Physicsaholics

DPP – 1 (WEP)

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Q 1. A particle moves from position $\vec{r}_1 = 3\hat{\imath} + 2\hat{\jmath} - 6\hat{k}$ to position $\vec{r}_2 = 14\hat{\imath} + 13\hat{\jmath} + 9\hat{k}$ under the action of force. The $(4\hat{\imath} + \hat{\jmath} + 3\hat{k})N$ work done by this force will be

(a) 100 J (b) 50 J (c) 200 J (d) 75 J

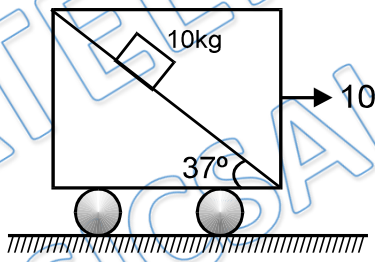
Q 2. The work done by kinetic friction on a body:

(a) is always negative (b) is always zero

(c) may be +ve, –ve or zero (d) is always positive

Q 3. A block of mass 10 kg is released on a fixed wedge inside a cart which is moved with constant velocity 10 m/s towards right. Take initial velocity of block with respect to cart zero. Then work done by normal reaction (with respect to ground) on block in two seconds will be:

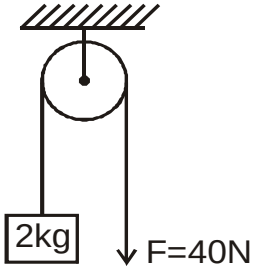
(g = 10 m/s^2).



(a) zero (b) 960 J

(c) 1200 J (d) none of these

Q 4. A block of mass 2 kg 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 = 40 N. At t = 0 the system is at rest as shown. Then in the time interval from t = 0 to t = $\frac{2}{\sqrt{10}}$ seconds, pick up the correct statement (s) : (g = 10 m/s^2)



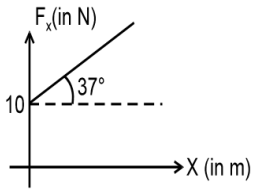
(a) tension in the string is 40 N

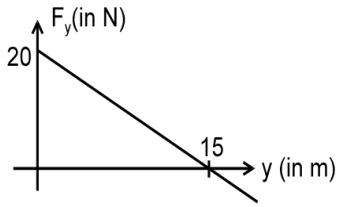
(b) work done by gravity is – 20 J

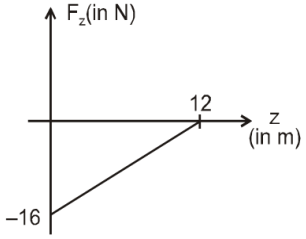
(c) work done by tension on block is 80 J

(d) None of these

Q 5. The components of a force acting on a particle are varying according to the graphs shown. When the particle moves from (0, 5, 12) to (4, 20, 0) then the work done by this force is :







(a) 192 J (b) 400/3 J (c) 0 (d) None of these

Q 6. A ball is released from the top of a tower. The ratio of work done by force of gravity in first second, 2nd second and third second of the motion of ball is
(a) 1 : 2 : 3 (b) 1 : 4 : 16 (c) 1 : 3 : 5 (d) 1 : 9 : 25

Q 7. A force $\vec{F} = -k(y\hat{i} + x\hat{j})$, where k is a positive constant, acts on a particle moving in the xy plane. Starting from the origin, the particle is taken along the positive x-axis to the point (a, 0) and then parallel to the y-axis to the point (a, a). The total work done by the force on the particle is
(a) $-2ka^2$ (b) $2ka^2$ (c) $-ka^2$ (d) ka^2

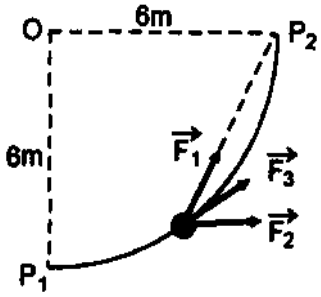
Q 8. A body is displaced from (0, 0) to (1m, 1m) along the path x = y by a force $\vec{F} = (x^2\hat{j} + y\hat{i})$ N. The work done by this force will be :
(a) $\frac{4}{3}$ J (b) $\frac{5}{6}$ J (c) $\frac{3}{2}$ J (d) $\frac{7}{5}$ J

Q 9. Force acting on a particle is $(2\hat{i} + 3\hat{j})$ N. Work done by this force is zero, when a particle is moved on the line 3y + kx = 5. Here value of k is:
(a) 2 (b) 4 (c) 6 (d) 8

Q 10. A particle of mass 0.5 kg is displaced from position $\vec{r}_1$ (2, 3, 1) to $\vec{r}_2$ (4, 3, 2) by applying a force of magnitude 30 N which is acting along $(\hat{i} + \hat{j} + \hat{k})$. The work done by the force is :
(a) $10\sqrt{3}$ J (b) $30\sqrt{3}$ J (c) 30 J (d) none

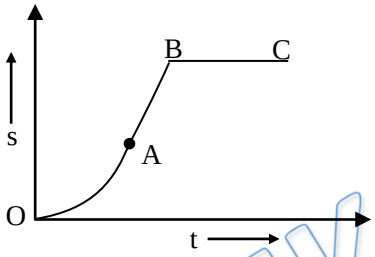
Q 11. Work done by a force on an object is zero, if:
(a) the force is always perpendicular to its acceleration
(b) the object is stationary but the point of application of the force moves on the object
(c) the force is always perpendicular to its velocity
(d) the object moves in such a way that the point of application of the force remains fixed

Q 12. A smooth track in the form of a quarter circle of radius 6 m lies in the vertical plane. A particle moves from P_1 to P_2 under the action of forces $\vec{F}_1, \vec{F}_2$ and $\vec{F}_3$. Force $\vec{F}_1$ is always toward P_2 and its magnitude is $10\sqrt{2}$ N, $\vec{F}_2$ is always horizontal and it is always 30 N in magnitude. Force $\vec{F}_3$ always acts tangentially to the track and is of magnitude 15 N. Select the correct alternative(s):



