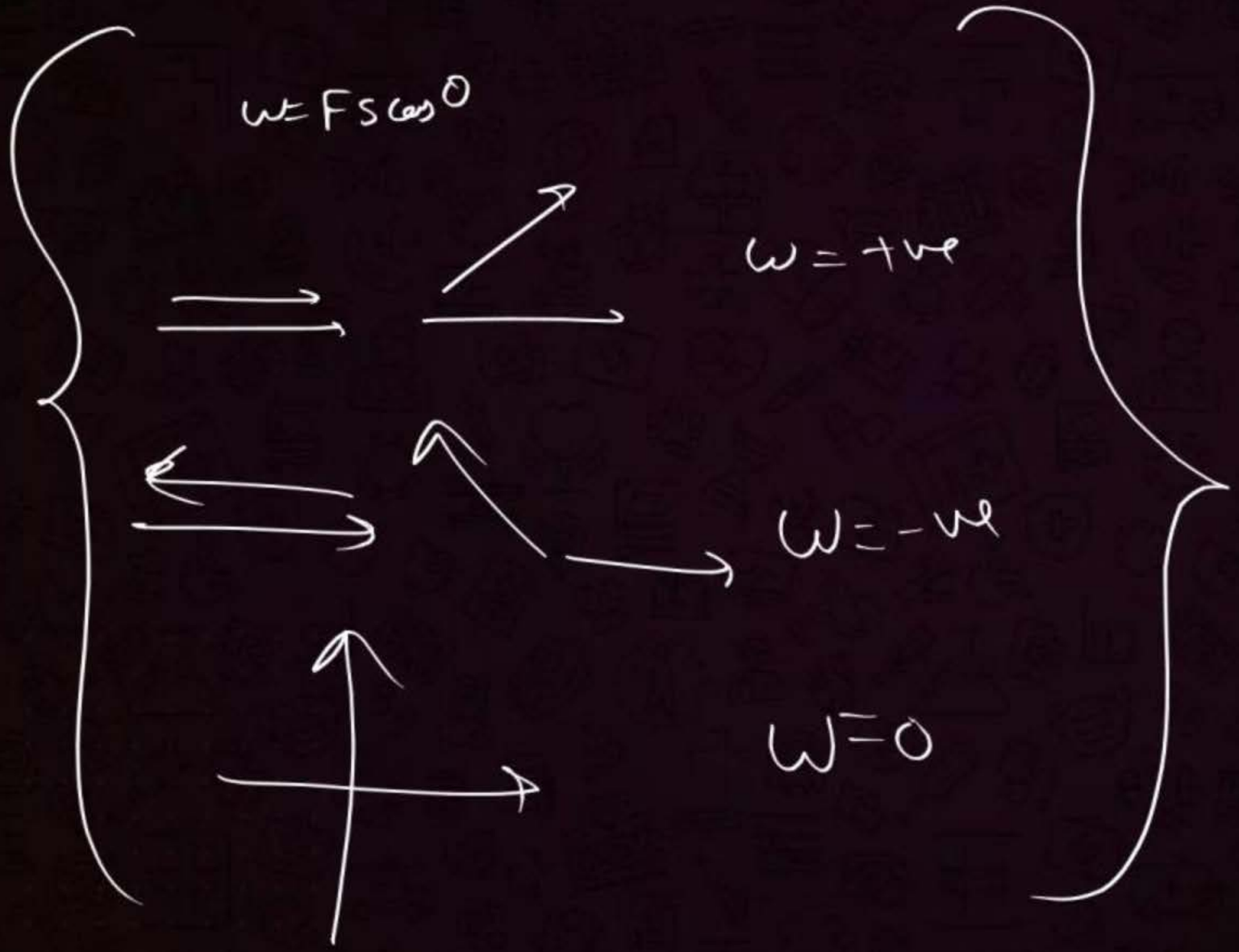
$\frac{1}{2} \times 12 \times (3+5) = \frac{1}{2} \times 12 \times 8 = 48\,J$

$-\frac{1}{2} \times 12 \times (1+2) = -6 \times 3 = -18\,J$

$W = 48 - 18\,J$

$W = 30\,J$

2.7 Work Done Directions

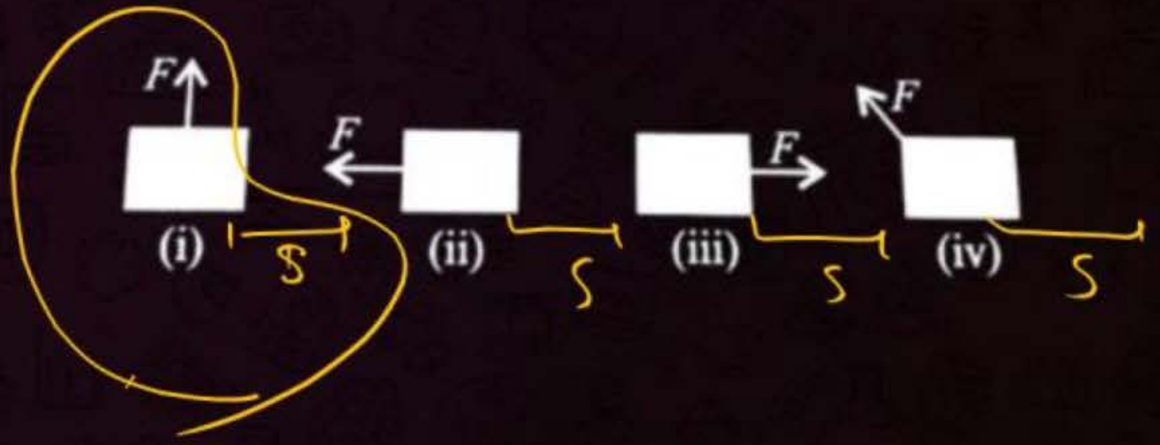


Difficulty Level : EASY

QUESTION-29

Figure shows four situations in which a force is applied to a block. In all four cases, the force has the same magnitude, and the displacement of the block is to the right and of the same magnitude. Which of the following cases work done by the applied force on the block is zero?

[NCERT Based]



1. (i)
2. (ii)
3. (iii)
4. (iv)

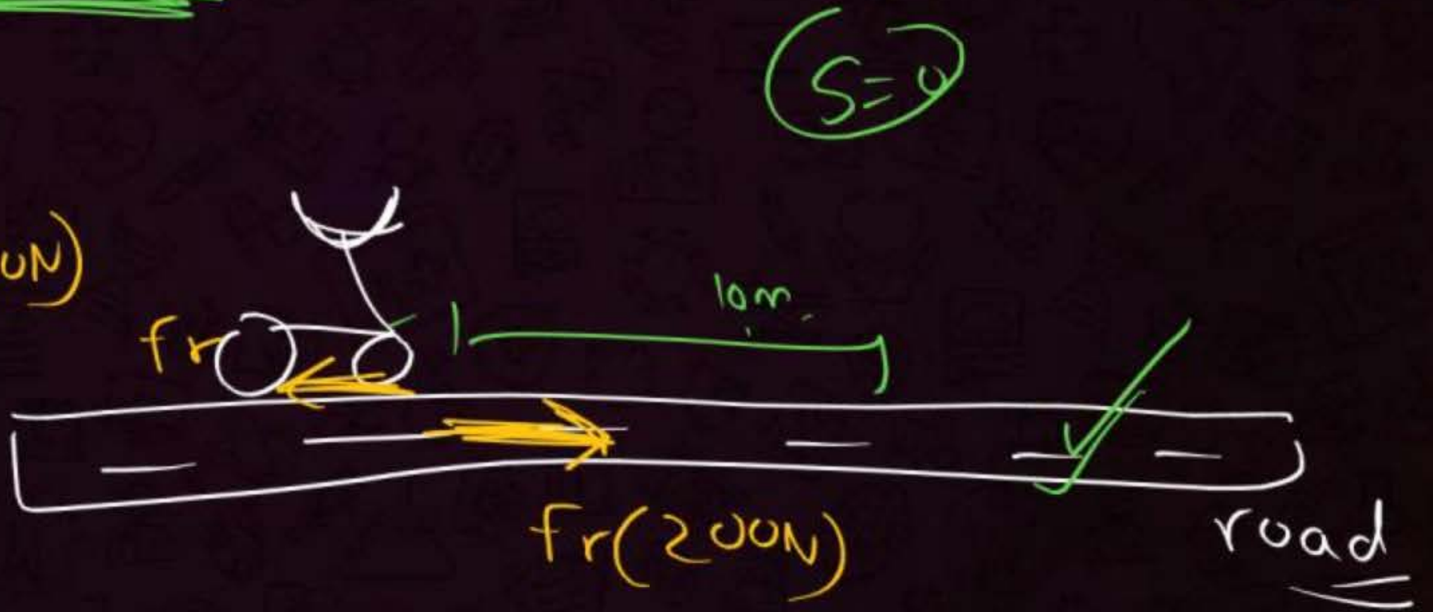
Difficulty Level : HARD

QUESTION-30

A bicyclist comes to a skidding stop in 10 m. During this process, the force on the bicycle due to the road is 200 N and is directly opposed to the motion. The work done by the cycle on the road is

[NCERT Exemplar]

1. + 2000 J
2. – 200 J
3. zero
4. – 20000 J

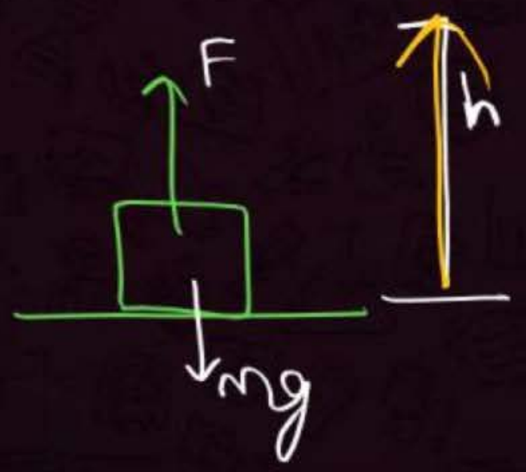


Difficulty Level : EASY

QUESTION-31

A body is being raised to a height h from the surface of earth. What is the sign of work done by applied force and gravitational force respectively? [NCERT Based]

1. Positive, Positive
2. Positive, Negative
3. Negative, Positive
4. Negative, Negative



D $\left(W_F, W_{mg}\right)$ $\left(+ve, -ve\right)$

Difficulty Level : MEDIUM

QUESTION-32

A weightlifter lifts a weight off the ground and holds it up then [NCERT Based]

1. work is done in lifting as well as holding the weight
2. no work is done in both lifting and holding the weight
3. work is done in lifting the weight but no work is required to done in holding it up
4. no work is done in lifting the weight but work is required to be done in holding it up.

Difficulty Level : YODHA

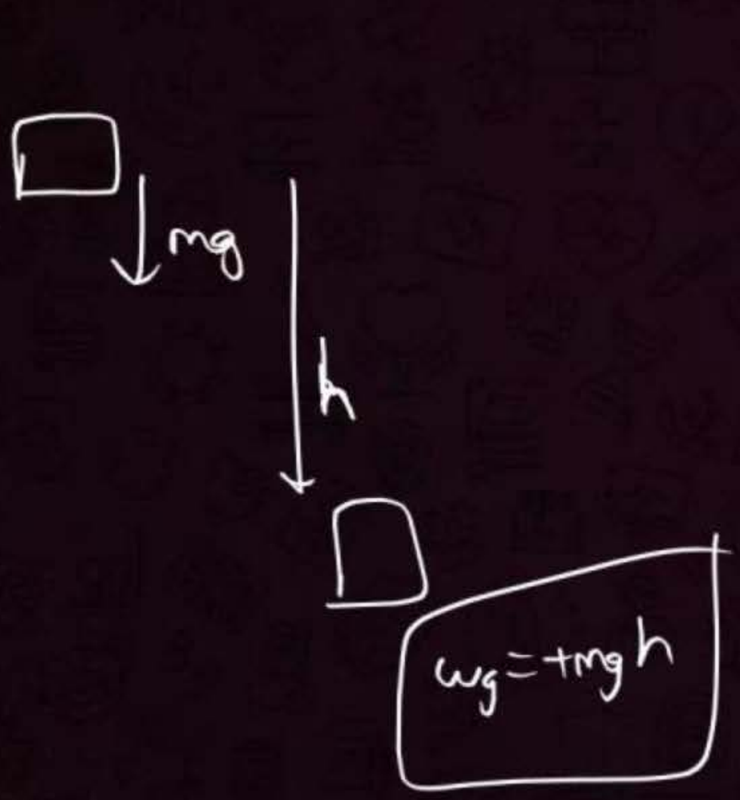
QUESTION-33

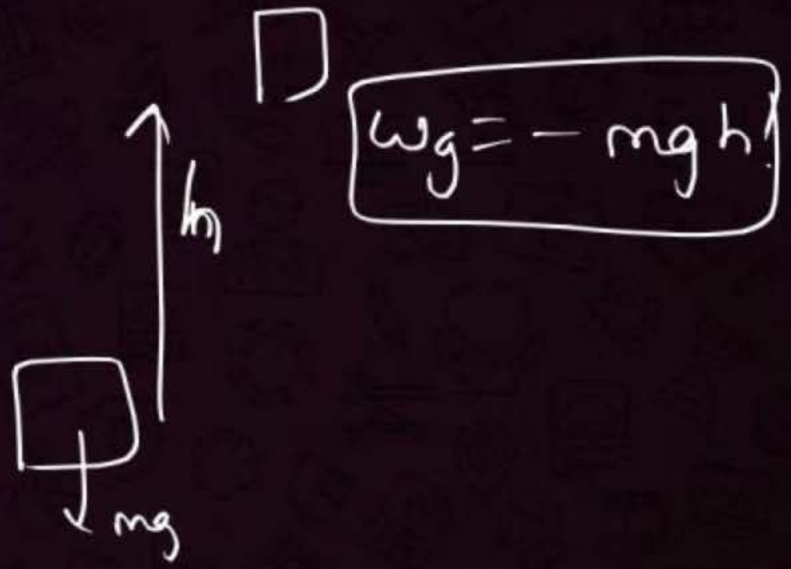
No work may be done by a force on an object if. (Identify Wrong Statement)

[HCV Objective]

1. the force is always perpendicular to its velocity (Uniform Circular Motion) W=0
2. the force is always perpendicular to its acceleration — Ajeeb hoga but ho sakta hai
3. the object is stationary but the point of application of the force moves on the object S=0 W=0
4. the object moves in such a way that the point of application of the force remains fixed. W=0

2.8 Work Done by Gravitation Force

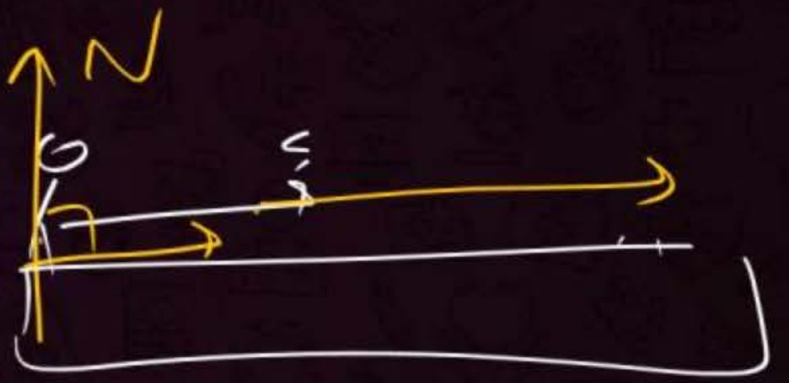




Difficulty Level : EASY

QUESTION-34

A person of mass m is standing on one end of a plank of mass M and length L and floating in water. The person moves from one end to another and stops. Work done by normal force is-



1. MgL
2. mgL
3. $mMgL/(M+m)$
4. 0 ✓

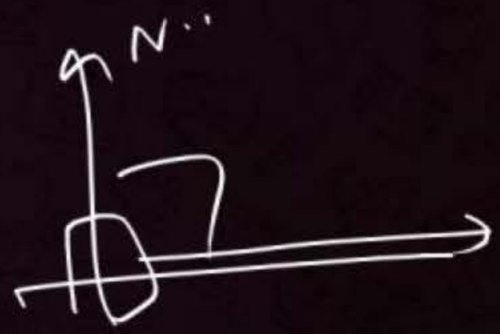
Difficulty Level : EASY

QUESTION-35

A 2 kg mass lying on a table is displaced in the horizontal direction through 50 cm. The work done by the normal reaction will be

HW

1. 0
2. 100 joule
3. 100 erg
4. 10 joule



Difficulty Level : MEDIUM

QUESTION-36

A body of mass M tied to a string is lowered at a constant acceleration of $(g/4)$ through a vertical distance h. The work done by the string will be

1. $3\,Mgh/4$
2. $Mgh/4$
3. $-3Mgh/4$
4. $-Mgh/4$



$a = \frac{g}{4}$

$g_{eff} = g - a$

$= g - \frac{g}{4}$

$= \frac{3g}{4}$

$T = \frac{3mg}{4}$



$W = -\frac{3}{4}mgh$

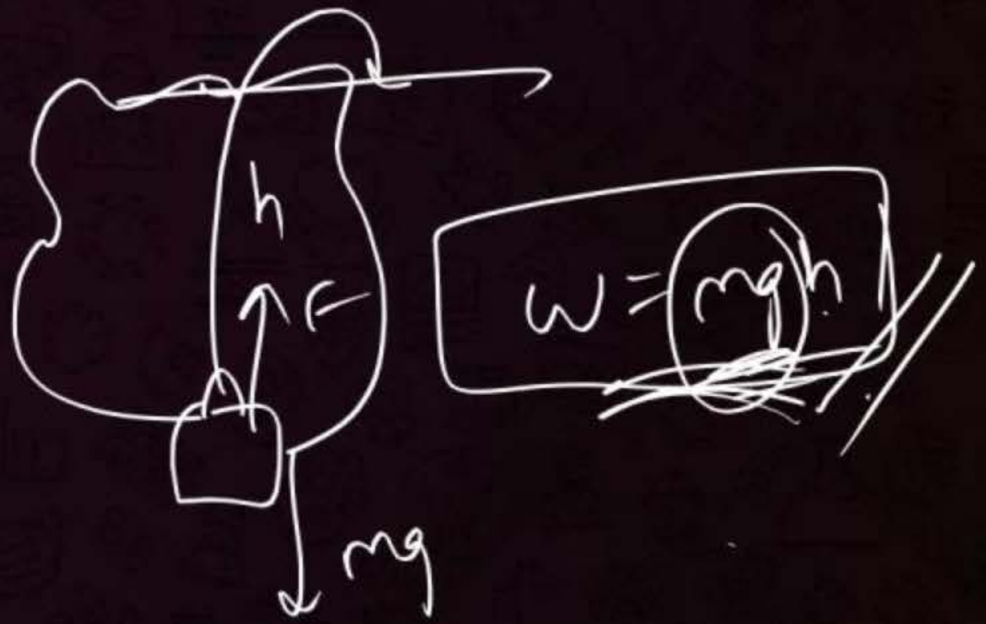
Difficulty Level : MEDIUM

QUESTION-37

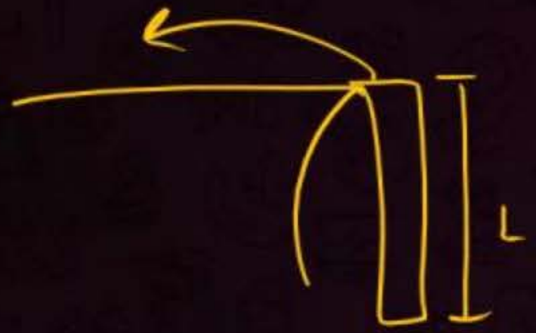
You lift a suitcase from the floor and keep it on a table. The work done by you on the suitcase depend on

[HCV Objective]

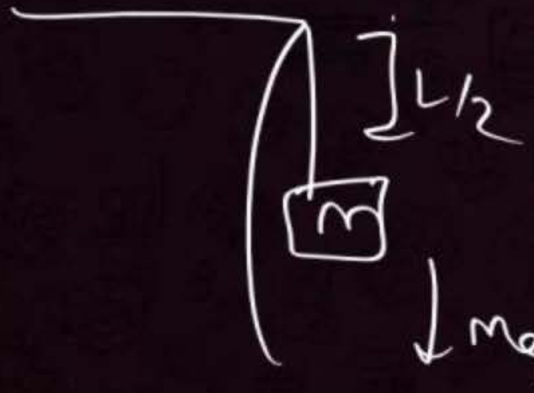
1. the path taken by the suitcase
2. the time taken by you in doing so
3. the weight of the suitcase
4. your weight.



2.9 Pulling up a Hanging Chain



$$W_g = -\frac{m_{latka}\, g\, l_{latka}}{2}$$



$$W_g = -\frac{mgL}{2}$$

Difficulty Level : HARD

QUESTION-38

A uniform chain of length 2 m is kept on a table such that a length of 60 cm hangs freely from the edge of the table. The total mass of the chain is 4 kg. The work done in pulling the entire chain on the table (Take $g = 10\ m\ s^{-2}$)

[NCERT Based]

1. 12.9 J
2. 6.3 J
3. 3.6 J
4. 2.0 J

$2\ m \rightarrow 4\ kg$

$200\ cm \rightarrow 4\ kg$

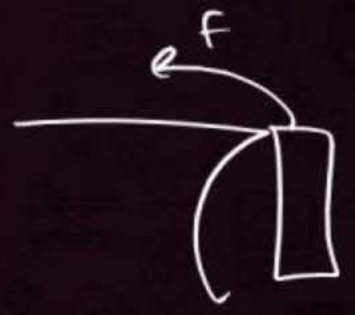
$1\ cm \rightarrow \frac{4}{200}\ kg$

$60\ cm = \frac{4 \times 60}{200}\ kg$

$m = \frac{6}{5}\ kg$

$l = 60\ cm$

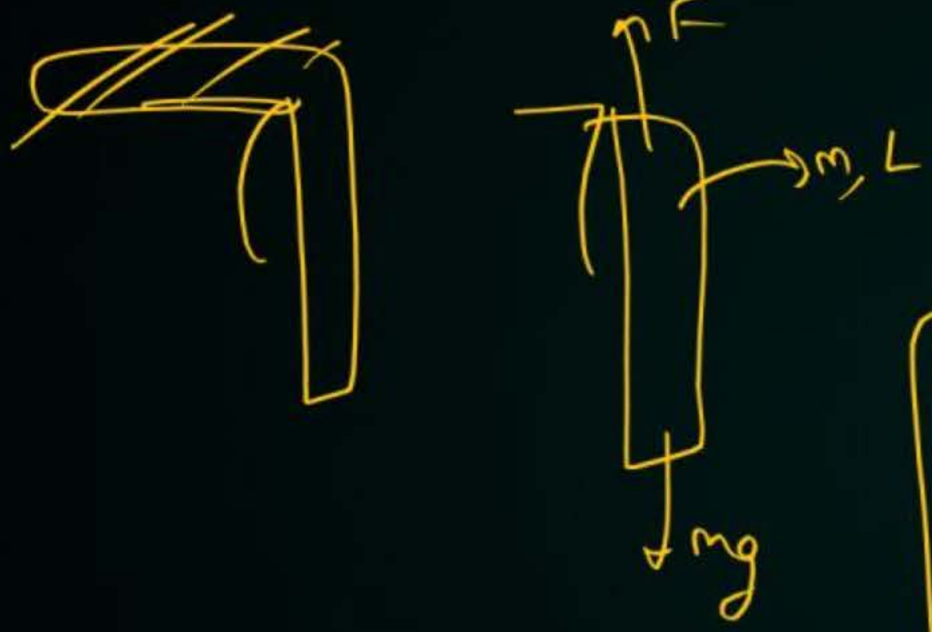
$l = \frac{3}{5}\ m$



$W_F = \frac{mgL}{2}$

$= \frac{6}{5} \times \frac{10 \times 3}{2 \times 5}$

$= \frac{18}{5} = 3.6\ J$



$$W_g = -\frac{mgL}{2}$$

$$W_F = \frac{mgL}{2}$$

Difficulty Level : HARD

QUESTION-39

A uniform chain of length L and mass M is lying on a smooth table and one third of its length is hanging vertically down over the edge of the table. If g is acceleration due to gravity, work required to pull the hanging part on to the table is

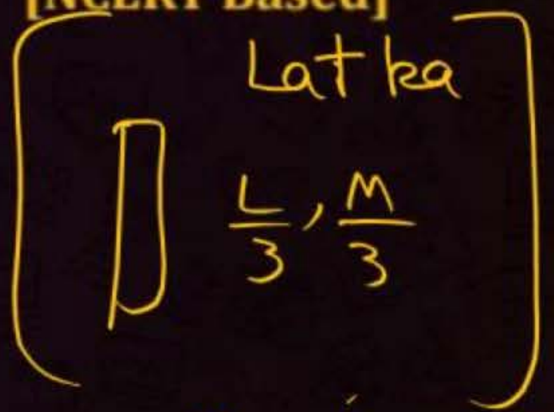
[NCERT Based]

(1) MgL

(2) $\frac{MgL}{3}$

(3) $\frac{MgL}{9}$

(4) $\frac{MgL}{18}$



$W_F = \frac{MgL}{2} = \frac{M}{3} g \frac{L}{3} = \frac{MgL}{18}$

2.10 Work Done by Frictional Force

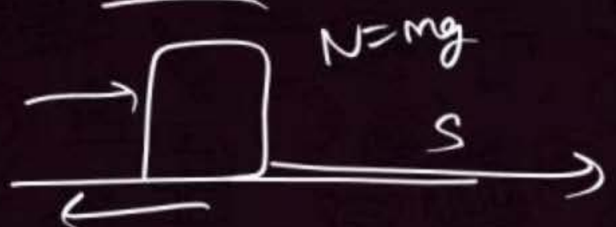
Static f

$W = 0$

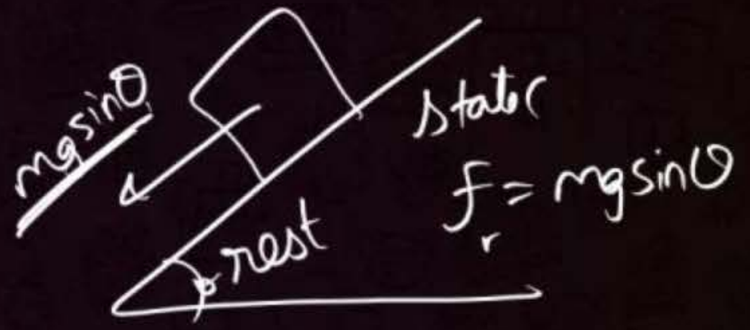


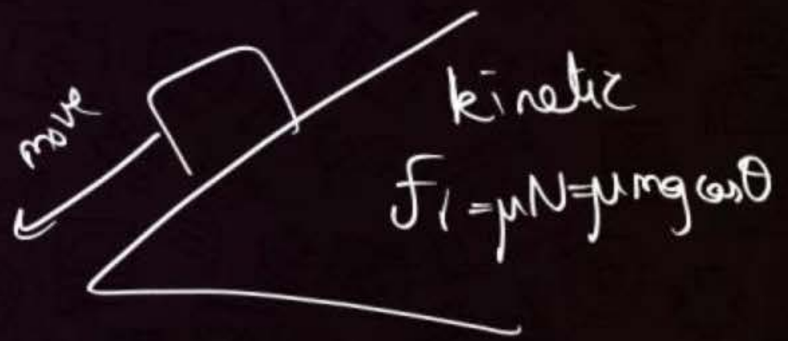
$W_{\text{static friction is zero in this case}}$

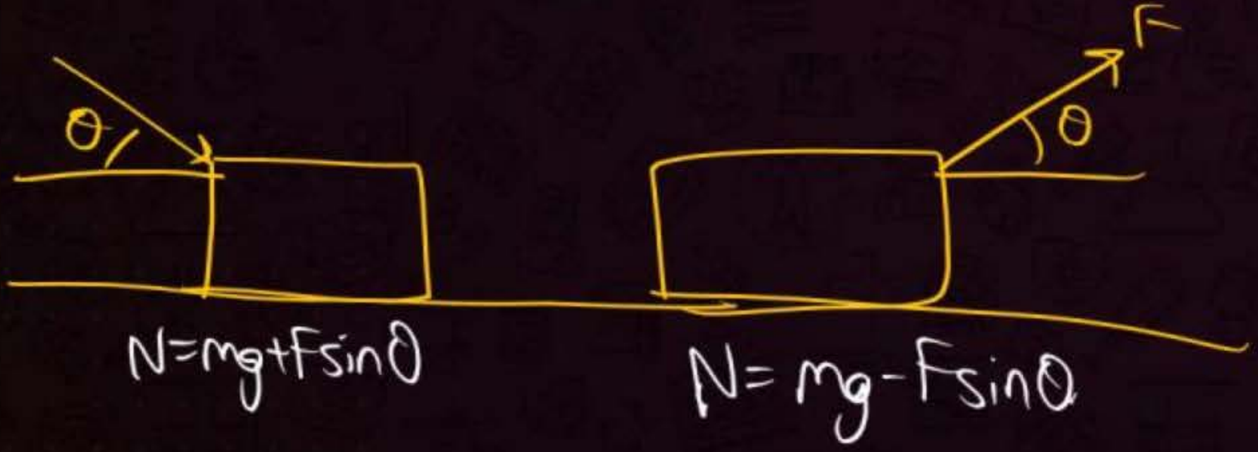
kinetic



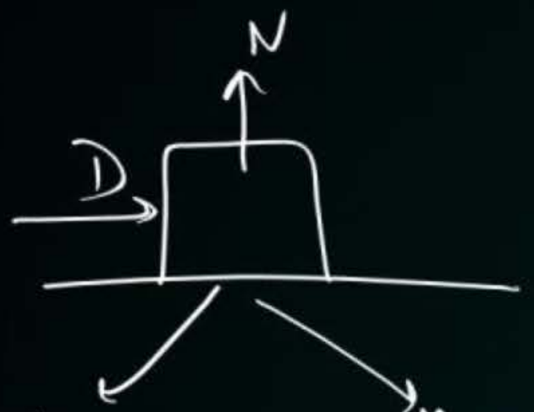
$W_f = -\mu mg s$







Revise f_r

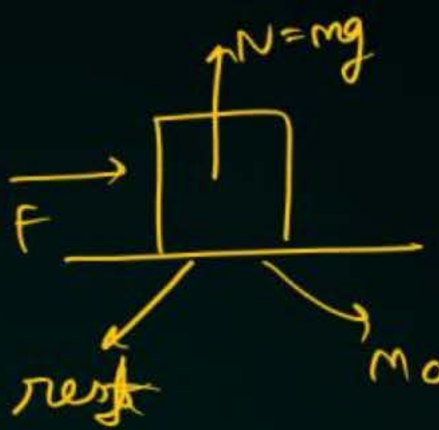


Rest
static

$f = D$

Move
kinetic

$f_r = \mu N$

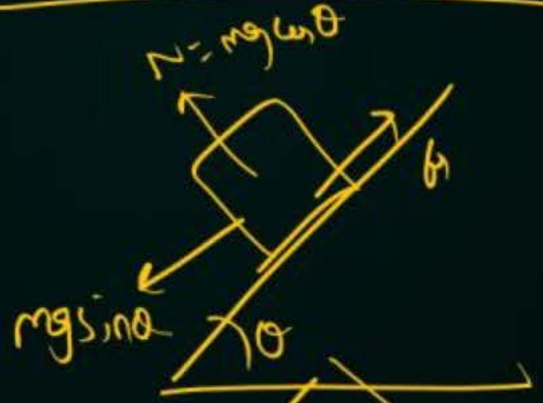


rest

Move

$f_r = F$

$f_r = \mu mg$



rest

move

$f_r = mg \sin\theta$

$f_r = \mu N = \mu mg \cos\theta$

Difficulty Level : HARD

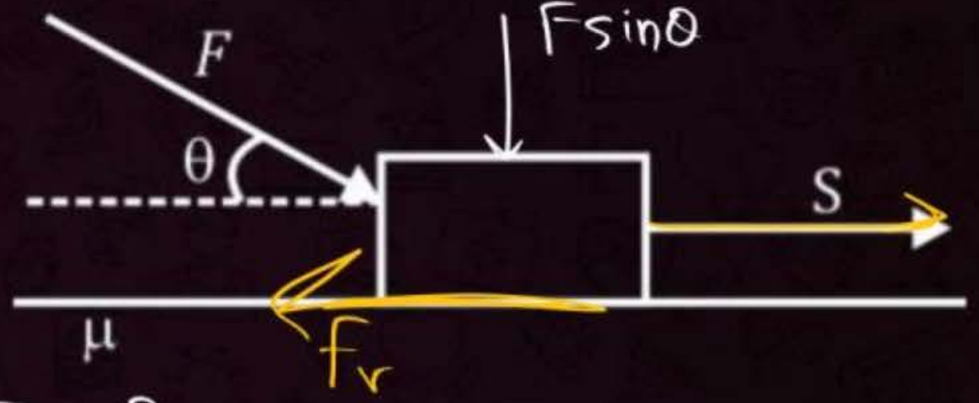
QUESTION-40

Find work done by friction for displacement 'S'?

kinetic, static

$W = -\mu N s$

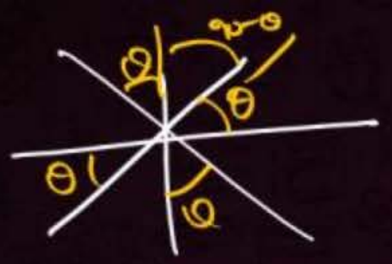
1. $\mu\,(mg + F\sin\theta).s$
2. $-\mu\,(mg + F\sin\theta).s$
3. $\mu(mg - F\sin\theta).s$
4. $-\mu\,(mg - F\sin\theta).s$



$N = mg + F\sin\theta$

$f = \mu N = \mu(mg + F\sin\theta)$

$W = -\mu(mg + F\sin\theta)\,S$



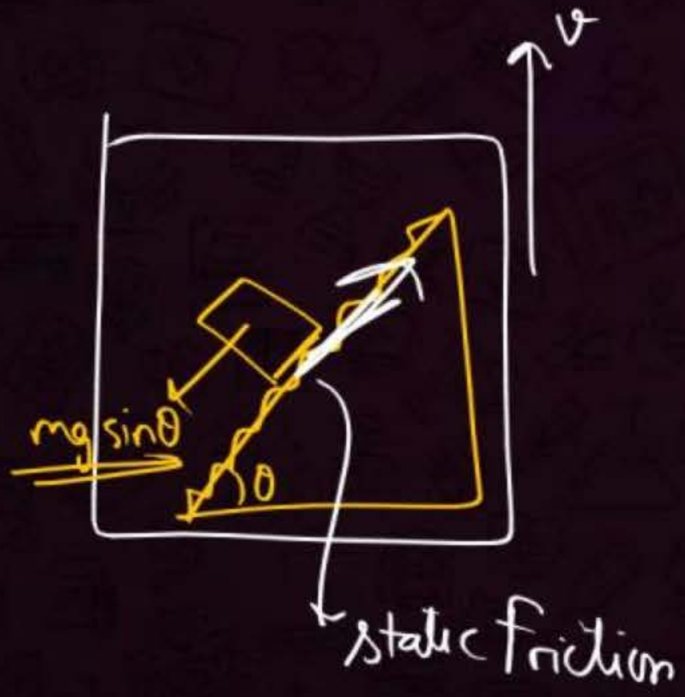
Difficulty Level : YODHA

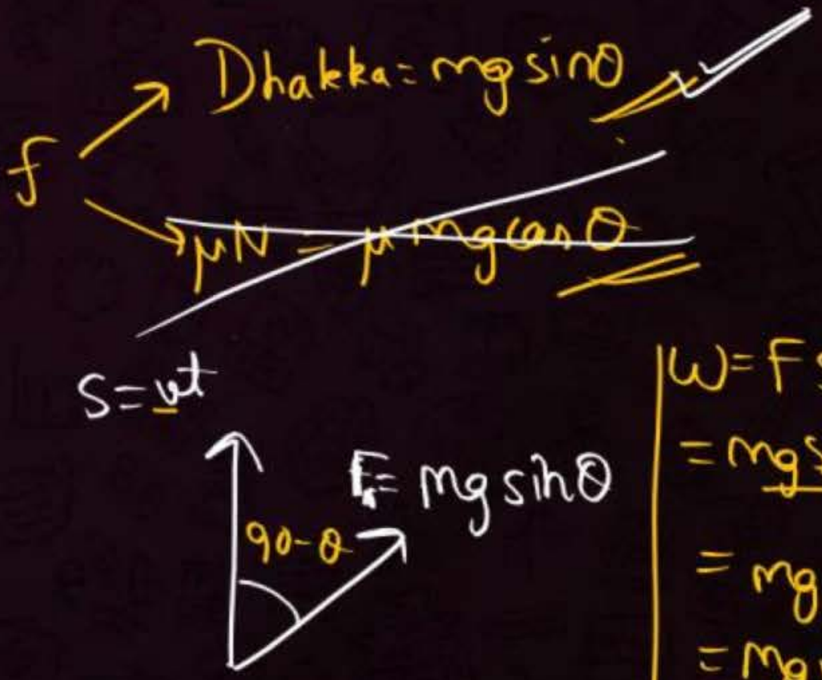
QUESTION-41

A small block of mass m is kept on a rough inclined surface of inclination θ fixed in an elevator. The elevator goes up with a uniform velocity v and the block does not slide on the wedge. The work done by the force of friction on the block in time t will be

[HCV Objective]

1. zero
2. $mgvt\cos^2\theta$
3. $mgvt\sin^2\theta$
4. $mgut\sin 2\theta$





$W = F S \cos(90-\theta)$

$= mg\sin\theta\ ut\ \cos(90-\theta)$

$= mg\ ut \sin\theta \sin\theta$

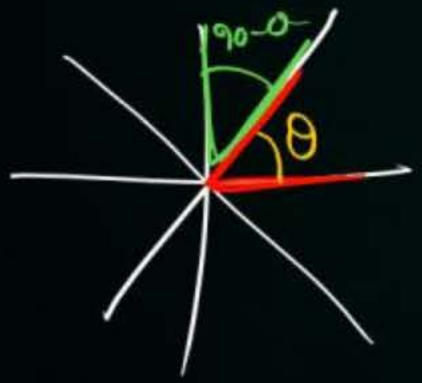
$= mgut\sin^2\theta$

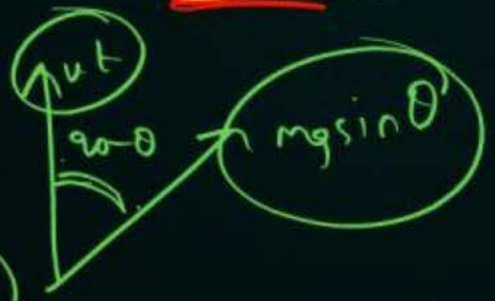
(I) v, t — displacement $= vt$

(II) f_r = static = Dhakka — $f = mg\sin\theta$



(III)





(IV) $W = mg\sin\theta \; vt \; \cos(90-\theta)$

$= mg\sin\theta \, vt \sin\theta$

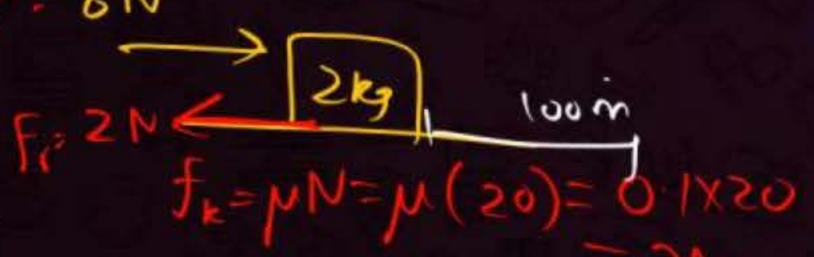
$W = mgvt\sin^2\theta$

A block of mass 2 kg initially at rest moves under the action of an applied horizontal force of 6 N on a rough horizontal surface. The coefficient of friction between block and surface is 0.1. (Take $g = 10\ m\ s^{-2}$) **Difficulty Level : HARD**

