PHYSICS

VMC MODULES ENGLISH

ENERGY & MOMENTUM

LEVEL - 0 - VERY SHORT ANSWER TYPE

1. A person is holding a suitcase and moving on a horizontal platform. Is he doing any work?

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2. Define work. When is work said to be done by a force ?

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3. Give an example of motion in which the force does no work.

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4. Define the unit joule.

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5. Define potential energy. Derive an expression for the potential energy of a body of mass m, at a height h above the surface of the Earth.

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LEVEL - 0 -SHORT ANSWER TYPE

1. Total energy of a body at rest at a height h from a point of reference is 75 J. What is its kinetic energy as it falls through a height h/2 ?

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2. Two machines are capable of doing the same work. Should they have the same power?

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3. What does the slope of a work-time graph represent?

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4. Can a body have momentum without energy?

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5. List the differences between energy and power.

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6. Law of Conservation of Energy

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7. If a compressed spring is dissolved in acid, what happens to the elastic potential energy of the spring ?

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8. Can a single isolated particle possess potential energy? Justify.

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9. Can you associate potential energy with a non conservative force ?

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10. An object of mass m, initially at rest under the action of a constant force F attains a velocity v in time t. Then, the average power supplied to mass is

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11. A spring balance reads forces in Newton. The scale is 20 cm long and read from 0 to 60 N. Find potential energy of spring when the scale reads 20 N.

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12. If KE of a body increases by 300%, by what $\%$ will the linear momentum of the body increase?

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13. A rocket explodes in mid air. What happens to its total momentum and total KE?

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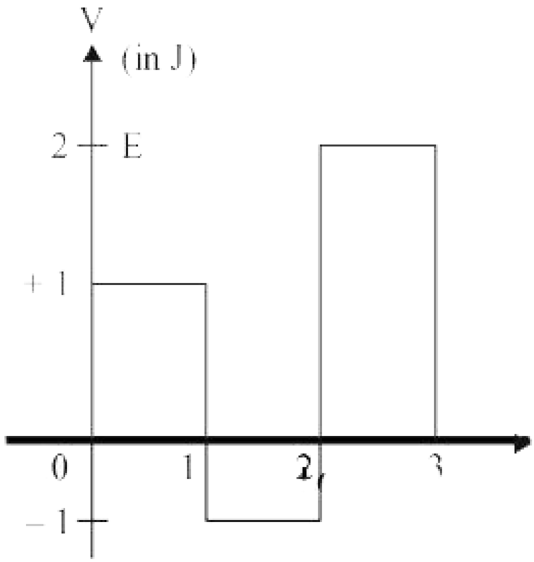
14. The potential energy 'V' of a particle moving along the positive x-direction in a conservative force field varies as shown in the figure. The total energy is E=2. Draw the corresponding kinetic energy K vs x graph.



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15. A rain drop of radius 2mm, falls from a height of 500 m above the ground. It falls with decreasing

acceleration due to viscous resistance of air until half its original height. It attains its maximum (terminal) speed, and moves with uniform speed there after. What is the work done by the gravitational force on the drop in the first half and second half of its journey ? Take density of water $= 10^3 kg/m^3$. What is the work done by the resistive force in the entire journey if its speed on reaching the ground is $10 ms^{-1}$?

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16. A pump on the ground floor of a building can pump up water to fill a tank of volume $30 m^3$ in 15

min. If the tank is 60 m above the ground, and the efficiency of the pump is 40%, how much electric power is consumed by the pump?

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

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17. Springs Aand B are identical except that A is stiffer than B. In which spring more work is done if(a) both are stretched by same amount ? (b) both are stretched by the same force ?

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18. Two springs A and B are identical except that A is stiffer than B i.e., $k_A > k_B$. If the two springs are stretched by the same force, then

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19. Anwer carefully, with reasons:

a) In an elastic collision of two billiard balls, is the total kinetic energy conserved during the short time of collision of the balls (i.e. when they are in contact)?