(a) Work done by $\vec{F}_1$ is 120 J (b) Work done by $\vec{F}_2$ is 180 J
(c) Work done by $\vec{F}_3$ is 45 π (d) None of these

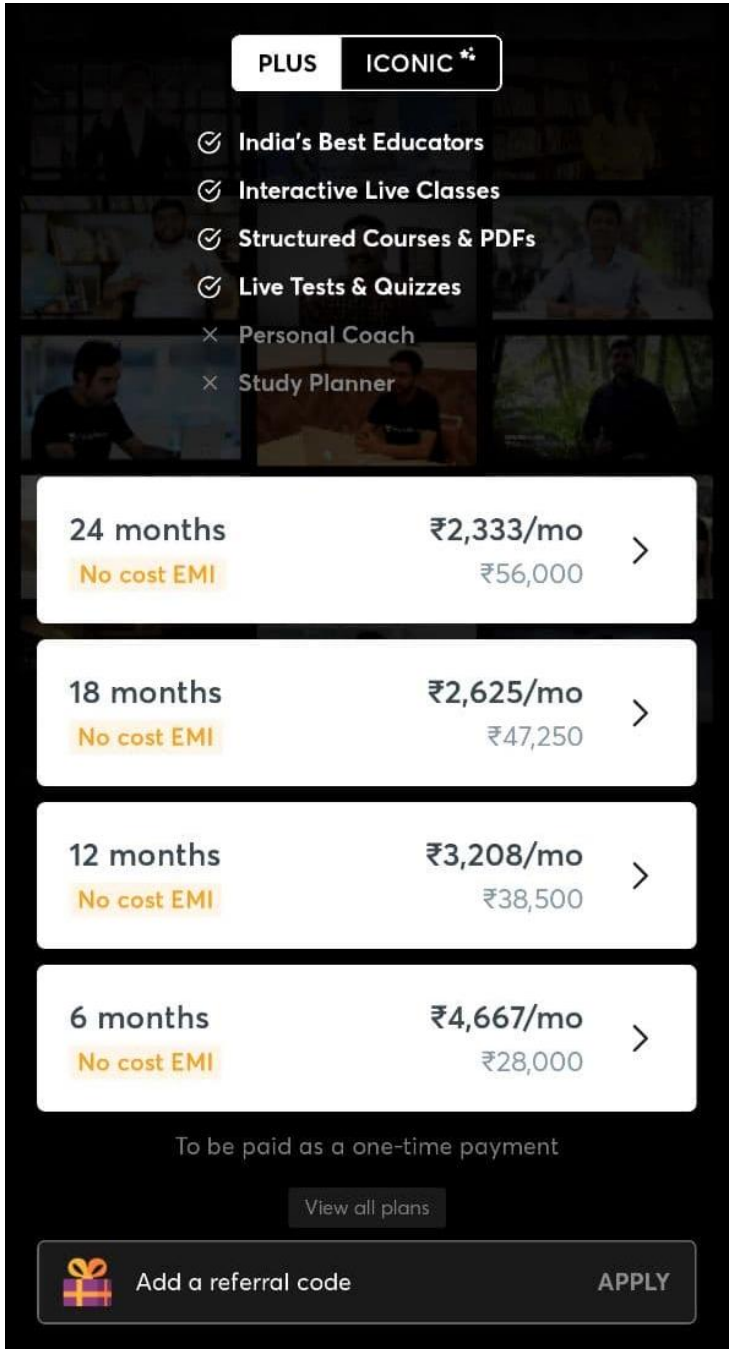
Q 13. The displacement-time graph of a body acted upon by some forces is shown in figure. Select the correct alternative(s) :



(a) Work done by the forces during BC is zero
(b) Work done by the forces during AB is zero
(c) Work done by the forces during AB is positive
(d) Work done by the forces during OA is positive (OA is a part of a parabola)

Answer Key

Q.1 a	**Q.2 c**	**Q.3 b**	**Q.4 a, c**	**Q.5 a**
Q.6 c	**Q.7 c**	**Q.8 b**	**Q.9 a**	**Q.10 b**
Q.11 b, c, d	**Q.12 a, b, c**	**Q.13 a, b, d**		



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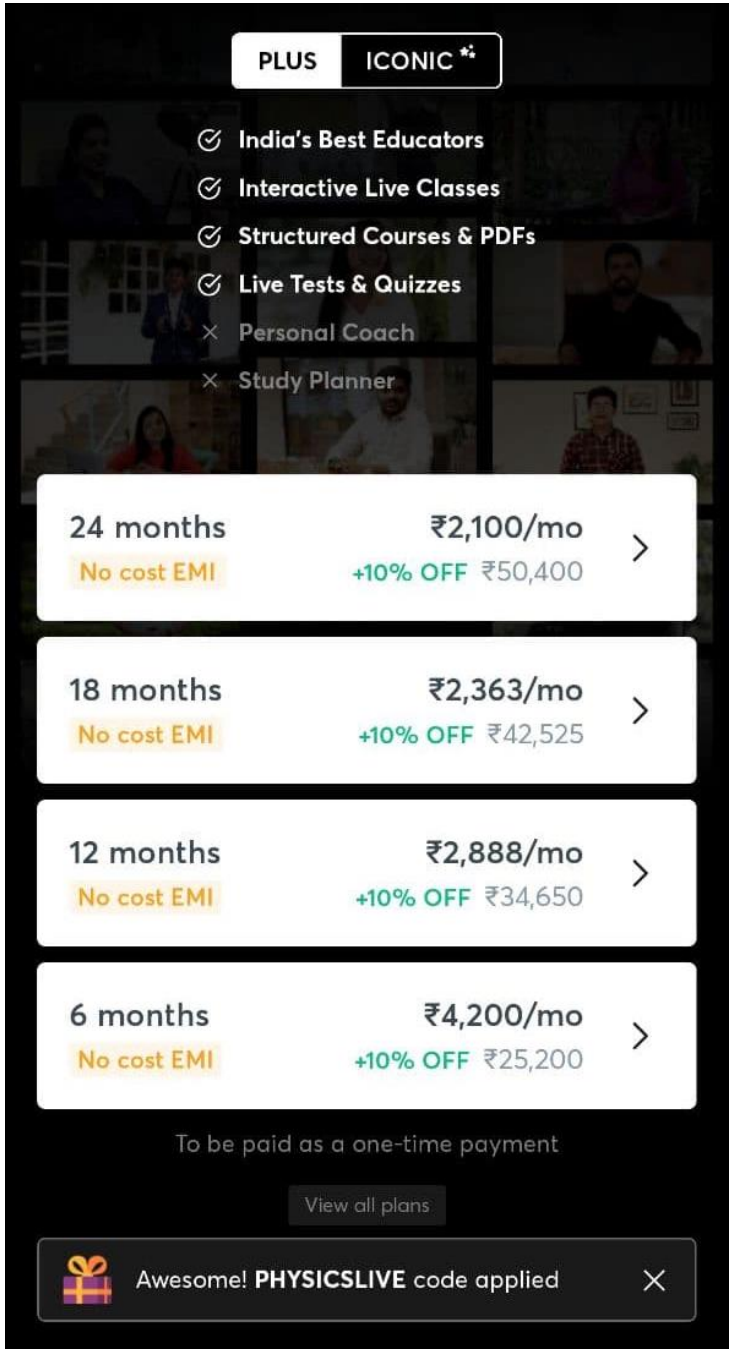