QUESTION-42

The work done by the applied force in 10 s is **[NCERT Based]**

1. 200 J
2. –200 J
3. 600 J
4. –600 J



$f_k = \mu N = \mu(20) = 0.1 \times 20 = 2N$

$a = \frac{F_{net}}{m} = \frac{6-2}{2} = \frac{4}{2} = 2\ m/s^2$

$S = \frac{1}{2}at^2 = \frac{1}{2} \times 10 \times 10 = 100\ m$

$W_F = 600\ J$

QUESTION-43

The work done by the ~~applied~~ friction in 10 s is **[NCERT Based]**

1. 200 J
2. –200 J
3. 600 J
4. –600 J

$W_{fr} = -200\ J$

$W_{total} = W_F + W_{fr}$

$= 600 - 200$

$= 400\ J$

Horizontal Plane



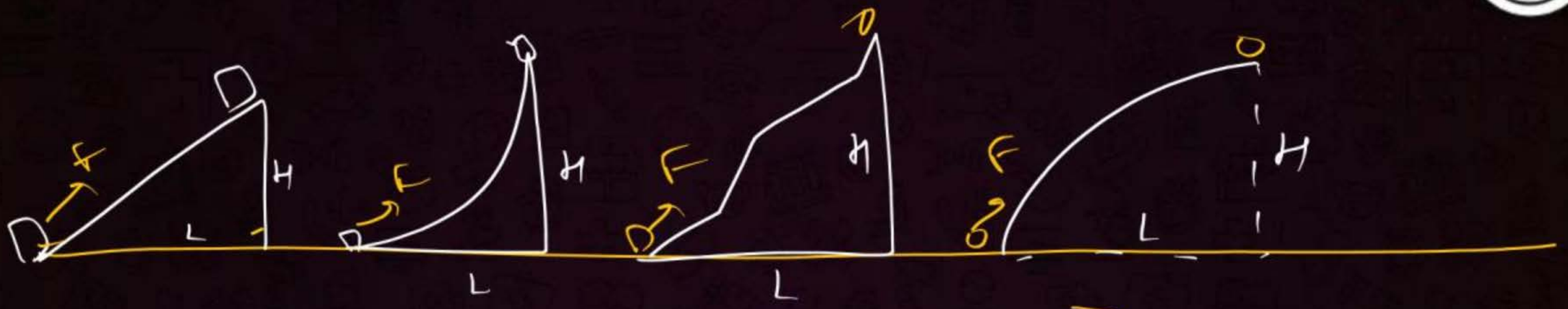
$$W_{fr} = -\mu mg\,(\text{Path})$$



$W = 0$

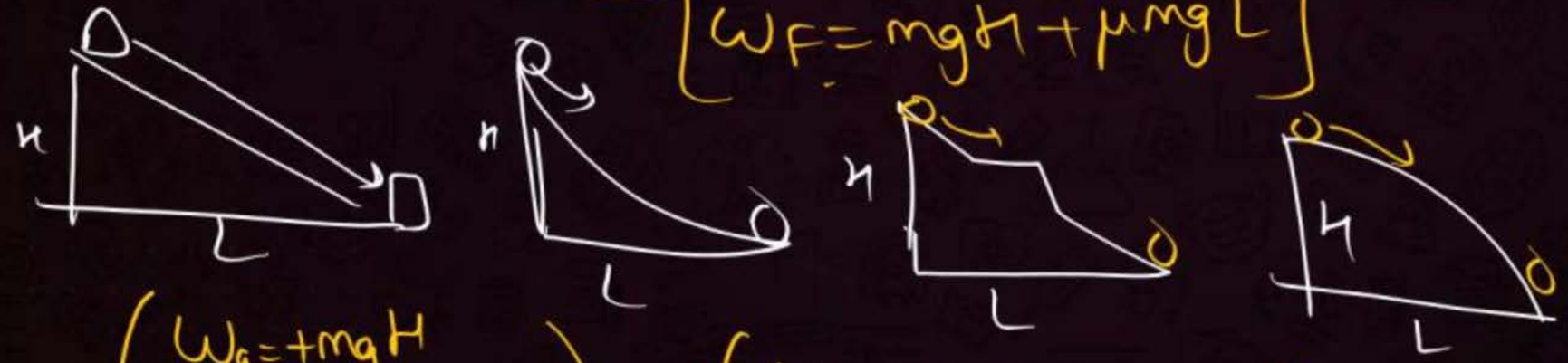
$(W_{fr} \neq 0)$

2.11 UPHILL DOWNHILL



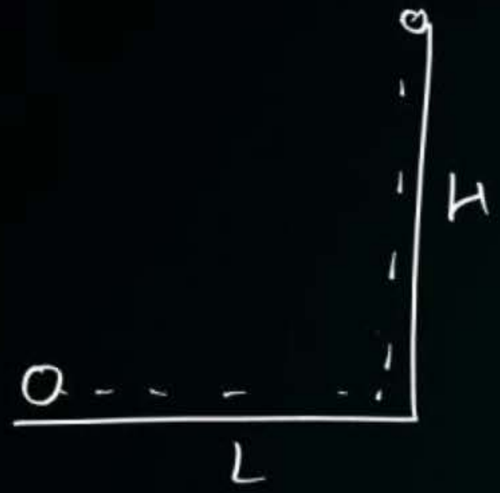
$$[W_g = -mgH \quad W_{fr} = -\mu mgL]$$

$$[W_F = mgH + \mu mgL]$$

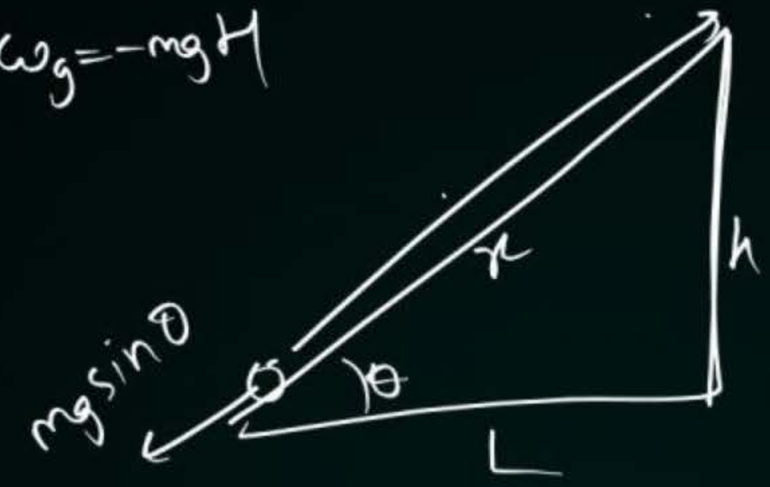


$(W_g = +mgH \quad W_{fr} = -\mu mgL)$

$(W_F = \mu mgL - mgH)$



$W_g = -mgH$



$W_g = -mg\sin\theta\, x = -mgH$ ✓

$W_{fr} = -\mu mgL$

$W_{fr} = -\mu mg\cos\theta\, x = -\mu mgL$ ✓



Difficulty Level : EASY

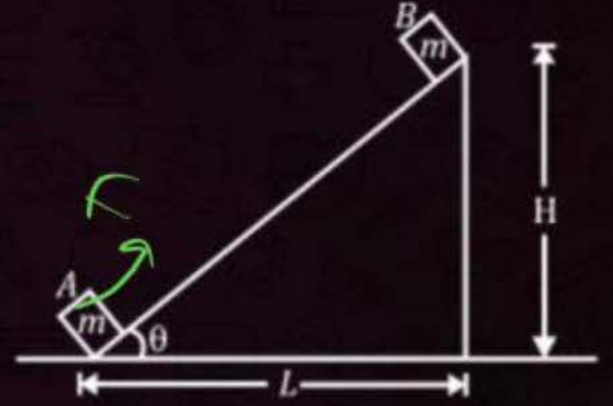
QUESTION-44

Calculate work done by friction and gravity in following cases. also calculate work required to takes object from A to B very slowly

$$W_g = -mgH$$

$$W_{fr} = -\mu mgL$$

$$W_F = mgH + \mu mgL$$



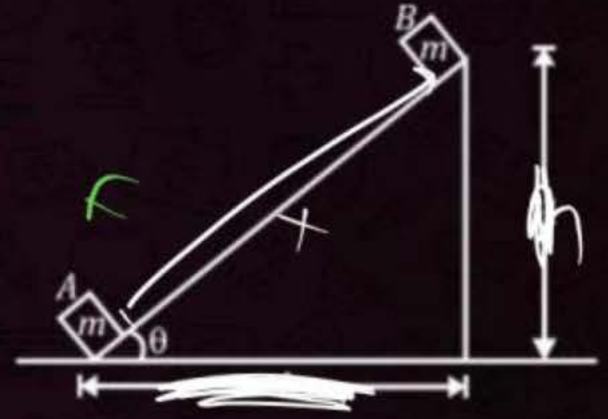
Difficulty Level : EASY

QUESTION-44

Calculate work done by friction and gravity in following cases. also calculate work required to takes object from A to B very slowly

$$W_g = -mg \times \sin\theta$$

$$W_{fr} = -\mu mg \times \cos\theta$$

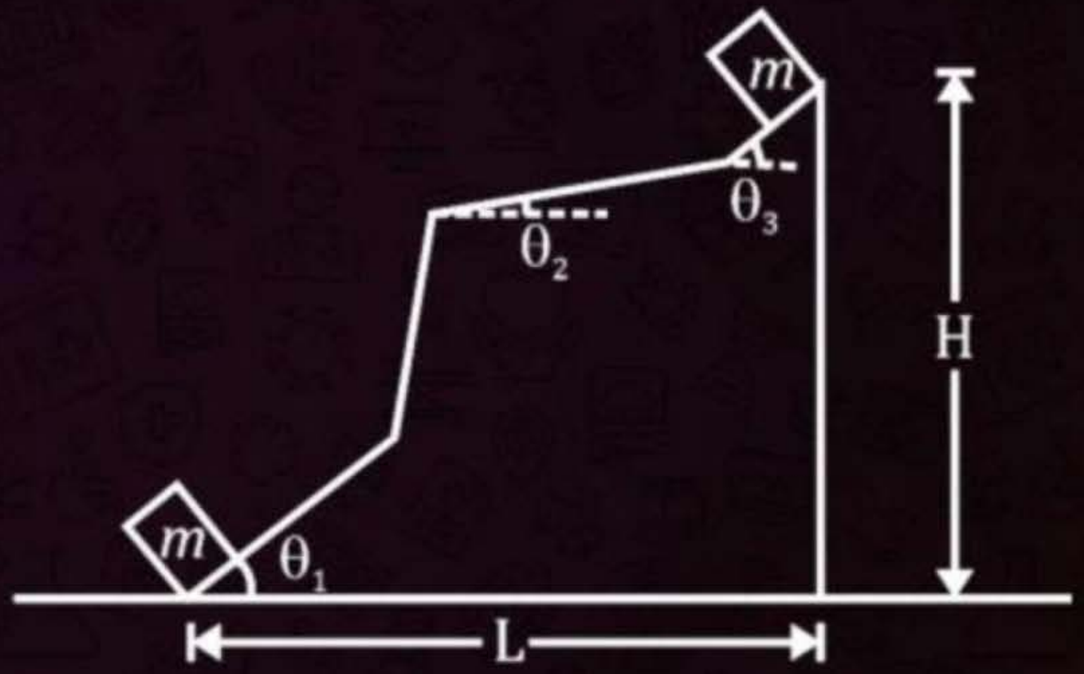


Difficulty Level : EASY

QUESTION-45

hw

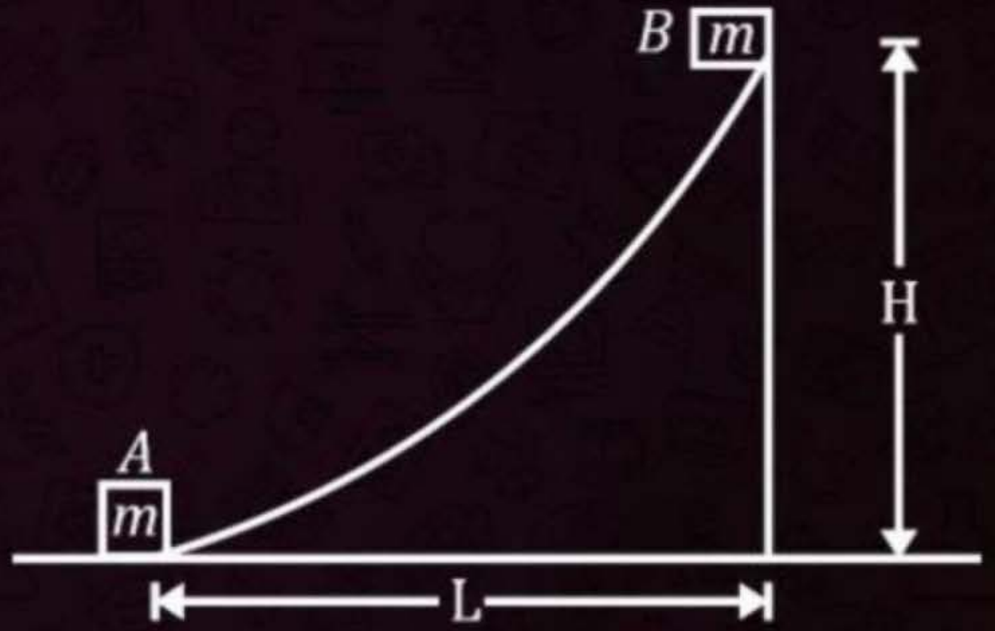
Calculate work done by friction and gravity in following cases. also calculate work required to takes object from A to B very slowly



Difficulty Level : EASY

QUESTION-46

Calculate work done by friction and gravity in following cases. also calculate work required to takes object from A to B very slowly



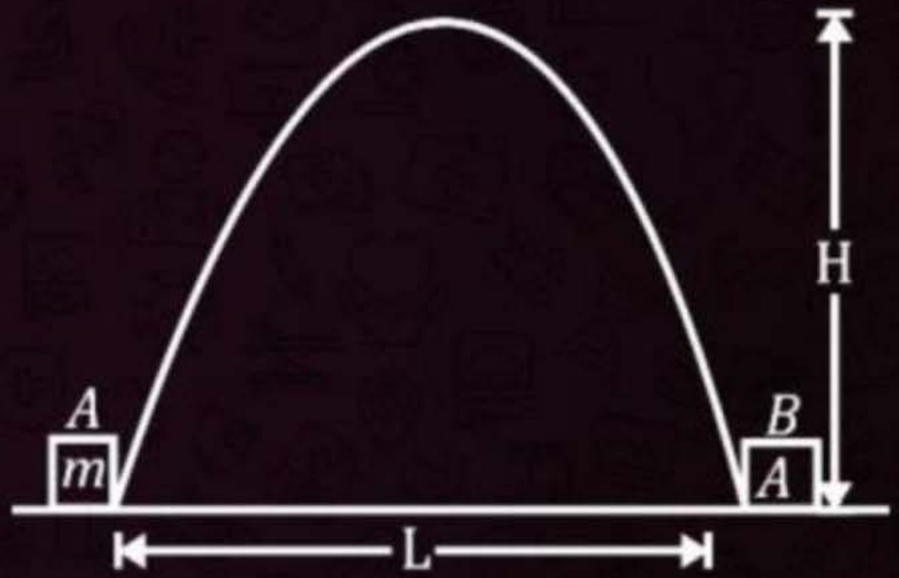
Difficulty Level : EASY

QUESTION-47

Calculate work done by friction and gravity in following cases. also calculate work required to takes object from A to B very slowly

$W_g = 0$

$W_{fr} = -\mu mgL$ ✓

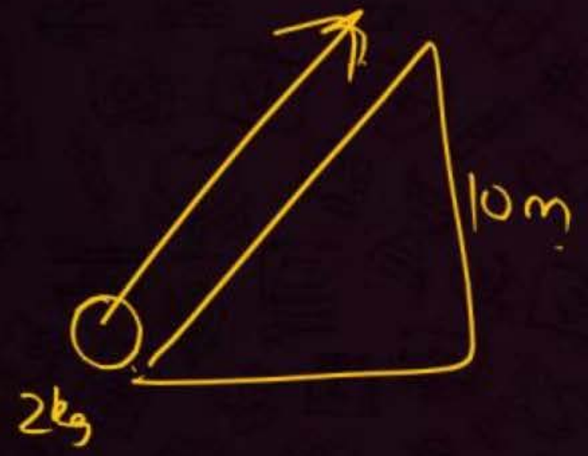


Difficulty Level : HARD

QUESTION-48

300 J of work is done in sliding a 2 kg block up an inclined plane of height 10 m. Taking $g = 10\ m/s^2$, work done against friction is: [2006]

1. 50 J
2. 100 J
3. Zero
4. 150 J



$W_g = -mgH = -2 \times 10 \times 10 = -200\,J$

$W_{fr} = -mgH$

$W_f = W_g + W_{fr}$

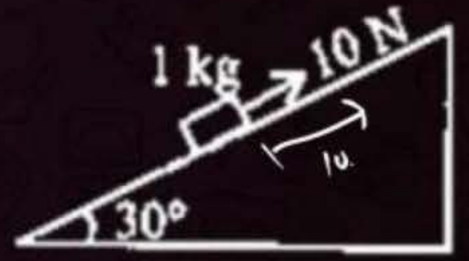
Difficulty Level : HARD

QUESTION-49

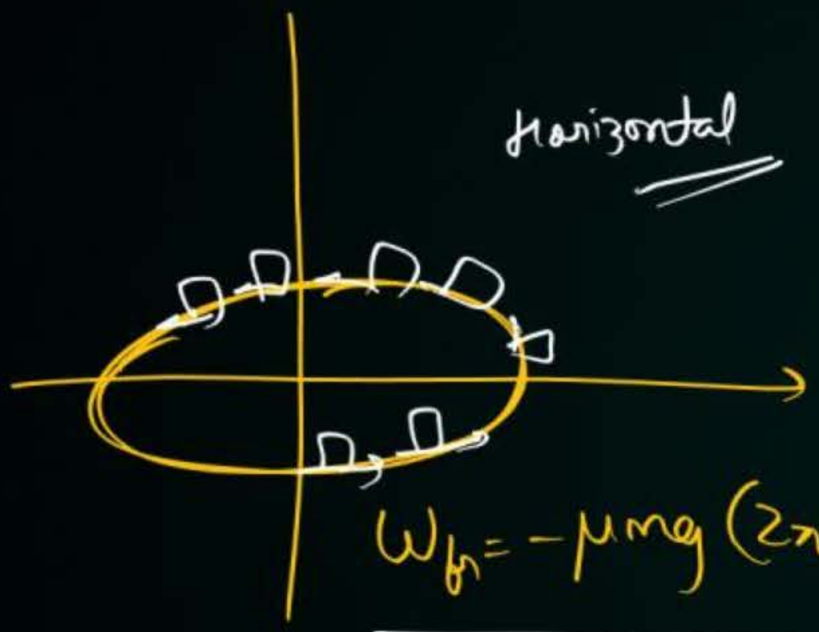
A block of mass 1 kg is pushed up a surface inclined to horizontal at an angle of 30° by a force of 10 N parallel to the inclined surface as shown in the figure. The coefficient of friction between block and the incline is 0.1. If the block is pushed up by 10 m along the incline, then the work against gravity is (Take $g = 10\ \text{m s}^{-2}$)

[NCERT Based]

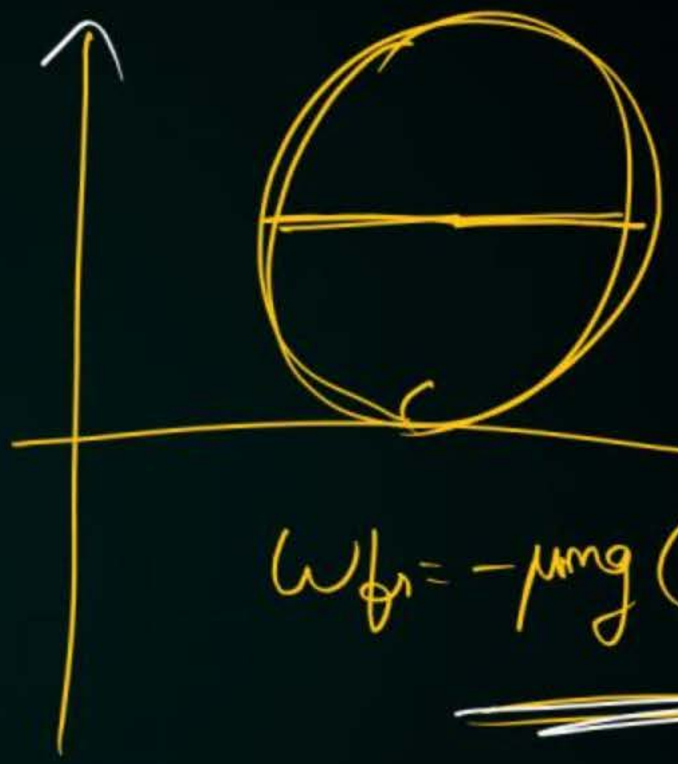
$+ mg \times \sin\theta$



1. 10 J
2. 50 J
3. 100 J
4. 150 J



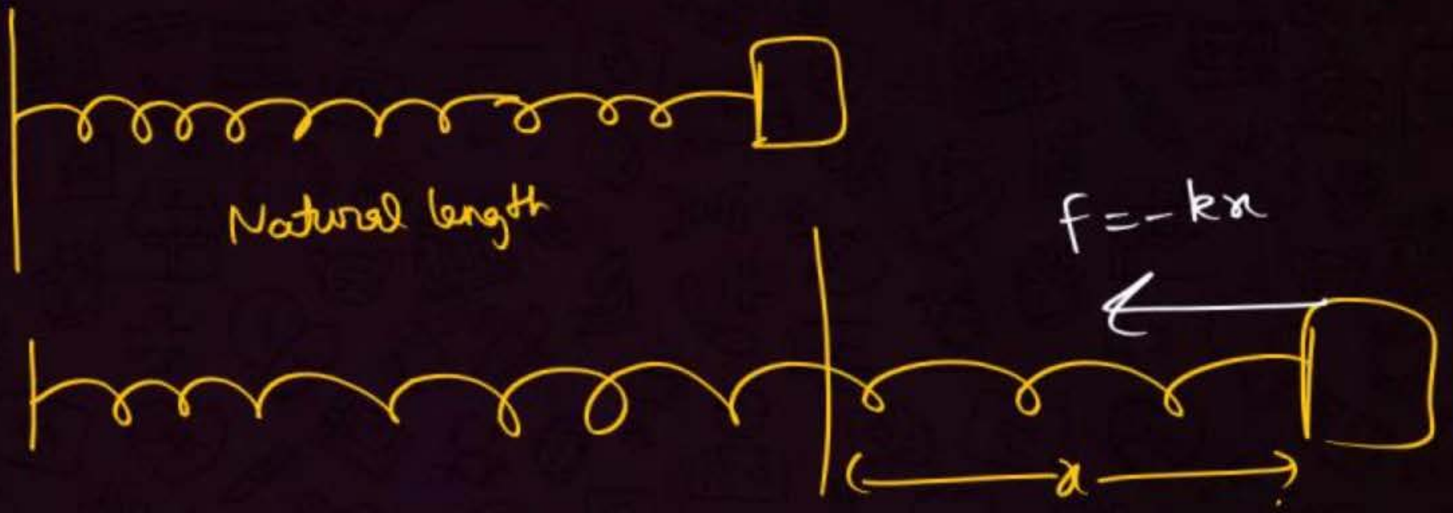
$W_{fr} = -\mu mg(2\pi r)$



Lg.

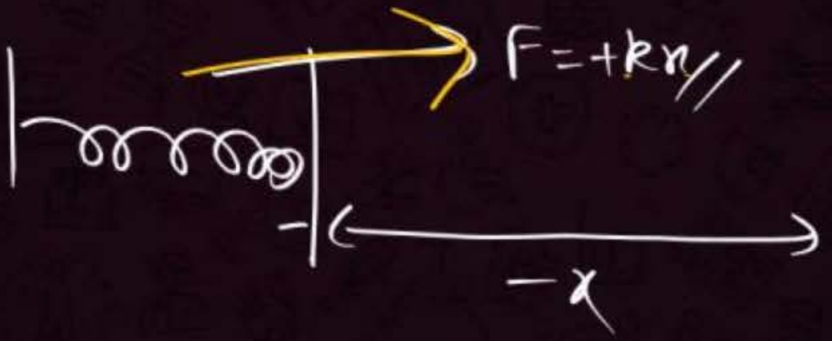
$W_{fr} = -\mu mg(4R)$

2.12 Work Done by Spring Force



$$W = -\int kx\,dx$$

$$W_s = -\frac{1}{2}kx^2$$

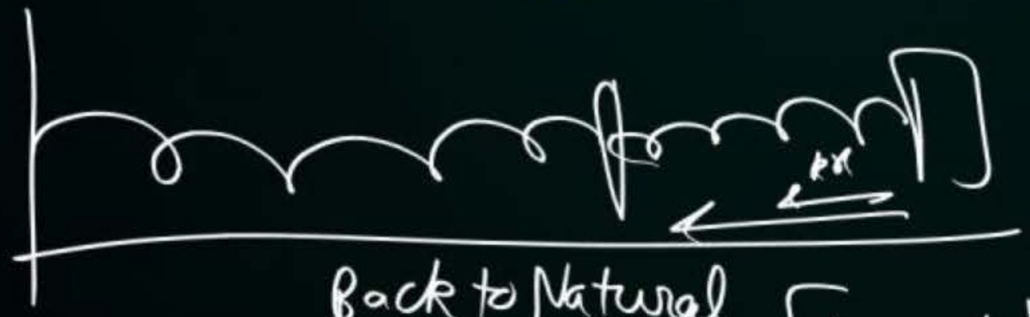




$$W_{spring} = -\frac{1}{2}kx^2$$

$$W_F = +\frac{1}{2}kx^2$$

$$W_{against\ spring} = \frac{1}{2}kx^2$$



$$\left[W_S = +\frac{1}{2}kx^2\right]$$

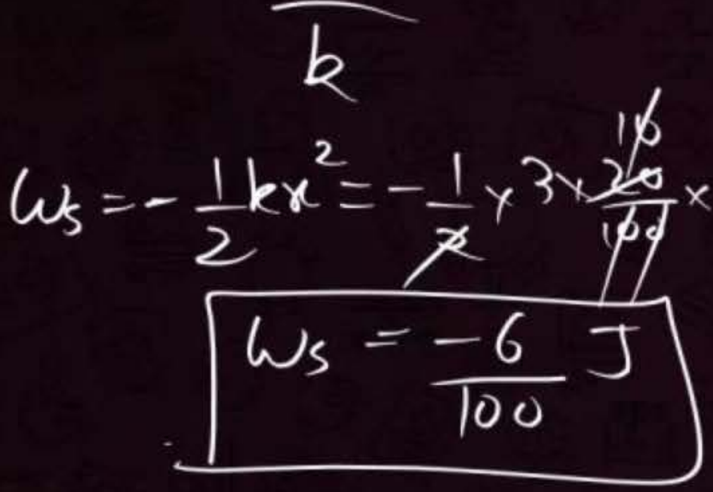
W_S is −ve when you extend / compress from natural length

W_S is +ve when spring returns to natural length

Difficulty Level : EASY

QUESTION-50

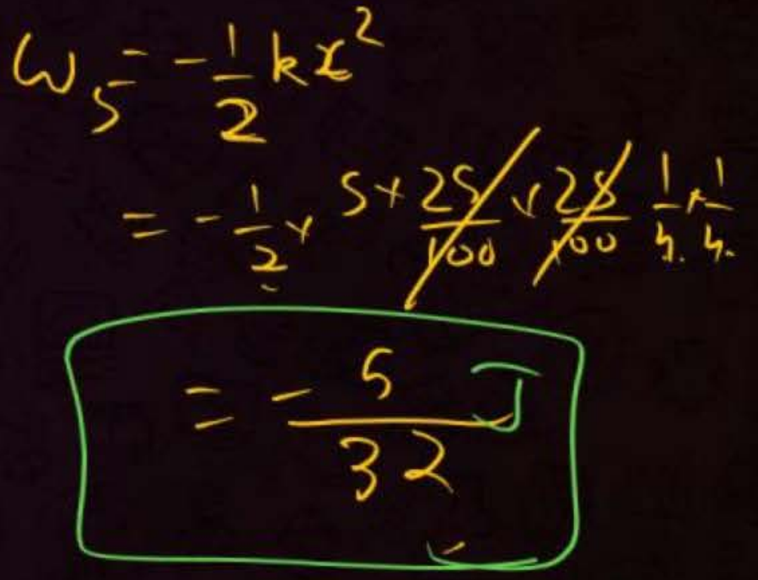
Calculate work by spring if it is stretched up & elongates by 20 cm if spring constant is 3 N/m



QUESTION-51

Calculate work done by spring if it is compressed by 25 cm if spring constant is 5 N/m.

(A) 5/16
(B) −5/16
(C) 5/8
(D) −5/8
(E) None

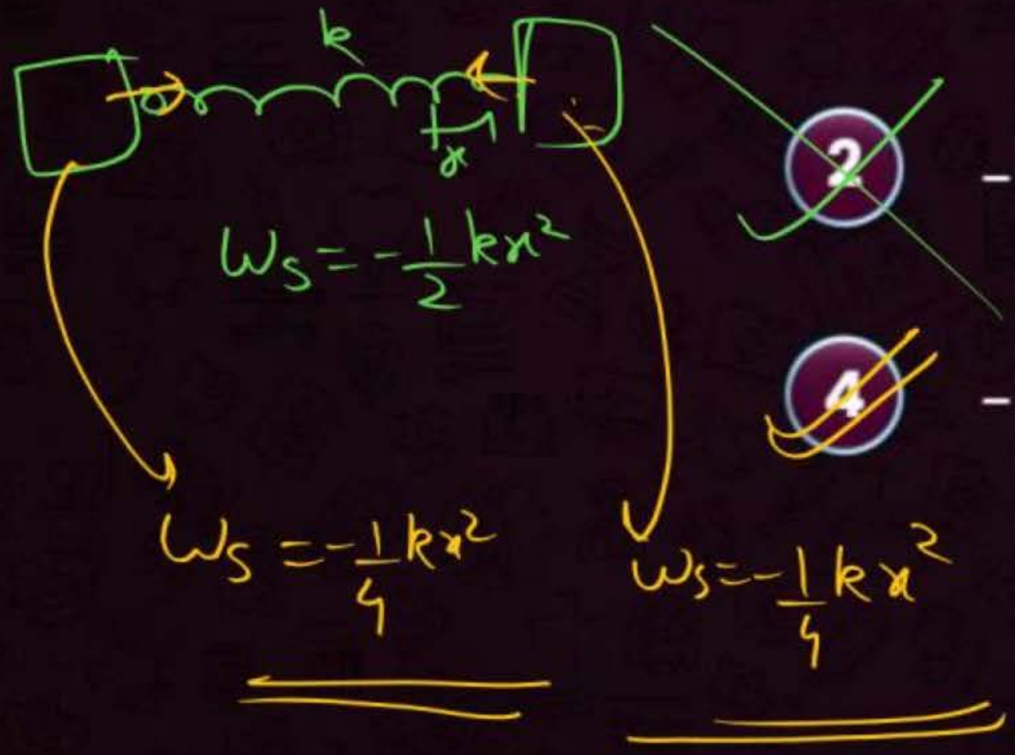


Difficulty Level : YODHA

QUESTION-52

Two equal masses are attached to the two ends of a spring of spring constant k. The masses are pulled out symmetrically to stretch the spring by a length x over its natural length. The work done by the spring on each mass is

[HCV Objective]



1. $\frac{1}{2}kx^2$
2. $-\frac{1}{2}kx^2$
3. $\frac{1}{4}kx^2$
4. $-\frac{1}{4}kx^2$

Difficulty Level : YODHA

QUESTION-53



One end of a light spring of spring constant k is fixed to a wall and the other end is tied to a block placed on a smooth horizontal surface. In a displacement, the work done by the spring is $\frac{1}{2}kx^2$. The possible cases are [HCV Objective]

(A) the spring was initially compressed by a distance x and was finally in its natural length

(B) it was initially streched by a distance x and finally was in its natural length

(C) it was initially in its natural length and finally in a compressed position

(D) it was initially in its natural length and finally in a stretched position.

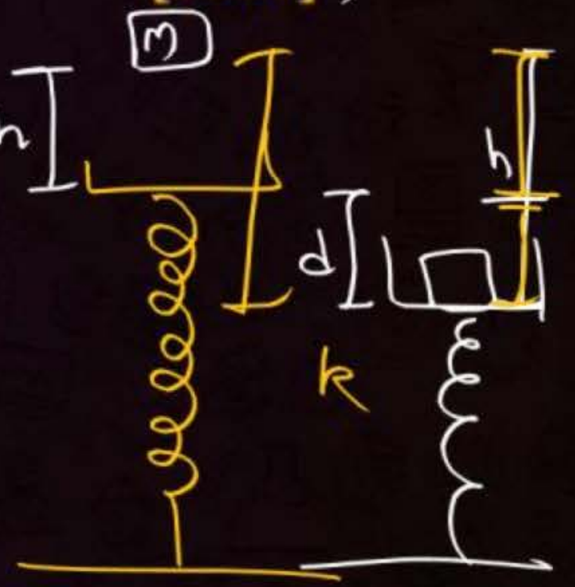
(1) A & B (2) B & C (3) C & D (4) A & D

Difficulty Level : HARD

QUESTION-54

A vertical spring with force constant k is fixed on a table. A ball of mass m at a height h above the free upper end of the spring falls vertically on the spring so that the spring is compressed by a distance d. The net work done in the process is:

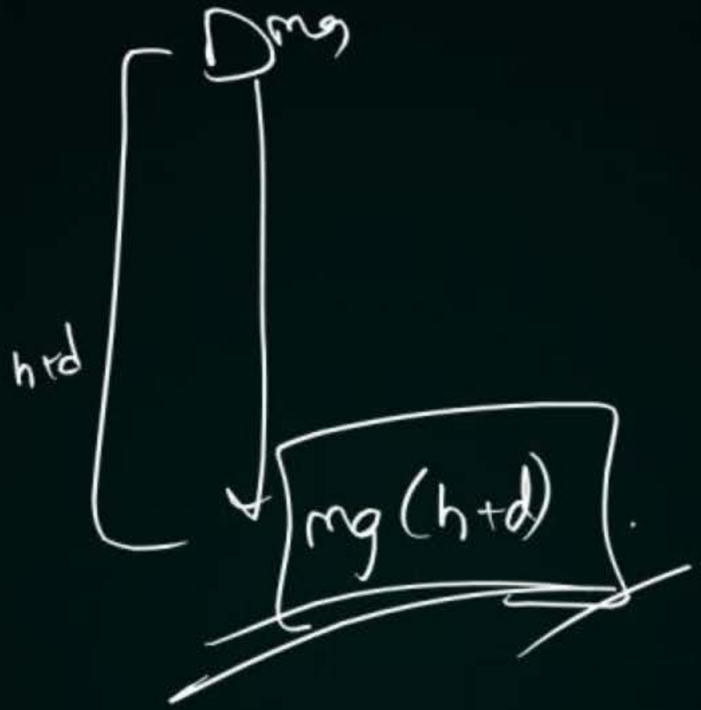
[2007]

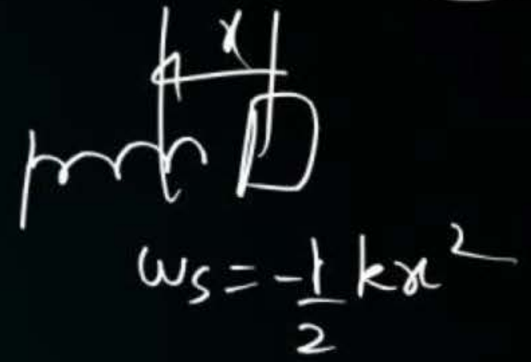


1. $mg(h+d)-\frac{1}{2}kd^2$
2. $mg(h-d)-\frac{1}{2}kd^2$
3. $mg(h-d)+\frac{1}{2}kd^2$
4. $mg(h+d)+\frac{1}{2}kd^2$

$$\left\{\begin{array}{l} W_g = mg(h+d) \\ W_s = -\frac{1}{2}kd^2 \end{array}\right\}$$





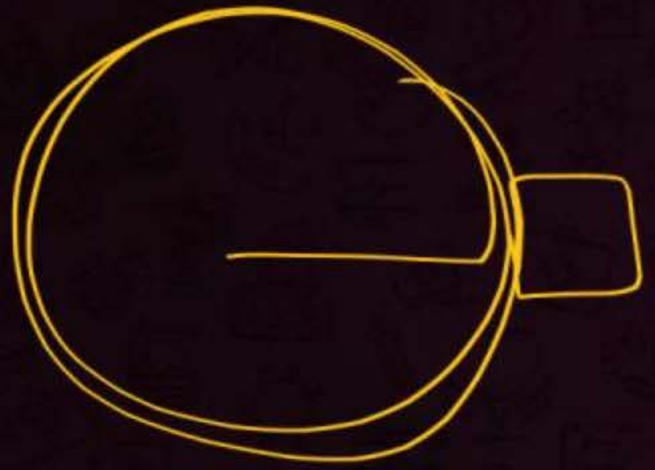




$$W_S = -\frac{1}{2} k d^2$$

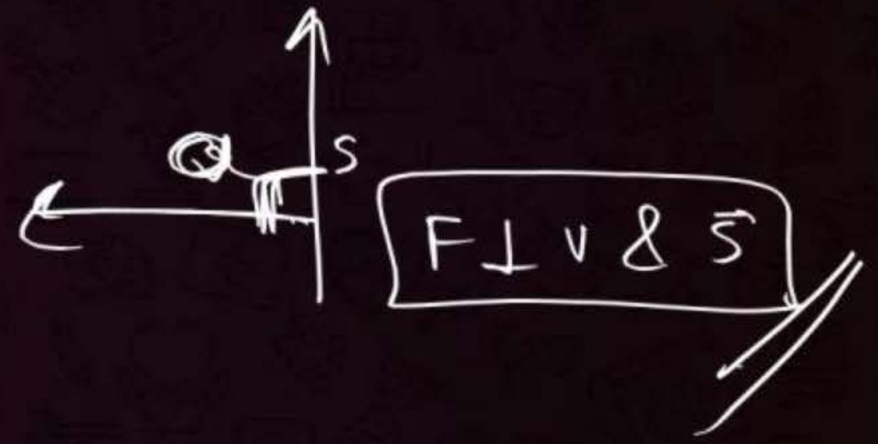
2.13 Work Done in a circle

Uniform Circular Motion



$W_{by\ C.P} = 0$

$W_{by\ C.F.} = 0$



✓ Tangential acc → Then Work may not be zero

Difficulty Level : EASY

QUESTION-55

When a body moves with a constant speed along a circle: [1994]

1. No work is done on it.
2. No acceleration is produced in it
3. Its velocity remains constant
4. No force acts on it

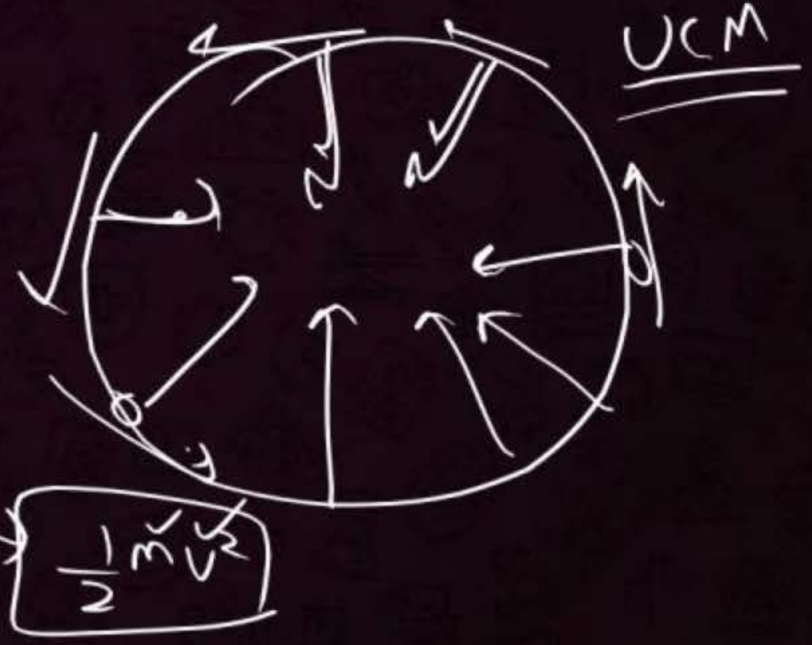
Difficulty Level : MEDIUM

QUESTION-56

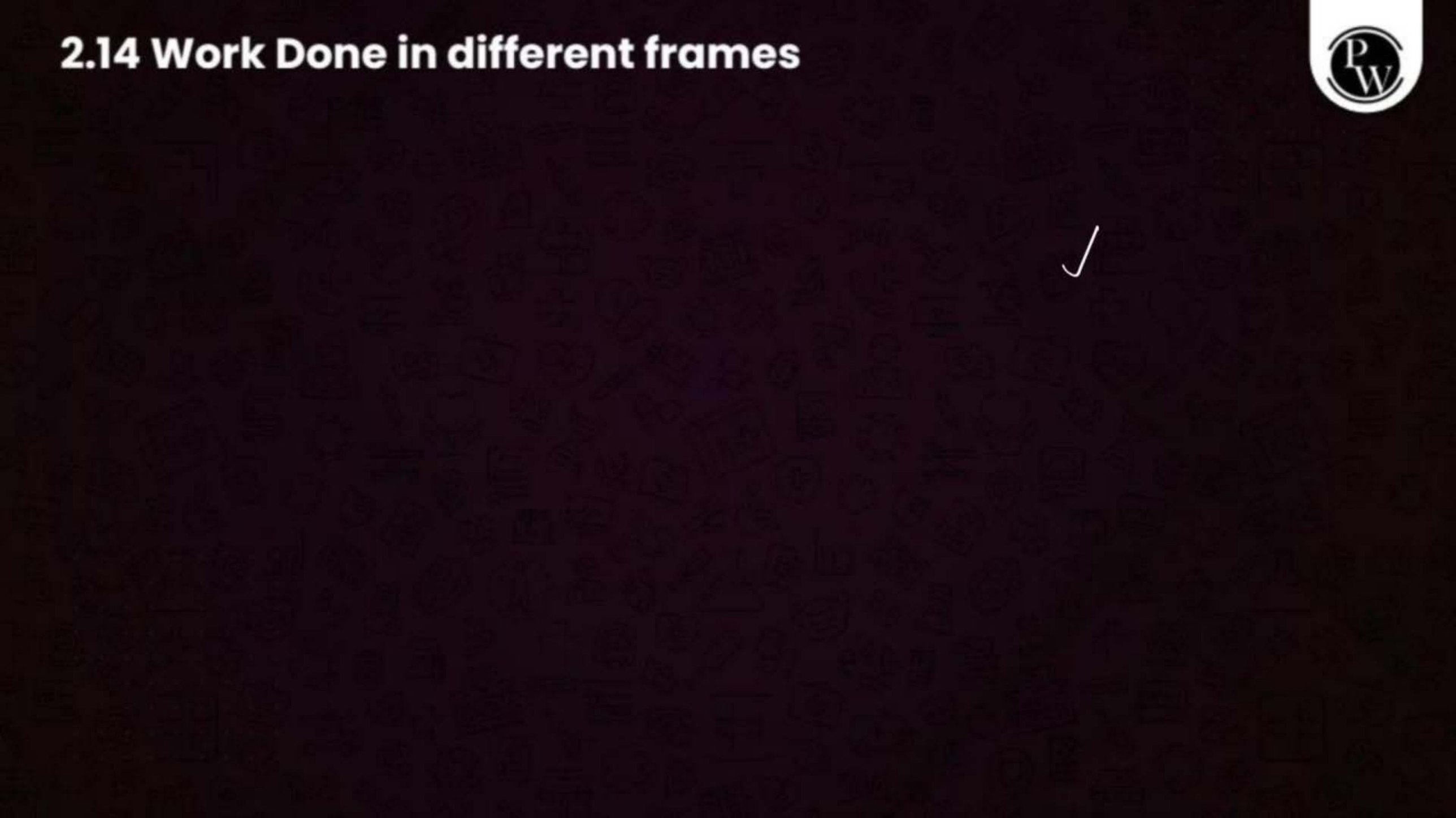
A particle is acted upon by a force of constant magnitude which is always perpendicular to the velocity of the particle. The motion of the particle takes place in a plane. It follows that

[HCV Objective]

1. its velocity is constant
2. its acceleration is constant
3. its kinetic energy is constant
4. it moves in a elliptical path.