Is the total linear momentum conserved during the short time of an elastic collision of two balls?

c) What are the answers to a) and b) for an inelastic collision?

d) If the potenital energy of two billiard balls depends only on the separation distance between their centers, is the collision elastic or inelastic? (note we are talking here of potential energy corresponding to the force during collision, not gravitational potential energy).

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20. Ram used to live in a remote village of Rajasthan which didn't have electricity. He was a good student and studied very hard to become an engineer in spite of all hardships. While studying, he came to know that solar energy can be converted to electrical energy by using specially designed devices.

He went to his village and discussed it with villagers. He also told them that Govt. also gives subsidy for using solar devices. All the villagers agreed and they contacted the Govt. officials who obliged their request and the village became the model village which used solar energy for electricity.

(iii) Why is solar energy a batter source of energy?

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21. Ram used to live in a remote village of Rajasthan which didn't have electricity. He was a good student and studied very hard to become an engineer in spite of all hardships. While studying, he came to know that solar energy can be converted to electrical energy by using specially designed devices.

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(ii) If direct solar energy is incident on the horizontal surface at an average rate of 200 watt per square metre and 20% of this energy can be converted to use electrical energy, then how much area is needed to supply 8 KW of electrical energy?

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22. Ram used to live in a remote village of Rajasthan which didn't have electricity. He was a good student and studied very hard to become an engineer in spite of all hardships. While studying, he came to know that solar energy can be converted to electrical energy by using specially designed devices.

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(i) What can you say about Ram?

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LEVEL - 0 - LONG ANSWER TYPE

1. Define mechanical energy and law of conservation of mechanical energy. Prove conversion of gravitational potential energy in to kinetic energy by the help of law of conservation of mechanical energy. Also draw graph between energy and height.

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2. For perfectly inelastic collision cofficient of restitution e is

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3. In inelastic collision,

A. the two particles stick together

B. they thrown apart

C. e = 0

D. e = 1

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4.

Derive final velocities V_1 and V_2 after perfectly elastic collision.

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5. A baloon filled with helium rises against gravity increasing its potential energy. The speed of the baloon also increases as it rises. How do you reconcile this with the law of conservation of mechanical energy ? You can neglect viscous drag of air and assume that density of air is constant.

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Level - 1

1. A particle moves 5m in the +x direction while being acted upon by a constant force $\overrightarrow{F} = (4N)\hat{i} + (2N)\hat{j} - (4N)\hat{k}$. The work done on the particle by this force is

A. (a)20 J

B. (b)10 J

C. (c)$-20J$

D. (d)30 J

Answer: A

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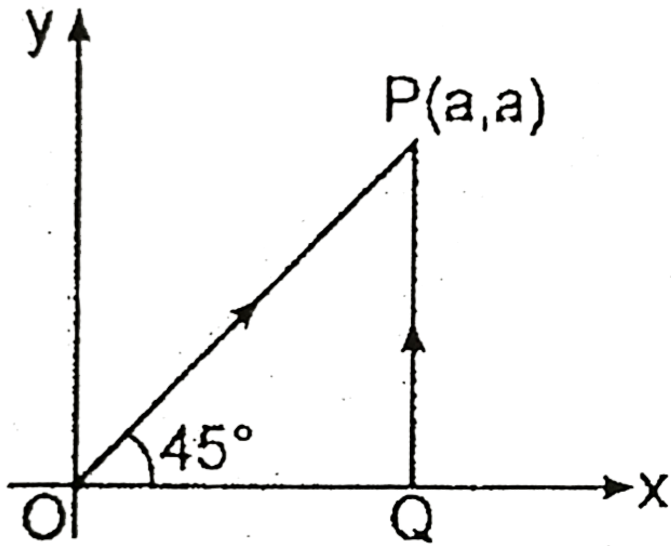
2. A particle is moved from $(0, 0) \rightarrow (a, a)$ under a force $F = \left(x^2\hat{i} + y^3\hat{j}\right)$ from two paths. Path 1 si OP and Path 2 is OQP. Let W_1 and W_2 be the work done by this force in these two paths. Then



A. (a)$W_1 = W_2$

B. (b)$W_1 = 2W_2$

C. (c)$W_1 = 2W_1$

D. (d)$W_2 = 4W_1$

Answer: A

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3. A ball is released from the top of a tower. The ratio of work done by force of gravity in 1st second, 2nd second and 3rd second of the motion of ball is