Written Solution

DPP- 1 WEP- Work Done by Constant & Variable Forces and Work done by F-X Curve

By Physicsaholics Team

Solution:1

$$\vec{r_1} = 3\hat{i} + 2\hat{j} - 6\hat{k}$$

$$\vec{r_2} = 14\hat{i} + 13\hat{j} + 9\hat{k}$$

$$\vec{\Delta r} = \vec{r_2} - \vec{r_1} = 11\hat{i} + 11\hat{j} + 15\hat{k}$$

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

Since $\vec{F}$ is Constant.

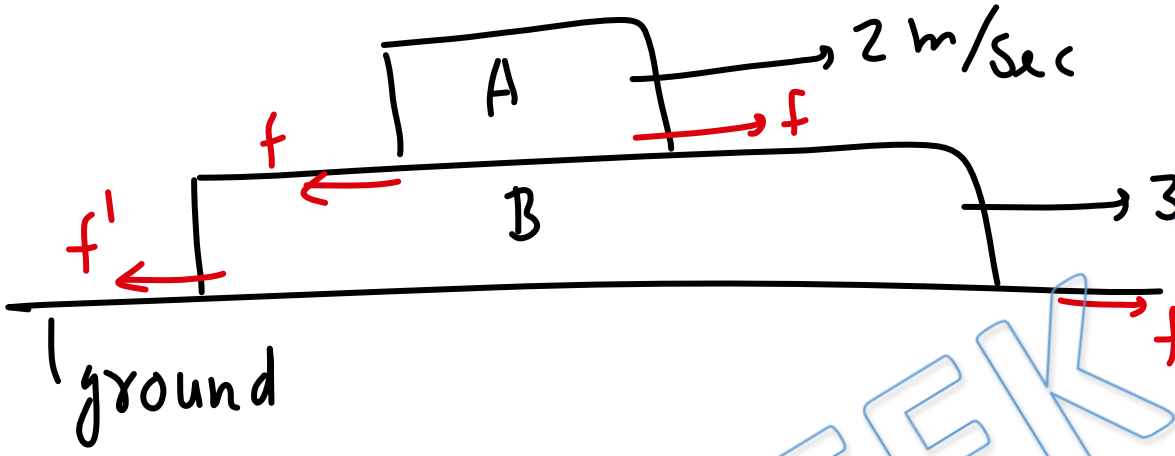
$$W = \vec{F} \cdot \vec{\Delta r} = (11 \times 4) + (11 \times 1) + (15 \times 3)$$

$$= 44 + 11 + 45$$

$$= 100\ J$$

Ans (a)

Solution:2



f & f' are Kinetic friction.

Work done by f on A is +ve.

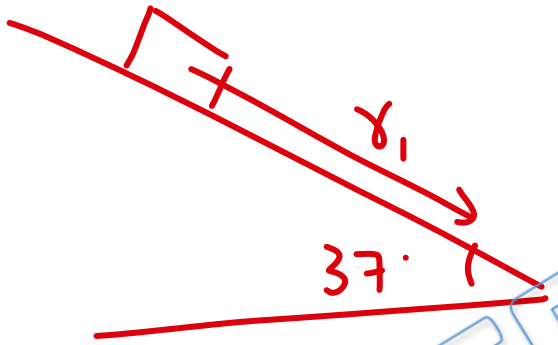
" " " " " B " -ve.

Work done by f' on ground is zero.

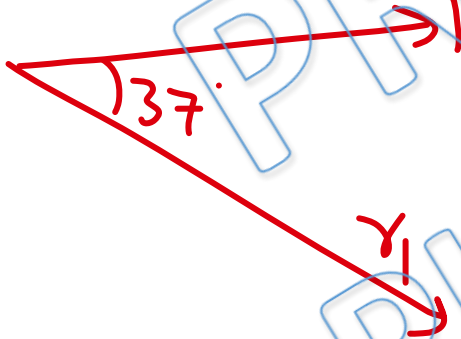
Ans (c)