2.14 Work Done in different frames

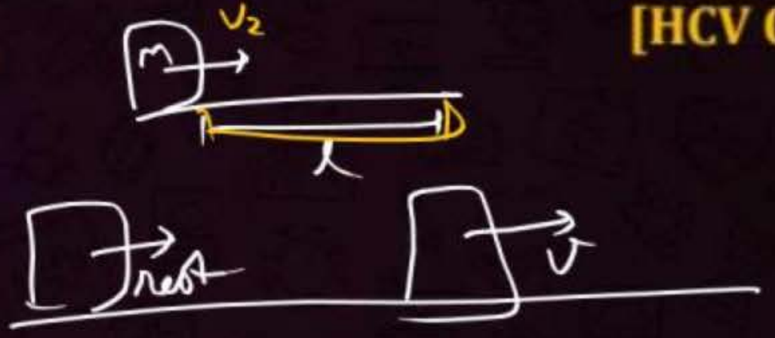


Difficulty Level : YODHA

QUESTION-57

Consider two observers moving with respect to each other at a speed v along a straight line. They observe a block of mass m moving a distance l on a rough surface. The following quantities will be same as observed by the two observers

[HCV Objective]



1. kinetic energy of the block at time t
2. work done by friction $W = -\mu mg l$
3. total work done on the block
4. acceleration of the block

Part 3 – Kinetic Energy



3.1 KE Direct Numericals

$$P = mv$$

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

$$P = \sqrt{2m\,KE}$$

m_1 m_2

If v is same

$$\frac{K_1}{K_2} = \frac{m_1}{m_2}$$

m m_2

P same

$$\frac{K_1}{K_2} = \frac{m_2}{m_1}$$



Difficulty Level : EASY

QUESTION-58

Which of the following statements is incorrect? [NCERT Based]

1. Kinetic energy may be zero, positive or negative.
2. Power, energy and work are all scalars.
3. Potential energy may be zero, positive or negative.
4. Ballistic pendulum is a device for measuring the speed of bullets.

Difficulty Level : MEDIUM

QUESTION-59

A mass of 5 kg is moving along a circular path of radius 1 m. If the mass moves with 300 revolutions per minute, its kinetic energy would be [NCERT Exemplar]

1. $250\pi^2$ J
2. $100\,\pi^2$ J
3. $5\,\pi^2$ J
4. 0 J

$m = 5$

$R = 1m$

$\omega = 300$ rpm

$= 300 \times \frac{2\pi}{60}$

$= 300 \times \frac{\pi}{30}$

$\omega = 10\pi$

$KE = \frac{1}{2}mv^2 = \frac{1}{2}m(\omega R)^2$

$= \frac{1}{2}m\omega^2 R^2$

$= \frac{1}{2} \times 5 \times 100\pi^2 \times 1^2$

$= 250\pi^2$

Difficulty Level : MEDIUM

QUESTION-60

A 120 g mass has a velocity $\vec{v} = 2\hat{i} + 5\hat{j}\ \text{m}^{-1}$ at a certain instant. Its kinetic energy is

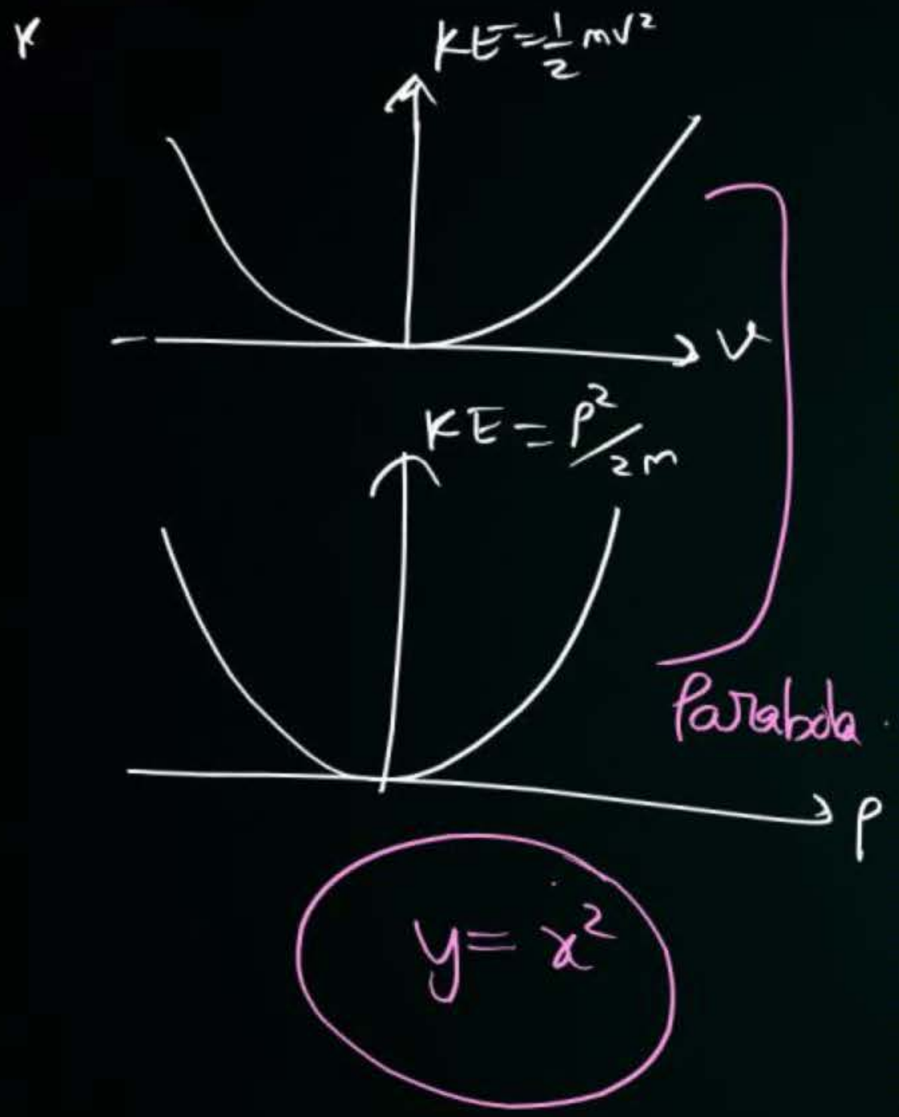
[NCERT Based]

Speed $= |v| = \sqrt{2^2+5^2} = \sqrt{4+25}$

$= \sqrt{29}$

$\frac{1}{2}mv^2 = \frac{1}{2} \times \frac{120}{1000} \times 29 = \frac{174}{100} = 1.74\,\text{J}$

1. 3 J
2. 4 J
3. 5 J
4. 1.74 J



For Constant speed



$K.E = \frac{1}{2}mv^2 \propto m$

St. Line

$(y = x)$

$KE \propto \frac{p^2}{2m} \propto \frac{1}{m}$

For Constant P



Hyperbola

$\left(y = \frac{1}{x}\right)$

Difficulty Level : EASY

QUESTION-61

The shape of the curve representing the relation between the speed and kinetic energy of a moving object is

[NCERT Based]

1. parabola
2. ellipse
3. straight line with positive slope
4. straight line with negative slope

3.2 KE & Momentum

$x = 10 \longrightarrow$ If becomes 3 times $\longrightarrow x = 30$

$x = 10 \longrightarrow$ If it becomes 500% $\longrightarrow x = 50$

$x = 10 \longrightarrow$ If it increase by 500% $\longrightarrow x = 10 + 50 = 60$

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

$$\% \text{ change} = \frac{\Delta K}{K_{original}} \times 100\%$$

$\left(\frac{K_2 - K_1}{K_1} \times 100\%\right)$

$K \propto p^2$

$p \longrightarrow 2$ times $\quad K \longrightarrow 4$ times

$p \longrightarrow 3$ times $\quad K \longrightarrow 9$ times

$p \longrightarrow \frac{1}{2}$ times $\quad K \longrightarrow \frac{1}{4}$ times

$p \longrightarrow \sqrt{2}$ times $\quad K \longrightarrow 2$ times

$p \longrightarrow \frac{1}{\sqrt{2}}$ times $\quad K \longrightarrow \frac{1}{2}$ times

$p \longrightarrow \sqrt{3}$ times $\quad K \longrightarrow 3$ times

$p \longrightarrow 5$ times $\quad K \longrightarrow 25$ times

$K \rightarrow$ increase by 300%

$K \rightarrow$ increase by 800%

$K \rightarrow$ decrease by 75%

$K \longrightarrow$ increase by 100%

$K \longrightarrow$ decrease by 50%

$K \longrightarrow$ increase by 200%

$K \longrightarrow$ increase by 2400%

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

$p \propto \sqrt{K}$

$\sqrt{2} = 1.414 \quad \sqrt{7} = 1.732 \quad \sqrt{10} = 3.16$

$\frac{1}{\sqrt{2}} = 0.707$

$K \propto p^2$

$K \longrightarrow 2$ times	$p \longrightarrow \sqrt{2}$ times
$K \longrightarrow 3$ times	$p \longrightarrow \sqrt{3}$ times
$K \longrightarrow \frac{1}{2}$ times	$p \longrightarrow \frac{1}{\sqrt{2}}$ times
$K \longrightarrow 10$ times	$p \longrightarrow \sqrt{10}$ times
$K \longrightarrow 4$ times	$p \longrightarrow 2$ times
$K \longrightarrow \frac{1}{9}$ times	$p \longrightarrow \frac{1}{3}$ times
$K \longrightarrow \frac{1}{4}$ times	$p \longrightarrow \frac{1}{2}$ times

$p \longrightarrow$	increase by 41.4%
$p \longrightarrow$	increase by 73.2%
$p \longrightarrow$	decrease by 29.3%
$p \longrightarrow$	increase by 216%
$p \longrightarrow$	inc. " 100%
$p \longrightarrow$	dec " 67%
$p \longrightarrow$	dec " 50%

HW

Difficulty Level : EASY

QUESTION-62

For a moving particle (mass m, velocity v) having a momentum p, which one of the following correctly describes the kinetic energy of the particle?

[NCERT Based]

1. $\frac{p^2}{2m}$
2. $\frac{p}{2m}$
3. $\frac{v^2}{2m}$
4. $\frac{v}{2m}$

Difficulty Level : MEDIUM

QUESTION-63

If the momentum of a body is increased n times, its kinetic energy increases.

1. n times
2. $2n$ times
3. $\sqrt{n}$ times
4. n^2 times ✓

Difficulty Level : MEDIUM

QUESTION-64

If the kinetic energy of a body is double of its initial kinetic energy, then the momentum of the body will be:-

1. $2\sqrt{2}$ times
2. $\sqrt{2}$ times
3. $1/\sqrt{2}$ times
4. none of these

Difficulty Level : MEDIUM

QUESTION-65

A particle of mass m_1 is moving with a velocity v_1 and another particle of mass m_2 is moving with a velocity v_b. Both of them have the same momentum but their different kinetic energies are E, and E_2 respectively. If $m_1 > m_2$ then: [2004]

$E_1 < E_2$

1. $\frac{E_1}{E_2} = \frac{m_1}{m_2}$
2. $E_1 > E_2$
3. $E_1 = E_2$
4. $E_1 < E_2$

Difficulty Level : MEDIUM

QUESTION-66

same momentum

A stationary particle explodes into two particles of masses m_1 and m_2 which move in opposite directions with velocities v_1 and v_2 The ratio of their kinetic energies E_1/E_2 is: [2003]

1. m_2/m_1
2. m_1/m_2
3. 1
4. m_1v_2/m_2v_1

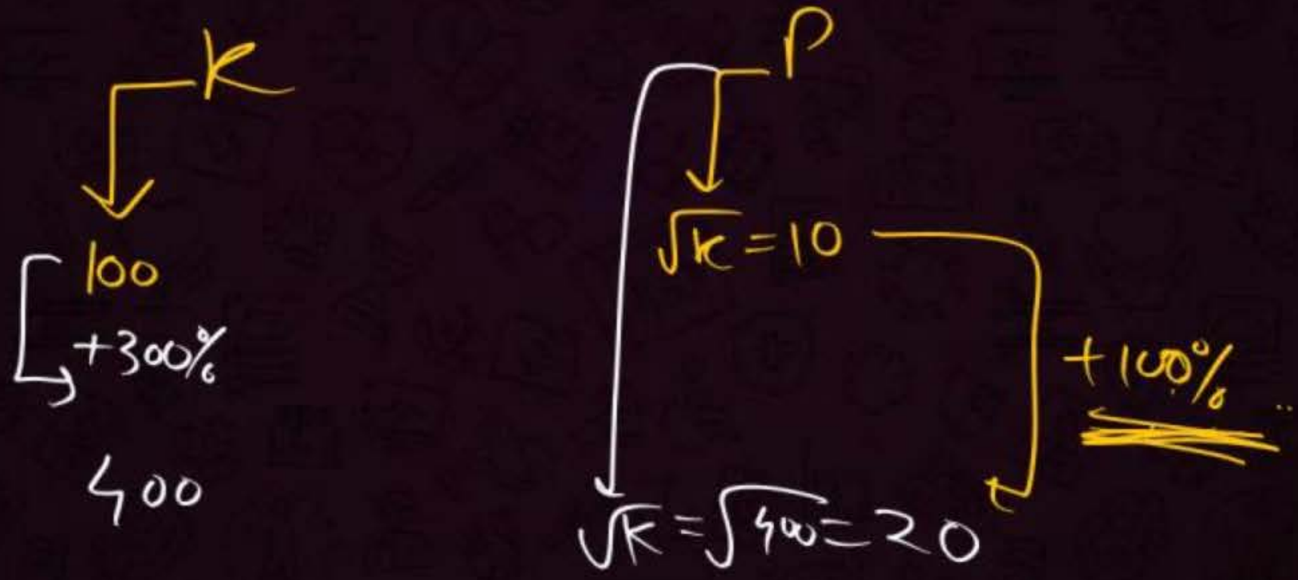
HW

Difficulty Level : MEDIUM

QUESTION-67

If kinetic energy of a body is increased by 300% then percentage change in momentum will be: [2002]

1. 100%
2. 150%
3. 265%
4. 73.2%



100 $\xrightarrow{+300\%}$ 400

100 $\xrightarrow{+600\%}$ 700

100 $\xrightarrow{-30\%}$ 70

100 $\xrightarrow{-80\%}$ 20

10 $\longrightarrow$ 40

10. $\longrightarrow$ 11.

10 $\longrightarrow$ 9.8

10 $\longrightarrow$ 0.12

100 $\xrightarrow{+300\%}$ 400 ✓

100 $\xrightarrow{+10\%}$ 110

100 $\xrightarrow{-2\%}$ 98

$[-\%98.8]$

100 $\longrightarrow$ 1.2

1000 $\longrightarrow$ 5423

100 $\longrightarrow$ 542.3

$+442.3\%$

10 $\longrightarrow$ 14.14

100 $\longrightarrow$ 141.4

$+141.4\%$

Difficulty Level : MEDIUM

QUESTION-68

Two bodies of masses m and $4m$ are moving with equal kinetic energies. The ratio of their linear momenta is: [1998, 97, 89]

1. 1 : 2
2. 1 : 4
3. 4 : 1
4. 1 : 1

Difficulty Level : MEDIUM

QUESTION-69

HW

Two masses of 1 g and 9 g are moving with equal kinetic energies. The ratio of the magnitudes of their respective linear momenta is: [1993]

1. 1 : 9
2. 1 : 3
3. 9 : 1
4. 3 : 1

3.3 KE & Error

Small change $(1 \text{ to } 5\%)$ — 10%

$K \propto P^2$

$\Delta K \%\text{change} = 2\,\Delta P \%\text{change}$

$$\frac{\Delta K}{K} = 2\frac{\Delta P}{P}$$

Difficulty Level : MEDIUM

QUESTION-70

If K.E. increases by 3%. Then momentum will increase by:-

1. 1.5%
2. 9%
3. 3%
4. 2%

$$\Delta K\% = 2\Delta P\%$$

$$3\% = 2\Delta P\%$$

$$\Delta P\% = 1.5\%$$

Difficulty Level : MEDIUM

QUESTION-71

If the kinetic energy of a body increases by 4% the momentum:

1. increases by 2%
2. increase by 4%
3. increases by 8%
4. increases by 16%

3.4 Special Cases of KE

Difficulty Level : HARD

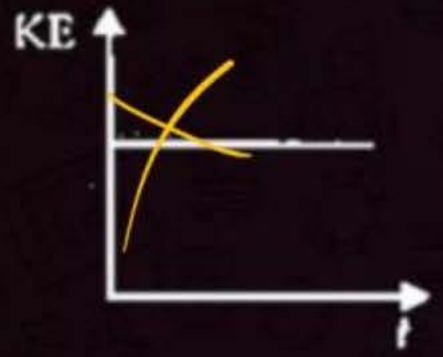
QUESTION-72

Which of the diagrams shown in figure most closely shows the variation in kinetic energy of the earth as it moves once around the sun in its elliptical orbit?

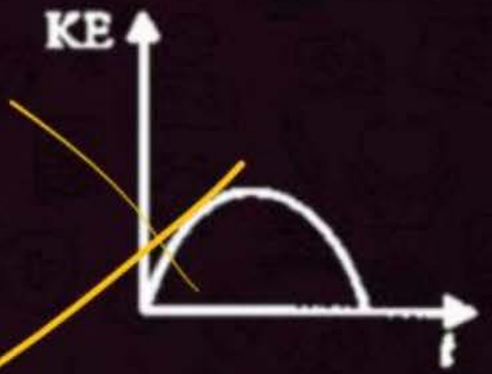
[NCERT Exemplar]



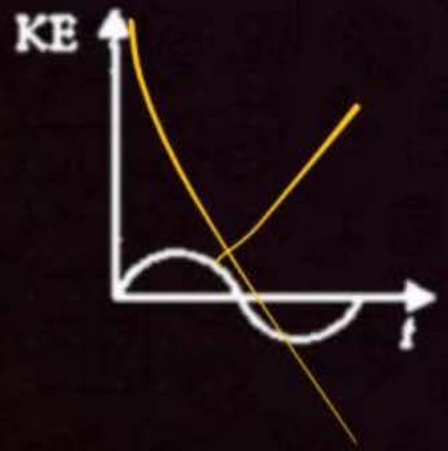
1



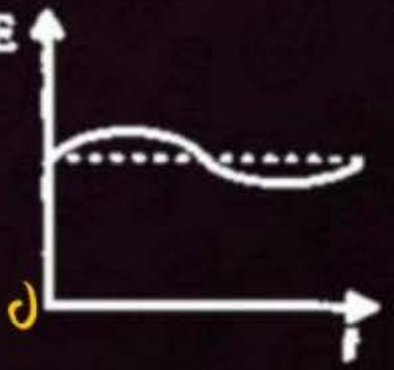
2



3



4



QUESTION-73

$V_p = \frac{2+\sqrt{4+4}}{2} = \frac{2+\sqrt{8}}{2} = \frac{2+2\sqrt{2}}{2} = 1+\sqrt{2}$ //

Difficulty Level : [redacted] YODHA

The K.E. of a person is just half of K.E. of a boy whose mass is just half of that person. If person increases its speed by 1m / s then its K.E. equals to that of boy then initial speed of person was:

[1999]

1. $(\sqrt{2}+1)\,m/s$
2. $(2+\sqrt{2})\,m/s$
3. $2(2+\sqrt{2})\,m/s$
4. None

$$\left[K_p = \frac{1}{2} \times K_B \quad ; \quad \frac{m_p}{2} = m_B\right]$$

$$\frac{1}{2} m_p v_p^2 = \frac{1}{2}\left(\frac{1}{2} m_B v_B^2\right)$$

$$m_p v_p^2 = \frac{1}{2}\frac{m_p}{2} v_B^2$$

$$\boxed{v_B = 2v_p}$$

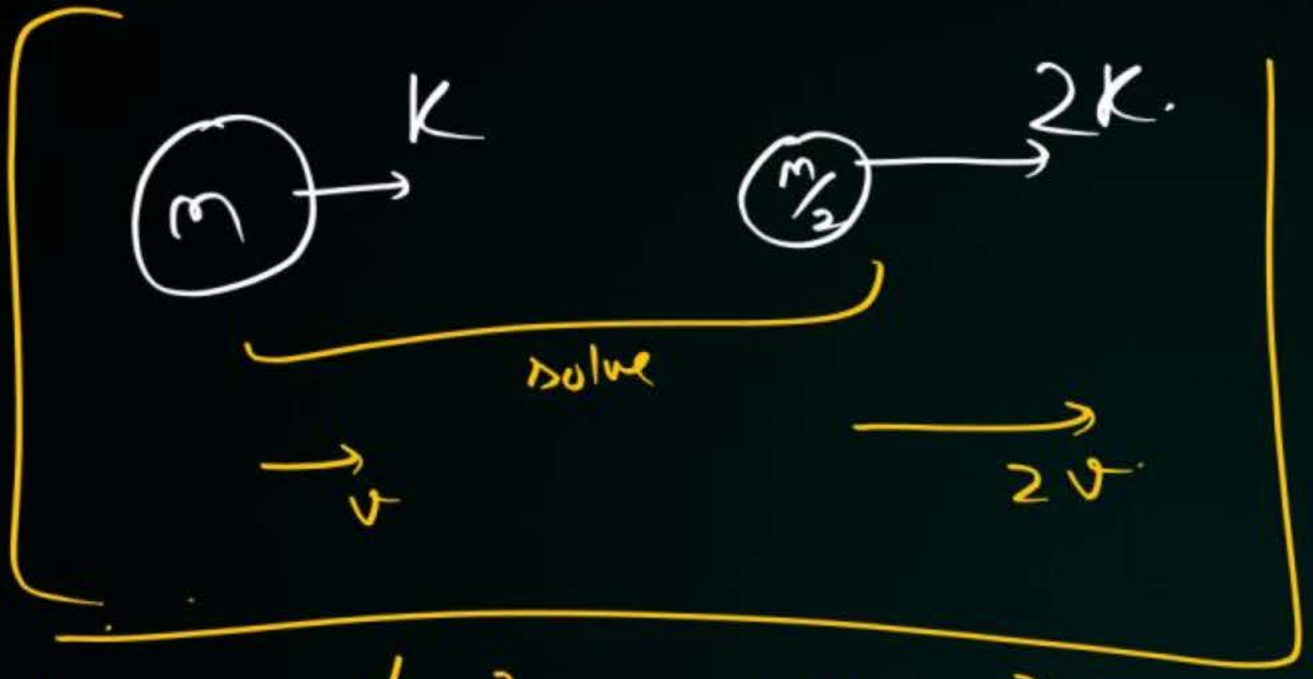
$$\frac{1}{2} m_p (v_p+1)^2 = \frac{1}{2} m_b v_b^2$$

$$m_p (v_p+1)^2 = \frac{m_p}{2}(2v_p)^2$$

$$(v_p+1)^2 = 2v_p^2$$

$$v_p^2 + 2v_p + 1 = 2v_p^2$$

$$v_p^2 - 2v_p - 1 = 0$$



Flow

$$\frac{1}{2}m(v+1)^2 = \frac{1}{2}\left(\frac{m}{2}\right)(2v)^2$$

$$v^2 - 2v - 1 = 0$$

↓ Solve

$$v = \sqrt{2}+1 \text{ m/s}$$

Difficulty Level : HARD

QUESTION-74

In a ballistics demonstration a police officer fires a bullet of mass 50 g with speed 200 m s^{-1} on soft plywood of thickness 2 cm. The bullet emerges with only 10% of its initial kinetic energy. The emergent speed of the bullet (in m/s) is

[NCERT Based]

$K = \frac{1}{2} \times \frac{50}{1000} \times 200 \times 200 = 1000$

$K_2 = 100 = \frac{1}{2} m v^2$

$100 = \frac{1}{2} \times \frac{50}{1000} v^2$

$v = \sqrt{\frac{10000 \times 2 \times 2}{5}}$

$V = \sqrt{4000} = 20\sqrt{10}$

HW

1. $2\sqrt{10}$
2. $20\sqrt{10}$
3. $10\sqrt{2}$
4. $10\sqrt{20}$

Difficulty Level : HARD

QUESTION-75

A bullet of mass m fired at 30° to the horizontal leaves the barrel of the gun with a velocity v. The bullet hits a soft target at a height h above the ground while it is moving downward and emerges out with half the kinetic energy it had before hitting the target. Which of the following statements is correct in respect of bullet after it emerges out of the target? [NCERT Based]

1. The velocity of the bullet remains the same.
2. The velocity of the bullet will be reduced to half its initial value.
3. The velocity of the bullet will be more than half of its earlier velocity.
4. The bullet will continue to move along the same parabolic path.

Part 4 – Conservative Force



❤ Work does not depend on path — $F_{conservative}$ → gravity, spring, electrostatic

❤ Work does depend on path — $F_{Non-conservative}$ → friction, viscous, magnetic, drag/resistance



$$[W_1 = W_2 = W_3 = W_4]$$

Conservative Force

Difficulty Level : EASY

QUESTION-76

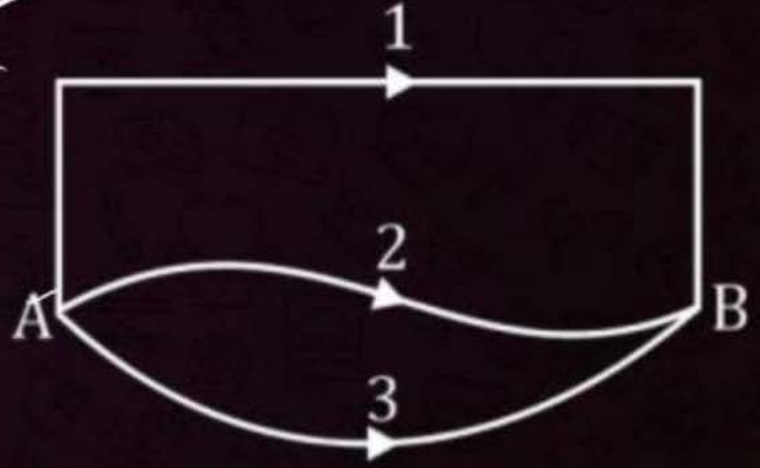
Which of the following statements is true for work done by conservative forces:-

1. It does not depend on path
2. It is equal to the difference of initial and final potential energy function
3. It can be recovered completely
4. All of the above

Difficulty Level : EASY

QUESTION-77

A gravitational field is present in a region and a mass is shifted from A to B through different paths as shown. If W_1, W_2 and W_3 represent the work done by the gravitational force along their respective paths, then:

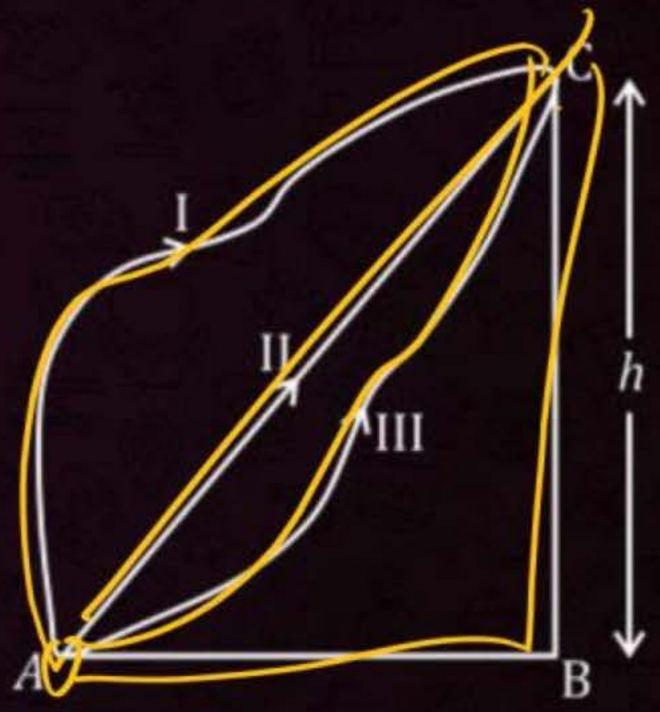


1. $W_1 = W_2 = W_3$
2. $W_1 > W_2 > W_3$
3. $W_1 > W_3 > W_2$
4. $W_1 < W_2 < W_3$

Difficulty Level : EASY

QUESTION-78

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:-



1. Work done is same for all the paths
2. Work done is minimum for path (II)
3. Work done is maximum for path (I)
4. None of the above

Difficulty Level : EASY

QUESTION-79

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

1. Work done in going from initial to final position is equal to change in kinetic energy of the particle.
2. Work done depends on path but not on initial and final positions.
3. Work done does not depend on path but depends only on initial and final positions
4. Work done on a particle in the field for a round trip is zero.

Difficulty Level : EASY

QUESTION-80

Which of the following is a non conservative force:-

1. Electric force
2. Gravitational force
3. Spring force
4. Viscous force

Difficulty Level : EASY

QUESTION-81

A 10 kg satellite completes one revolution around the earth at a height of 100 km in 108 minutes. The work done by the gravitational force of earth will be-

hw

1. $108 \times 100 \times 10$ J
2. $108 \times 10/100$ J
3. 0 J
4. $100 \times 10/108$ J

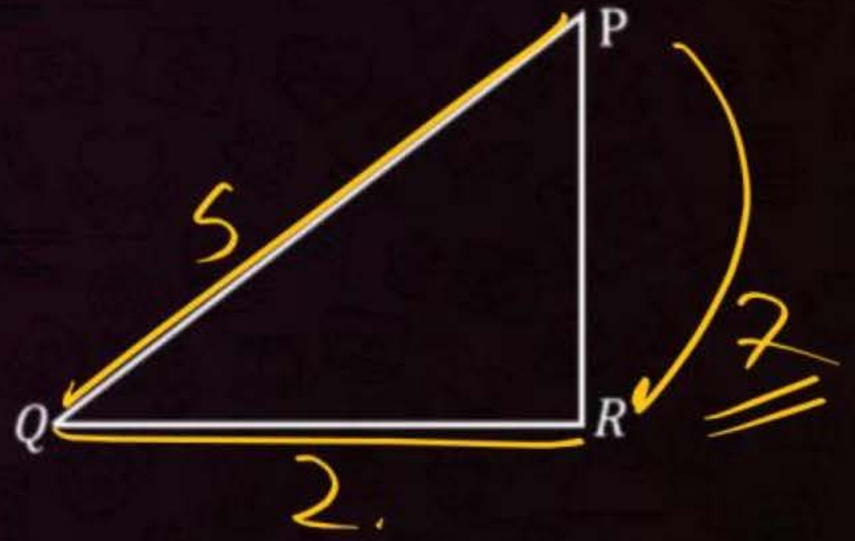
Difficulty Level : MEDIUM

QUESTION-82

For the path PQR in a conservative force field the amounts 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 .

1. 7 J
2. 3 J
3. $\sqrt{21}$ J
4. Zero





Part 5 – Potential Energy

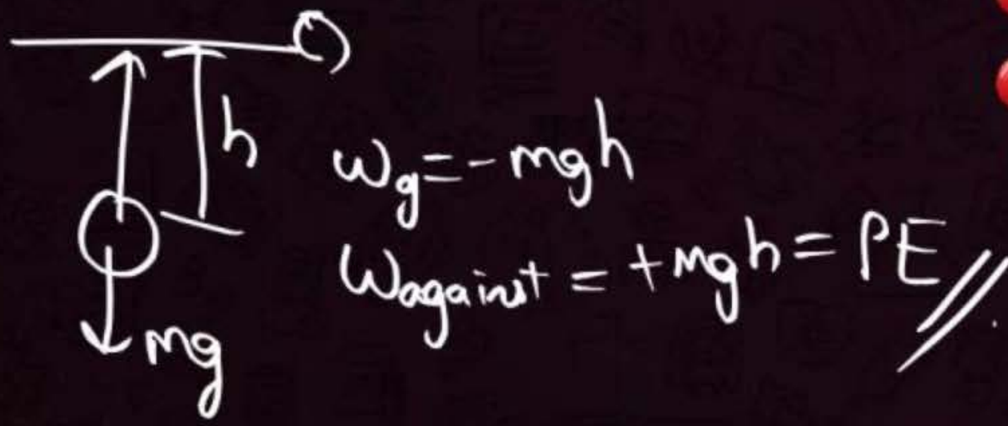


5.1 PE – Theory

It is the energy by an object's position relative to other objects.

The potential energy of a system increases if work is done by the system against a conservative force

The negative of the work done by the conservative internal forces on a system equals to the change in Potential Energy



$W_g = -mgh$

$W_{against} = +mgh = PE$

$\Delta PE = W_{against\ C.F.}$

$\Delta FE = -W_{C.F.}$

Difficulty Level : EASY

QUESTION-83

_____of a two particle system depends only on the separation between the two particles. The most appropriate choice for the blank space in the above sentence is

[HCV Objective]

1. Kinetic energy
2. Total mechanical energy
3. Potential energy
4. Total energy

Difficulty Level : EASY

QUESTION-84

The potential energy of a system increases if work is done: [2011 Pre]

1. Upon the system by a nonconservative force
2. By the system against a conservative force
3. By the system against a nonconservative force
4. Upon the system by a conservative force

$PE = W_{against\ CF}$

$= -W_{CF}$

Difficulty Level : EASY

QUESTION-85

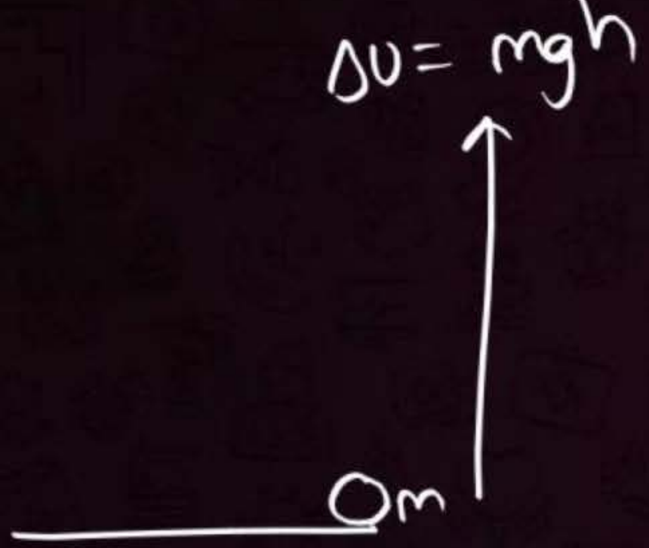
The negative of the work done by the conservative internal forces on a system equals to the change in

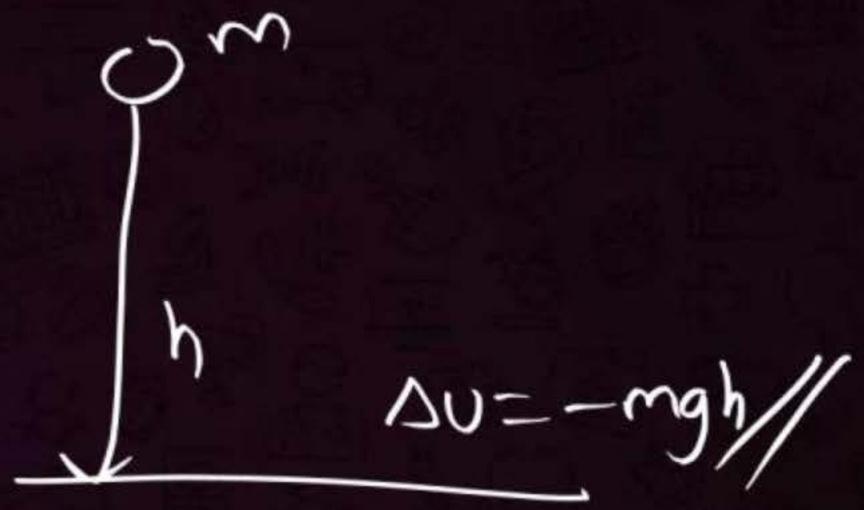
[NCERT Based]

$PE = -W_{CF}$

1. total energy
2. kinetic energy
3. potential energy
4. none of these

5.2 PE - Gravitation





Difficulty Level : EASY

QUESTION-86

A body of mass 2 kg falls from a height of 20 m. What is the loss in potential energy:-

$(g = 9.8 \approx 10)$

NW

1. 400 J ✓
2. 300 J
3. 200 J
4. 100 J

Difficulty Level : MEDIUM

QUESTION-87

A ball bounces to 80% of its original height. What fraction of its potential energy is lost in each bounce?

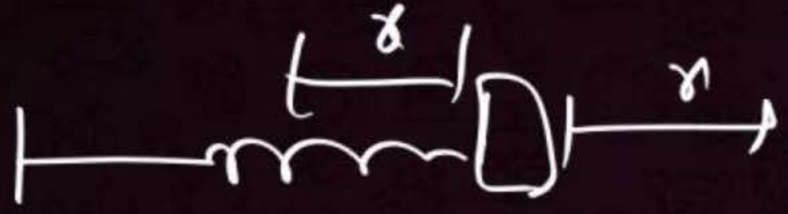
[NCERT Based]



1. 0.20 ✓
2. 0.60
3. 0.40
4. 1

$$\frac{20}{100} = 0.2$$

5.3 PE - Spring



$$\Delta U = \frac{1}{2} k x^2$$

Difficulty Level : EASY

QUESTION-88

The potential energy of a long spring when stretched by 2 cm is U. If the spring is stretched by 8 cm the potential energy stored in it is: [2006, 2023]

1. 4U
2. U/8
3. 16U
4. U/4

$U \propto x^2$

$x \rightarrow 4$ times

$U \rightarrow 4^2$ times

QUESTION-89

$(U \propto x^2)$

When a long spring is stretched by 2 cm, its potential energy is U. If the spring is stretched by 10 cm, the potential energy stored in it will be: [2003]

1. U/5
2. 5 U
3. 10 U
4. 25 U

Difficulty Level : MEDIUM

QUESTION-90

If a spring extends by x on loading then energy stored by the spring is (T is tension in the spring, K = spring const.)

$$\left[U = \frac{1}{2}kx^2 \qquad T = kx\right]$$

1. $T^2/2x$
2. $T^2/2k$
3. $2k/T^2$
4. $2T^2/k$

$$T^2 = k^2x^2$$

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

Difficulty Level : MEDIUM

QUESTION-91

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

Two springs A and B having spring constant K_A and K_B ($K_A = 2K_B$) are stretched by applying force of equal magnitude. If energy stored in spring A is E then energy stored in B will be: [2001]

$U = \frac{1}{2}kx^2 = \frac{1}{2}\frac{k^2x^2}{k} = \frac{F^2}{2k}$

1. 2E
2. E/4
3. E/2
4. 4E

F same $U \propto \frac{1}{k}$

x same $U \propto k$

QUESTION-92

HW

2 : 1
1 : 2

Two springs A and B ($K_A = 2K_B$) are stretched by same suspended weights then work done in stretching is: [1999]

same F

$U \propto \frac{1}{k}$

1. 1 : 2
2. 2 : 1
3. 1 : 1
4. 1 : 4

Difficulty Level : HARD

QUESTION-93

HW

Two springs A and B ($k_A = 2k_B$) are stretched by applying forces of equal magnitudes at the four ends. If the energy stored in A is E, that in B is

[HCV Objective]

1. E/2
2. 2E
3. E
4. E/4

Difficulty Level : MEDIUM

QUESTION-94

When a spring is subjected to 4 N force its length is a metre, and if 5 N is applied length is b metre. If 9 N is applied its length is: [1999]

1. $4b - 3a$
2. $sb - a$
3. $5b - 4a$
4. $5b - 2a$

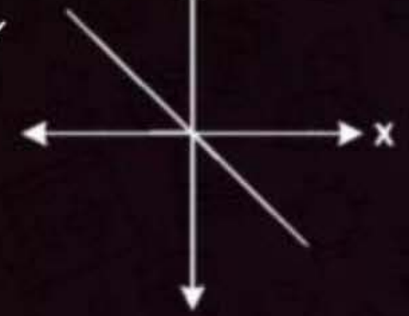
Difficulty Level : EASY

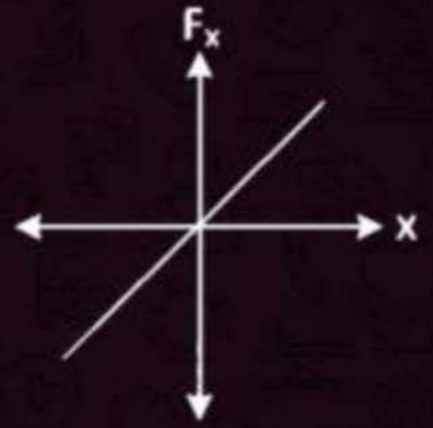
QUESTION-95

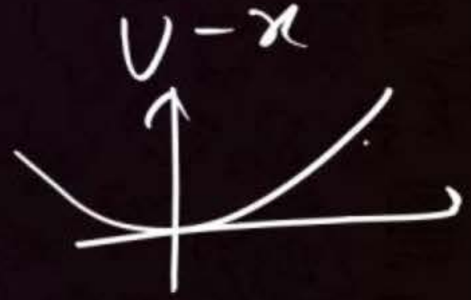
The restoring force of a spring with a block attached to the free end of the spring is represented by

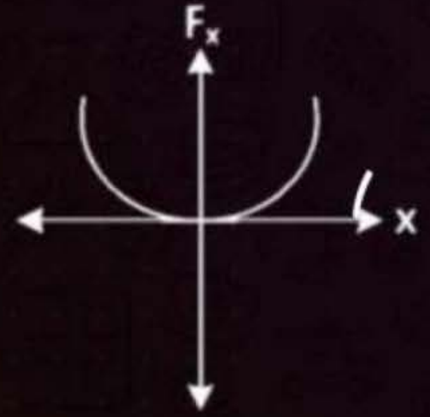
[2022 Re]

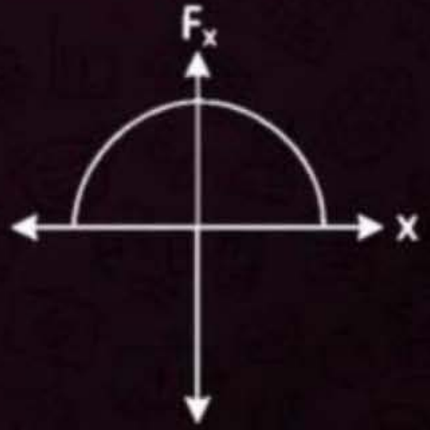
$F = -kx$

1. 