A. $1:2:3$

B. $1:4:16$

C. $1:3:5$

D. $1:9:25$

Answer: C

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4. A 0.50 kg object moves in a horizontal circular track of radius of 2.5 m. An external force of 3.0 N, always tangent to the track, causes the object to speed up as it goes around. The work done by the external force as the object makes one revolution is :

A. (a)24 J

B. (b)47 J

C. (c)59 J

D. (d)94 J

Answer: B

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5. A man pushes a 80 N crate a distance of 5.0 m upward along a frictionless slope that makes an angle of 30° with the horizontal. The force he exerts is parallel to the slope. If the speed of the crate increases at a rate of 1.5 then the work done by the man is :

A. $-200J$

B. 61 J

C. 140 J

D. 260 J

Answer: D

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6. Two bodies of masses m_1 and m_2 have same kinetic energy. The ratio of their momentum is

A. proportional to their masses

B. proportional to the squares of their masses

C. proportional to the square roots of their masses

D. inversely proportional to their masses

Answer: C

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7. why is the weight of an object on the moon $\frac{1}{6}th$ its weight on the earth ?

A. $6:1$

B. $36:1$

C. $1:1$

D. $1:6$

Answer: C

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8. A man who is running has half the kinetic energy of a boy of half his mass. The man speeds up by 1 ms^{-1} and then has the same kinetic energy as the boy. The original speeds of the man and the boy was:

A. $2m/s$

B. $9.6m/s$

C. $4.8m/s$

D. $7.2m/s$

Answer: C

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9. A ball of mass 5.0 gm and relative density 0.5 strikes the surface of the water with a velocity of 20 m/sec. It comes to rest at a depth of 2m. Find the work done by the resisting force in water: (take $g = 10m / s^2$)

A. (a)$6J$

B. (b)$+7.5J$

C. (c)-$9J$

D. (d)$-10J$

Answer: C

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10. At time $t = 0s$ particle starts moving along the $x-$ axis. If its kinetic energy increases uniformly with time $'t'$, the net force acting on it must be proportional to

A. (a)constant

B. (b)proportional to t

C. (c)inversely proportional to t^2

D. (d)proportional to$1 / \sqrt{t}$

Answer: D

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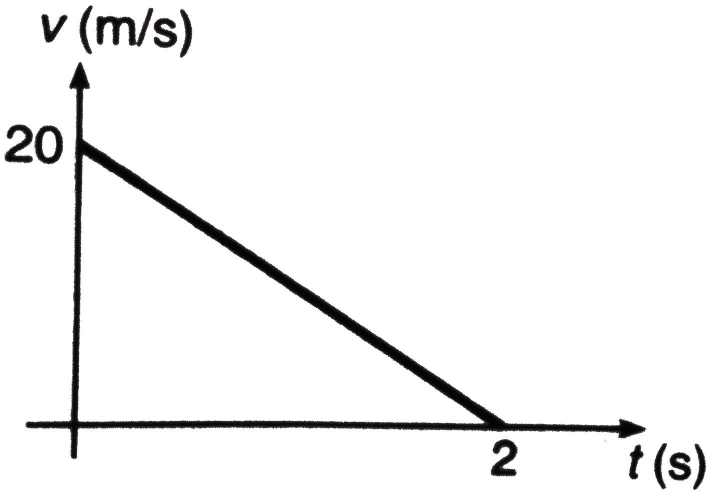
11. Velocity-time graph of a particle of mass (2 kg) moving in a straight line is as shown in Fig. 9.20. Find the word done by all the forces acting on the particle.



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12. An object of mass m is allowed to fall from rest along a rough inclined plane. The speed of the object on reaching the bottom of the plane is proportional to

A. m^0

B. m

C. m^2

D. m^{-1}

Answer: A

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13. A block of mass M 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 of the block increases by $40J$ in $1s$. State whether the following statements are true or false.

(a) The tension in the string is Mg .

(b) The work done the tension on the block is $40J$.