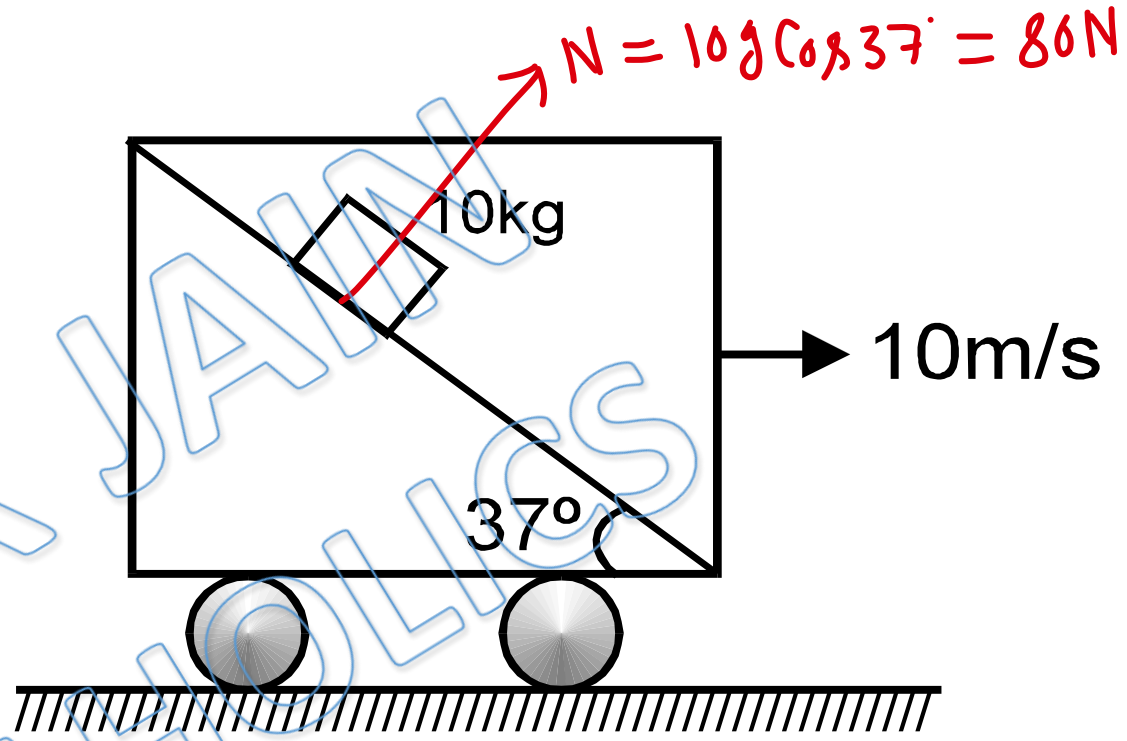
Solution:3

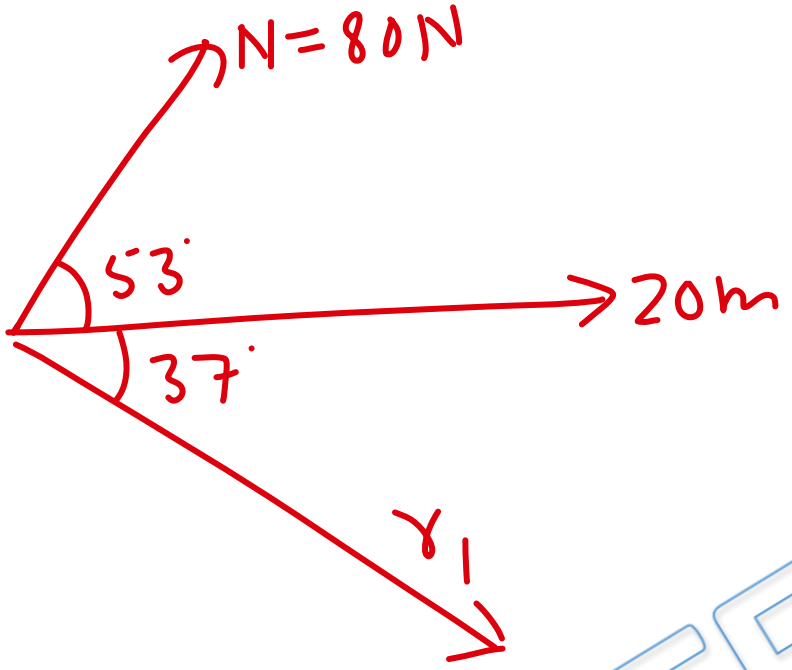
Displacement of block w.r.t. Cart =



= Displacement of block w.r.t. ground







work done by N

$= 80 \times 20 \cos 53^\circ + 80 \times \gamma_1 \cos 90^\circ$

$= 80 \times 20 \times \frac{3}{5}$

$= 960$ J

Ans(6)

Solution:4

Since point A is massless

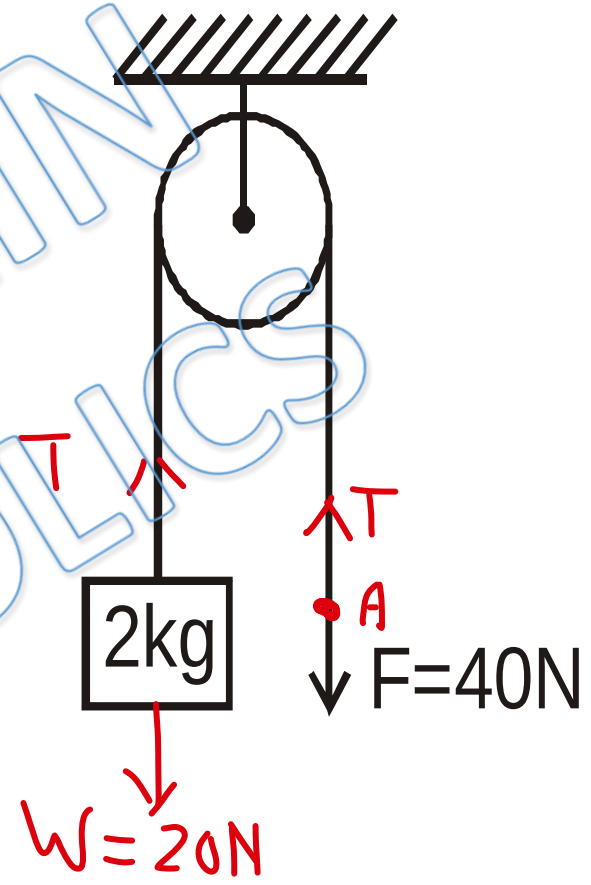
$T = 40N$

acceleration of 2 Kg block

$= \frac{40-20}{2} = 10 m/Sec^2 \uparrow$

Displacement in $\frac{2}{\sqrt{10}}$ Sec $= \frac{1}{2} \times 10 \times \left(\frac{2}{\sqrt{10}}\right)^2$