2. 



3. 

4. 

Difficulty Level : HARD

QUESTION-96

hw

Two similar springs P and Q have spring constants K_P and K_Q such that $K_P > K_Q$. They stretched first by the same amount (case a), the same force (case b). The work done by the springs W_P and W_Q are related as in case (a) case (b), respectively [2015]

1. $W_P = W_Q$; $W_P = W_Q$
2. $W_P > W_Q$; $W_Q > W_P$
3. $W_P < W_Q$; $W_Q < W_P$
4. $W_P = W_Q$; $W_P > W_Q$

5.4 PE & F

$$dW = F \cdot dx$$

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

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

$$U = -\int F \cdot dx$$

Difficulty Level : EASY

QUESTION-97

The relation between conservative force and potential energy U is given by:-

1. $F = dU/dx$
2. $F = \int U dx$
3. $F = -dU/dx$ ✓
4. $F = dU/dx$

Difficulty Level : MEDIUM

QUESTION-98

Calculate Force in following Cases

A. $U = x^2$

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

B. $U = x^3$

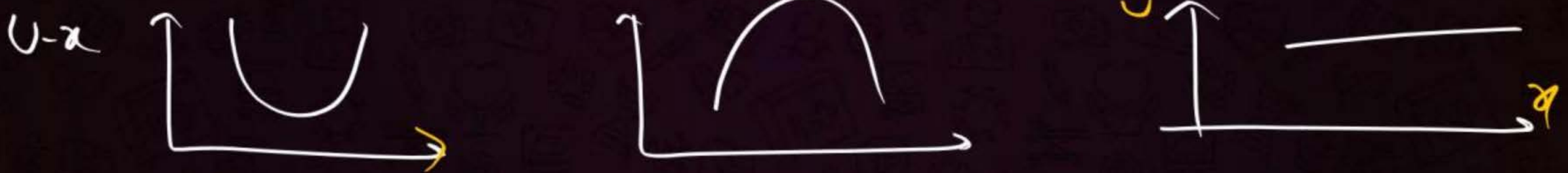
$$F = -\frac{dU}{dx} = -3x^2$$

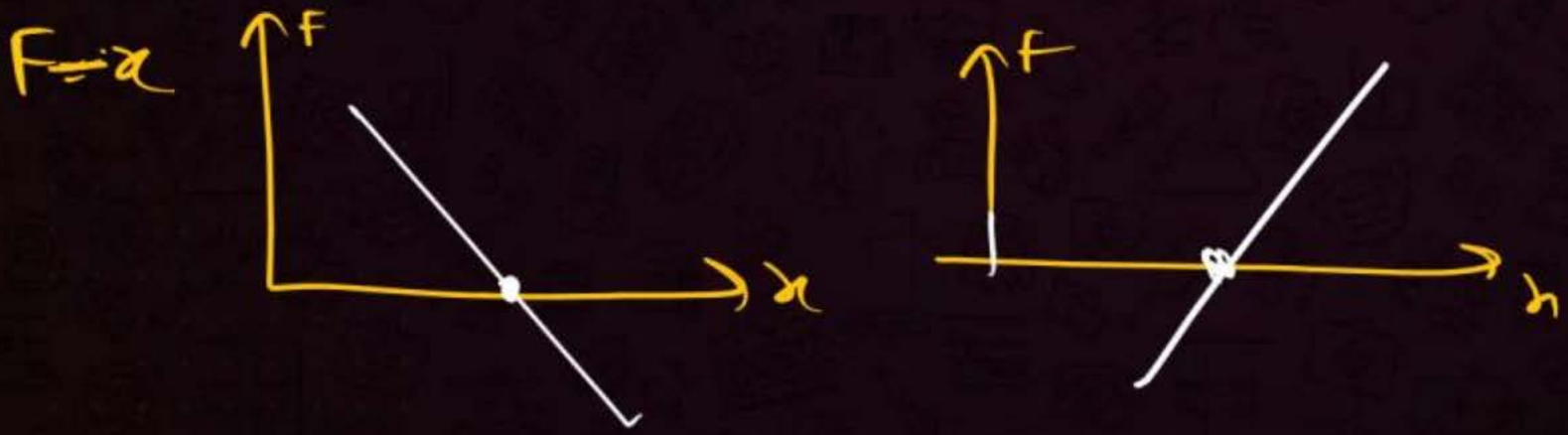
5.5 Equilibrium



$F = 0$

- Stable Eqm
- Unstable Eqm
- Neutral Eqm



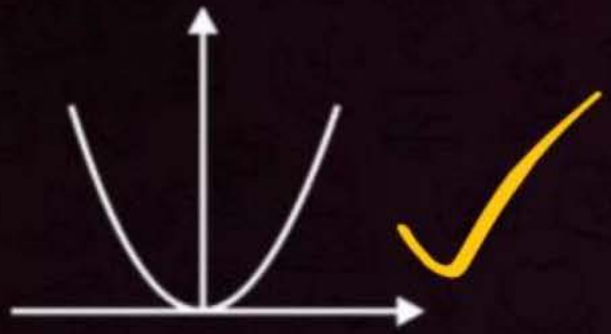


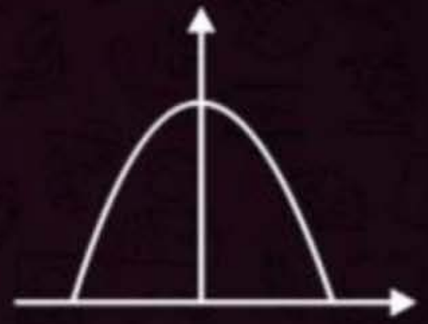

V
F
stable
Unstable

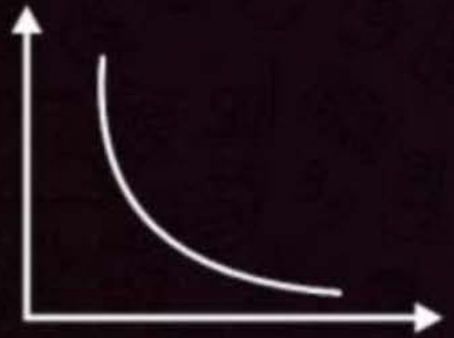
Difficulty Level : EASY

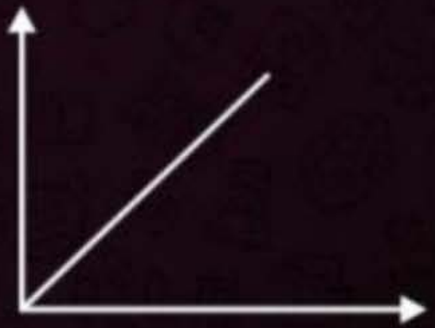
QUESTION-99

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

1 

2 

3 

4 

Difficulty Level : MEDIUM

QUESTION-100

A particle moves in a potential region given by $U = 8x^2 - 4x + 400$ J. Its state of equilibrium is

1. $x = 25$ m
2. $x = 0.25$ m
3. $x = 0.025$ m
4. $x = 2.5$ m

$$F = -\frac{dU}{dx} = -(16x - 4) = 0$$

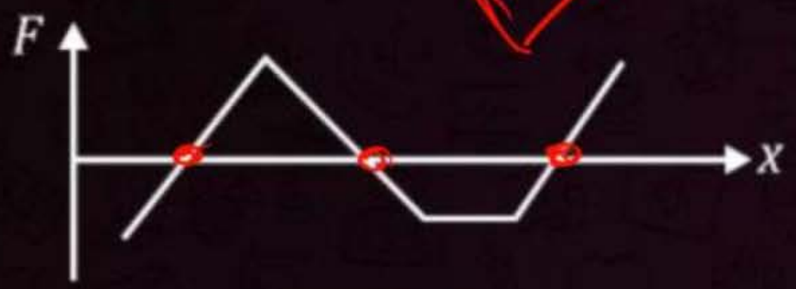
$$16x = 4$$

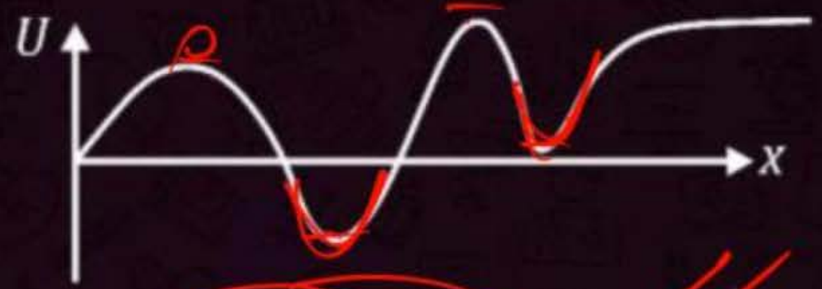
$$x = \frac{1}{4} = 0.25$$

Difficulty Level : HARD

QUESTION-101

Identify position of stable, unstable and neutral equilibrium from the given graphs





5.6 $U = \frac{A}{r^{2n}} - \frac{B}{r^{n}}$

↳ stable eq^{n}

$F = -\frac{dU}{dr} = 0$

eq^{m} //

① $r^{n} = \frac{2a}{b}$

② $U = -\frac{b^2}{4a}$



Difficulty Level : YODHA

QUESTION-102

$x^6 = \frac{2a}{b}$

The potential energy between two atoms, in a molecule, is given by $U(x) = \frac{a}{x^{12}} - \frac{b}{x^6}$ where a and b are positive constants and x is the distance between the atoms. The atom is in stable equilibrium, when: [1995]

$U = \frac{a}{x^{12}} - \frac{b}{x^6}$

$F = -\frac{dU}{dx} = -\frac{12a}{x^{13}} + \frac{6b}{x^7} = 0$

$\frac{6b}{x^7} = \frac{12a}{x^{13}} x^6$

$x^6 = \frac{12a}{6b} = \frac{2a}{b}$ $\quad x = \left(\frac{2a}{b}\right)^{1/6}$

1. $x = \left(\frac{2a}{b}\right)^{1/6}$
2. $x = \left(\frac{11a}{5b}\right)^{1/6}$
3. $x = 0$
4. $x = \left(\frac{a}{2b}\right)^{1/6}$

Difficulty Level : YODHA

QUESTION-103

If the potential energy of two molecules is give by, $U = (A/r^{12}) - (B/r^6)$ then at equilibrium position, its potential energy is equal to:

1. $A^2/4\,B$
2. $-B^2/4A$
3. $2\,B/A$
4. $3\,A$

Difficulty Level : YODHA

QUESTION-104

The potential energy of particle in a force field is $U = \frac{A}{r^2} - \frac{B}{r}$ where A and B are positive constants and r is the distance of particle from the centre of the field. For stable equilibrium, the distance of the particle is: [2012 Pre]

$r = \frac{2A}{B}$

1. B/2A
2. 2A/B ✓
3. A/B
4. B/A

5.7 Calculus PE

$U = -2x^2$

$F = -\frac{dU}{dx} = +4x$ ✓

$U = -2x^2y$

$-\frac{\partial U}{\partial x} = +2y\,2x\ \hat{i}$

$-\frac{\partial U}{\partial y} = +2x^2\ \hat{j}$

$F = 4xy\hat{i} + 2x^2\hat{j}$ ✓

$$U = x^2 y^3 z^4$$

$$-\frac{\partial U}{\partial x} = -y^3 z^4 (2x)\,\hat{i}$$

$$-\frac{\partial U}{\partial y} = -x^2 z^4 (3y^2)\,\hat{j}$$

$$-\frac{\partial U}{\partial z} = -x^2 y^3 (4z^3)\,\hat{k}$$

QUESTION-105

$\frac{d}{dz}\left(\frac{1}{z}\right) = -\frac{1}{z^2}$

Difficulty Level : YODHA

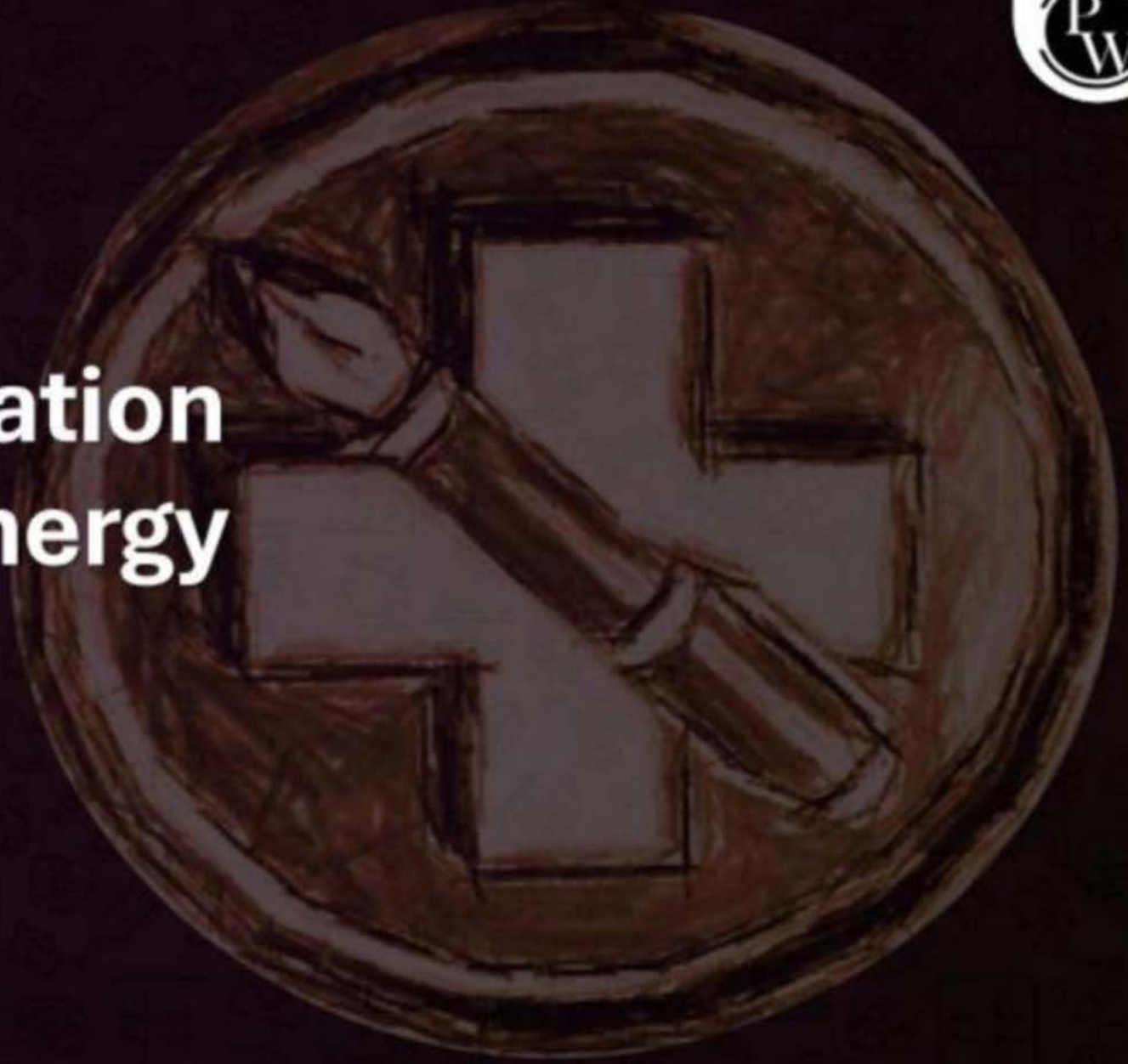
A particle in a certain conservative force field has a potential energy given by $U = \frac{20xy}{z}$. The force exerted on it is

[NCERT Based]

1. $\left(\frac{20y}{z}\right)\hat{i} + \left(\frac{20x}{z}\right)\hat{j} + \left(\frac{20xy}{z^2}\right)\hat{k}$
2. $-\left(\frac{20y}{z}\right)\hat{i} - \left(\frac{20x}{z}\right)\hat{j} + \left(\frac{20xy}{z^2}\right)\hat{k}$
3. $-\left(\frac{20y}{z}\right)\hat{i} - \left(\frac{20x}{z}\right)\hat{j} - \left(\frac{20xy}{z^2}\right)\hat{k}$
4. $\left(\frac{20y}{z}\right)\hat{i} + \left(\frac{20x}{z}\right)\hat{j} - \left(\frac{20xy}{z^2}\right)\hat{k}$

$-\frac{\partial U}{\partial x} = -\frac{20y}{z}\hat{i}$ $\quad -\frac{\partial U}{\partial y} = -\frac{20x}{z}\hat{j}$ $\quad -\frac{\partial U}{\partial z} = 20xy\left(+\frac{1}{z^2}\right)\hat{k}$

Part 6 – Conservation of Mechanical Energy



6.1 KE and PE Gravitation

Conservation of Energy is only valid if there is no non-Conservative Force or $(W_{NCF} = 0)$

Difficulty Level : EASY

QUESTION-106

A body is falling freely under the action of gravity alone in vacuum. Which of the following quantities remain constant during the fall? [NCERT Exemplar]

1. Kinetic energy
2. Potential energy
3. Total mechanical energy
4. Total linear momentum

Difficulty Level : EASY

QUESTION-107

A heavy stone is thrown from a cliff of height h in a given direction. The speed with which it hits the ground

[HCV Objective]

1. must be independent of the speed of projection
2. must be larger than the speed of projection
3. must be independent of the speed of projection
4. may be smaller than the speed of projection.

Difficulty Level : EASY

QUESTION-108

A heavy stone is thrown from a cliff of height h with a speed v. The stone will hit the ground with maximum speed if it is thrown [HCV Objective]



1. vertically downward
2. vertically upward
3. horizontally
4. the speed does not depend on the initial direction.

Difficulty Level : EASY

QUESTION-109

A child is sitting on a swing. Its minimum and maximum heights from the ground is 0.75 m and 2 m respectively, its maximum speed will be: [2001]

1. 10 m/s
2. 5 m/s
3. 1 m/s
4. 15 m/s

$$\Delta PE = \Delta KE$$

$$mg\Delta h = \frac{1}{2}mv^2$$

$$10 \times 1.25 = \frac{v^2}{2}$$

$$25 = v^2$$

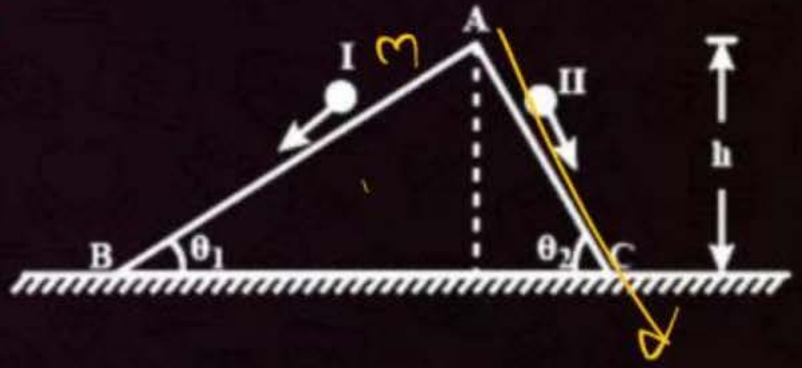
$$v = 5$$

QUESTION-110

Difficulty Level : MEDIUM

Hard

Two inclined frictionless tracks, one gradual and the other steep meet at A from where two stones are allowed to slide down from rest, one on each track as shown in figure. Which of the following statements is correct? **[NCERT Exemplar]**



1. Both the stones reach the bottom at the same time but not with the same speed.

2. Both the stones reach the bottom with the same speed and stone I reaches the bottom earlier than stone II.

3. Both the stones reach the bottom with the same speed and stone II reaches the bottom earlier than stone I.

4. Both the stones reach the bottom at different times and with different speeds.

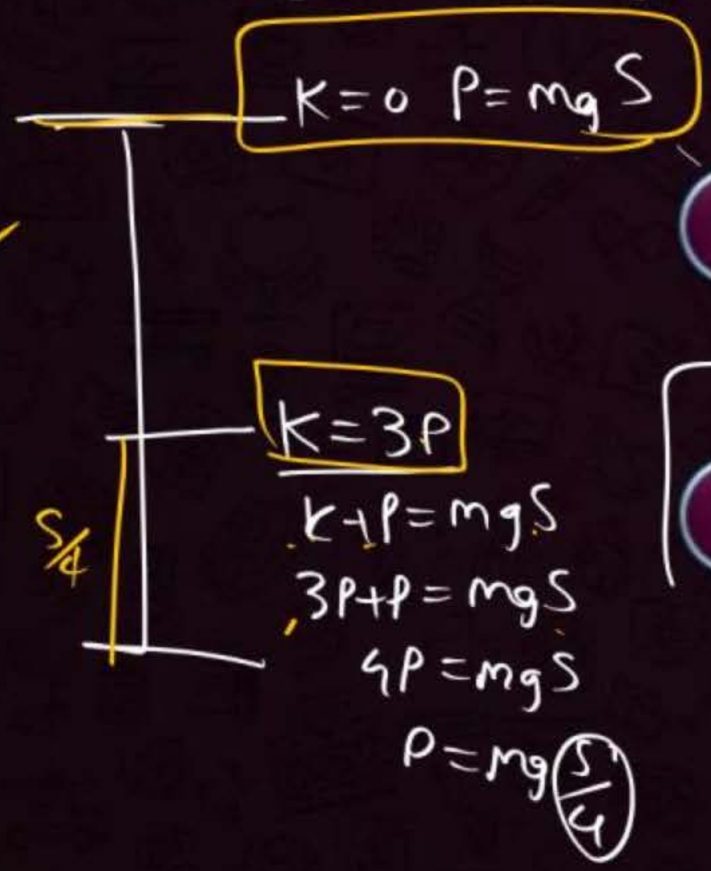
Difficulty Level : HARD

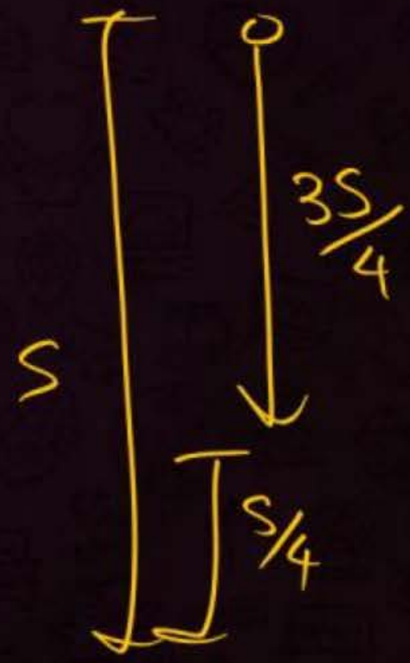
QUESTION-111

A particle is released from height S from the surface of the Earth. At a certain height its kinetic energy is three times its potential energy. The height from the surface of earth and the speed of the particle at that instant are respectively:

[2021]

1. $\frac{S}{4}, \sqrt{\frac{3gs}{2}}$
2. $\frac{S}{2}, \sqrt{\frac{3gs}{2}}$
3. $\frac{S}{4}, \sqrt{\frac{3gs}{2}}$
4. $\frac{S}{4}, \frac{3gs}{2}$





$v = \sqrt{2gh_{fall}}$

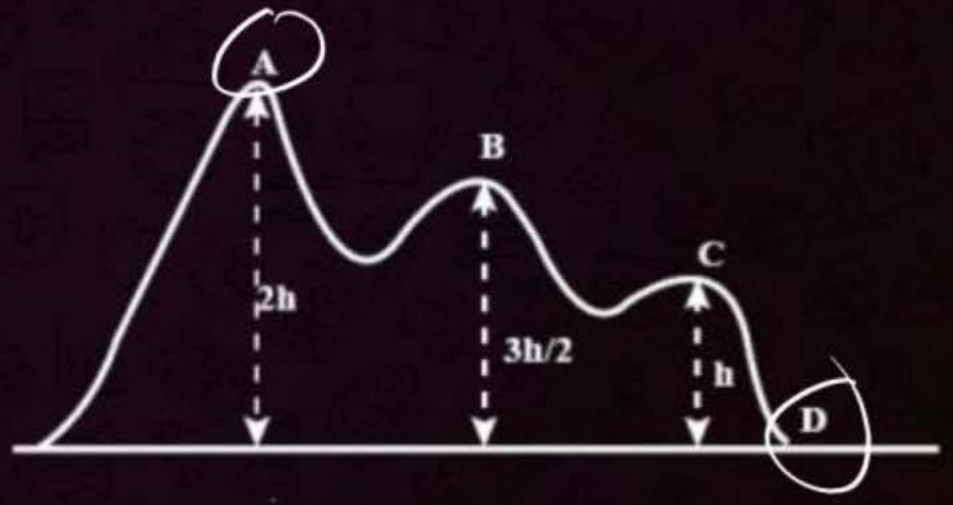
$= \sqrt{R \times g \frac{3S}{4}}$

Difficulty Level : MEDIUM

QUESTION-112

A small roller coaster starts at point A with a speed u on a curved track as shown in the figure. The friction between the roller coaster and the track is negligible and it always remains in contact with the track. The speed of roller coaster at point D on the track will be

[NCERT Based]



1. $(u^2 + gh)^{1/2}$
2. $(u^2 + 2gh)^{1/2}$
3. $(u^2 + 4gh)^{1/2}$
4. u

Difficulty Level : EASY

QUESTION-113

A ball of mass m is dropped from a cliff of height H. The ratio of its kinetic energy to the potential energy when it is fallen through a height 3/4 H is

[NCERT Based]

1. 3 : 4
2. 4 : 3
3. 1 : 3
4. 3 : 1

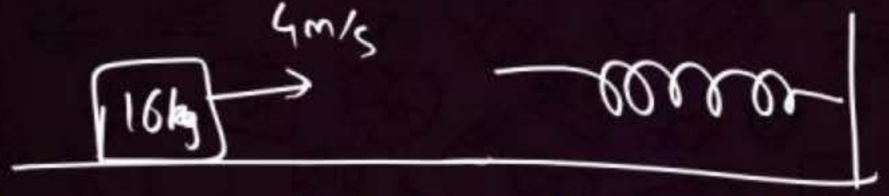
6.2 KE and PE Spring

Difficulty Level : EASY

QUESTION-114

A block of mass 16 kg is moving on a frictionless horizontal surface with velocity 4 m/s and comes to rest after pressing a spring. If the force constant of the spring is 100 N/m then the compression in the spring will be

1. 3.2 m
2. 1.6 m
3. 0.6 m
4. 6.1 m



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

$$16 \times 4 \times 4 = 100\,x^2$$

$$x = \sqrt{\frac{16 \times 16}{100}} = \frac{16}{10} = 1.6\,m$$

Difficulty Level : MEDIUM

QUESTION-115

HW//

A block of mass m moving with speed v compresses a spring through distance x before its speed is halved. What is the value of spring constant

1. $3mv^2/4x^2$
2. $mv^2/4x^2$
3. $mv^2/2x^2$
4. $2mv^2/x^2$

$$\Delta K = \Delta U$$

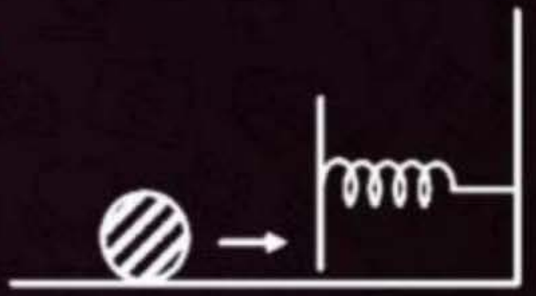
$$\frac{1}{2}mv^2 - \frac{1}{2}m\left(\frac{v}{2}\right)^2 = \frac{1}{2}kx^2$$

$$\frac{3mv^2}{4x2}$$

Difficulty Level : EASY

QUESTION-116

A mass of 0.5 kg moving with a speed of 1.5 m/s on a horizontal smooth surface, collides with a nearly weightless spring of force constant $k = 50\text{N} / \text{m}$ The maximum compression of the spring would be: [2004]



1. 0.12 m
2. 1.5 m
3. 0.5 m
4. 0.15 m

Difficulty Level : EASY

QUESTION-117

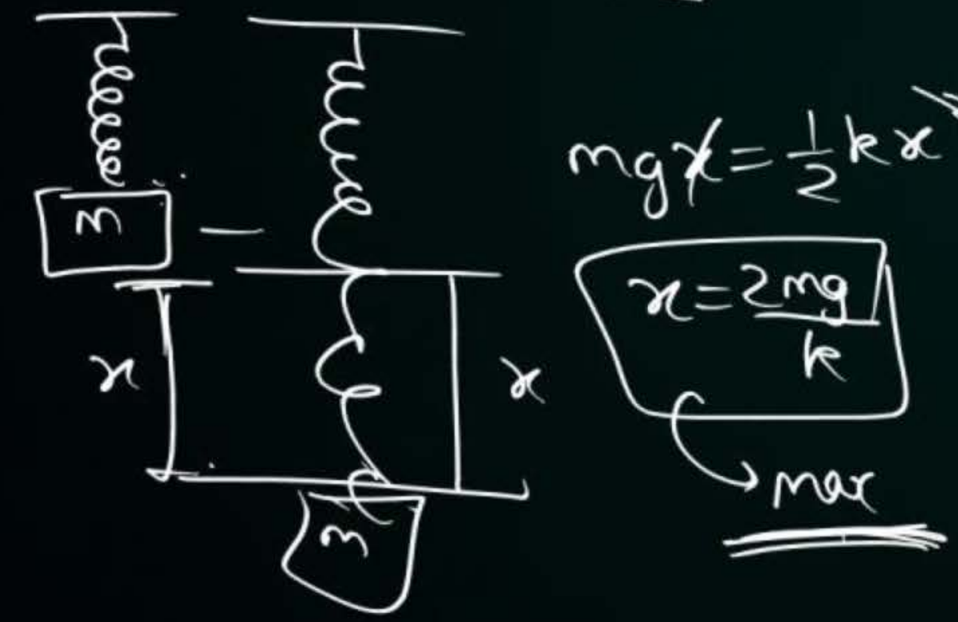
A 15 g ball is shot from a spring gun whose spring has a force constant 600 N m^{-1}. The spring is compressed by 5 cm. The greatest possible horizontal range of the ball for this compression (Take g = 10 m s^{-2}) [NCERT Based]

1. 6 m
2. 8 m
3. 10 m
4. 12 m

6.3 PE Spring and PE Gravitation

$mg\Delta h = \frac{1}{2}mv^2$

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



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

$x = \frac{2mg}{k}$

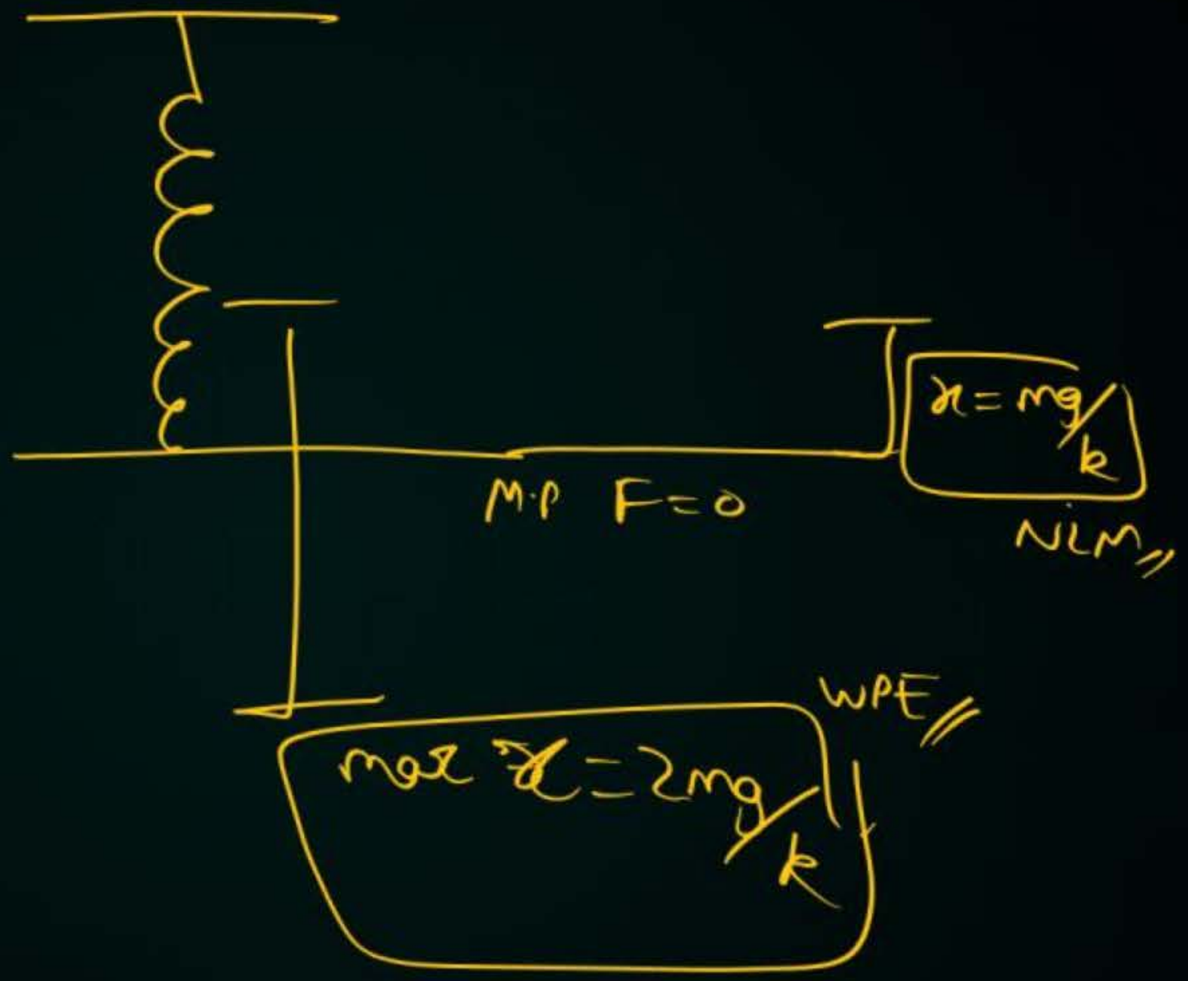
$\rightarrow ma_r$

Difficulty Level : MEDIUM

QUESTION-118

A block of mass M is attached to the lower end of a vertical spring. The spring is hung from a ceiling and has force constant value k. The mass is released from rest with the spring initially unstretched. The maximum extension produced in the length of the spring will be: [2009]

1. 2 Mg/k
2. 4 Mg/k
3. Mg/2k
4. Mg/k


x = mg/k
M.P F=0
NLM
WPE
max x = 2mg/k

Difficulty Level : EASY

QUESTION-119

A block of mass 2 kg is dropped from a height of 40 cm on a spring whose force-constant is 1960 N m^{-1}. The maximum distance through which the spring is compressed by

[NCERT Based]

1. 5 cm
2. 15 cm
3. 20 cm
4. 10 cm

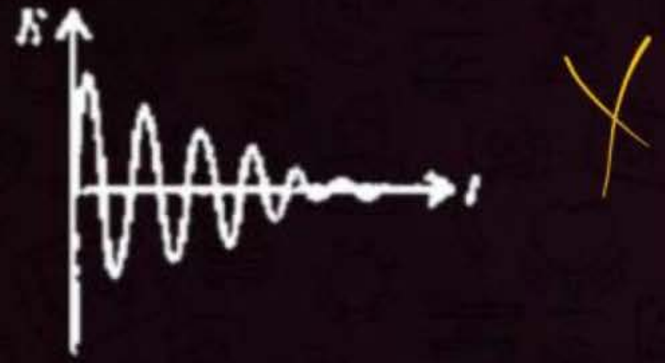
6.4 Special Cases

Difficulty Level : HARD

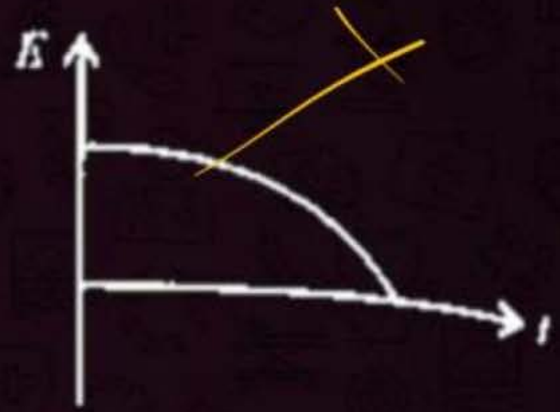
QUESTION-120

Which of the diagrams shown in figure represents variation of total mechanical energy of a pendulum oscillating in air as function of time? [NCERT Exemplar]

1



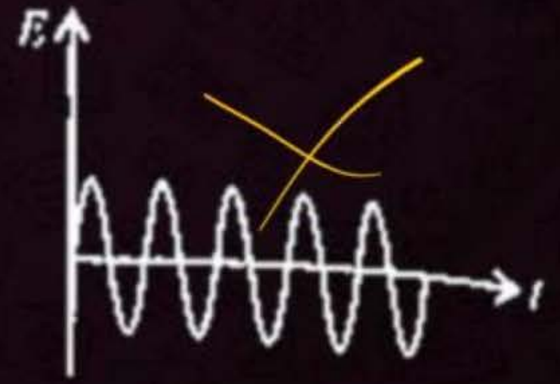
2



3



4



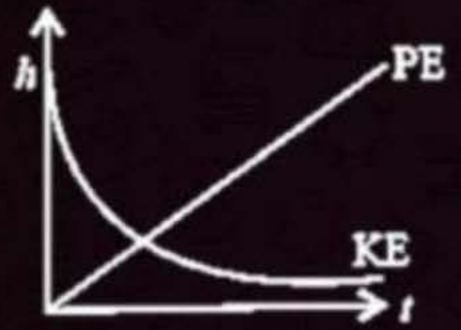
Difficulty Level : HARD

QUESTION-121

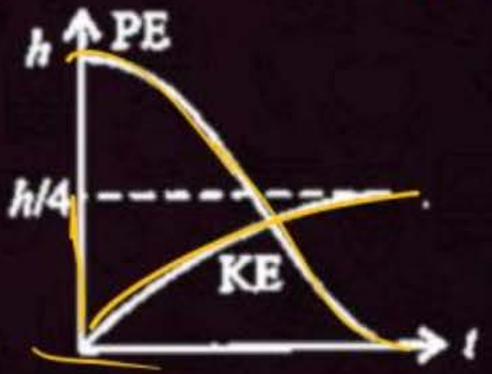
A raindrop falling from a height h above ground, attains a near terminal velocity when it has fallen through a height $\left(\frac{3}{4}\right)h$. Which of the diagrams shown in figure correctly shows the change in kinetic and potential energy of the drop during its fall up to the ground?