(c) the tension in the string is F.

(d) The work done by the force of gravity is 40J in the above 1s .

A. The tension in the string is Mg

B. The tension in the string is F

C. The work done by the tension on the block is

20 J in the above 1s

D. The work done by the force of gravity is -20 J

in the above 1s

Answer: B

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14. A particle moves move on the rough horizontal ground with some initial velocity V_0. If $\frac{3}{4}$ of its kinetic enegry lost due to friction in time t_0. The coefficient of friction between the particle and the ground is.

A. $\frac{v_0}{2gt_0}$

B. $\frac{v_0}{4gt_0}$

C. $\frac{3v_0}{4gt_0}$

D. $\frac{v_0}{gt_0}$

Answer: A

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15. A particle of mass 2 kg starts moving in a straight line with an intial velocity of $2m/s$ at a constant acceleration of $2m/s^2$. Then, rate of change of kinetic energy

A. is four times the velocity at any moment

B. is two times the displacement at any moment

C. is four times the rate of change of velocity at any moment

D. is constant throughout

Answer: A

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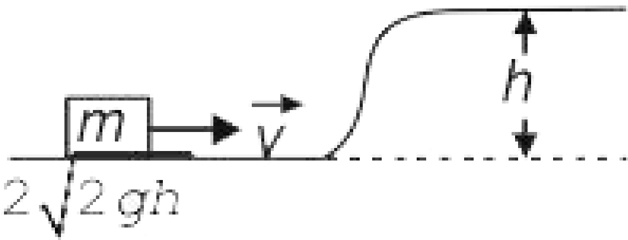
16. For a block of mass m to slide without friction up the rise of height h shown, it must have a minimum initial speed of:



A. $1/2\sqrt{gh}$

B. $\sqrt{gh/2}$

C. $\sqrt{2gh}$

D. $2\sqrt{\dfrac{m}{2gh}}$

Answer: C

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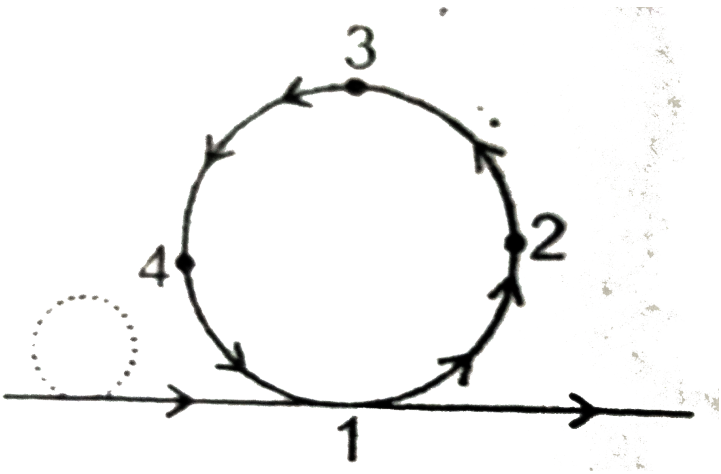
17. A rectangular block is mobing along a frictionless path, when it encounters the circular loop as shown. The block passes points $1, 2, 3, 4,$ before ret runing to the horizontal tracks. At point 3



A. its mechanical energy is minimum

B. the forces on it are balanced

C. it is not accelerating

D. its speed is minimum

Answer: D

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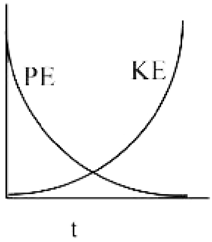
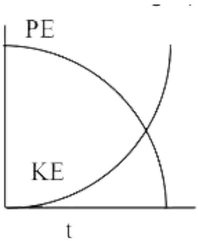
18. A particle falls from rest under gravity. Its potential energy with respect to the ground (PE) and its kinetic energy (KE) are plotted against time (t). Choose the correct graph.

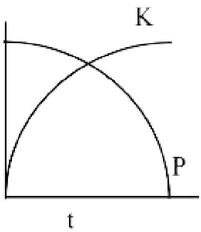
A.