$= 2m$

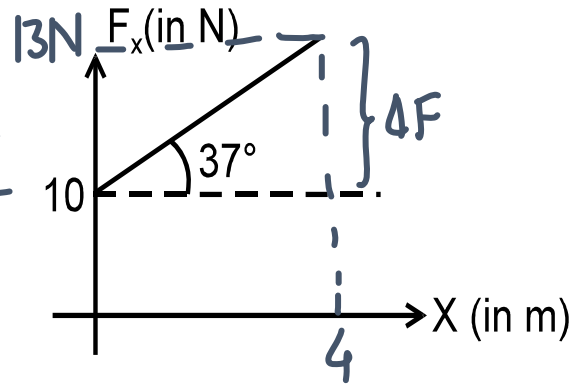


work done by gravity $= -mgh = -20 \times 2 = -40J$

work done by tension on block $= 40 \times 2 = 80J$

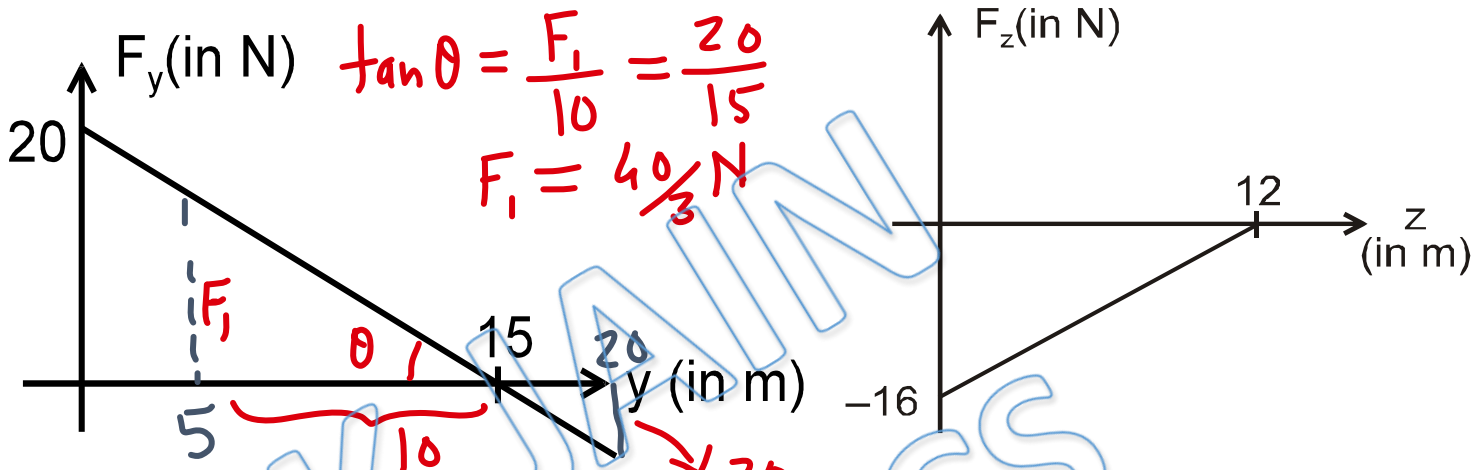
Ans (a,c)

Solution:5



$\tan 37 = \frac{\Delta F}{4}$

$\Rightarrow \Delta F = 3\,N$



$\tan\theta = \frac{F_1}{10} = \frac{20}{15}$

$F_1 = \frac{40}{3}\,N$

work done by force $= \int \vec{F} \cdot d\vec{x}$

$= \int F_x\,dx + \int F_y\,dy + \int F_z\,dz$ = Sum of area of each curve.

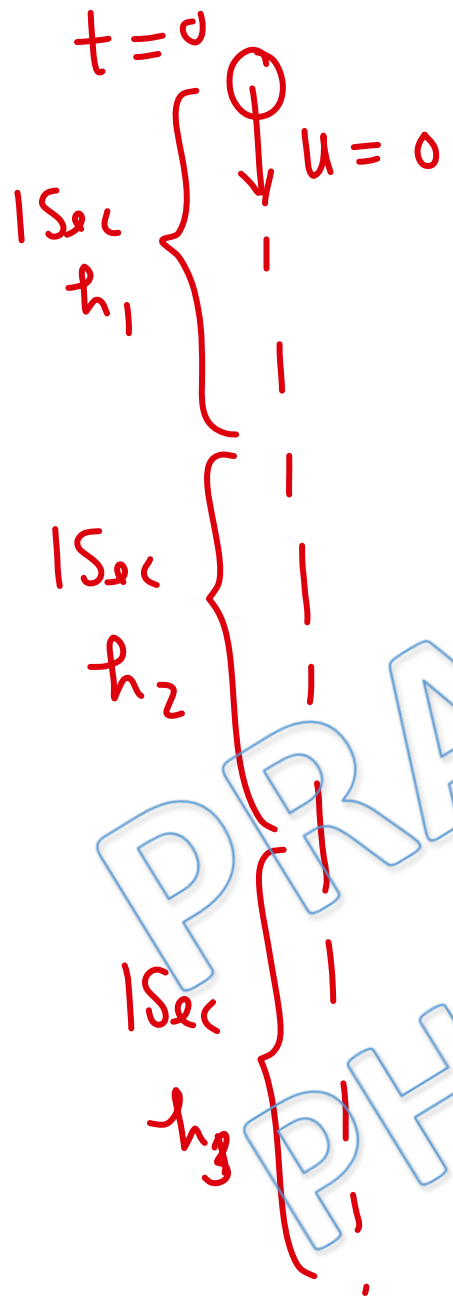
$= \frac{1}{2}\times 4(13+10) + \left(\frac{1}{2}\times 10\times\frac{40}{3} - \frac{1}{2}\times 5\times\frac{20}{3}\right) + \left(\frac{1}{2}\times 12\times 16\right)$