[NCERT Exemplar]

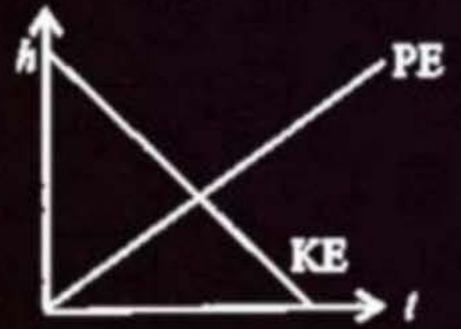
1



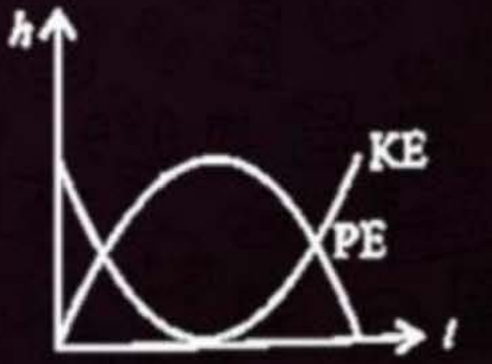
2



3



4



Difficulty Level : YODHA

Challenge

QUESTION-122

Consider a one-dimensional motion of a particle with total energy E. There are four regions A, B, C and D in which the relation between potential energy V, kinetic energy K and total energy E is as given below:

Region A: $V > E$ Region B: $V < E$

Region C: $K > E$ Region D: $V > K$

Which of the following regions the particle cannot be found? [NCERT Based]

1. A
2. B
3. C
4. D

Difficulty Level : YODHA

Challenge #2

Gravitation

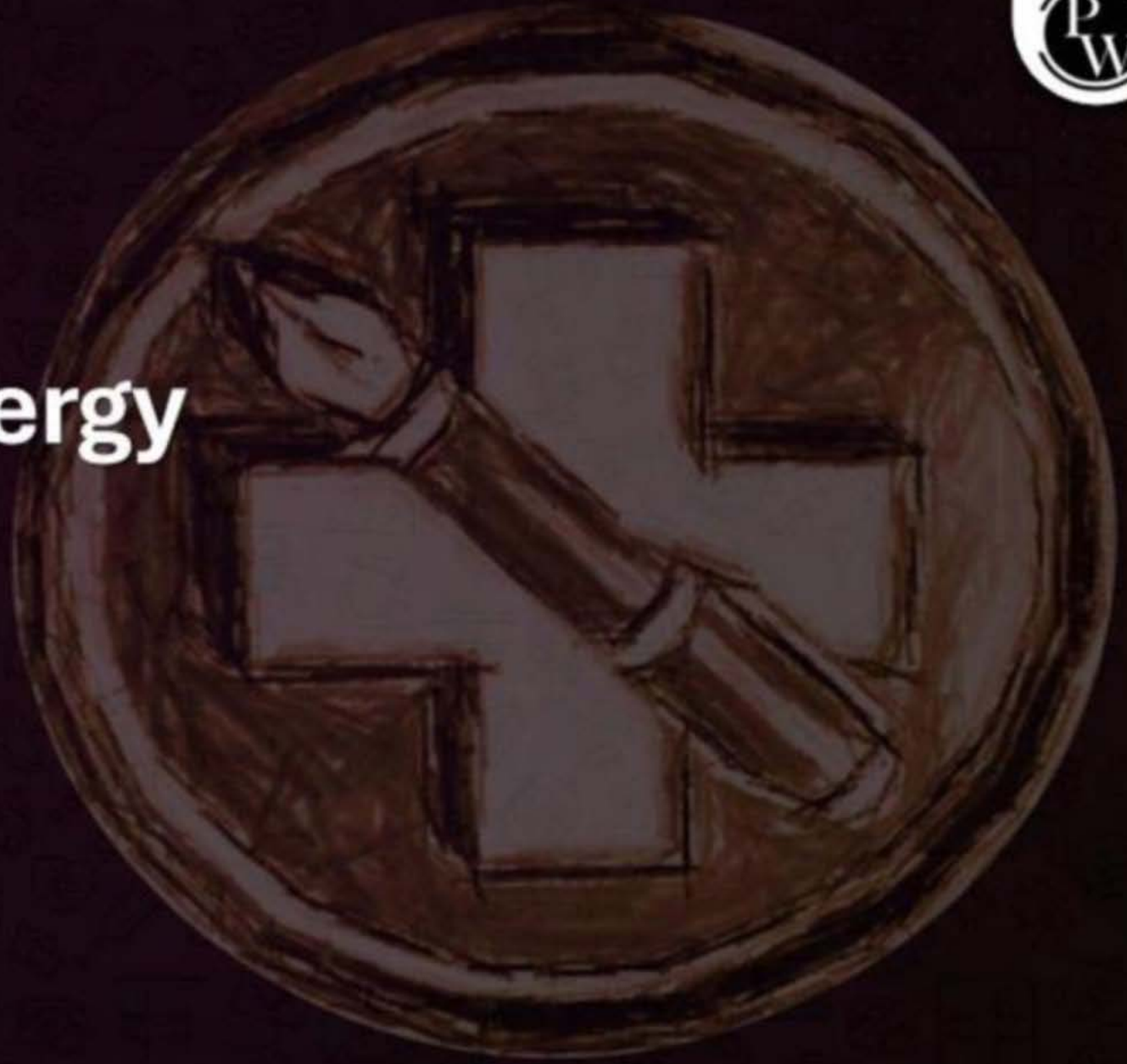
QUESTION-123

A particle of mass m is moving in a horizontal circle of radius r, under a centripetal force equal to $-(k/r^2)$ where k is constant. The total energy of the particle is

[NCERT Based]

1. $-\frac{k}{r}$
2. $-\frac{k}{2r}$
3. $\frac{k}{2r}$
4. $\frac{2k}{r}$

Part 7 – Work Energy Theorem



7.1 Theory Based

WET – Work Energy Theorem

$$W_{\text{all Force}} = \Delta KE$$

(External, Internal, CF, NCF)

All matlab All

$$W_{\text{against CF}} = \Delta PE$$

$$-W_{CF} = \Delta PE$$

Many times $W_{\text{Internal Force}} = 0$

$$W_{\text{external F}} = \Delta KE$$

$$W_{E} + \cancel{W_{Int}} = \Delta KE$$

$$W_{CF} + W_{NCF} = \Delta KE$$

$$W_{NCF} = \Delta KE - W_{CF} = \Delta K + \Delta U$$

Difficulty Level : EASY

QUESTION-124

The kinetic energy of a particle continuously increases with time. [HCV Objective]

1. The resultant force on the particle must be parallel to the velocity at all instants.
2. The resultant force on the particle must be at an angle less than 90° all the time.
3. Its height above the ground level must continuously decrease.
4. The magnitude of its linear momentum is decreasing continuously

Difficulty Level : EASY

QUESTION-125

The work done by a body against friction always results in [NCERT Based]

1. loss of kinetic energy
2. loss of potential energy
3. gain of kinetic energy
4. gain of potential energy

Difficulty Level : EASY

QUESTION-126

Identify the false statement from the following. [NCERT Based]

1. Work-energy theorem is not independent of Newton's second law.
2. Work-energy theorem holds in all inertial frames.
3. Work done by friction over a closed path is zero.
4. Work done is a scalar quantity.

Difficulty Level : EASY

QUESTION-127

The work-energy theorem states that the change in [NCERT Based]

1. kinetic energy of a particle is equal to the work done on it by the net force
2. kinetic energy of a particle is equal to the work done by one of the forces acting on it
3. potential energy of a particle is equal to the work done on it by the net force
4. potential energy of a particle is equal to the work done by one of the forces acting on it.

Difficulty Level : EASY

QUESTION-128

The negative of the work done by the conservative internal forces on a system equals the change in [HCV Objective]

1. total energy
2. kinetic energy
3. potential energy
4. none of these.

Difficulty Level : EASY

QUESTION-129

The work done by the external forces on a system equals the change in

[HCV Objective]

1. total energy
2. kinetic energy
3. potential energy
4. none of these

Difficulty Level : EASY

QUESTION-130

The work done by all the forces (external and internal) on a system equals the change in [HCV Objective]

1. total energy
2. kinetic energy
3. potential energy
4. none of these.

Difficulty Level : EASY

QUESTION-131

The total work done on a particle is equal to the change in its kinetic energy

[HCV Objective]

1. always
2. only if the forces acting on it are conservative
3. only if gravitational force alone acts on it
4. only if elastic force alone acts on it.

7.2 W and KE

Difficulty Level : MEDIUM

QUESTION-133

A truck and a car moving with the same kinetic energy are brought to rest by the application of brakes which provide equal retarding forces. Which of them will come to rest in a shorter distance? **[NCERT Based]**

$KE = F \cdot S$ (Same)

1. The truck
2. The car
3. Both will travel the same distance before coming to rest
4. Cannot be predicted

Difficulty Level : MEDIUM

QUESTION-134

A block of mass 10 kg moving in x direction with a constant speed of 10 ms^{-1}, is subjected to a retarding force $F = -0.1x$ J/m during its travel from $x = 20$m to 30 m. Its final K.E. will be: [2015]

1. 450 J
2. 275 J
3. 250 J
4. 475 J

$$W = \int F \cdot dx$$

$$= \frac{-0.1x^2}{2}$$

$$= \frac{-0.1}{2}(30^2 - 20^2)$$

$$= \frac{-0.1}{2}(500)$$

$$= -25\,J$$

$$K_i = \frac{1}{2}mu^2$$

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

$$= 500\,J$$

Difficulty Level : HARD

QUESTION-135

The kinetic energy acquired by a mass m in travelling distance d, starting from rest, under the action of a constant force is directly proportional to: [1994]

1. m
2. m^0
3. $\sqrt{m}$
4. $1/\sqrt{m}$

$W = \Delta KE$

$\Rightarrow F \cdot s = \Delta KE$

→ same

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

Difficulty Level : MEDIUM

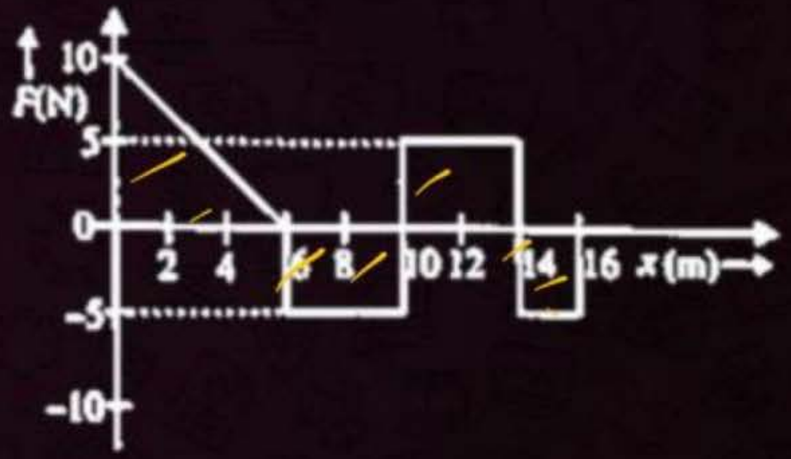
QUESTION-136

A particle is acted upon by a force F which varies with position x as shown in figure. If the particle at $x = 0$ has kinetic energy of 25 J, then the kinetic energy of the particle at $x = 16\ m$ is

[NCERT Based]

1. 45 J
2. 30 J
3. 70 J
4. 20 J

$W = \Delta K$



HW

Difficulty Level : MEDIUM

QUESTION-137

A variable force, given by the 2-dimensional vector $\vec{F} = (3x^2\hat{i} + 4\hat{j})$ acts on a particle. The force is in newton x is in metre. What is the change in the kinetic energy of the particle as it moves from the point with coordinates (2, 3) to (3, 0)? (The coordinates are in metres.) [NCERT Based]

1. –7 J
2. zero
3. +7 J
4. +19 J

Difficulty Level : MEDIUM

QUESTION-138

A block of mass M is hanging over a smooth and light pulley through a light string. The other end of the string is pulled by a constant force F. The kinetic energy of the block increases by 20 J in 1 s. [HCV Objective]

1. The tension in the string is Mg.
2. The tension in the string is F.
3. The work done by the tension on the block is 20 J in the above 1 s.
4. The work done by the force of gravity is –20 J in the above 1 s.

Difficulty Level : HARD

QUESTION-139

A particle of mass 10 g moves along a circle of radius 6.4 cm with a constant tangential acceleration. What is the magnitude of this acceleration if the kinetic energy of the particle becomes equal to 8×10^{-4} J by the end of the second revolution after the beginning of the motion? [2016-I]

1. $0.1\ m/s^2$
2. $0.15\ m/s^2$
3. $0.18\ m/s^2$
4. $0.2\ m/s^2$

$\frac{1}{2}mv^2 = 8\times10^{-4}$

$\frac{1}{2}\times10\times10^{-3}v^2 = 8\times10^{-4}$

$v^2 = \frac{16}{100}$

$u = 0$ $\quad v = \frac{4}{10}$



$S = 4\pi r$

$v^2 = u^2 + 2a_t S$ → Scalar; Speed; distance

$\frac{16}{100} = 0 + 2\times a_t \times 4\pi r$

$\frac{16}{100} = 8\pi\times\frac{6.4}{100}a_t$ ✓

7.3 W by non conservative force

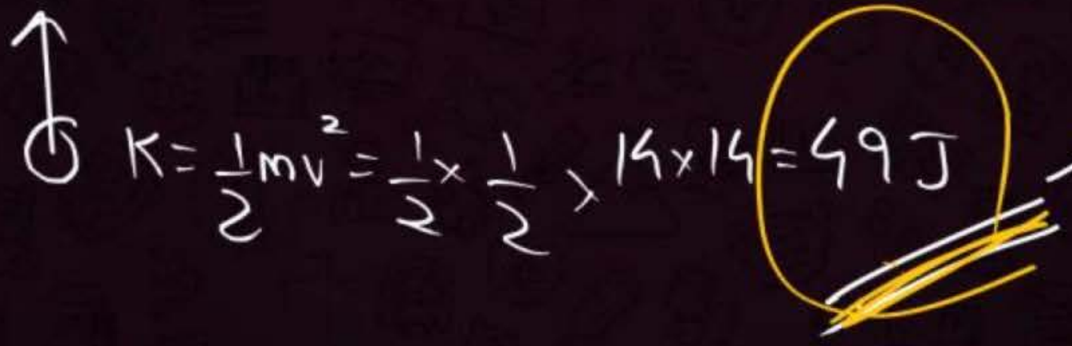
- W_{NCF} = Energy Loss
- $W_{NCF} = \Delta K + \Delta U$

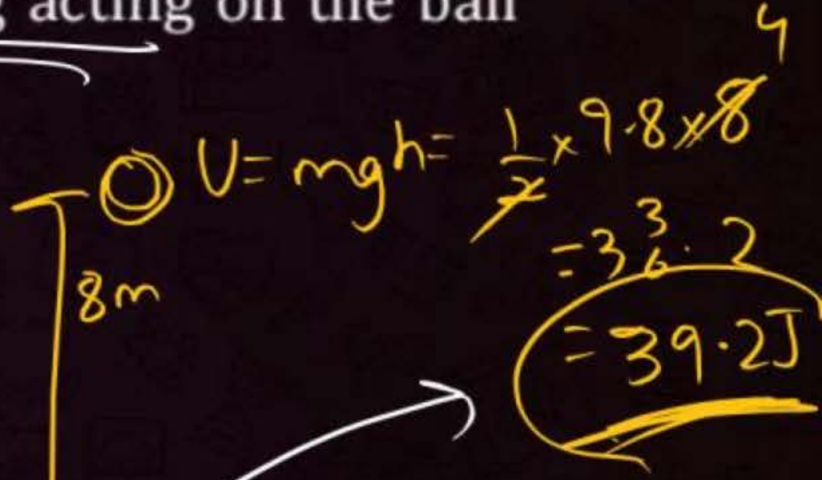
Difficulty Level : HARD

QUESTION-140

A 0.5 kg ball is thrown up with an initial speed 14 m/s and reaches a maximum height of 8.0 m. How much energy is dissipated by air drag acting on the ball during the ascent?

1. 19.6 J
2. 4.9 J
3. 10 J
4. 9.8 J





$$\begin{array}{r} 49 \\ -39.2 \\ \hline 10 \\ -0.2 \\ \hline 9.8\ J \end{array}$$

Difficulty Level : HARD

QUESTION-141

A bullet of mass 10 g leaves a rifle at an initial velocity of 1000 m/s and strikes the earth at the same level with a velocity of 500 m/s. The work done in joule for overcoming the resistance of air will be [1989]

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

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

1. 375
2. 3750
3. 5000
4. 500

Difficulty Level : HARD

QUESTION-142

A body of mass 1 kg is thrown upwards with a velocity 20 m/s. It momentarily comes to rest after attaining a height of 18 m. How much energy is lost due to air friction? ($g = 10 m/s^2$) [2009]

1. 30 J
2. 40 J
3. 10 J
4. 20 J

Difficulty Level : HARD

QUESTION-143

A raindrop of mass 1 g falling from a height of 1 km hits the ground with a speed of 50 m s^{-1} Which of the following statements is correct?

(Take $g = 10$ m s^{-2})

[NCERT Based]

1. The loss of potential energy of the drop is 10 J.
2. The gain in kinetic energy of the drop is 1.25 J.
3. The gain in kinetic energy of the drop is not equal to the loss of potential energy of the drop.
4. All of these.

Difficulty Level : HARD

QUESTION-144

A raindrop of mass 1 g falling from a height of 1 km hits the ground with a speed of 50 m s^{-1}. If the resistive force is proportional to the speed of the drop, then the work done by the resistive force is (Take $g = 10$ m s^{-2}) [NCERT Based]

1. 10 J
2. – 10 J
3. 8.75 J
4. – 8.75 J

Difficulty Level : HARD

QUESTION-145

Consider a drop of rain water having mass 1 g 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:

[2017-Delhi]

1. (i) 1.25 J (ii) –8.25 J
2. (i) 100 J (ii) 8.75 J
3. (i) 10 J (ii) –8.75 J
4. (i) –10 J (ii) –8.25 J

Difficulty Level : HARD

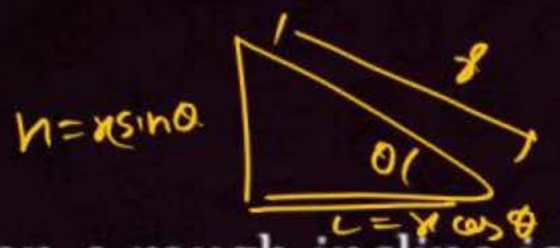
QUESTION-146

A bullet of mass 10 g leaves a rifle at an initial velocity of 100 m/s and strikes the earth at the same level with a velocity of 500 m/s. The work done in joule overcoming the resistance of air will be: [1989]

1. 375
2. 3750
3. 5000
4. 500

Difficulty Level : YODHA

QUESTION-147



$\Delta U = -mgh = -mgx\sin\theta$

$W_f = -\mu mgL = -\mu mgx\cos\theta$

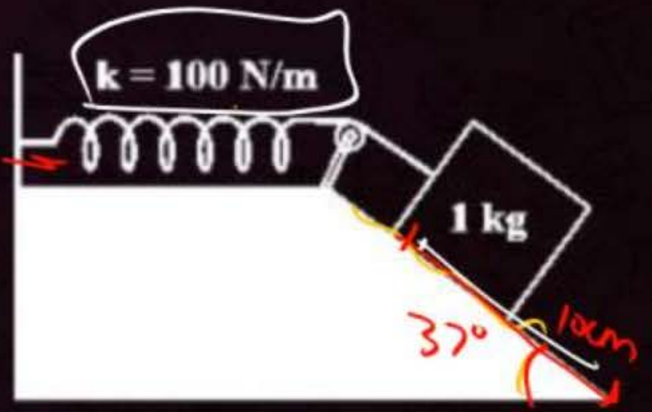
A 1 kg block situated on a rough incline is connected to a spring of negligible mass having spring constant 100 N m^{-1} as shown in the figure. The 1 block is released from rest with the spring in the un-stretched position. The block moves 10 cm down the incline before coming to rest. The coefficient of friction between the block and the incline is (Take g = 10 m s^{-2} s and assume that the pulley is = frictionless) angle of incline = 37^0

$W_f = \Delta K + \Delta U$

$W_f = 0 + \Delta U$

$W_f = \Delta U_{spring} + \Delta U_{gravity}$

$$-\mu mg\frac{10}{100}\cos 37^\circ = \frac{1}{2}kx^2 - mg\frac{10}{100}\sin 37^\circ$$

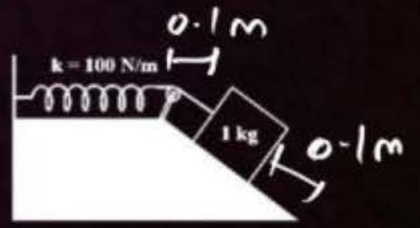


1. 0.2
2. 0.3
3. 0.5
4. 0.6

Difficulty Level : YODHA

QUESTION-147

A 1 kg block situated on a rough incline is connected to a spring of negligible mass having spring constant 100 N m^{-1} as shown in the figure. The 1 block is released from rest with the spring in the un-stretched position. The block moves 10 cm down the incline before coming to rest. The coefficient of friction between the block and the incline is (Take g = 10 m s^{-2} s and assume that the pulley is = frictionless) angle of incline = 37^0



1. 0.2
2. 0.3
3. 0.5
4. 0.6

$$\Delta U_s = \frac{1}{2}kx^2 = \frac{1}{2}\times 100\times 0.1\times 0.1 = 0.5\ \text{J}$$

$$\Delta U_g = -mgh = -mg\times\sin 37^\circ = -1\times 10\times 0.1\times\frac{3}{5} = -0.6\ \text{J}$$

$$W_f = -\mu mgL = -\mu mg\times\cos 37^\circ = -\mu\times 1\times 10\times 0.1\times\frac{4}{5} = -0.8\mu$$

$$W_f = \Delta U_s + \Delta U_g$$

$$-0.8\mu = 0.5 - 0.6$$

$$-0.8\mu = -0.1$$

$$\mu = \frac{1}{8}$$

$$\mu = 0.125$$

Difficulty Level : HARD

QUESTION-148

250 N force is required to raise 75 kg mass from a pulley. If rope is pulled 12 m then the load is lifted to 3 m, the efficiency of pulley system will be: [2001]

1. 25%
2. 33.3%
3. 75%
4. 90%

Part 8 – Power



8.1 P instantaneous

Power = Rate of doing Work = Rate of Energy Production or Consumption

- $P_{inst} = \vec{F} \cdot \vec{v}$
- $P_{avg} = \frac{W}{time} = \left(\vec{F} \cdot V_{avg}\right)$ ($\vec{F}$ constant)

Power SI → unit Watt

$1 kW = 1000 W$

$1 hp = 746 W$ (horse power)

Dimension = $[ML^2T^{-3}]$

Difficulty Level : EASY

QUESTION-149

An electric motor produces a tension of 4500 N in a load lifting cable and rolls it at the rate of 2 m/s. The power of the motor is

$P = F.v = 4500 \cdot 2$

1. 9 kW
2. 15 kW
3. 225 kW
4. 9×103hp

Difficulty Level : EASY

QUESTION-150

A motor of 100hp is moving a car with a constant velocity of 72 km/hour. The forward force exerted by the engine on the car is

1. 3.73×10^3 N
2. 3.73×10^2 N
3. 3.73×10^1 N
4. None of the above

Difficulty Level : EASY

QUESTION-151

If the force applied is F and the velocity gained is v, then the instantaneous power is

1. F/v
2. v^2/F
3. $Fv/2$
4. Fv

Difficulty Level : EASY

QUESTION-152

A constant force F is pulling a body of mass m at an angle of θ with the horizontal with a constant velocity v. The power P exerted is

$F \cdot v = Fv\cos\theta$

1. $Fv\cos\theta$ ✓
2. $F\cos\theta/mg$
3. $Fmg\cos\theta/v$
4. $mg\sin\theta/F$

Difficulty Level : EASY

QUESTION-153

A particle moves with a velocity $(5\hat{i}-3\hat{j}+6\hat{k})$ ms^{-1} horizontally under the action of constant force $(10\hat{i}+10\hat{j}+20\hat{k})$ N. The instantaneous power supplied to the particle is:

[2023-Manipur]

$P = F \cdot v$

$50 - 30 + 120$

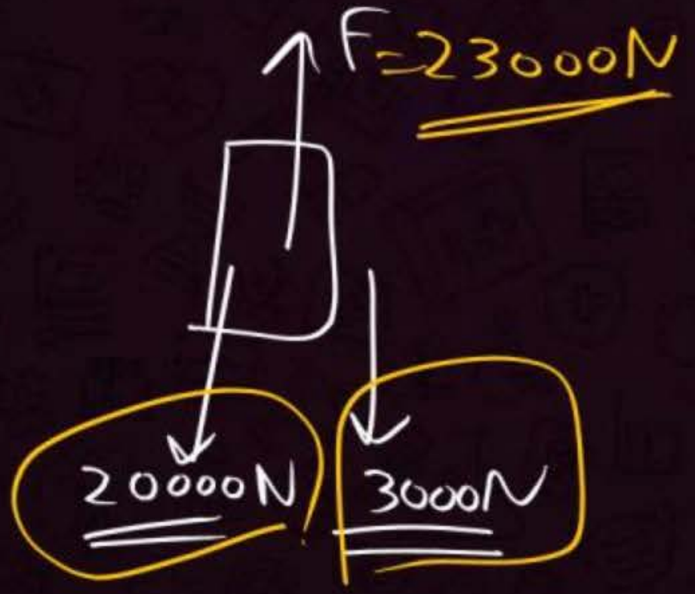
1. 200 W
2. Zero
3. 100 W
4. 140 W

Difficulty Level : MEDIUM

QUESTION-154

An electric lift with a maximum load of 2000 kg (lift + passengers) is moving up with a constant speed of 1.5 ms^{-1}. The frictional force opposing the motion is 3000 N. The minimum power delivered by the motor to the lift in watts is: ($g = 10\ ms^{-2}$)

[2022]



$P = F \cdot V$

$= 23000 \times \frac{3}{2}$

$= 11500 \times 3$

$= 34500$

1. 23500
2. 23000
3. 20000
4. 34500

Difficulty Level : YODHA

QUESTION-155

A body of mass 1 kg begins to move under the action of a time dependent force $F = (2t\hat{i} + 3t^2\hat{j})$ N, where $\hat{i}$ and $\hat{j}$ are unit vectors along x and y axis. What power will be developed by the force at the time t? [2016-I]

1. $(2t^2 + 3t^2)$W
2. $(2t^2 + 4t^4)$W
3. $(2t^3 + 4t^4)$W
4. $(2t^3 + 3t^5)$W

$F = 2t\,\hat{i} + 3t^2\,\hat{j}$

$a = \frac{F}{m} = 2t\,\hat{i} + 3t^2\,\hat{j}$

$v = \int a\,dt = \frac{2t^2}{2}\,\hat{i} + \frac{3t^3}{3}\,\hat{j}$

$P = F \cdot v = 2t t^2 + 3t^2 t^3$

$$\boxed{P = 2t^3 + 3t^5}$$

Difficulty Level : EASY

QUESTION-156

hw

If $\vec{F} = (60\hat{\imath} + 15\hat{\jmath} - 3\hat{k})$N and $\vec{V} = (2\hat{\imath} - 4\hat{\jmath} + 5\hat{k})$m/s then instantaneous power is: [2000]

1. 195 watt
2. 45 watt
3. 75 watt
4. 100 watt

8.2 P average

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

F/a constant

$$v_{avg} = \frac{u+v}{2}$$

$$P_{avg} = F \cdot v_{avg} = F\left(\frac{u+v}{2}\right)$$

Difficulty Level : EASY

QUESTION-157

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

1. 1960 W
2. 2205 W
3. 4410 W
4. 0 W

$$P_{avg} = \frac{W}{t} = \frac{mgh}{t} = \frac{300 \times 98 \times 2}{3}$$

Difficulty Level : EASY

QUESTION-158

Water is falling on the blades of a turbine at a rate of 100 kg/s from a certain spring. If the height of the spring be 100 metres, the power transferred to the turbine will be:-

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

1. 100 kW ✓
2. 10 kW
3. 1 kW
4. 1000 kW

Difficulty Level : HARD

QUESTION-159

If the force applied is F and the velocity gained is v, then the average power developed is:-

1. F/v
2. v/F
3. $Fv/2$
4. Fv^2

$P_{av} = F \cdot v_{av}$

$F\left(\frac{u+v}{2}\right)$

$F\left(\frac{0+v}{2}\right)$

$\frac{Fv}{2}$

Difficulty Level : EASY

QUESTION-160

The energy that will be ideally radiated by a 100 kW transmitter in 1 hour is:

[2022]

1. 1×10^5 J
2. 36×10^7 J
3. 36×10^4 J
4. 36×10^5 J

Difficulty Level : EASY

QUESTION-161

Water falls from a height of 60 m at the rate of 15 kg/s to operate a turbine. The losses due to frictional force are 10% of the input energy. How much power is generated by the turbine? ($g = 10\ m/s^2$) [2021, 2008]

1. 8.1 kW
2. 12.3 kW
3. 7.0 kW
4. 10.2 kW

Difficulty Level : MEDIUM

QUESTION-162

A particle of mass M starting from rest undergoes uniform acceleration. If the speed acquired in time T is V, the power delivered to the particle is: **[2010 Mains]**

$W = \Delta K = \frac{1}{2}mv^2$

$P = \frac{W}{T} = \frac{mv^2}{2T}$

1. $\frac{1}{2}\frac{MV^2}{T^2}$
2. $\frac{2}{1}\frac{MV^2}{T^2}$
3. $\frac{MV^2}{T^2}$
4. $\frac{1}{2}\frac{MV^2}{T}$

Difficulty Level : MEDIUM

QUESTION-163

How much water a pump of 2 kW can raise in one minute to a height of 10 m? (Take $g = 10\ m/s^2$) [1990]

1. 1000 litres
2. 1200 litres
3. 100 litres
4. 2000 litres

8.3 constant P

Constant P

$Fv = P$

$F \propto \frac{1}{v}$

$P = F \cdot v$

$P = ma \cdot v$

$P = m\frac{dv}{dx}v$

$\int P\,dx = \int m v^2 dv$

$Px = \frac{mv^3}{3}$

$x \propto v^3$

$P = m\frac{dv}{dt}v$

$P\,dt = mv\,dv$

$Pt = \frac{mv^2}{2}$

$v^2 \propto t$

$v \propto t^{1/2}$

$x \propto t^{3/2}$

QUESTION-132

Difficulty Level : HARD

$P = \frac{\Delta K}{t}$

$\Delta K = Pt$

$\Delta K \propto t$

If the force acting on a a body is inversely proportional to its speed, then its kinetic energy is

[NCERT Based]

$F \propto \frac{1}{v} \rightarrow$ P constant

$v \propto \sqrt{t}$

$\frac{1}{2} m v^2 \propto t$ Linear

1. linearly related to time
2. inversely proportional to time
3. inversely proportional to the square of time
4. a constant.

Difficulty Level : HARD

QUESTION-164

A body of mass m starting from rest from origin moves along x-axis with constant power (P). Calculate relation between velocity/distance-

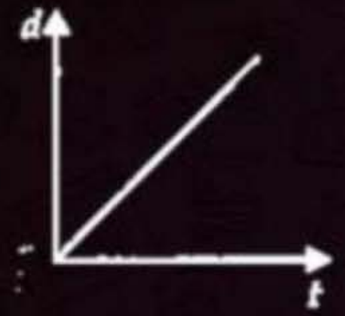
1. $x \propto \sqrt{v}$
2. $x \propto v^2$
3. $x \propto v$
4. $x \propto v^3$

Difficulty Level : HARD

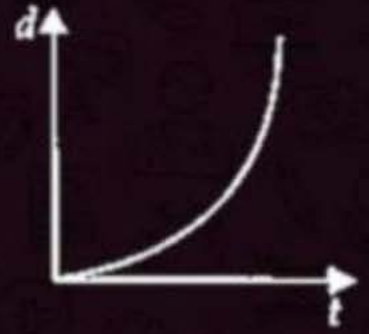
QUESTION-165

A body is moving uni-directionally under the influence of a source of constant power supplying energy. Which of the diagrams shown in figure correctly shows the displacement-time curve for its motion? [NCERT Exemplar]

1

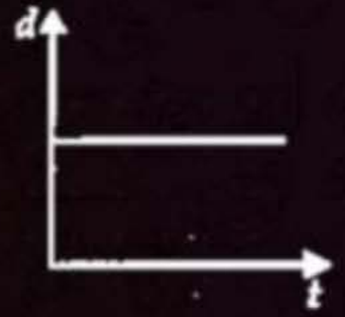


2

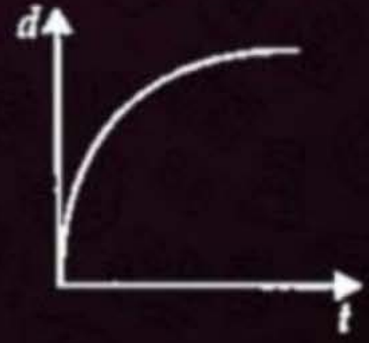


$x \propto t^{3/2}$

3



4



Difficulty Level : HARD

QUESTION-166

hw//

A particle of mass m is driven by a machine that delivers a constant power k watts. If the particle starts from rest the force on the particle at time t is: [2015]

1. $\sqrt{mkt^{\frac{-1}{2}}}$
2. $\sqrt{2mkt^{\frac{-1}{2}}}$
3. $\frac{1}{2}\sqrt{mkt^{\frac{-1}{2}}}$
4. $\sqrt{\frac{mk}{2}t^{\frac{-1}{2}}}$

Difficulty Level : HARD

QUESTION-167

A car of mass m starts from rest and accelerates so that the instantaneous power delivered to the car has a constant magnitude P_0. The instantaneous velocity of this car is proportional to:

[2012 Mains]

1. t^2P_0
2. $t^{1/2}$
3. $t^{-1/2}$
4. $\frac{1}{\sqrt{m}}$

8.4 Special Cases

Variable mass

P & motor

mass = ρ Volume

= ρ Area length

$$F_{vm} = \rho A v^2$$



NLM

$$P = F \cdot v = \rho A v^2 \cdot v = \rho A v^3$$

$$\frac{dK}{dt} = \text{Rate of kinetic Energy} = \frac{1}{2} \rho A v^3$$

QUESTION-168

Difficulty Level : ~~YODHA~~ Hard

PV → Pressure Volume

The heart of a man pumps 5 litres of blood through the arteries per minute at a pressure of 150 mm of mercury. If the density of mercury be 13.6×10^3 kg/m^3 and $g = 10$ m/s^2 then the power of heart in watt is: [2015 Re]

1. 1.50
2. 1.70
3. 2.35
4. 3.0

$\frac{\text{Vol}}{\text{time}} = \frac{5L}{60\,\text{sec}} = \frac{5L}{60\,\text{sec}}$

$P = 150\,\text{mm of Hg}$

$\rho = 13.6 \times 10^3$

$P = \frac{W}{\text{time}} = \frac{PV}{\text{time}} = \frac{[150 \times 10 \times 13.6 \times 10^3] \times [5 \times 10^{-3}]}{60}$

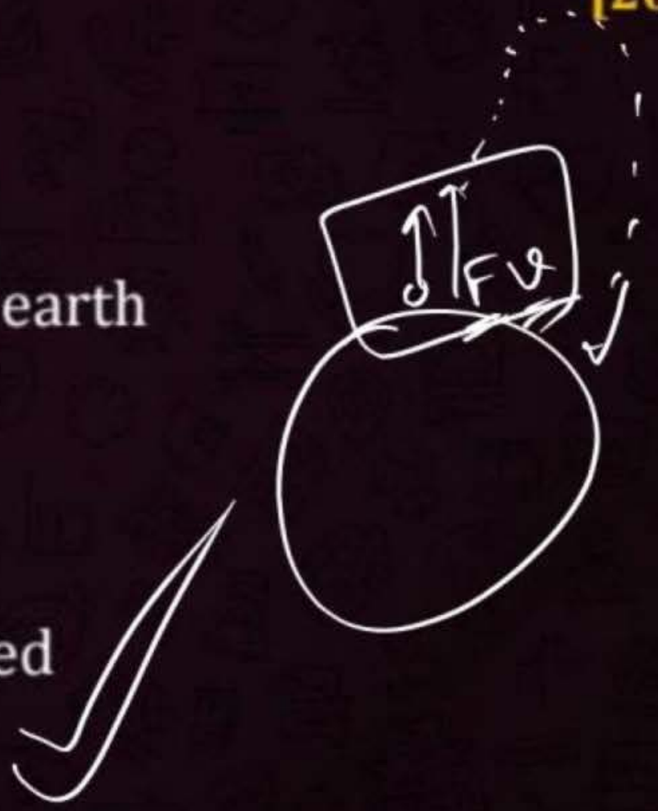
$P = \rho g h$

Difficulty Level : MEDIUM

QUESTION-169

A body projected vertically from the earth reaches a height equal to earth's radius before returning to the earth. The power exerted by the gravitational force is greatest [2011 Pre]

1. At the highest position of the body
2. At the instant just before the body hits the earth
3. It remains constant all through
4. At the instant just after the body is projected



Difficulty Level : HARD

QUESTION-170

Match Column-I with Column-II.