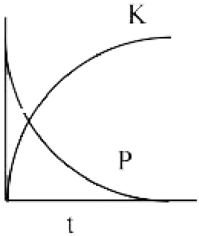
B.



C.



D.



Answer: B

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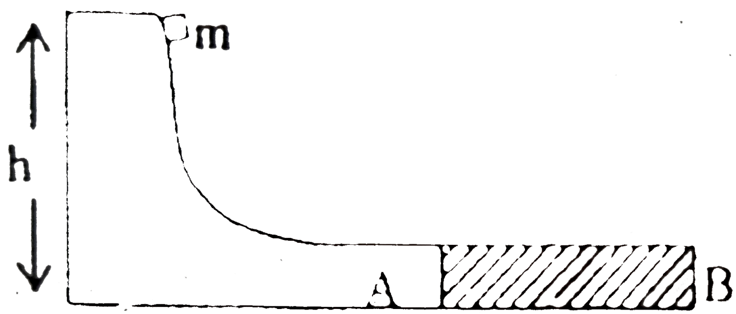
19. A particle of mass m is released from height h on smooth quarter circular fixed wedge. The horizontal surface AB following the circular path at bottom of wedge is rough with coefficient of friction μ between surface and m. Find the distance from bottom of wedge where the mass will stop.



A. $\frac{2h}{\mu}$

B. $\frac{h}{\mu}$

C. $\frac{h}{\mu g}$

D. $\frac{h}{\mu g}$

Answer: B

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20. A block is released from the top of two inclined rough surfaces of height h each. The angle of inclination of the two planes are 30° and 60° respectively. All other factors (e.g., coefficient of friction, mass of block etc.) are same in both the cases. Let K_1 and K_2 be the kinetic energies of the block at the bottom of the plane in two cases. Then,

A. $K_1 = K_2$

B. $K_1 > K_2$

C. $K_1 < K_2$

D. Data sufficient

Answer: C

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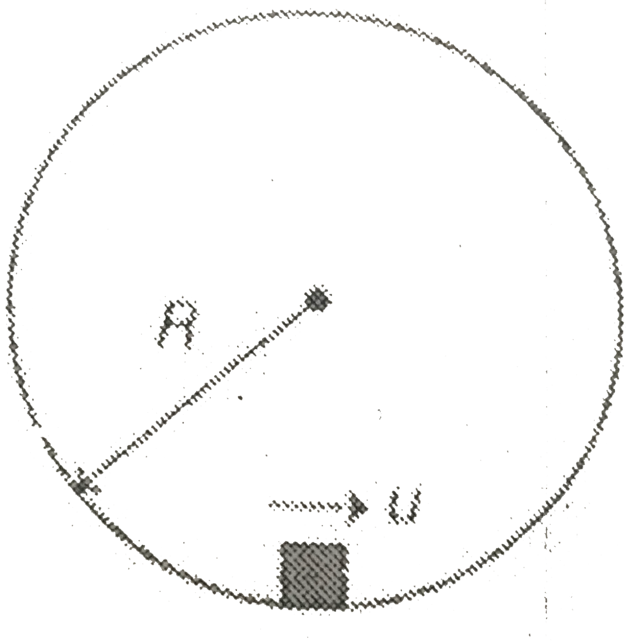
21. A particle is given an initial speed u inside a smooth spherical shell of radius $R = 1$ m such that it is just able to complete the circle. Acceleration of the particle when its velocity is vertical is



A. $g\sqrt{10}$

B. g

C. $g\sqrt{2}$

D. $g\sqrt{6}$

Answer: A

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22. A small object of mass m, on the end of a light cord, is held horizontally at a distance r from a fixed support as shown. The object is then released. What is the tension in the cord when the object is at the lowest point of its swing?