$= 46 + \frac{200}{3} - \frac{50}{3} + 96$

$= 142 + 50 = 192\,J$

Ans (a)

Solution:6



$$h_1 = \frac{1}{2} \times 10 \times 1^2 = 5m$$

$$h_1 + h_2 = \frac{1}{2} \times 10 \times 2^2 = 20m$$

$$\Rightarrow h_2 = 15m$$

$$h_1 + h_2 + h_3 = \frac{1}{2} \times 10 \times 3^2 = 45 \Rightarrow h_3 = 25m$$

work done in first 1 sec $W_1 = mgh_1$

" " Second " $W_2 = mgh_2$

" " third " $W_3 = mgh_3$

$$W_1 : W_2 : W_3 = h_1 : h_2 : h_3 = 1 : 3 : 5$$

Ans(c)

Solution:7

$$W_{OA} = \int F_x\,dx + \int F_y\,dy$$

$$= \int -Ky\,dx + \int -Kx\,dy$$

(0 on OA; 0 on OA)

$$= 0$$

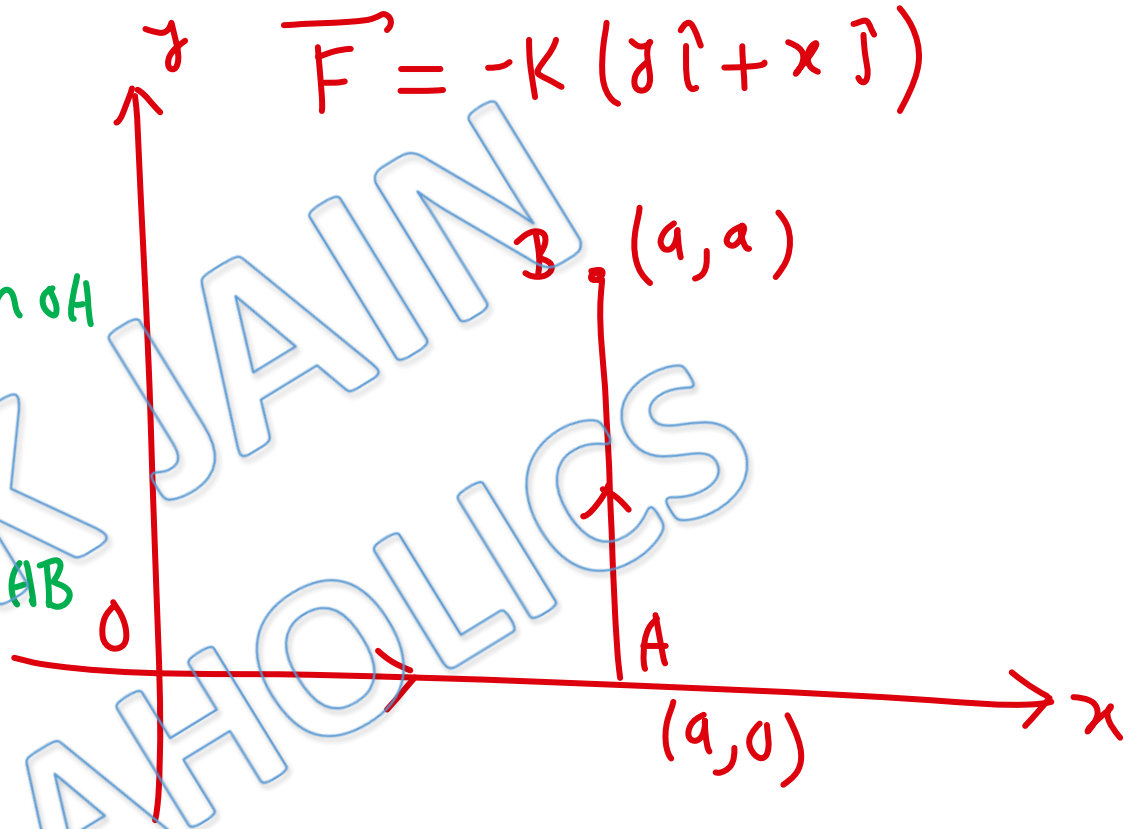
$$W_{AB} = \int -Ky\,dx + \int -Kx\,dy$$

(0 on AB; a on AB)