[NCERT Based]

	Column-I		Column-II
(A)	When a body does work against friction, its kinetic energy	(p)	independent of time
(B)	Work done by a body is	(q)	Time
(C)	Power of a body varies inversely as	(r)	force must be conservative
(D)	When work done over a closed path is zero	(s)	decreases

1. A – p, B – q, C – r, D – s
2. A – q, B – r, C – s, D – p
3. A – s, B – r, C – q, D – p
4. A – s, B – p, C – q, D – r

Difficulty Level : HARD

QUESTION-171

An engine pumps water through a hose pipe. Water passes through the pipe and leaves it with a velocity of 2 m/s. The mass per unit length of water in the pipe is 100 kg/m. What is the power of the engine? [2010 Pre]

1. 800 W
2. 400 W
3. 200 W
4. 100 W

$P = \rho A v^3$

Difficulty Level : YODHA

QUESTION-172

An engine pumps water continuously through a hose. Water leaves the hose with a velocity v and m is the mass per unit length of the water jet. What is the rate at which kinetic energy is imparted to water? [2009]

$\frac{dK}{dt} = \frac{1}{2}\rho A v^3$

(1) mv^3

(2) $\frac{1}{2}mv^2$

(3) $\frac{1}{2}m^2v^2$

(4) $\frac{1}{2}mv^3$

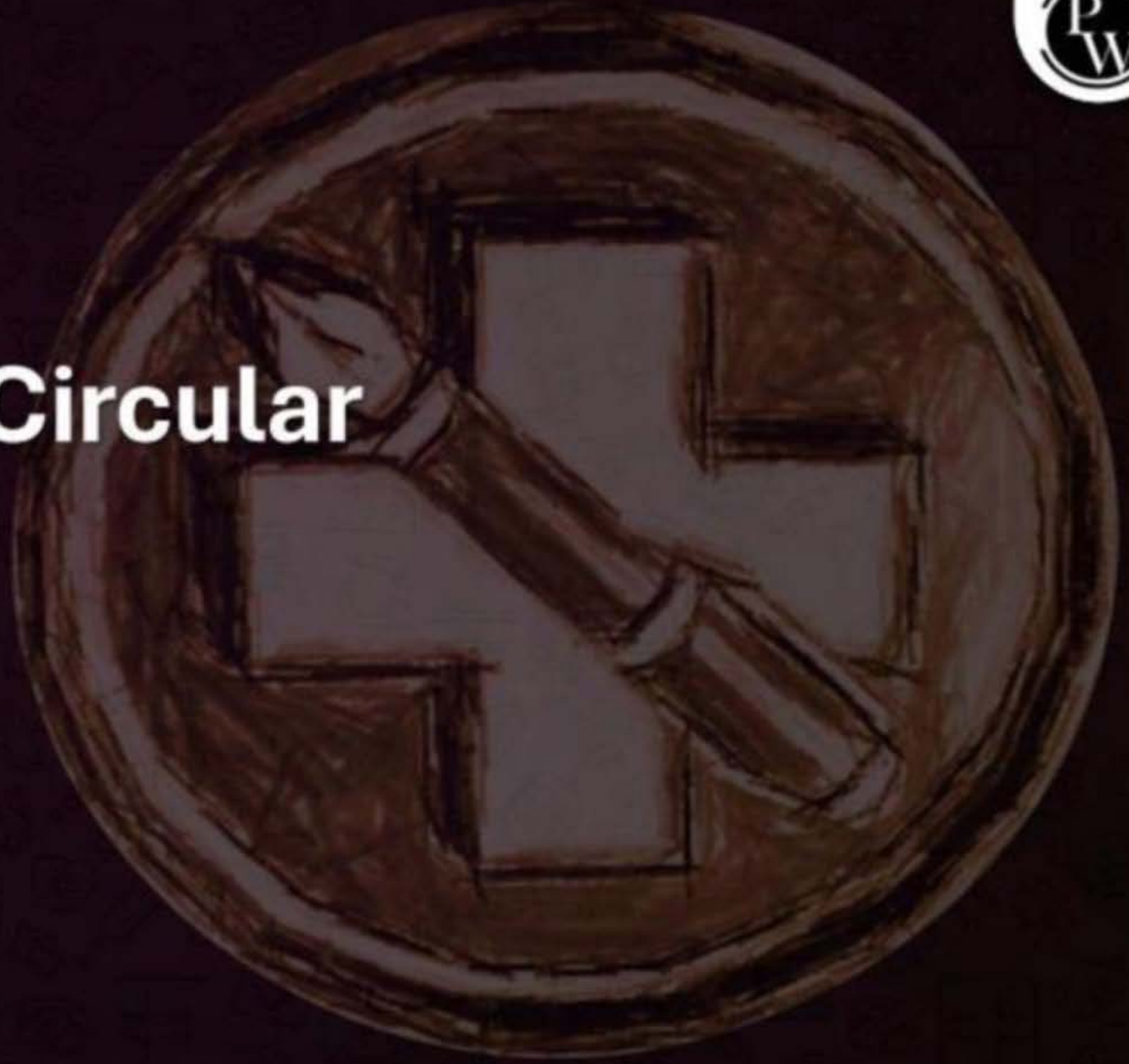
$\frac{dK}{dt} = \frac{d}{dt}\left(\frac{1}{2}mv^2\right)$

$= \frac{v^2}{2}\left(\frac{dm}{dt}\right)$

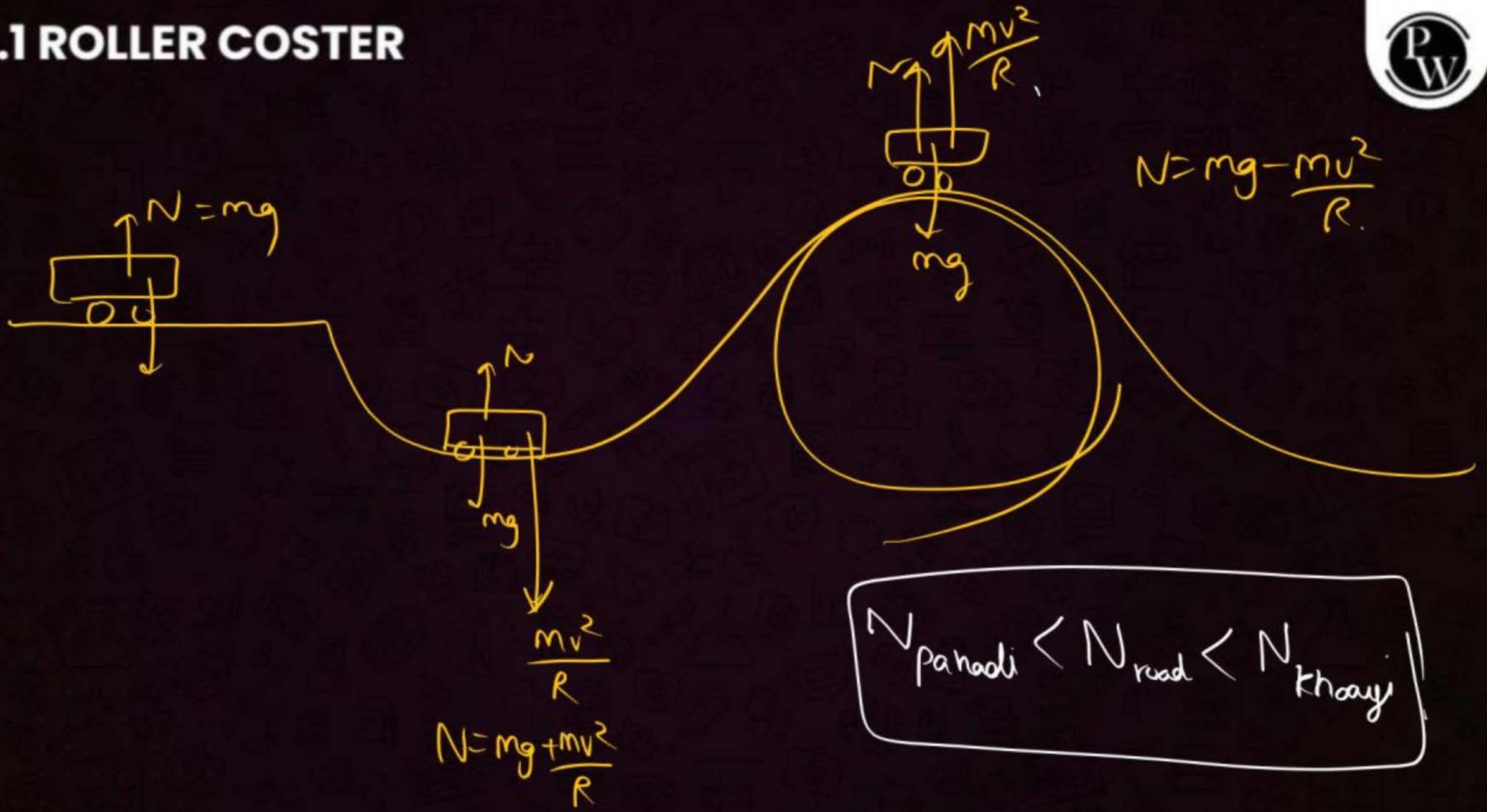
$= \frac{v^2}{2}\rho A v$

$= \frac{\rho A v^3}{2}$

Part 9 – Vertical Circular Motion



9.1 ROLLER COSTER

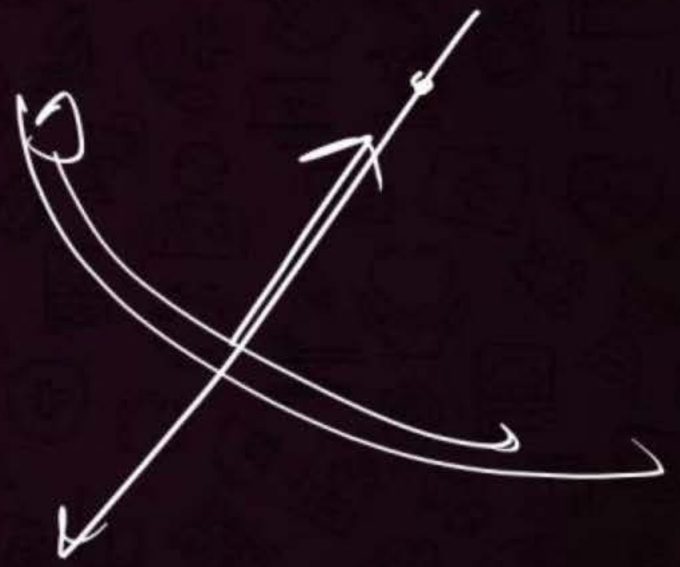


Difficulty Level : EASY

QUESTION-173

A block of mass m slides down a smooth vertical circular track. During the motion, the block is in

[HCV Objective]



1. vertical equilibrium
2. horizontal equilibrium
3. radial equilibrium
4. none of these

QUESTION-174

Difficulty Level : MEDIUM

A roller coaster is designed such that riders experience "weightlessness" as they go round the top of a hill whose radius of curvature is 20 m. The speed of the car at the top of the hill is between: [2008]

$N = 0$

$N = mg - \frac{mv^2}{R}$

$mg = \frac{mv^2}{R}$

$v = \sqrt{gR} = \sqrt{10 \times 20} = \sqrt{200}$

$= 10\sqrt{2}$

$= 10 \times 1.4$

$= 14$

1. 13 m/s and 14 m/s
2. 14 m/s and 15 m/s ✓
3. 15 m/s and 16 m/s
4. 16 m/s and 17 m/s

QUESTION-175

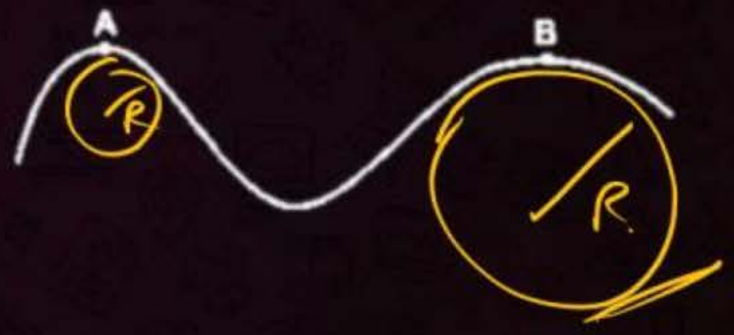
Difficulty Level : EASY

A car moves at a constant speed on a road as shown in figure. The normal force by the road on the car is N_A and N_B when it is at the points A and B respectively. Information to decide the relation of N_A and N_B. [HCV Objective]

1. $N_A = N_B$
2. $N_A > N_B$
3. $N_A < N_B$
4. insufficient

$N = mg - \frac{mv^2}{R}$ ↓

R↑ ⟶ N↑





QUESTION-176

Difficulty Level : EASY

A motorcyle is going on an overbridge of radius R. The driver maintains a constant speed. As the motorcycle is ascending on the overbridge, the normal force on it

[HCV Objective]

1. increases
2. decreases
3. remains the same
4. fluctuates

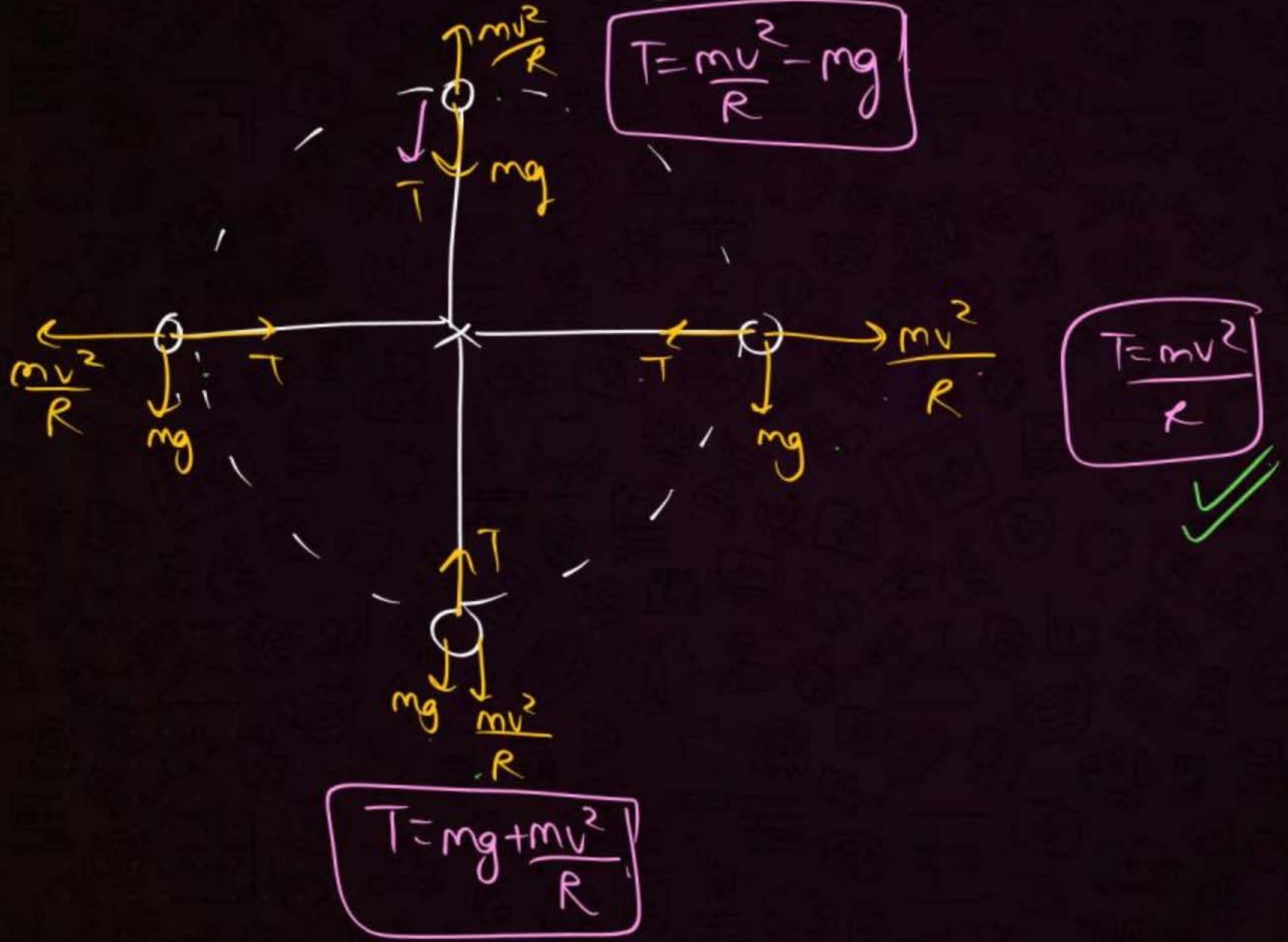
QUESTION-177

Difficulty Level : EASY

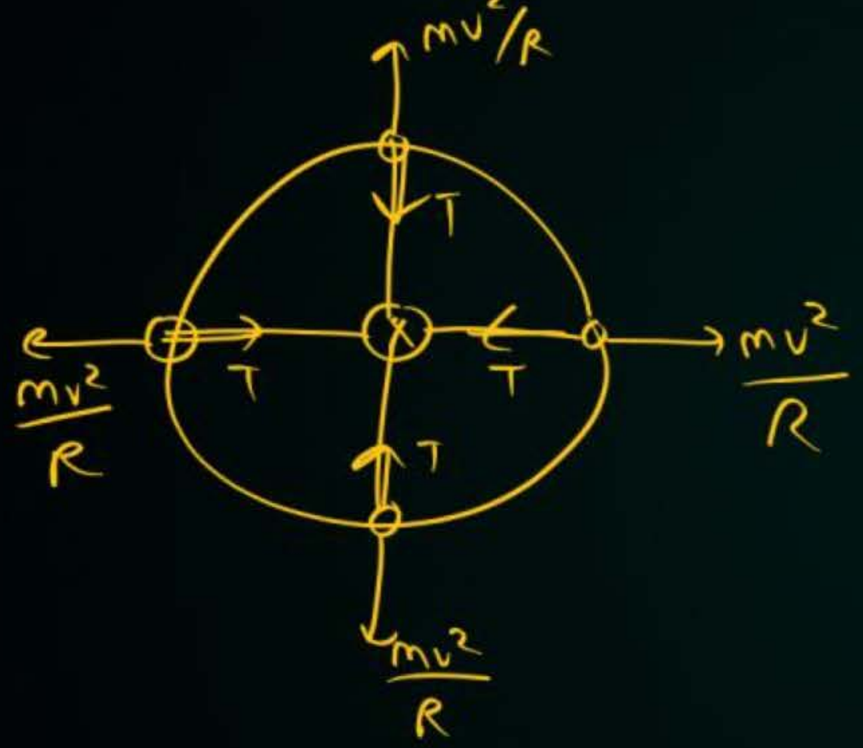
Three identical cars A, B and C are moving at the same speed on three bridges. The car A goes on a plane bridge, B on a bridge convex upward and C goes on a bridge concave upward. Let F_A, F_B and F_C be the normal forces exerted by the cars on the bridges when they are at the middle of bridges. [HCV Objective]

1. F_A is maximum of the three forces.
2. F_B is maximum of the three forces.
3. F_C is maximum of the three forces.γε
4. $F_A = F_B = F_C$.

9.2 VCM – Calculating Tensions

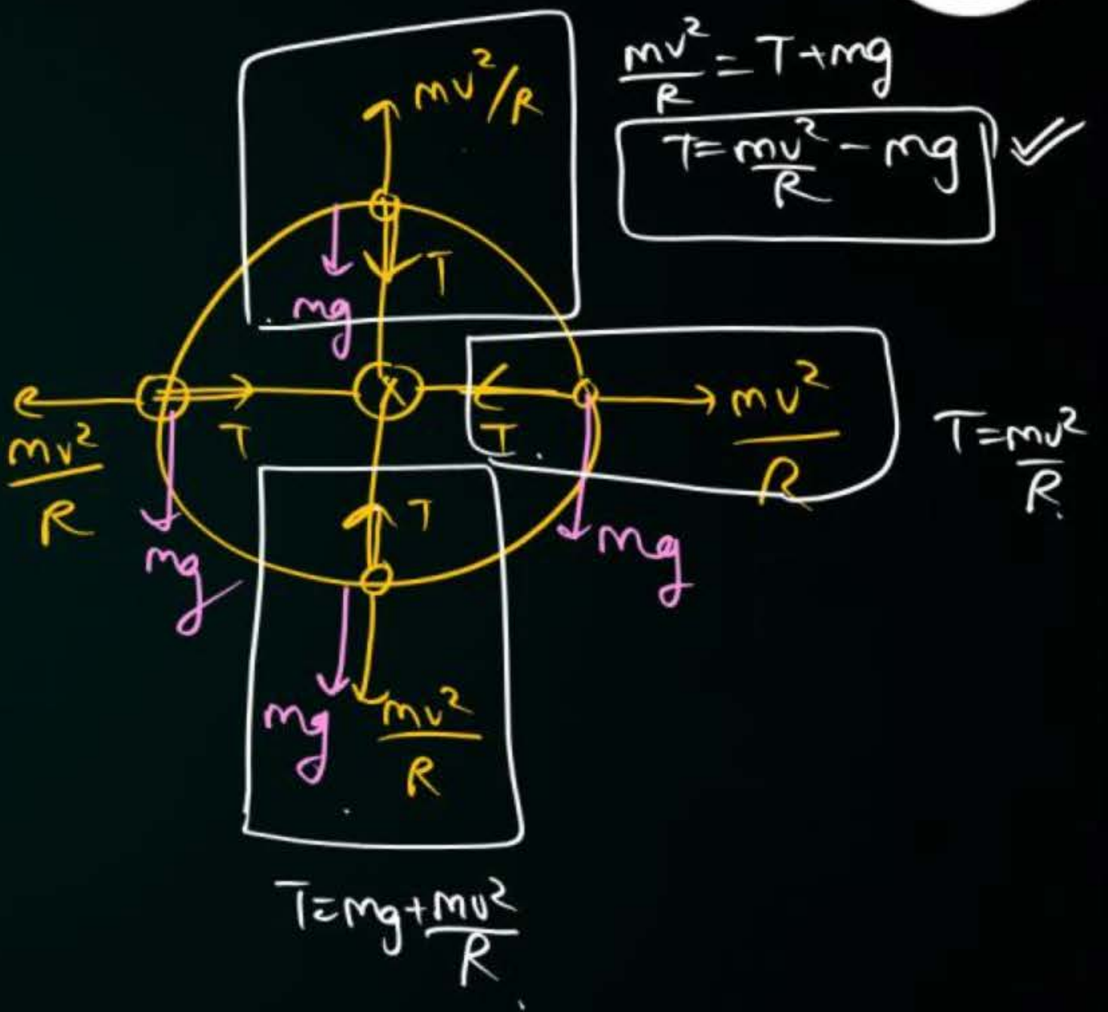


Circle



VCM

$\{g$

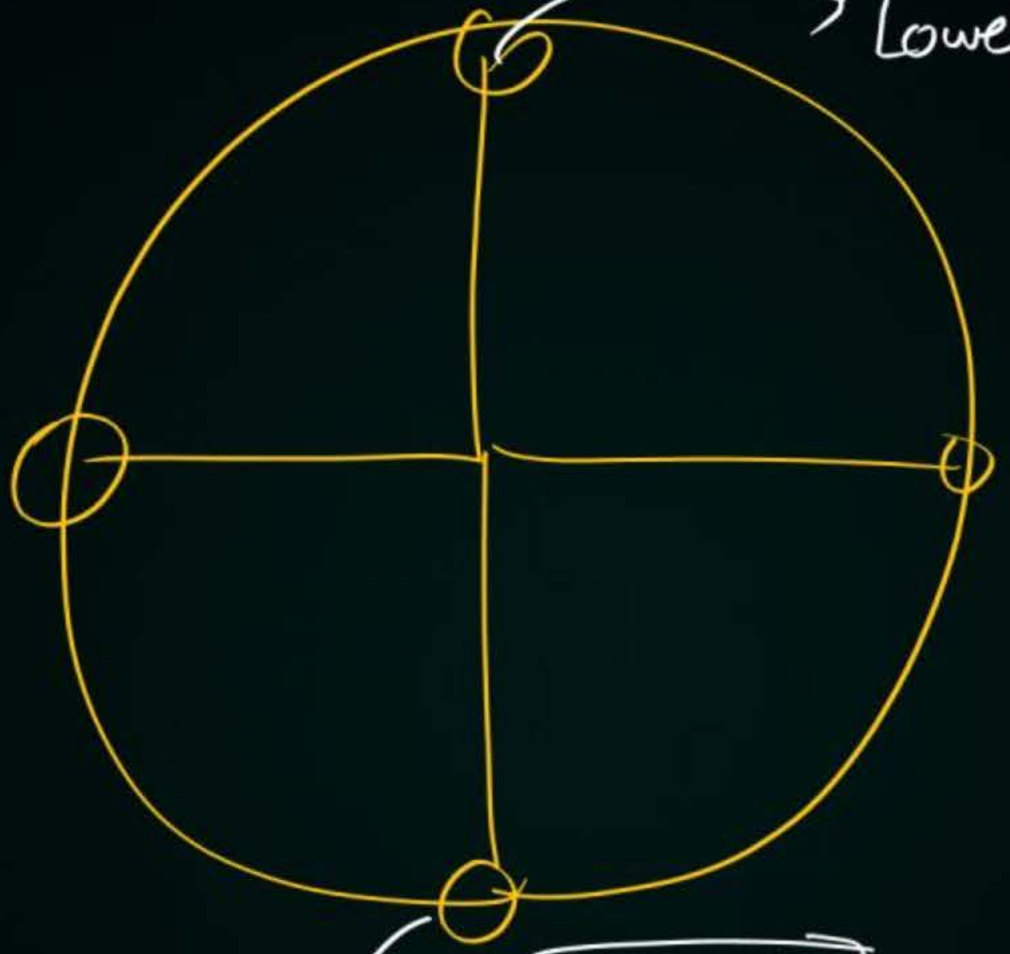


$\frac{mv^2}{R} = T + mg$

$T = \frac{mv^2}{R} - mg$

$T = \frac{mv^2}{R}$

$T = mg + \frac{mv^2}{R}$


Lowest
$T = \frac{mv^2}{R} - mg$
Highest
$T = mg + \frac{mv^2}{R}$

Difficulty Level : EASY

QUESTION-178

A stone attached to one end of a string is whirled in a vertical circle. The tension in the string is maximum when:-

1. the string is horizontal
2. the string is vertical with the stone at highest position
3. the string is vertical with the stone at the lowest position
4. the string makes an angle of 45° with the vertical

Difficulty Level : EASY

QUESTION-179

In a vertical circle of radius (r), at what point in its path a particle may have tension equal to zero:-

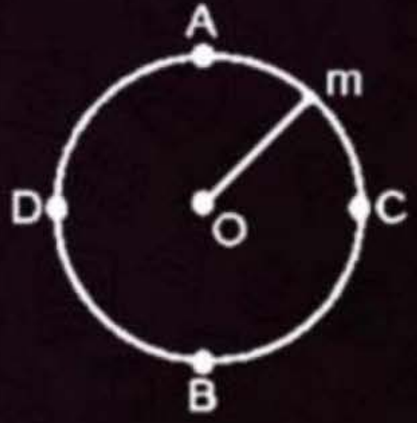
1. highest point
2. lowest point
3. at any point
4. at a point horizontal from the centre of radius

Difficulty Level : EASY

QUESTION-183

A mass is performing vertical circular motion (see figure). If the average velocity of the particle is increased, then at which point the string will break:

[2000]



1. A
2. B
3. C
4. D

Difficulty Level : EASY

QUESTION-184

A mass m is attached to a thin wire and whirled in a vertical circle. The wire is most likely to break when: [2019]

1. The mass is at the highest point
2. The wire is horizontal
3. The mass is at the lowest point
4. Inclined at an angle of $60°$ from vertical

QUESTION-185

Difficulty Level : HARD

Challenge

A stone of mass m tied to the end of a string revolves in a vertical circle of radius R. The net forces at the lowest and highest points of the circle directed vertically downwards are-

T_1 and v_1 denote the tension and speed at the lowest point. T_2 and v_2 denote corresponding values at the highest point.

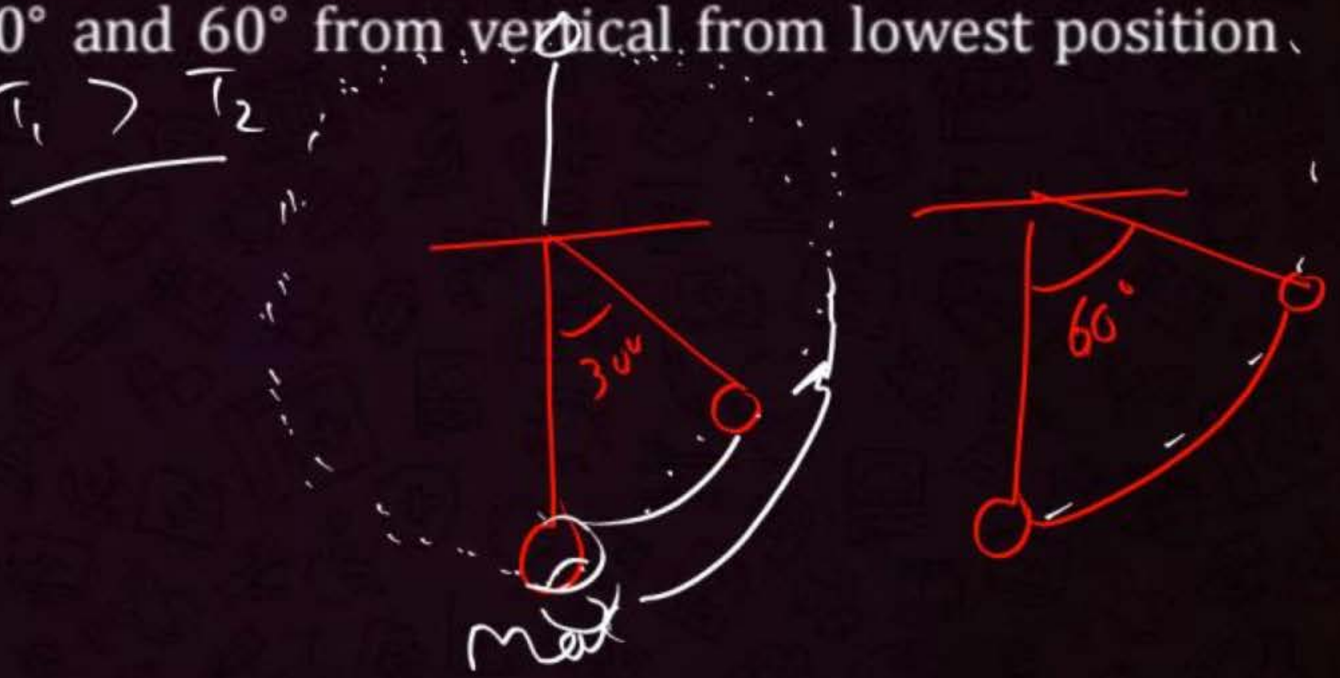
[NCERT Based]

	Lowest Point	Highest Point
1	$mg - T_1$	$mg + T_2$
2	$mg + T_1$	$mg - T_2$
3	$mg + T_1 - \left(\frac{mv_1^2}{R}\right)$	$mg - T_2 + \left(\frac{mv_2^2}{R}\right)$
4	$mg - T_1 - \left(\frac{mv_1^2}{R}\right)$	$mg + T_2 + \left(\frac{mv_2^2}{R}\right)$

Difficulty Level : EASY

QUESTION-181

A particle is moving in a vertical circle the tension in the string when passing through two position at angle 30° and 60° from vertical from lowest position are T_1 and T_2 respectively then:-

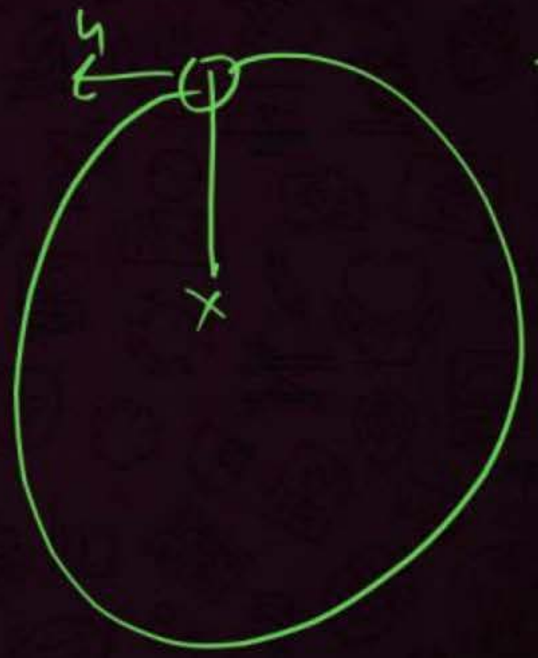


1. $T_1 = T_2$
2. $T_1 > T_2$
3. $T_1 < T_2$
4. $T_1 \geq T_2$

Difficulty Level : EASY

QUESTION-180

A stone of mass 1 kg is tied to the end of a string of 1 m length. It is whirled in a vertical circle. If the velocity of the stone at the top be 4 m/s. What is the tension in the string (at that instant)



$T = \frac{mv^2}{R} - mg$ ✓

1. 6 N
2. 16 N
3. 5 N
4. 10 N

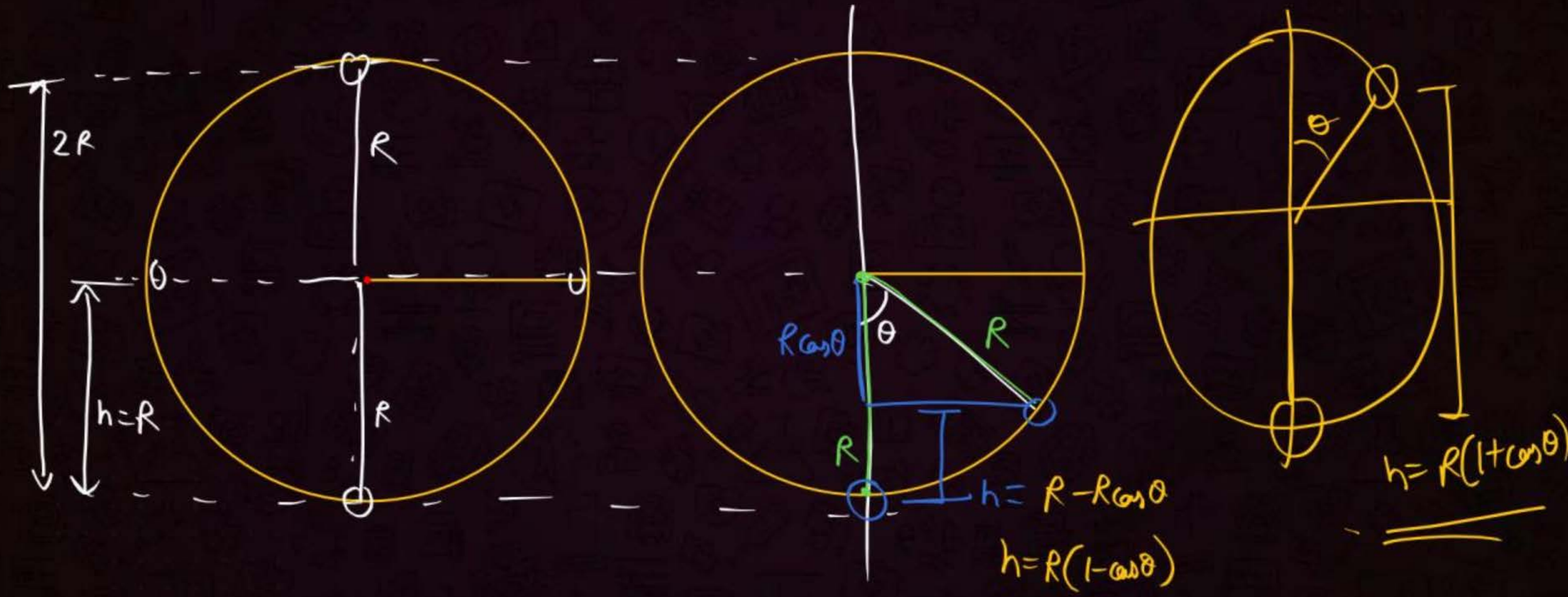
Difficulty Level : EASY

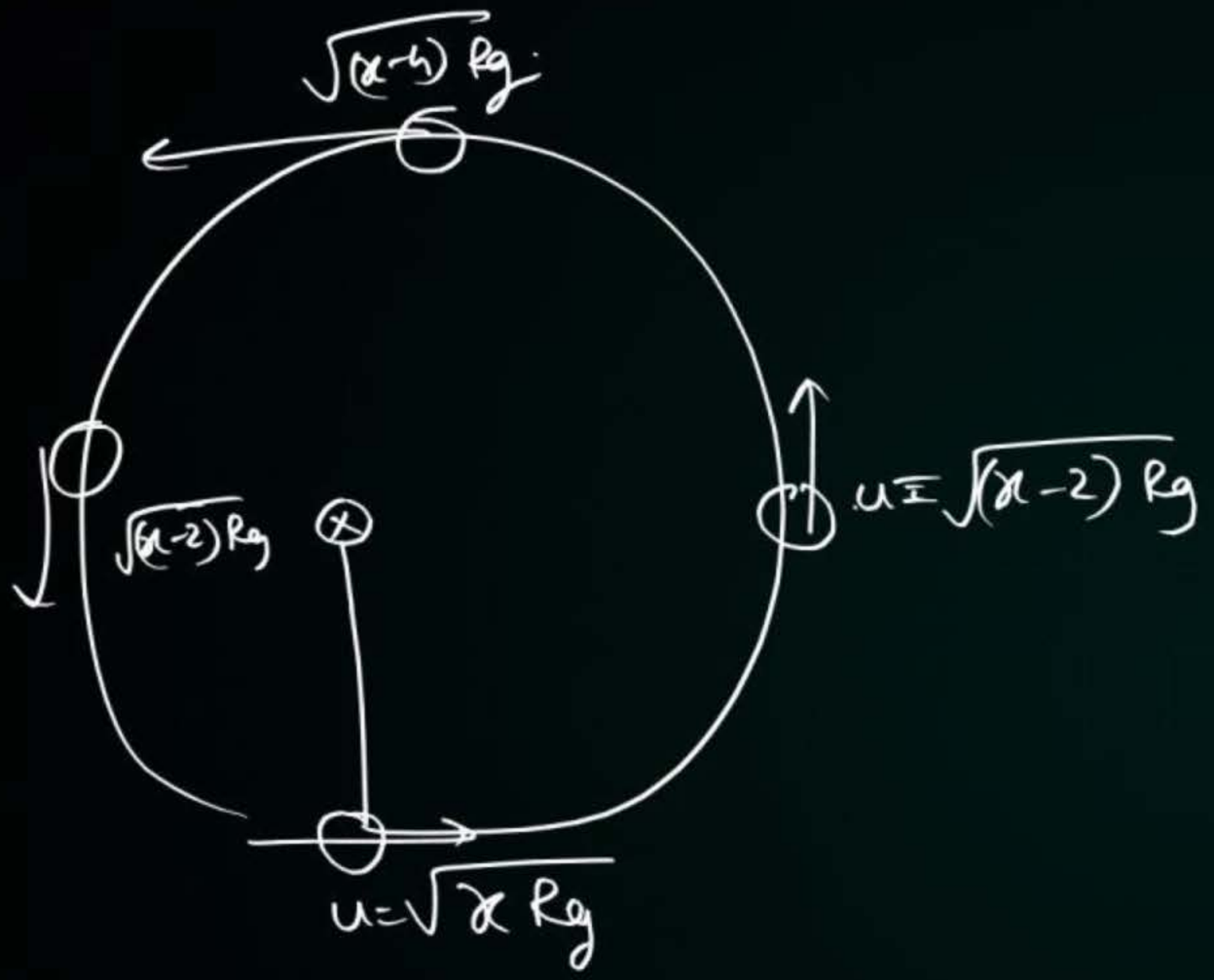
QUESTION-182

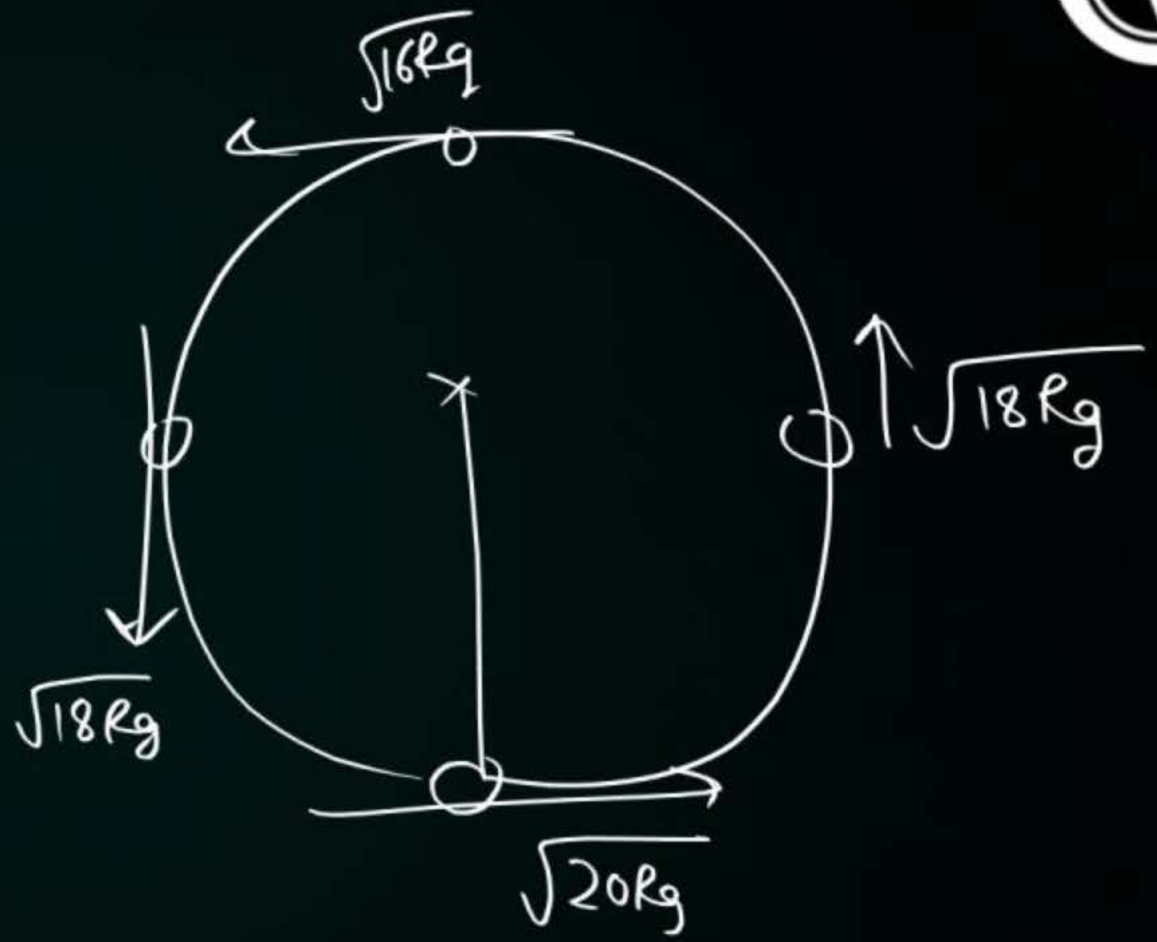
A body crosses the topmost point of a vertical circle with critical speed. What will be its centripetal acceleration when the string is horizontal:-

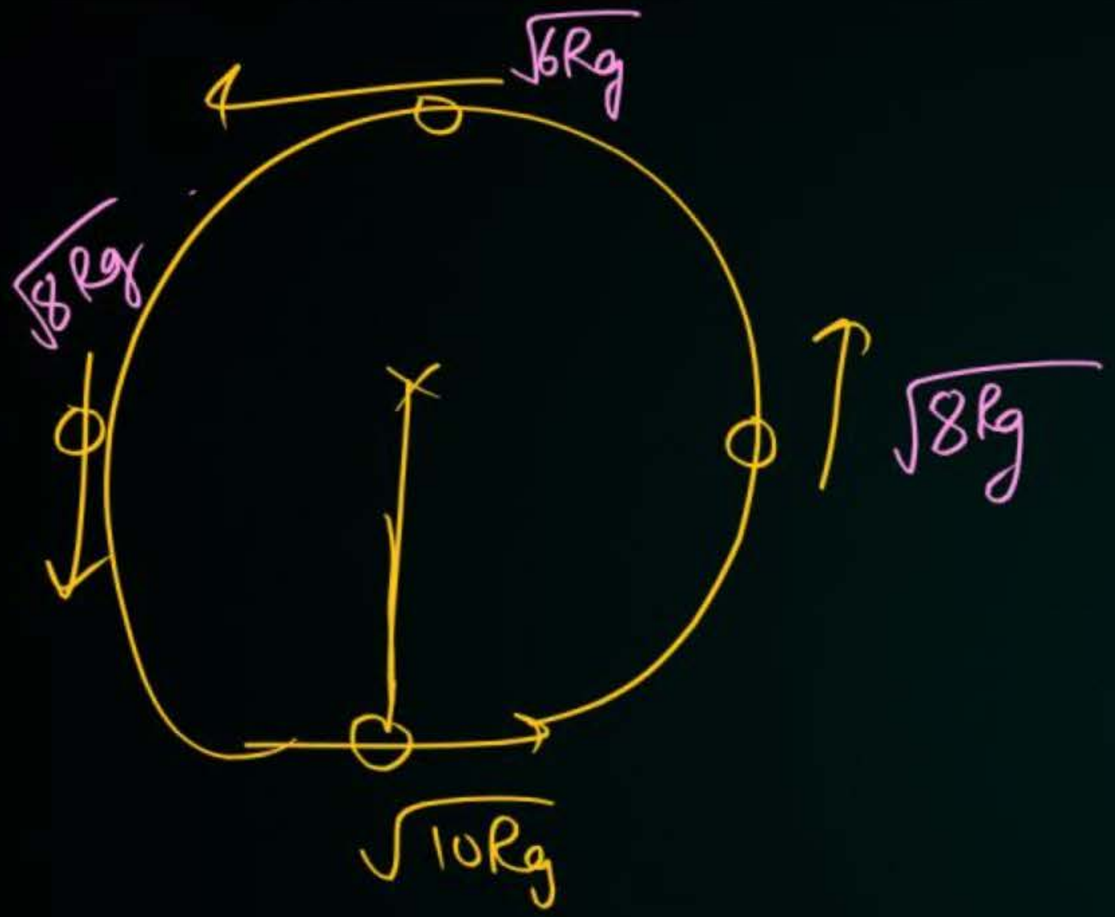
1. g
2. $2g$
3. $3g$
4. $6g$

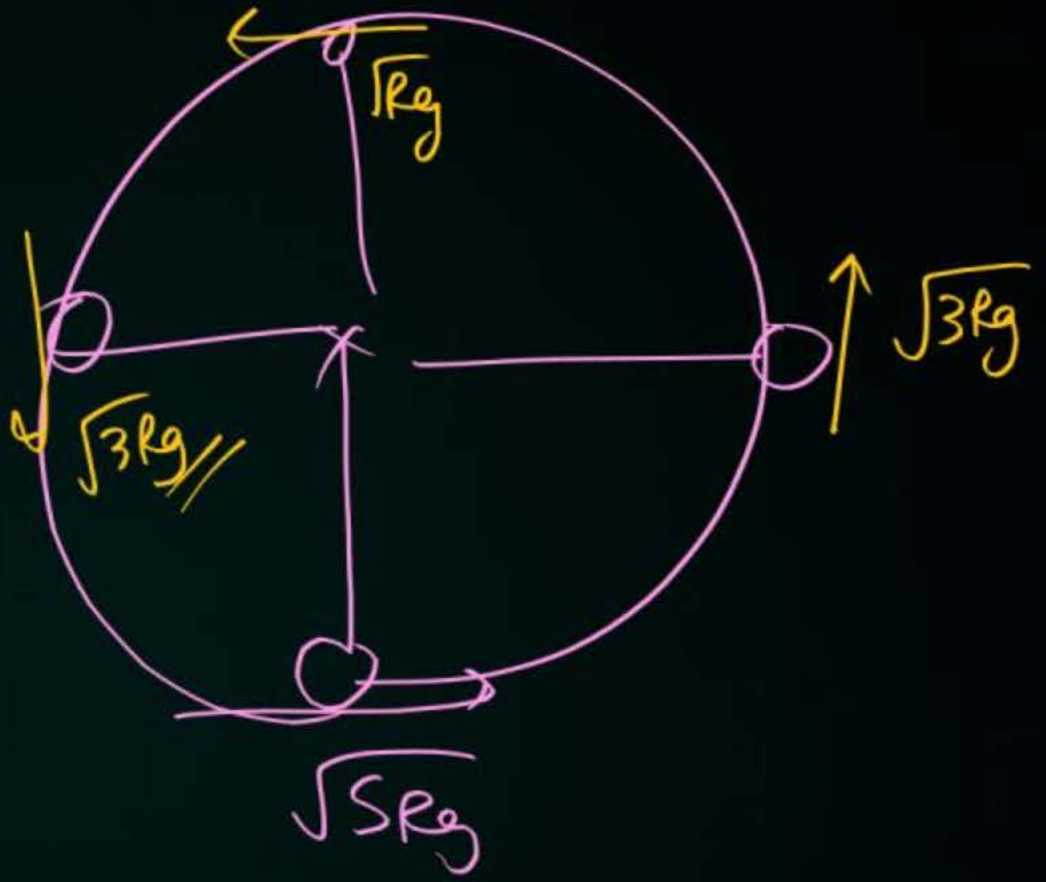
9.3 VCM – Calculating Energies

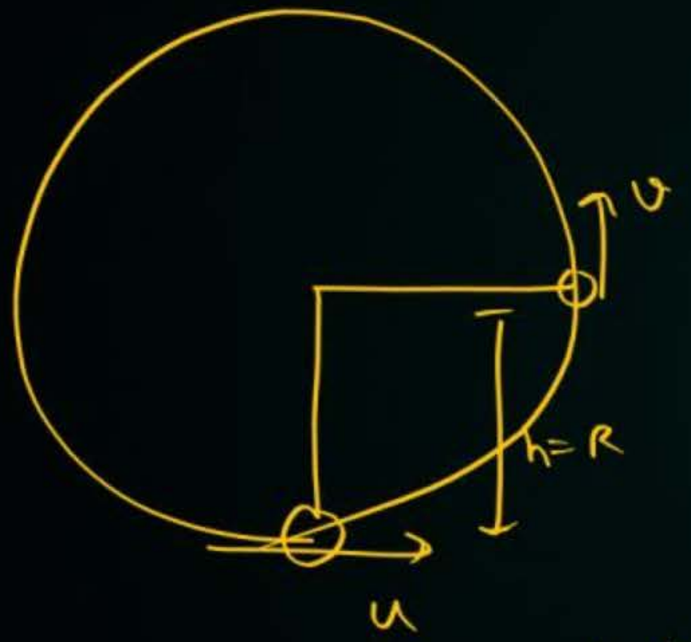



$\sqrt{(\alpha-4)Rg}$
$\sqrt{(\alpha-2)Rg}$
$u=\sqrt{(\alpha-2)Rg}$
$u=\sqrt{\alpha Rg}$


$\sqrt{16Rg}$
$\sqrt{18Rg}$
$\sqrt{18Rg}$
$\sqrt{20Rg}$


√6Rg
√8Rg
√8Rg
√10Rg

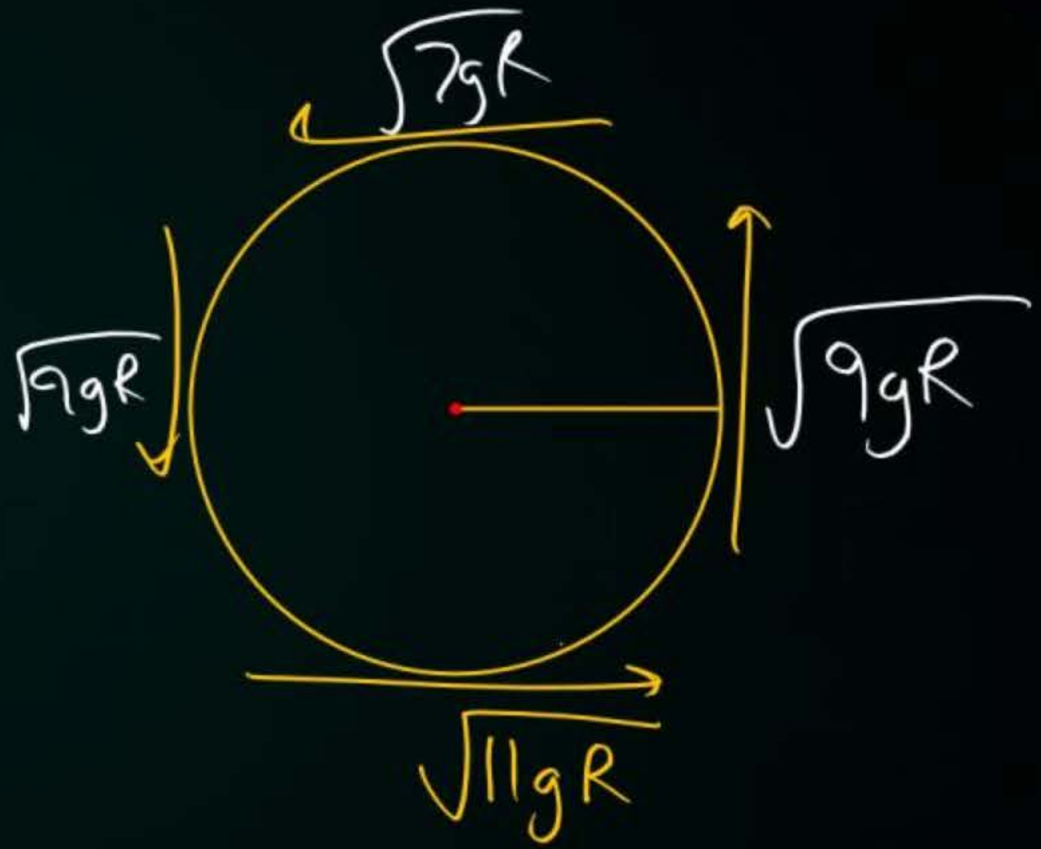

√Rg
√3Rg
√3Rg
√5Rg

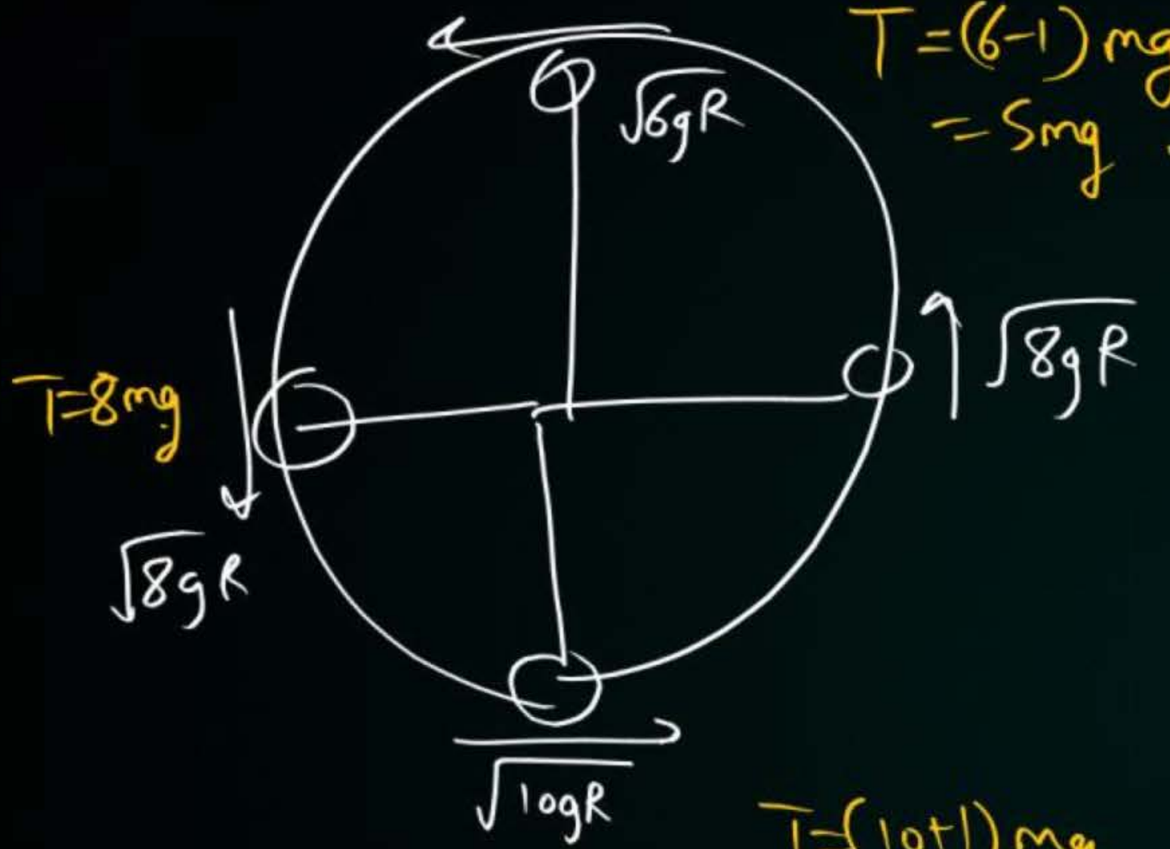


$$\frac{1}{2}mu^2 = \frac{1}{2}mv^2 + mgh$$

$$u^2 = v^2 + 2gR$$

$$v^2 = u^2 - 2gR$$



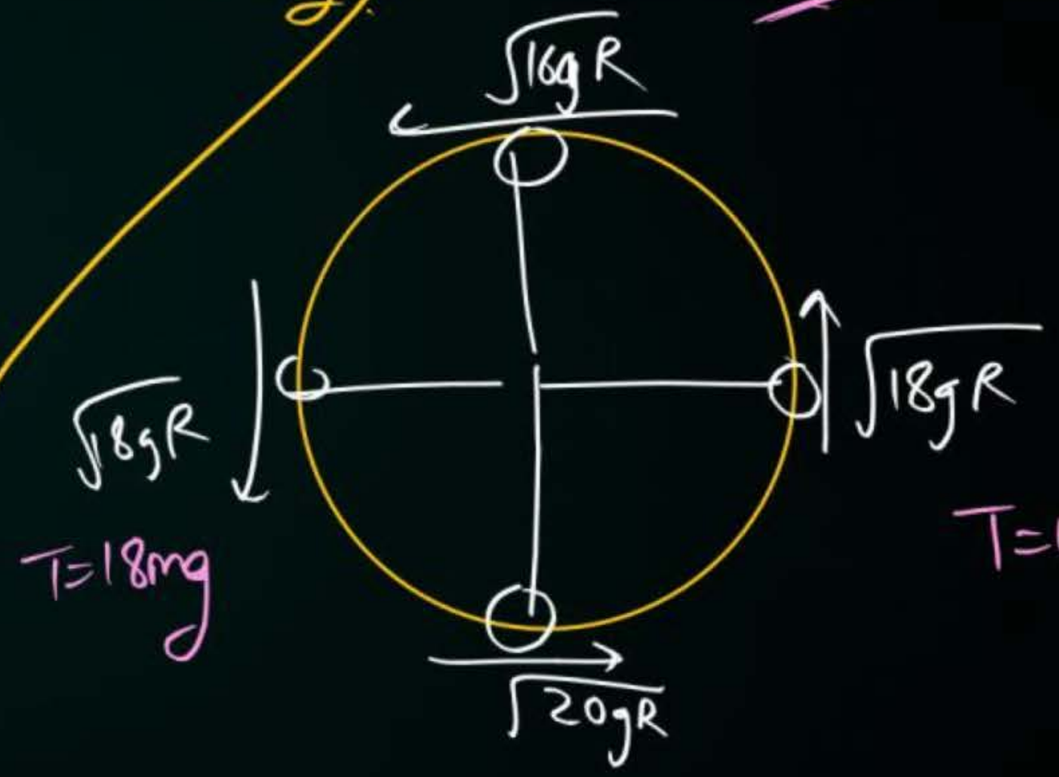


$T=(6-1)mg$
$=5mg$

$T=8mg$

$T=(10+1)mg$
$=11mg$

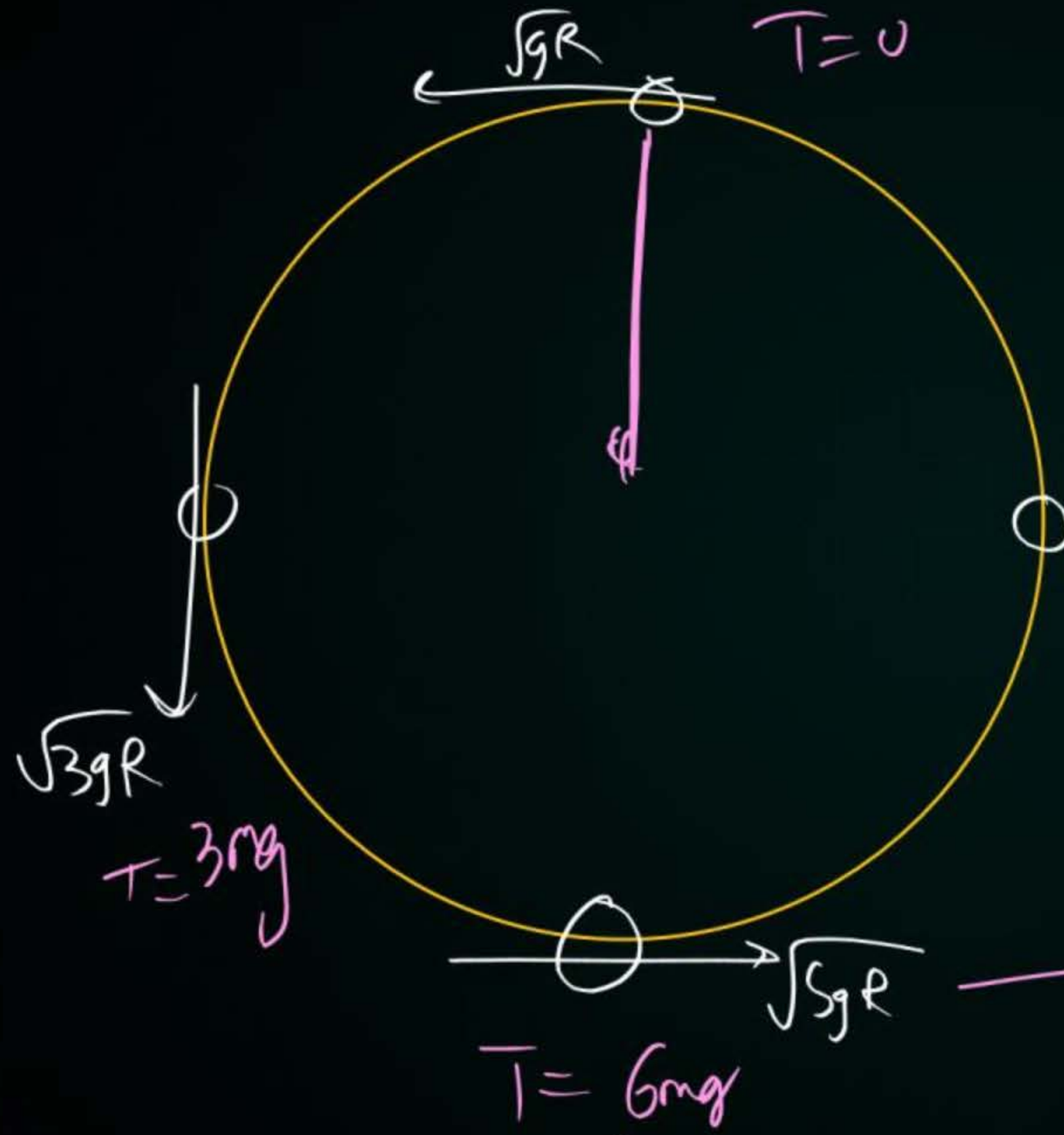
$T=15mg$



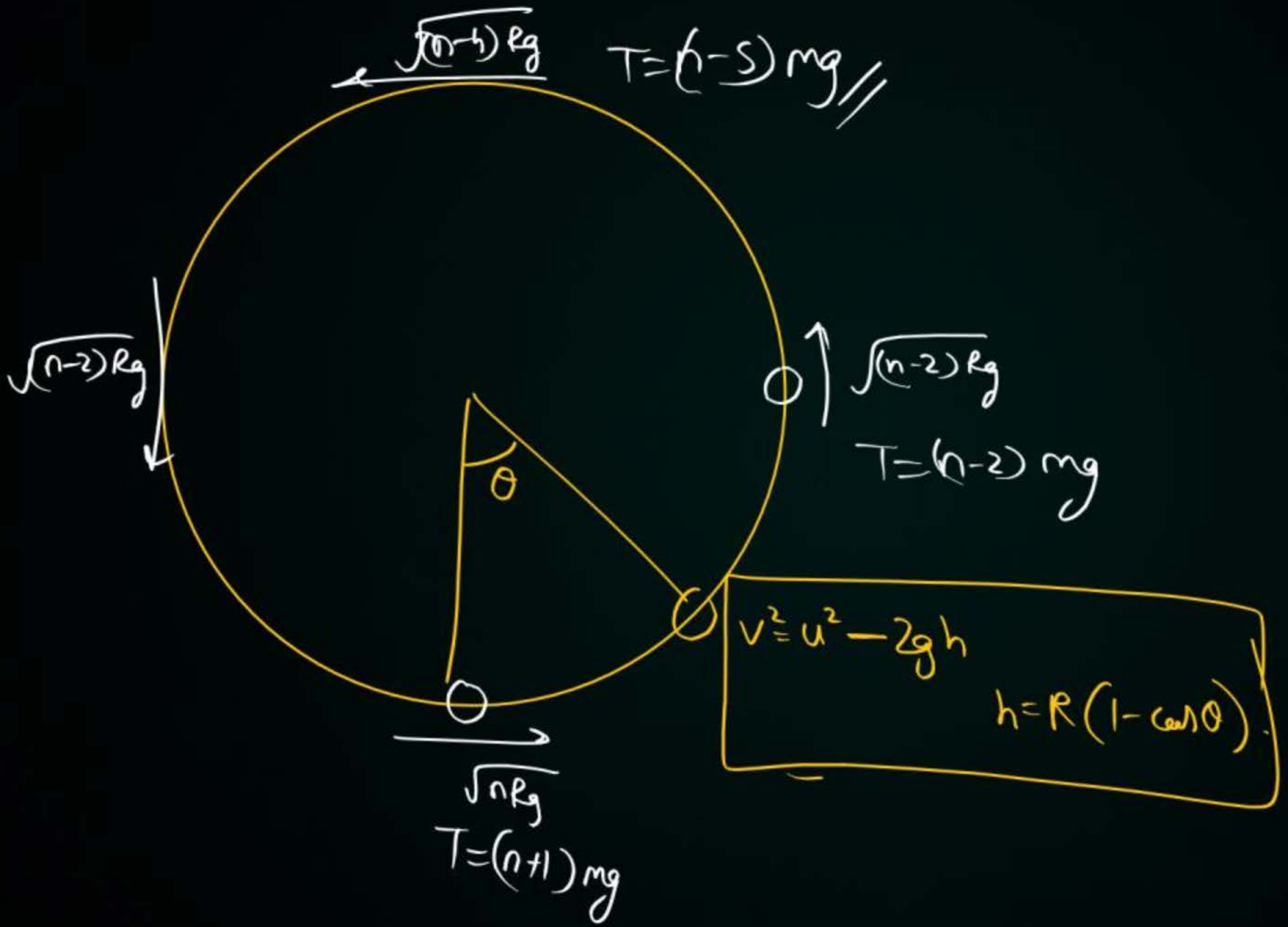
$T=18mg$

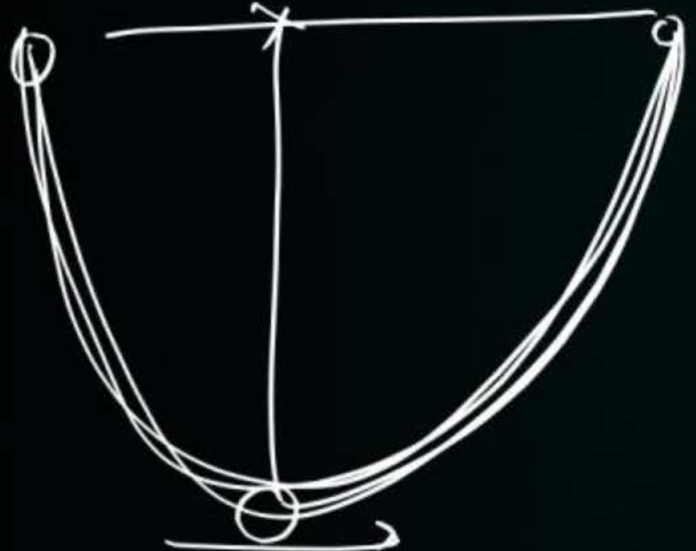
$T=18mg$

$T=21mg$



Minimum Speed at bottom to complete circle

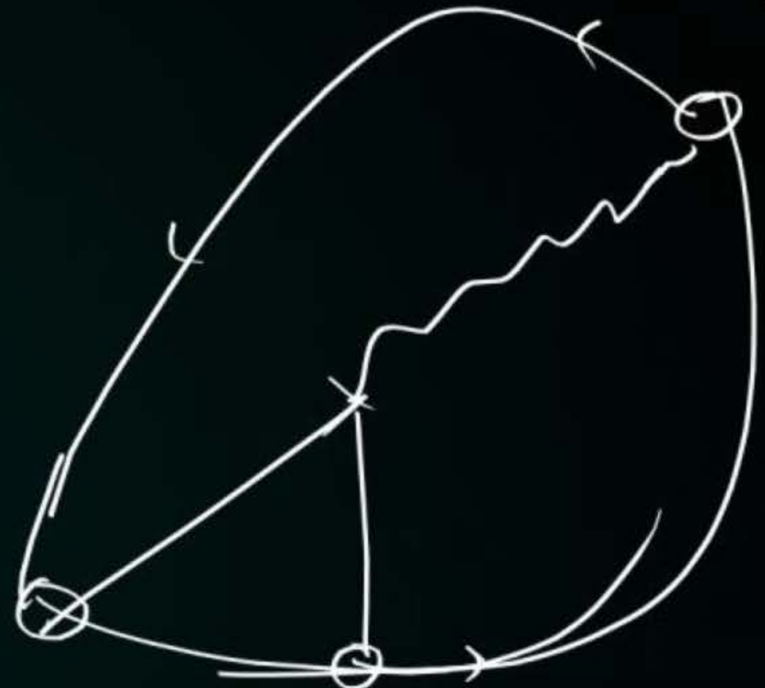

$\sqrt{(n-1)Rg}$
$T=(n-5)mg$
$\sqrt{(n-2)Rg}$
$\sqrt{(n-2)Rg}$
$T=(n-2)mg$
θ
$v^2=u^2-2gh$
$h=R(1-\cos\theta)$
$\sqrt{nRg}$
$T=(n+1)mg$



$u \leq \sqrt{2gR}$



$u \geq \sqrt{5gR}$



$\sqrt{2gR} < u < \sqrt{5gR}$

Half Circle - Half Projectile



$mgH = \frac{1}{2}mu^2$

$u = \sqrt{2gH}$

To complete circle

$u \geq \sqrt{5gR}$

$\sqrt{2gH} \geq \sqrt{5gR}$

$H \geq \frac{5R}{2}$

$H \geq 2.5R$

Difficulty Level : MEDIUM

QUESTION-186

A pendulum bob has a speed 3 m/s while passing through its lowest position, length of the pendulum is 0.5 m then its speed when it makes an angle of 60° with the vertical is:

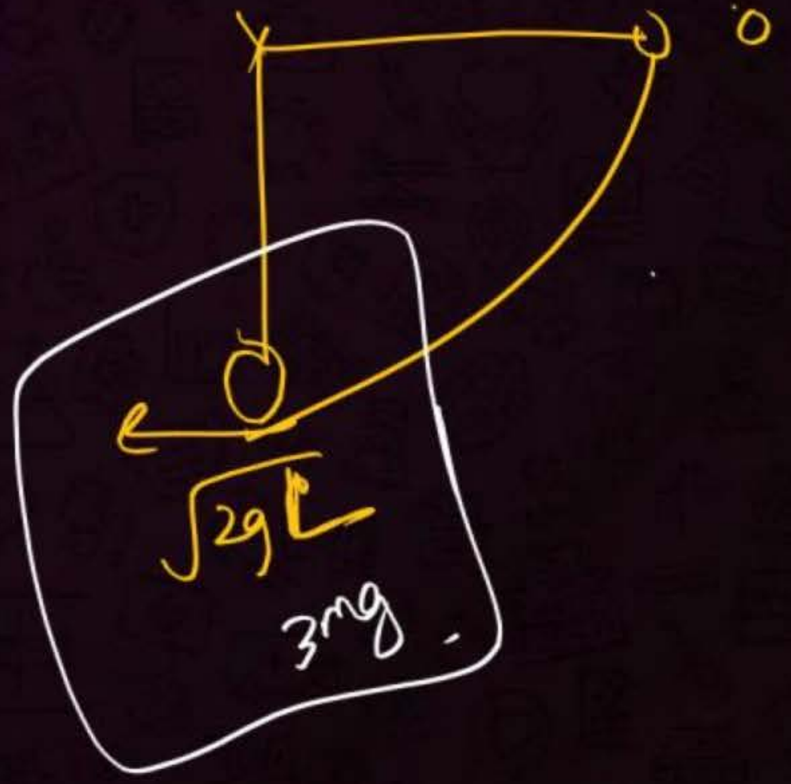
1. 2 m/s
2. 1 m/s
3. 4 m/s
4. 3 m/s

Difficulty Level : MEDIUM

QUESTION-187

The mass of the bob of a simple pendulum of length L is m. If the bob is left from its horizontal position then the speed of the bob and the tension in the thread in the lowest position of the bob will be respectively:-

1. $\sqrt{(2gL)}$ and 3mg
2. 3mg and $\sqrt{(2gL)}$
3. 2mg and $\sqrt{(2gL)}$
4. 2gL and 3mg

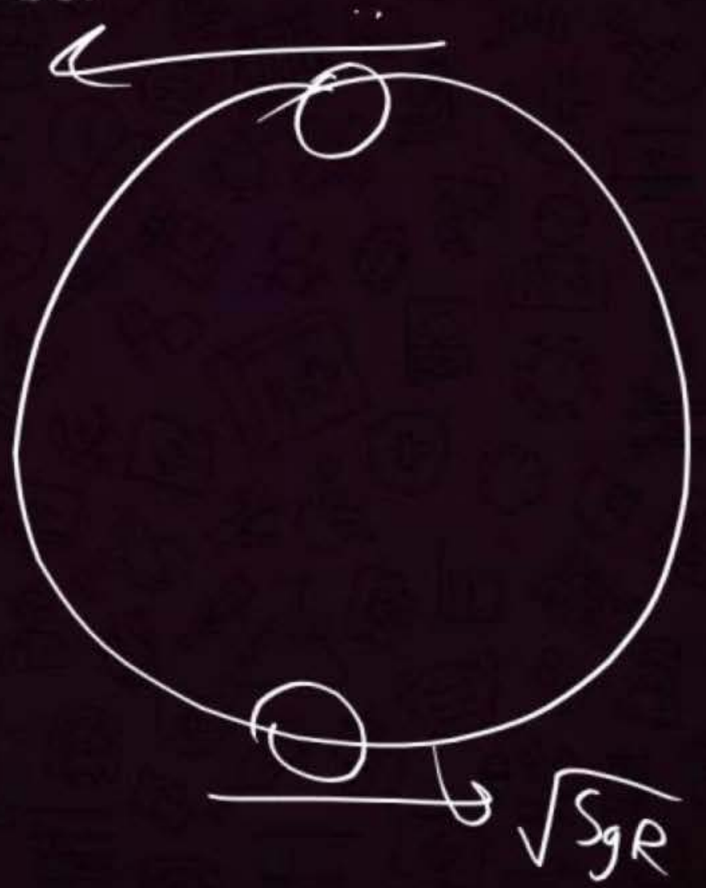


Difficulty Level : EASY

QUESTION-188

A fighter plane is moving in a vertical circle of radius r. Its minimum velocity at the highest point of the circle will be:-

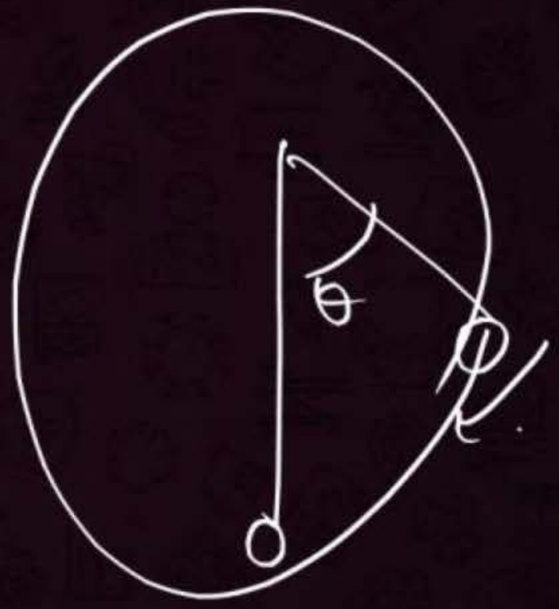
1. $\sqrt{(3gr)}$
2. $\sqrt{(2gr)}$
3. $\sqrt{(gr)}$ ✓
4. $\sqrt{(gr/2)}$



Difficulty Level : HARD

QUESTION-189

A suspended simple pendulum of length (is making an angle θ with the vertical. On releasing, its velocity at lowest point will be:-



$v = \sqrt{2gh}$

1. $\sqrt{[2gL(1+\cos\theta)]}$
2. $\sqrt{(2gL\sin\theta)}$
3. $\sqrt{[2gL(1-\cos\theta)]}$ ✓
4. $\sqrt{(2gL)}$

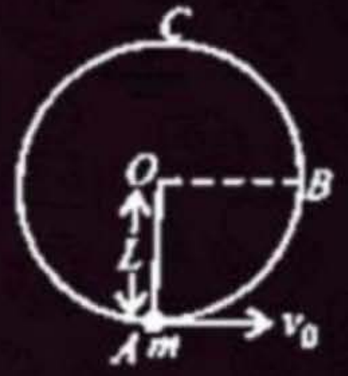
Difficulty Level : EASY

QUESTION-190

A bob of mass m is suspended by a light string of length L. It is imparted a horizontal velocity v_0 at the lowest point A such that it completes a circle in the vertical plane.

Match Column-I with Column-II.

[NCERT Based]



(1) A – p, B – q, C – s, D – r

(2) A – q, B – r, C – p, D – s

(3) A – r, B – s, C – q, D – p

(4) A – s, B – p, C – r, D – q

	Column-I		Column-II
(A)	Velocity v_0 is	(p)	3
(B)	Velocity at point B is	(q)	$\sqrt{gL}$
(C)	Velocity at point C is	(r)	$\sqrt{5gL}$
(D)	Ratio of kinetic energy at B and C is	(s)	$\sqrt{3gL}$

Difficulty Level : EASY

QUESTION-191

What is the minimum velocity with which a body of mass m must enter a vertical loop of radius R so that it can complete the loop? [2016-I]

1. $\sqrt{gR}$
2. $\sqrt{2gR}$
3. $\sqrt{3gR}$
4. $\sqrt{5gR}$

Difficulty Level : HARD

QUESTION-192

The bob of a pendulum is released from a horizontal position. If the length of pendulum is 2 m, what is the speed (m s^{-1}) with which the bob arrives at the lower most point. Assume that 10% of its energy is dissipated against air resistance. (Take $g = 10$ m s^{-2})

[NCERT Based]

1. 4
2. 6
3. 8
4. 10

Difficulty Level : HARD

QUESTION-193

A particle of mass m is attached to a light string of length l, the other end of which is fixed. Initially the string is kept horizontal and the particle is given an upward velocity v. The particle is just able to complete a circle. [HCV Objective]

1. The string becomes slack when the particle reaches its highest point.
2. The velocity of the particle becomes zero at the highest point.
3. The kinetic energy of the ball in initial position was $\frac{1}{2}mv^2 = mgl$.
4. The particle never passes through the initial position.