$$= 0 + (-K)\int_0^a a\,dy$$

$$= -Ka\int_0^a dy$$

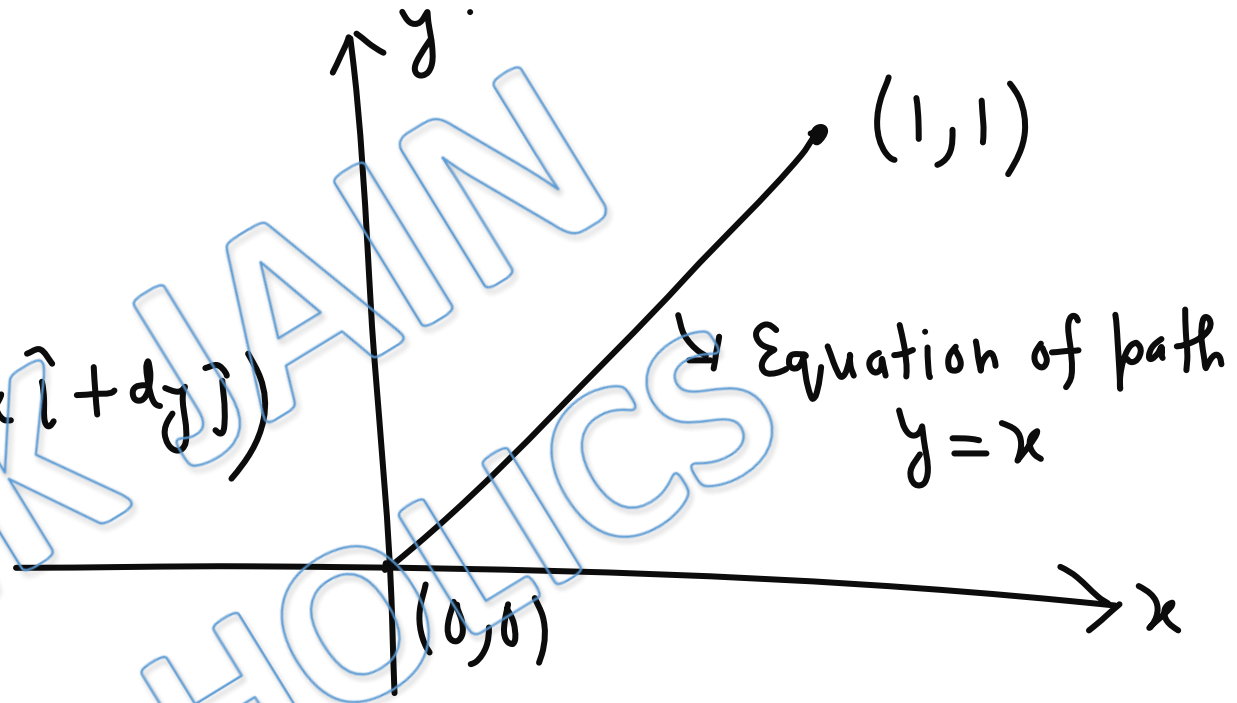
$$= -Ka^2$$



Ans(c)

Solution:8

$$\vec{F} = x^2 \hat{j} + y \hat{i}$$



$$W = \int \vec{F} \cdot d\vec{r} = \int (x^2 \hat{j} + y \hat{i}) \cdot (dx \hat{i} + dy \hat{j})$$

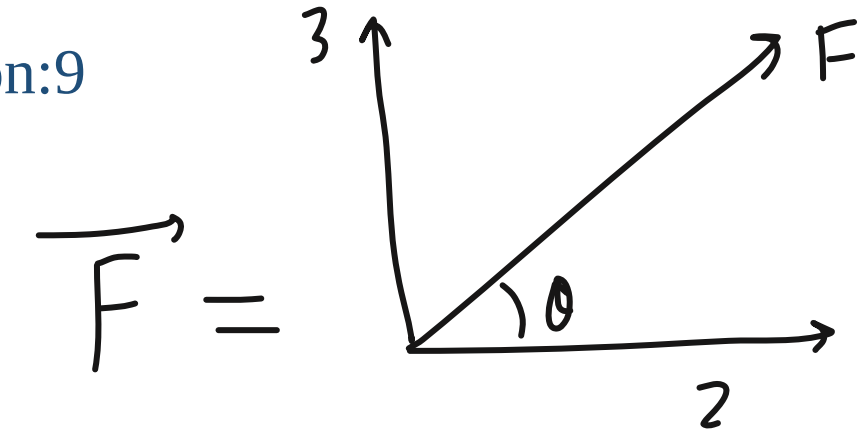
$$= \int_{y=0}^{y=1} x^2 \, dy + \int_{x=0}^{x=1} y \, dx$$

$$= \int_{y=0}^{y=1} y^2 \, dy + \int_{x=0}^{x=1} x \, dx$$

$$= \left[\frac{y^3}{3}\right]_0^1 + \left[\frac{x^2}{2}\right]_0^1 = \frac{1}{3} + \frac{1}{2} = \frac{5}{6}$$

ANS(b)

Solution:9



$\vec{F} =$

$\tan\theta = 3/2$

$3y + Kx = 2 \Rightarrow y = -\frac{K}{3}x + \frac{2}{3} \Rightarrow \text{Slope} = -K/3$

$W = 0 \Rightarrow \vec{F} \perp \vec{\Delta r} \Rightarrow m_1 m_2 = -1$

$\Rightarrow \frac{3}{2} \times \left(-\frac{K}{3}\right) = -1 \Rightarrow K = 2$

Ans(a)

Solution:10

$$\overrightarrow{\Delta r} = \overrightarrow{r_2} - \overrightarrow{r_1} = (4-2)\hat{i} + (3-3)\hat{j} + (2-1)\hat{k}$$

$$= 2\hat{i} + 0\hat{j} + \hat{k}$$

$$\vec{F} = 30\text{N along } \hat{i}+\hat{j}+\hat{k}$$

$$= 30\left(\frac{\hat{i}+\hat{j}+\hat{k}}{\sqrt{3}}\right)$$

{ unit vector of $\hat{i}+\hat{j}+\hat{k}$ $= \frac{\hat{i}+\hat{j}+\hat{k}}{\sqrt{1^2+1^2+1^2}} = \frac{\hat{i}+\hat{j}+\hat{k}}{\sqrt{3}}$

$$W = \vec{F}\cdot\overrightarrow{\Delta r} = \frac{30}{\sqrt{3}}(\hat{i}+\hat{j}+\hat{k})\cdot(2\hat{i}+0\hat{j}+\hat{k})$$

$$= \frac{30}{\sqrt{3}}(2+0+1)$$

$$= 30\sqrt{3}\ \text{J}$$

Ans(b)