Difficulty Level : EASY

QUESTION-194

A point mass 'm' is moved in a vertical circle of radius 'r' with the help of a string. The velocity of the mass is $\sqrt{7gr}$ at the lowest point. The tension in the string at the lowest point is

[2020-Covid]

1. 7 mg
2. 8 mg
3. 1 mg
4. 6 mg

Difficulty Level : HARD

QUESTION-195

A stone is tied to a string of length 'ℓ and is whirled in a vertical circle with the other end of the string at the centre. At a certain instant of time, the stone is at its lowest position and has a speed 'u'. The magnitude of the change in velocity as it reaches a position where the string is horizontal (g being acceleration due to gravity) is: [2004]

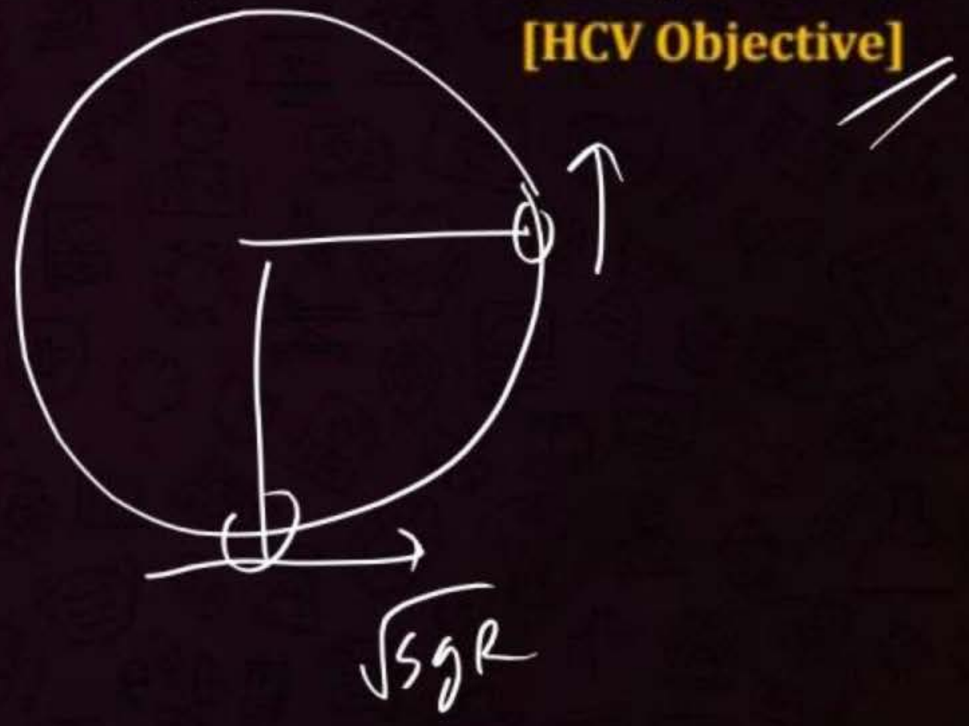
1. $\sqrt{u^2 - g\ell}$
2. $u - \sqrt{u^2 - 2g\ell}$
3. $\sqrt{2g\ell}$
4. $\sqrt{2(u^2 - g\ell)}$

Difficulty Level : EASY

QUESTION-196

A particle is rotated in a vertical circle by connecting it to a string of length l and keeping the other end of the string fixed. The minimum speed of the particle when the string is horizontal for which the particle will complete the circle is

[HCV Objective]



1. $\sqrt{gl}$
2. $\sqrt{2gl}$
3. $\sqrt{3gl}$
4. $\sqrt{5gl}$

9.4 VCM + WPE

Difficulty Level : HARD

QUESTION-197

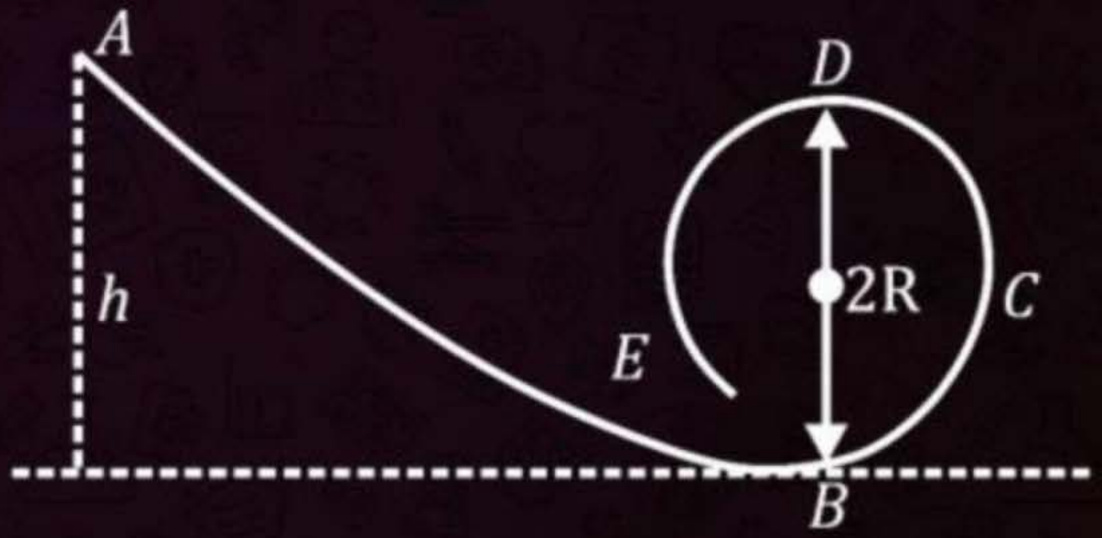
A frictionless track $ABCDE$ ends in a circular loop of radius R. A body slides down the track from point A which is at a height $h = 5$ cm. Maximum value of R for the body to successfully complete the loop is

1. 5 cm
2. 2 cm
3. 10/3 cm
4. 15/4 cm

$h = 2.5R$

$5 = 2.5R$

$R = 2\text{cm}$



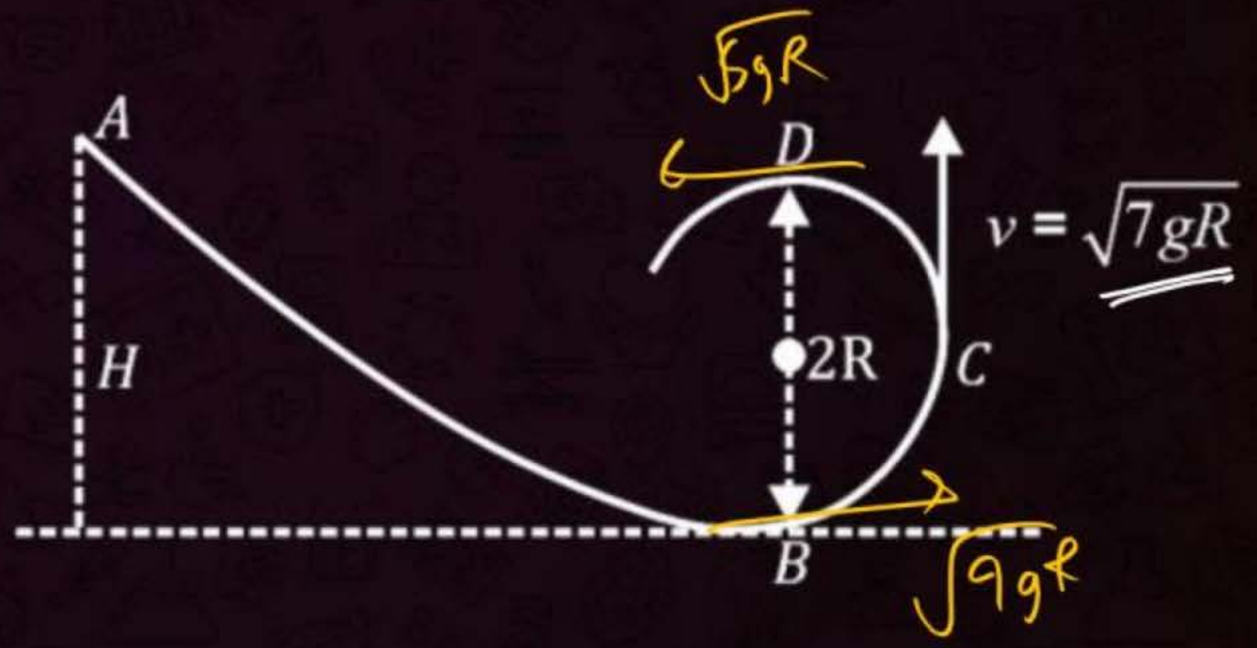
Difficulty Level : HARD

QUESTION-198

Calculate the following for the situation shown:-

(a) Speed at D

(b) Height H $= 9R/2$

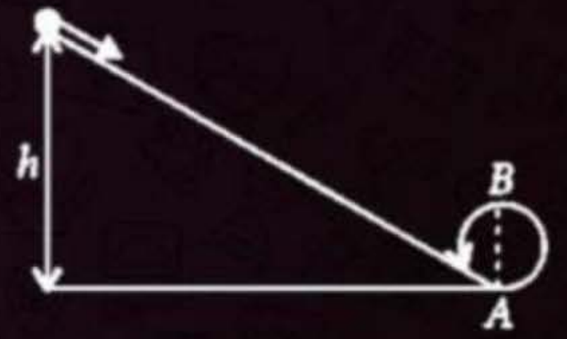


Difficulty Level : HARD

QUESTION-199

A body initially at rest and sliding along a frictionless track from a height h (as shown in the figure) just completes a vertical circle of diameter AB = D The height h is equal to:

[2018]



1. $\frac{7}{5}$ D
2. D
3. $\frac{3}{2}$ D
4. $\frac{5}{4}$ D

QUESTION-200

Difficulty Level : HARD

A simple pendulum having a bob of mass m is suspended from the ceiling of a car used in a stunt film shooting. The car moves up along an inclined cliff at a speed v and makes a jump to leave the cliff and lands at some distance. Let R be the maximum height of the car from the top of the cliff. The tension in the string when the car is in air is

[HCV Objective]

1. mg
2. $mg - \frac{mv^2}{R}$
3. $mg + \frac{mv^2}{R}$
4. zero

QUESTION-201

Difficulty Level : HARD

Water in a bucket is whirled in a vertical circle with a string attached to it. The water does not fall down even when the bucket is inverted at the top of its path. We conclude that in this position [HCV Objective]

1. $mg = \frac{mv^2}{r}$
2. mg is greater than $= \frac{mv^2}{r}$
3. mg is not greater than $= \frac{mv^2}{r}$
4. mg is not less than $= \frac{mv^2}{r}$

QUESTION-202

Difficulty Level : YODHA

$v = \frac{2\pi R}{T}$

A particle moving in a circle of radius R with a uniform speed takes a time T to complete one revolution. If this particle were projected with the same speed at an angle 'θ' to the horizontal, the maximum height attained by it equals 4R. The angle of projection, θ, is then given by:

[2021]

1. $\theta = \cos^{-1}\left(\frac{\pi^2 R}{gT^2}\right)^{1/2}$
2. $\theta = \cos^{-1}\left(\frac{\pi^2 R}{gT^2}\right)^{1/2}$
3. $\theta = \cos^{-1}\left(\frac{2gT^2}{\pi^2 R}\right)^{1/2}$
4. $\theta = \cos^{-1}\left(\frac{gT^2}{\pi^2 R}\right)^{1/2}$

$H_{max} = \frac{u^2 \sin^2\theta}{2g}$

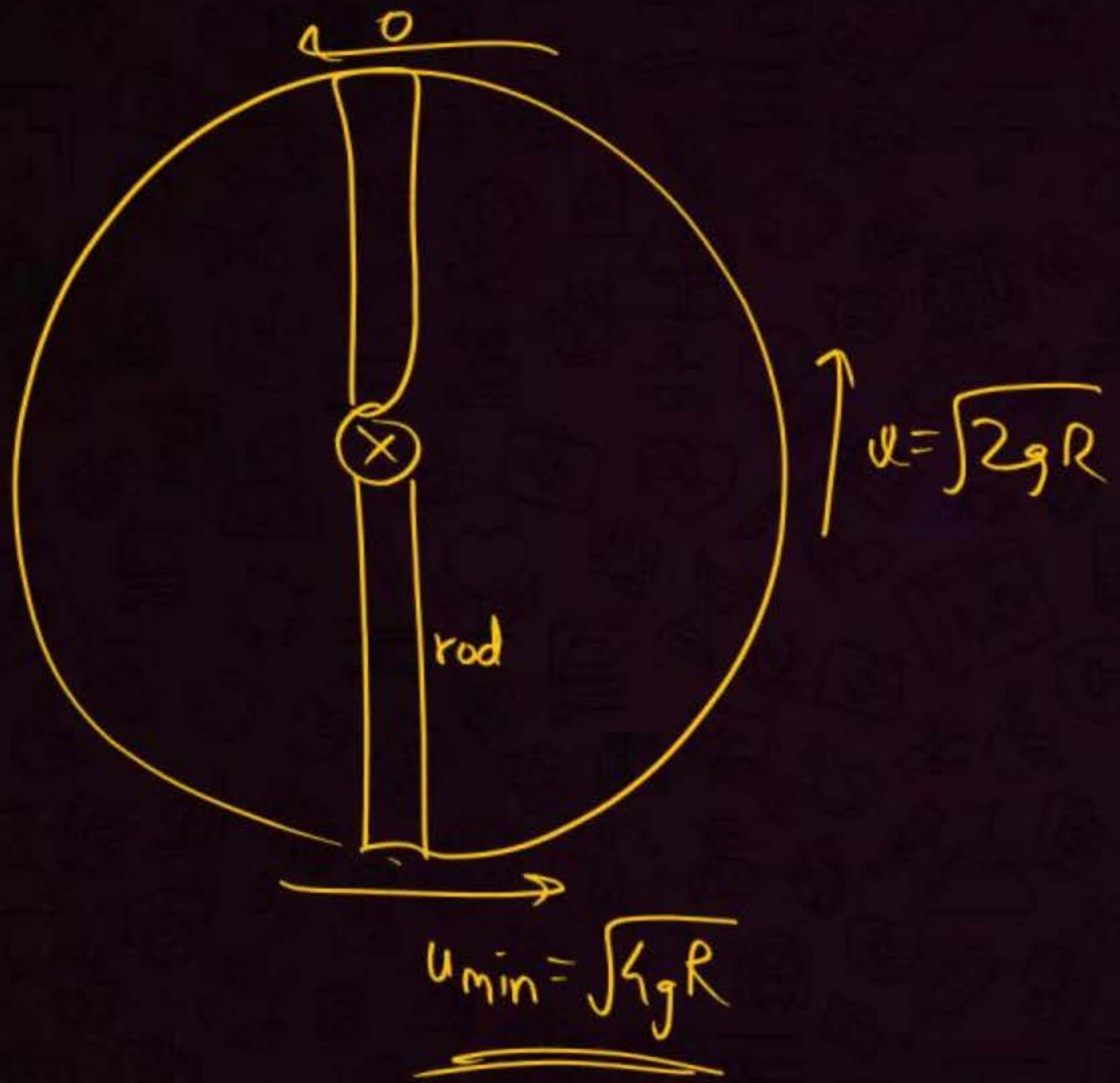
$4R = \frac{4\pi^2 R^2 \sin^2\theta}{T^2 2g}$

$\sin^2\theta = \frac{2gT^2}{\pi^2 R}$

$\sin\theta = \left(\frac{2gT^2}{\pi^2 R}\right)^{1/2}$

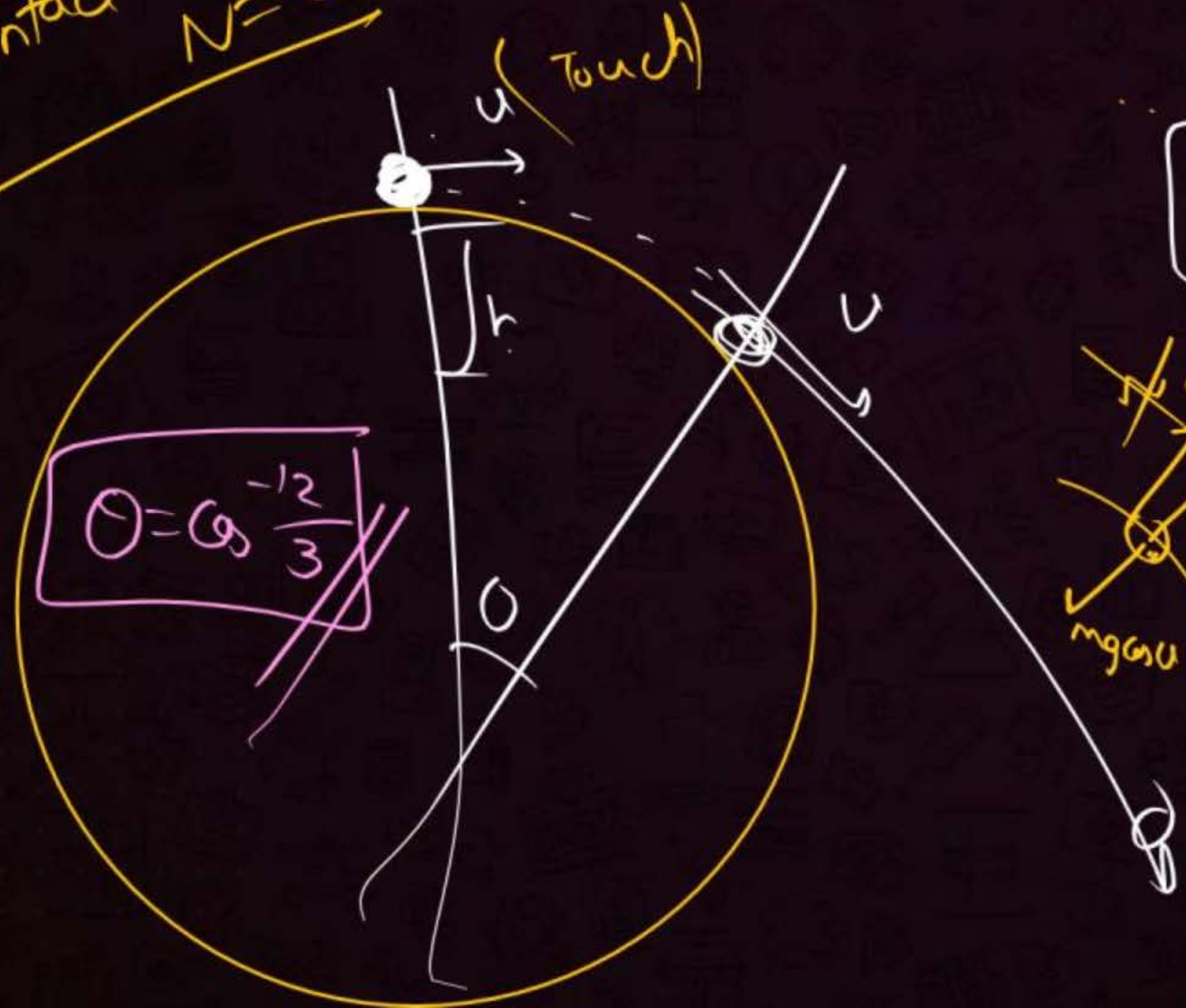
$\theta = \sin^{-1}\left(\frac{2gT^2}{\pi^2 R}\right)^{1/2}$.

9.5 VCM with Rod



9.6 Contact loose with Coin Katora

Contact Loose
$N = 0$



$\theta = \cos^{-1}\frac{2}{3}$

$v^2 = u^2 + 2gh$

$v^2 = u^2 + 2gR(1-\cos\theta)$ — (1)



$\frac{mv^2}{R} = mg\cos\theta$

$v^2 = Rg\cos\theta$

$Rg\cos\theta = 0 + 2gR - 2gR\cos\theta$

$3Rg\cos\theta = 2gR$

$\cos\theta = 2/3$

Part 10 – Theory and AR Questions



QUESTION-203 (Assertion and Reason)

Assertion: No work is done if the displacement is zero.

Reason: 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 displacement.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (1)

QUESTION-204 (Assertion and Reason)

Assertion: Work done by the friction or viscous force on a moving body is negative.

Reason: Work done is a scalar quantity which cannot be negative like mass.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (3)

QUESTION-205 (Assertion and Reason)

Assertion: A light body and a heavy body have same momentum. Then they also have same kinetic energy.

Reason: Kinetic energy does not depend on mass of the body.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (4)

QUESTION-206 (Assertion and Reason)

Assertion: The work done by a conservative force such as gravity depends on the initial and final positions only.

Reason: The work done by a force can not be calculated if the exact nature of the force is not known.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (3)

QUESTION-207 (Assertion and Reason)

Assertion: For two bodies, the sum of the mutual forces exerted between them is zero from Newton's third law.

Reason: The sum of work done by the two forces must always cancel.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (3)

QUESTION-208 (Assertion and Reason)

Assertion: Work done by the force of friction in moving a body around a closed loop is zero.

Reason: Work done does not depend upon the nature of force.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (4)

QUESTION-209 (Assertion and Reason)

Assertion: Work done by friction over a closed path is not zero and no potential energy can be associated with friction.

Reason: Every force encountered in mechanics have an associated potential energy.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (3)

QUESTION-210 (Assertion and Reason)

Assertion: A spring has potential energy, when it is either compressed or stretched.

Reason: In compressing or stretching a spring, work is done on it against the restoring force.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (1)

QUESTION-211 (Assertion and Reason)

Assertion: The work done by the spring force in a cyclic process is zero.

Reason: Spring force is a conservative force.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (1)

QUESTION-212 (Assertion and Reason)

Assertion: A person working on a horizontal road with a load on his head, does no work.

Reason: No work is said to be done, if directions of force and displacement of load are perpendicular to each other.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (1)

QUESTION-213 (Assertion and Reason)

Assertion: Energy can neither be created nor destroyed.

Reason: The principle of conservation of energy cannot be proved.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (3)

QUESTION-214 (Assertion and Reason)

Assertion: Internal forces can change the kinetic energy but not the momentum of the system.

Reason: The rate of change of total momentum of a many particle system is proportional to the sum of the internal forces of the system.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (3)

QUESTION-215 (Assertion and Reason)

Assertion: Kilowatt hour is the unit of power.

Reason: One kilowatt hour is equivalent to 3.6×10^5 J.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (4)

QUESTION-216 (Assertion and Reason)

Assertion: A person walking on a horizontal road with a load on his head does no work.

Reason: No work is said to be done, if directions of force and displacement of load are perpendicular to each other.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (1)

QUESTION-217 (Assertion and Reason)

Assertion: The work done during a round trip is always zero.

Reason: No force is required to move a body in its round trip.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (4)

QUESTION-218 (Assertion and Reason)

Assertion: Work done by friction on a body sliding down an inclined plane is negative.

Reason: Work done is greater than zero, if angle between force and displacement is acute or both are in the same direction.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (2)

QUESTION-219 (Assertion and Reason)

Assertion: When a gas is allowed to expand, work done by gas is positive.

Reason: Force due to gaseous pressure and displacement (of piston) are in the same direction.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (1)

QUESTION-220 (Assertion and Reason)

Assertion: A light body and a heavy body have the same momentum. Then they also have the same kinetic energy.

Reason: Kinetic energy does not depend on the mass of the body.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (4)

QUESTION-221 (Assertion and Reason)

Assertion: The instantaneous power of an agent is measured as the dot product of instantaneous velocity and the force acting on it at that instant.

Reason: The unit of instantaneous power is watt.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (2)

QUESTION-222 (Assertion and Reason)

Assertion: The change in kinetic energy of a particle is equal to the work done on it by the net force.

Reason: Change in kinetic energy of a particle is equal to the work done only in case of a system of one particle.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (3)

QUESTION-223 (Assertion and Reason)

Assertion: A spring has potential energy, both when it is compressed or stretched.

Reason: In compressing or stretching, work is done on the spring against the restoring force.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (1)

QUESTION-224 (Assertion and Reason)

Assertion: Comets move around the Sun in elliptical orbits. The gravitational force on the comet due to Sun is not normal to the comet's velocity but the work done by the gravitational force over every complete orbit of the comet is zero.

Reason: Gravitational force is a non-conservative force.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (3)

QUESTION-225 (Assertion and Reason)

Assertion: The rate of change of total momentum of a many particle system is proportional to the sum of the internal forces of the system.

Reason: Internal forces can change the momentum of the system.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (4)

QUESTION-226 (Assertion and Reason)

Assertion: Water at the foot of the water-fall is always at different temperature from that at the top.

Reason: The potential energy of water at the top is converted into heat energy during falling.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (1)

QUESTION-227 (Assertion and Reason)

Assertion: The power of a pump which raises 100 kg of water in 10 s to a height of 100 m is 10 kW.

Reason: The practical unit of power is horse power.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (2)

QUESTION-228 (Assertion and Reason)

Assertion: According to law of conservation of mechanical energy, change in potential energy is equal and opposite to the change in kinetic energy.

Reason: Mechanical energy is not a conserved quantity.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (3)

QUESTION-229 (Assertion and Reason)

Assertion: When the force retards the motion of a body, the work done is negative.

Reason: Work done depends on angle between force and displacement.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (1)

QUESTION-230 (Assertion and Reason)

Assertion: A body cannot have energy without having momentum but it can have momentum without having energy.

Reason: Momentum and energy have the same dimensions.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (4)

QUESTION-231 (Assertion and Reason)

Assertion: Power developed in circular motion is always zero.

Reason: Work done in case of circular motion is zero.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (4)

QUESTION-232 (Assertion and Reason)

Assertion: A kinetic energy of a body is quadrupled, when its velocity is doubled.

Reason: Kinetic energy is proportional to square of velocity.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (1)

QUESTION-233 (Assertion and Reason)

Assertion: Work done by or against spring force is independent of the actual path followed between the two points.

Reason: Spring force is a conservative force.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (1)

QUESTION-234 (Assertion and Reason)

Assertion: Wire through which current flows gets heated.

Reason: When current is drawn from a cell, chemical energy is converted into heat energy.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (3)

QUESTION-235 (Assertion and Reason)

Assertion: Graph between potential energy of a spring versus the extension or compression of the spring is a straight line.

Reason: Potential energy of a stretched or compressed spring is directly proportional to extension or compression.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (4)

QUESTION-236 (Assertion and Reason)

Assertion: Heavy water is used as moderator in nuclear reactor.

Reason: Water cools down the fast neutrons.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (3)

QUESTION-237 (Assertion and Reason)

Assertion: Mass and energy are not conserved separately, but are conserved as a single entity called mass-energy.

Reason: Mass and energy conservation can be obtained by Einstein equation for energy.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (1)

QUESTION-238 (Assertion and Reason)

Assertion: If two protons are brought near one another, then magnitude of gravitational potential energy of the system will increase.

Reason: The charge on the proton is $+ 1.6 \times 10^{-19}$ C.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (2)

QUESTION-239 (Assertion and Reason)

Assertion: In case of bullet fired from the gun, the ratio of kinetic energy of gun and bullet is equal to ratio of mass of bullet and gun.

Reason: In firing, momentum is conserved.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (1)

QUESTION-240 (Assertion and Reason)

Assertion: Power of machine gun is determined by both, the number of bullets fired per second and kinetic energy of bullets.

Reason: Power of any machine is defined as work done (by it) per unit time.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (1)

QUESTION-241 (Assertion and Reason)

Assertion: Area under force-displacement curve with proper algebraic sign represents work done by the force.

Reason: Work done for a small displacement is given by $dW = \vec{F}.d\vec{s}$.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (1)

QUESTION-242 (Assertion and Reason)

Assertion: Mountain roads rarely go straight up the slope.

Reason: Slope of mountains is high, therefore there are more chances of vehicle to slip from the roads.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (1)

QUESTION-243 (Assertion and Reason)

Assertion: Soft steel can be made red hot by continued hammering on it, but hard steel cannot.

Reason: Energy transfer in case of soft iron is larger than in hard steel.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (1)

QUESTION-244 (Assertion and Reason)

Assertion: The work done by tension in the rotating loop about its axis in uniform circular motion is zero.

Reason: In uniform motion, tension is always perpendicular to the velocity.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (4)

QUESTION-245 (Assertion and Reason)

Assertion: Work done by force of friction may be positive, negative or zero.

Reason: Friction force is a contact force.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (2)

QUESTION-246 (Assertion and Reason)

Assertion: Engine of a car moving on a smooth track with uniform velocity does some work.

Reason: Engine always works to keep a car moving.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (4)

QUESTION-247 (Assertion and Reason)

Assertion: In absence of external forces, the components of the system can change their position of rest or motion.

Reason: The change in position of components of the system will be such that the position of rest or motion of centre of mass will remain the same.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (1)

QUESTION-248 (Assertion and Reason)

Assertion: Tennis ball bounces higher on hills than in plains.

Reason: Value of g on the hills is less than that at the plains.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (1)

QUESTION-249 (Assertion and Reason)

Assertion: A system is in stable equilibrium when its kinetic energy is minimum.

Reason: In stable equilibrium position, the body should have minimum energy or minimum kinetic energy.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (4)

QUESTION-250 (Assertion and Reason)

Assertion: A system is in equilibrium if its potential energy is minimum.

Reason: For equilibrium, net force must be constant.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (4)

QUESTION-251 (Assertion and Reason)

Assertion: Work done by an external force is always equal to gain in its kinetic energy.

Reason: According to work-energy theorem, work done by external force changes its kinetic energy.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (4)

QUESTION-252 (Assertion and Reason)

Assertion: When a body is raised from the surface of Earth, through a small height h, then increase in its potential energy is mgh.

Reason: Work done = F × s, always.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (3)

QUESTION-253 (Assertion and Reason)

Assertion: No work is done by centripetal force; howsoever large force may act on the body to make it move in a circular path.

Reason: The force acting on the body is always perpendicular to the direction of its velocity, at any instant.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (1)

QUESTION-254 (Assertion and Reason)

Assertion: Centripetal force does no work.

Reason: Force and displacement are perpendicular to each other.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (1)

QUESTION-255 (Assertion and Reason)

Assertion: Work done in uniform circular motion is zero.

Reason: Force is always directed along displacement.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (3)

QUESTION-256 (Assertion and Reason)

Assertion: If momentum of a body increases by 5%, its kinetic energy will increase by 10%.

Reason: Kinetic energy is double of momentum.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (3)

QUESTION-257 (Assertion and Reason)

Assertion: If restoring force is more, then spring is said to be more stiff and vice-versa.

Reason: Spring constant k is a measure of the stiffness or softness of the spring.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (1)

QUESTION-258 (Assertion and Reason)

Assertion: When a particle is slightly displaced from its position then it does not experience any force acting on it and continues to be in equilibrium in the displaced position, it is said to be in neutral equilibrium.

Reason: Potential energy is constant.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (1)

QUESTION-259 (Assertion and Reason)

Assertion: If a vehicle moves with some initial velocity and due to some retarding force, it stops after some time covering a certain distance; then that distance is known as stopping distance.

Reason: In the process of stopping, friction force does work on the vehicle and destroys the motion.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (2)

QUESTION-260 (Assertion and Reason)

Assertion: If a porter with a suitcase on his head moves up a staircase, work done by the upward lifting force relative to him will be zero (as displacement relative to him is zero) while relative to a person on the ground it will be *mgh*.

Reason: The work done by a force will be different in different frames.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (1)

QUESTION-261 (Assertion and Reason)

Assertion: When a coolie travels on a horizontal platform with a load on his head, work done against friction on the coolie is zero.

Reason: Work done does not depend on nature of force.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (4)

QUESTION-262 (Assertion and Reason)

Assertion: The graph between kinetic energy and mass of a moving body is a straight line momentum is constant.

Reason: Kinetic energy is proportional to mass of the body.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (4)

QUESTION-263 (Assertion and Reason)

Assertion: If a body is moved from position A to another position B on a rough table, work done against frictional force shall depend on the length of the path between A and B and not only on the positions A and B.

Reason: The frictional force is a non-conservative force.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (1)

QUESTION-264 (Assertion and Reason)

Assertion: Kinetic energy depends on frame of reference.

Reason: Kinetic energy is a vector quantity.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (3)

QUESTION-265 (Assertion and Reason)

Assertion: Kinetic energy is $(1/2)mv^2$ only for low speed (compared to light speed).

Reason: At high speed, mass of body does change.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (1)

QUESTION-266 (Assertion and Reason)

Assertion: Potential energy is defined only for conservative forces.

Reason: In case of conservative force (field), potential energy is equal to negative of work done in shifting the body from reference position to given position.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (2)

QUESTION-267 (Assertion and Reason)

Assertion: When a man raises himself up by pulling down on a horizontal bar as in a gymnasium, it is work done by the normal reaction from the bar that goes on to increase his potential energy.

Reason: Normal force applied by the bar on the man is responsible for lifting the centre of mass of the man.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (4)

QUESTION-268 (Assertion and Reason)

Assertion: A body falls toward Earth in air, its total mechanical energy cannot be conserved during the fall.

Reason: Some work has to be done against resistive force of air which is a non-conservative force. Therefore, gain in kinetic energy < loss in potential energy.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (1)

QUESTION-269 (Assertion and Reason)

Assertion: Under the action of a force of constant magnitude. work done is path independent.

Reason: Work done by force of gravity is path independent only near the surface of the Earth.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (4)

QUESTION-270 (Assertion and Reason)

Assertion: A man can jump higher on moon than on the Earth.

Reason: The acceleration due to gravity on moon is less than acceleration due to gravity on the Earth.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (1)

QUESTION-271 (Assertion and Reason)

Assertion: A body is sliding down with constant speed on an inclined plane. Its total kinetic energy remains constant.

Reason: Work done by friction on the body is balanced by loss in gravitational potential energy.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (1)

QUESTION-272 (Assertion and Reason)

Assertion: Two cars of unequal masses are moving with equal velocity in a straight line. On both the cars, total work done to stop them is equal.

Reason: Work done is equal to change in the kinetic energy.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (1)

QUESTION-273 (Assertion and Reason)

Assertion: A heavy weight is suspended from the spring. A person lifts the weight slowly till the spring become slack. The work done by person is W. The energy stored on the stretched spring was E. The gain in potential energy is (W + E).

Reason: Work done by the spring force is always negative.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (2)

QUESTION-274 (Assertion and Reason)

Assertion: Kinetic energy of a system can be increased without applying any external force on the system.

Reason: Single external force acting on a particle necessarily changes its kinetic energy.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (3)

QUESTION-275 (Assertion and Reason)

Assertion: Faster car has higher probability to have an accident in comparison to slower identical one.

Reason: Faster car has larger stopping distance as compared to slower one.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (1)

QUESTION-276 (Assertion and Reason)

Assertion: Work is always the same in all reference frames as it is an invariant physical quantity.

Reason: Force and displacement are independent on frame of reference.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (4)

QUESTION-277 (Assertion and Reason)

Assertion: A body can have momentum when its total mechanical energy is negative.

Reason: Total mechanical energy is sum of kinetic energy and potential energy.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (1)

QUESTION-278 (Assertion and Reason)

Assertion: When a spring is compressed, its potential energy increases.

Reason: Potential energy depends upon shape, size, position and configuration.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (2)

QUESTION-279 (Assertion and Reason)

Assertion: A woman rowing a boat upstream is at rest with respect to shore. There is no work being done by her with respect to shore.

Reason: Work done by her is equal to change in kinetic energy.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (4)

QUESTION-280 (Assertion and Reason)

Assertion: Work done by force of friction exerted by moving body of mass m on a horizontal surface up to distance x is μmgx.

Reason: Change in potential energy becomes μmgx.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (3)

QUESTION-281 (Assertion and Reason)

Assertion: Electrical, gravitational and elastic energies are nothing but potential energies for different types of forces in nature.

Reason: System of particles has potential energy when these particles are held certain distance apart against some force.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (1)

QUESTION-282 (Assertion and Reason)

Assertion: Sun does not do a work on Earth when the Earth revolves in perfectly circular orbit around the Sun.

Reason: Angle between gravitational pull and direction of motion at any instant is perpendicular.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (1)

QUESTION-283 (Assertion and Reason)

Assertion: In projectile motion, the rate of change in magnitude of potential energy of a particle first decreases and then increases during the motion.

Reason: In projectile motion, the rate of change in momentum of a particle remains constant during the motion.

1. If both A and R are true and reason is the correct explanation of assertion.
2. If both A and R are true but reason is not the correct explanation of assertion.
3. If assertion is true but reason is false.
4. If both assertion and reason are false.

Ans. (2)

Part 11 – Revision and PUPPY POINTS



PUPPY POINTS 1

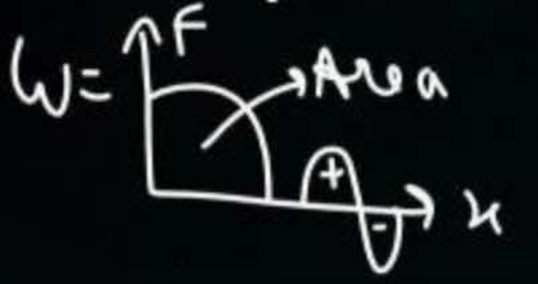
Work

$W = \vec{F} \cdot \vec{S} = F s \cos\theta$

$W = \int F \cdot ds$

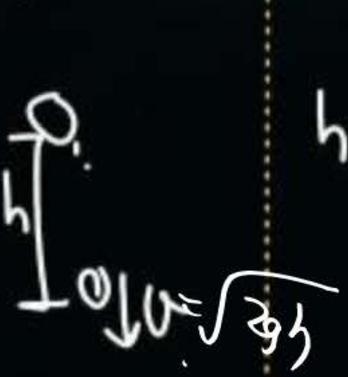
$(a\hat{i} + b\hat{j} + c\hat{k}) \cdot (x\hat{i} + y\hat{j} + z\hat{k})$

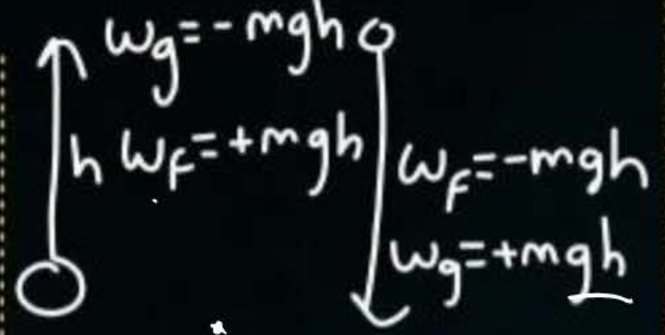
$= ax + by + cz$

$W =$ 

$S = ut + \frac{1}{2}gt^2$

$V = \sqrt{2gh}$



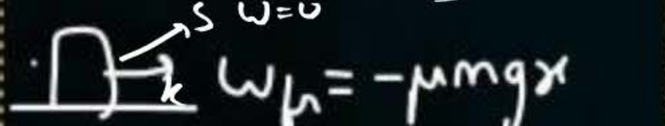


$W_f = -mgh$

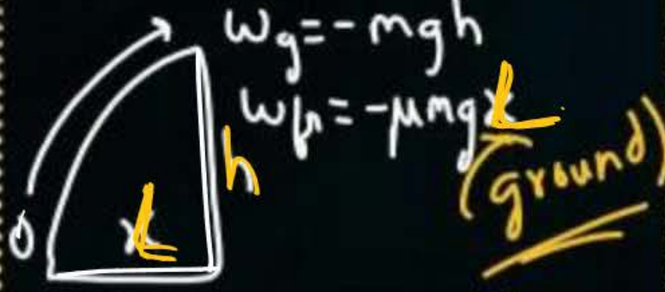
$W_g = +mgh$

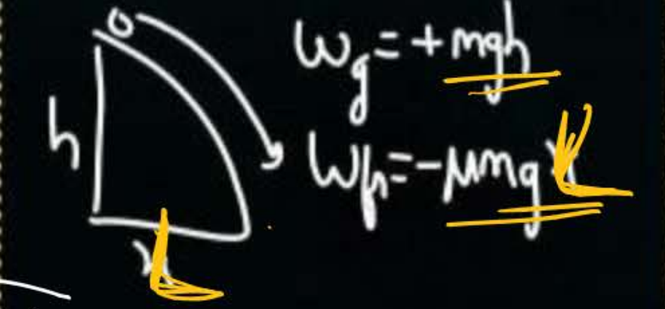


$W_s = -\frac{1}{2}kx^2$



$W_f = -\mu mgx$





$W_g = +mgh$

$W_f = -\mu mgx$

$P = mv$ $K = \frac{1}{2}mv^2 = \frac{P^2}{2m}$

V constant $K \propto m$

P constant $K \propto 1/m$ $\left[\frac{\Delta K}{K} = 2\frac{\Delta P}{P}\right]$ (1 to 5%)

$W_{cons\,F} = -\Delta U$ = Potential Energy (g, spring, electro.)

↳ Round trip $W = 0$

↳ No heat loss, recoverable



$g \Rightarrow \Delta U = mgh = mg\Delta h$

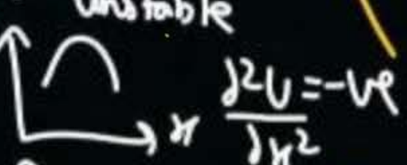
spring $\Delta U = \frac{1}{2}kx^2 = \frac{1}{2}k(x_2^2 - x_1^2)$

Eq^m $F = -\frac{dU}{dx} = 0$

stable

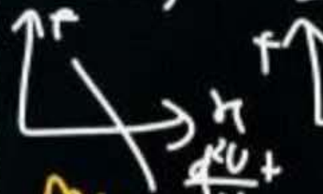


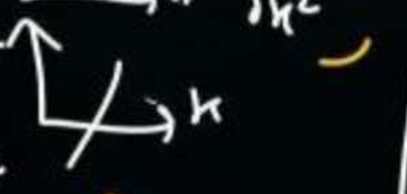
unstable



$\frac{d^2U}{dx^2} = -ve$

(Neutral $\frac{d^2U}{dx^2} = 0$)





max

$U = \frac{a}{r^{12}} - \frac{b}{r^6}$

$r^6 = \frac{2a}{b}$ $U = -\frac{b^2}{4a}$

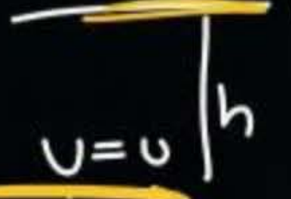
PUPPY POINTS-2

Energy

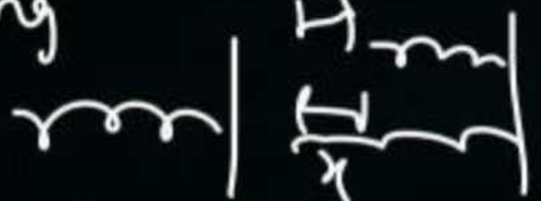
$\Delta U = \Delta K$ (only Conservative forces)

$T_i = T_f$ $\quad U_i + K_i = U_f + K_f$

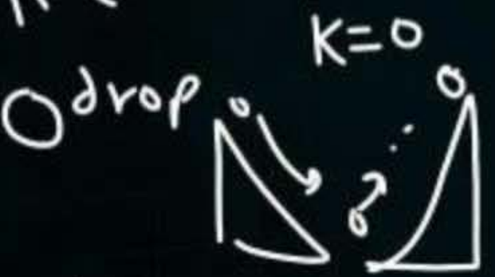
Kese



Spring



K (see v)



Total Energy = U+K is constant

WET

$W_{All} = \Delta K$

$W_{fr} = \Delta U + \Delta K$

W_{fr} = Loss in Energy = $T_i - T_f$

Power

$P_{inst} = F \cdot v = Fv\cos\theta$

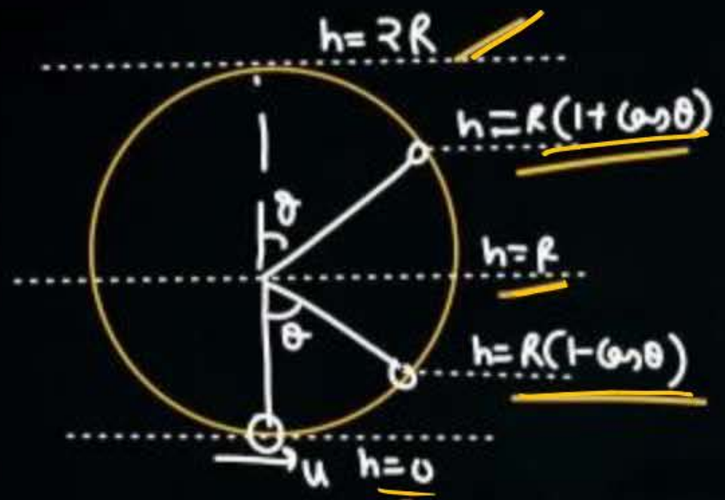
$P_{avg} = F \cdot V_{avg}$ — [F constant, a constant, $V_{avg} = \left(\frac{u+v}{2}\right)$]

$P_{avg} = \frac{W}{t} = \frac{E}{t} = \frac{mgh}{t}$

If Power is constant $x \propto v^3$ ($v \propto t^{1/2}$, $x \propto t^{3/2}$, $KE \propto t$)

1 hp = 746 W $\quad E = P \times t$

PUPPY POINTS 3 VCM



$$\frac{1}{2}mu^2 = \frac{1}{2}mv^2 + mgh$$

$$v = \sqrt{u^2 - 2gh}$$

(min) $T = \frac{mv^2}{R} - mg$

$T = \frac{mv^2}{R} - mg\cos\theta$

$T = \frac{mv^2}{R}$

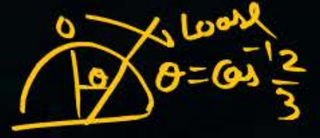
$T = \frac{mv^2}{R} + mg\cos\theta$

(max) $T = \frac{mv^2}{R} + mg$

$u \le \sqrt{2gR}$	$\sqrt{2gR} < u < \sqrt{5gR}$	$u \ge \sqrt{5gR}$
Pendulum	Half Circle Half Projectile	Full Circle





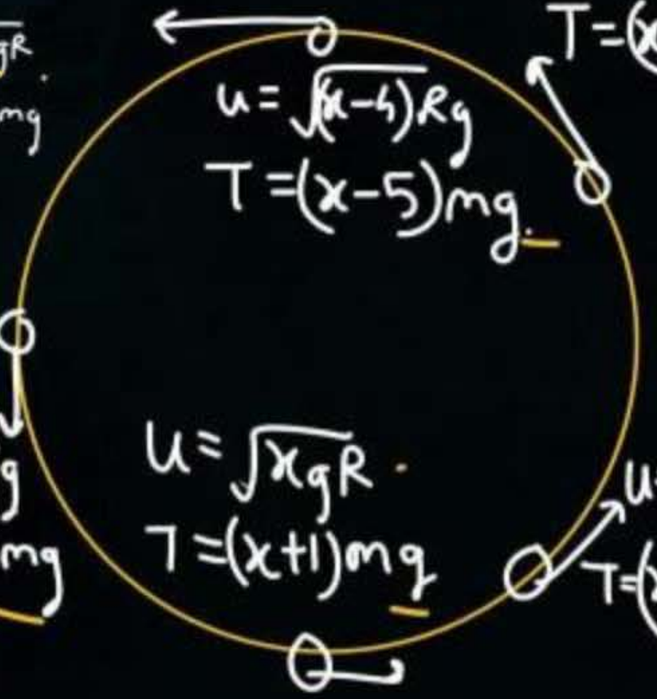


Rod (I) $u = \sqrt{4Rg}$



$H_{min} = 2.5R$

$H = \frac{3R}{2}$




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