Solution: 11

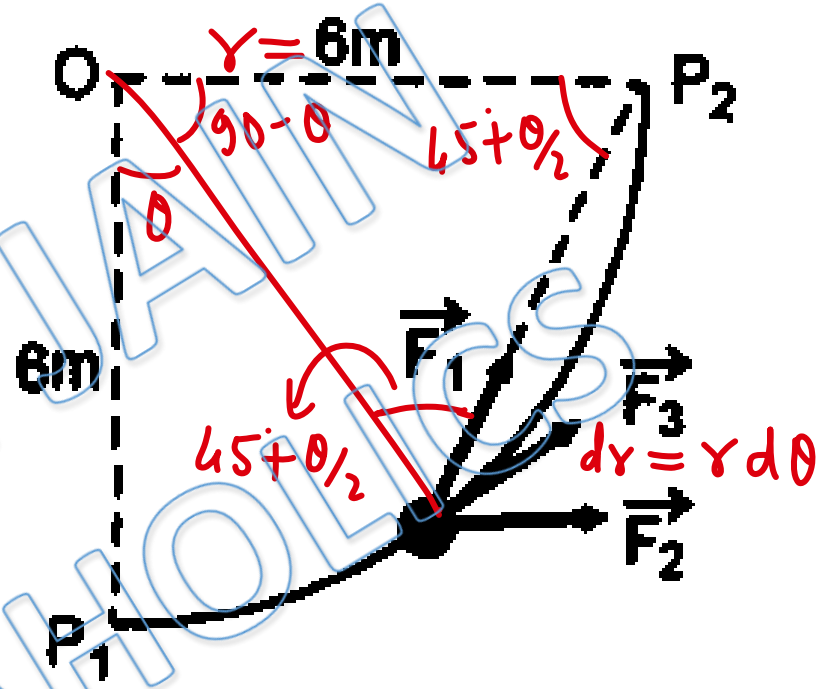
If particle at which force is acting is in motion & $\vec{F}$ is not perpendicular to it's velocity $\Rightarrow W \neq 0$

OR

Point of application of force must move with object for non zero work.

Ans(b,c,d)

Solution:12 $F_1 = 10\sqrt{2}\ N,\ F_2 = 30N,\ F_3 = 15N$



$$W_1 = \int \vec{F_1} \cdot d\vec{r}$$

$$= \int 10\sqrt{2}\ r\,d\theta \cos\left(90 - (45 + \theta/2)\right)$$

$$= 60\sqrt{2} \int_0^{90^\circ} \sin(45^\circ + \theta/2)\, d\theta$$

$$= 60\sqrt{2} \left[-2\cos(45^\circ + \theta/2)\right]_0^{90^\circ}$$

$$= 60\sqrt{2} \left[(-2\cos 90^\circ) - (-2\cos 45^\circ)\right]$$

$$= 120\ J$$

$$W_2 = \vec{F_2} \cdot \vec{\Delta r} = F_2 \cdot (\text{horizontal displacement})$$

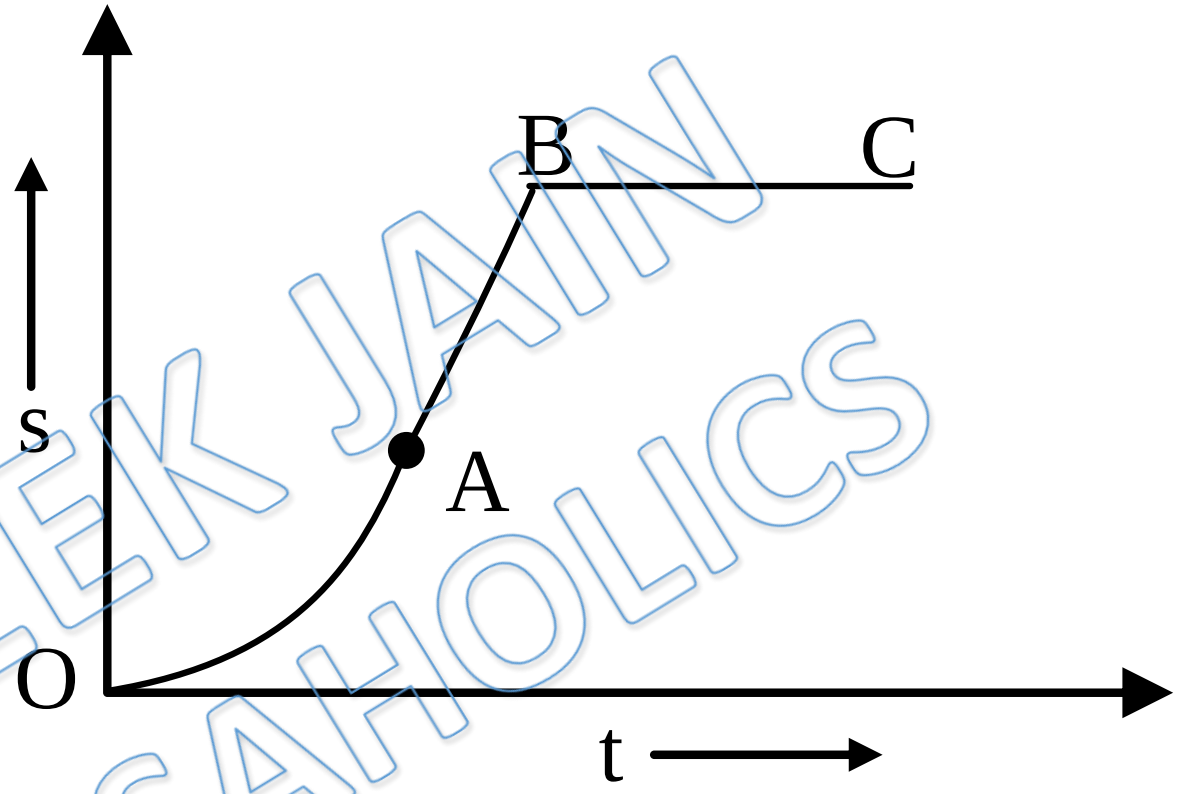
$$= 30 \times 6 = 180\ \text{J}$$

$$W_3 = \int \vec{F_3} \cdot d\vec{r} = \int F_3 \cdot dr = F_3 \int dr = F_3 \times \text{distance}$$

$$= 15 \times \frac{\pi \times 6}{2} = 45\pi\ \text{J}$$

Ans(a,b,c)

Solution:13



In BC →

$\Delta r = 0$, $a = 0$, $F = 0$

$\Rightarrow W = 0$

In AB →

$\Delta r \neq 0$, V = Constant

$\Rightarrow a = 0 \Rightarrow F = 0 \Rightarrow W = 0$

In OA

Δr is +ve , V is +ve and increasing $\Rightarrow a$ is +ve

$\Rightarrow F$ is +ve $\Rightarrow W$ = +ve.

Ans (a, b, d)

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