A. (a)$mgl2$

B. (b)mg

C. (c)$2mg$

D. (d)$3mg$

Answer: D

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23. A particle is rotated in vertical circle by connecting it to string fixed. The minimum speed of the particle when the string is horizontal for which the particle will complete the circle is

A. $\sqrt{gl}$

B. $\sqrt{2gl}$

C. $\sqrt{3gl}$

D. $\sqrt{gl}$

Answer: C

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24. A heavy particle of weight w, attached to a fixed point by a light inextensible string describes a circle in a vertical plane. The tension in the string has the values nw and mw respectively when the particle is at the highest and lowest points in the path. Then :

A. $m+n=6$

B. $\frac{m}{n}=2$

C. $m-n=-6$

D. $n-m=-6$

Answer: D

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

A. (a)$E/2$

B. (b)$2E$

C. (c)E

D. (d)$E/4$

Answer: B

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26. A block of mass m is initially moving to the right on a horizontal frictionless surface at a speed v. It then compresses a spring of spring constant k. At the instant when the kinetic energy of the block is equal to the potential energy of the spring, the spring is compressed a distance of :

A. (a)$v\sqrt{m / 2k}$

B. (b)$v\sqrt{m / k}$

C. (c)$v\sqrt{m / 4k}$

D. (d)$mv^2 / 4k$

Answer: A

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27. A horizontal 50 N force acts on a 2 kg crate which is at rest on a smooth horizontal surface. At the instant the particle has gone 2 m, the rate at which the force is doing work is :

A. (a)2.5 W

B. (b)25 W

C. (c)100 W

D. (d)500 W

Answer: D

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28. The speed v reached by a car of mass m in travelling a distance x, driven with constant power P, is given by

A. $v = \frac{3xP}{m}$

B. $v = \left(\frac{3xP}{m}\right)^{1/2}$

C. $v = \left(\frac{3xP}{m}\right)^{1/3}$

D. $v = \left(\frac{3xP}{m}\right)^{2}$

Answer: C

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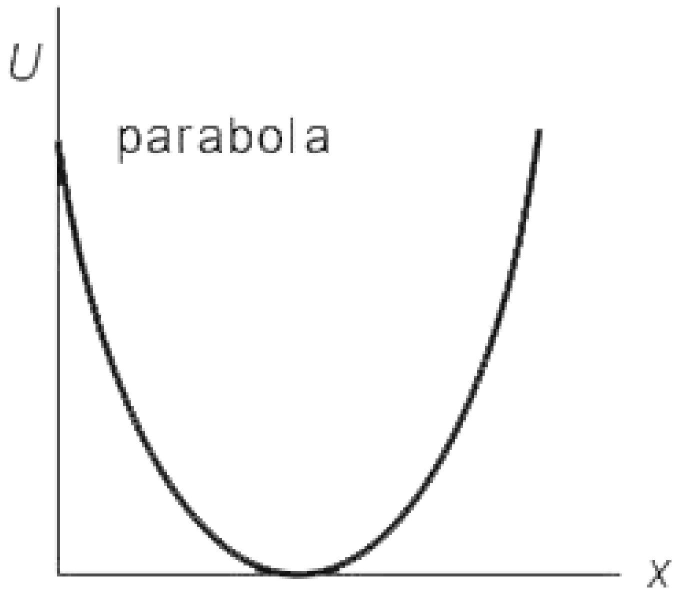
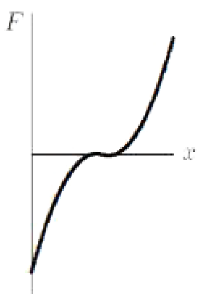
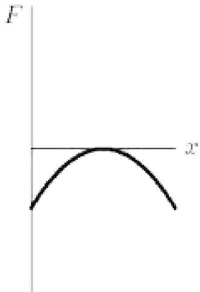
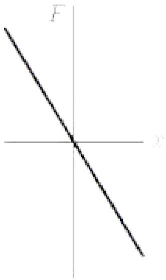
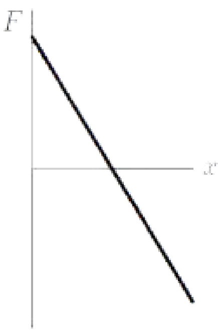
29. The first graph shows the potential energy $U(x)$ for a particle moving on the x axis. Which of the other four graphs correctly gives the force F exerted on the particle?



A. 

B. 

C. 

D. 

Answer: D

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30. Potential energy of a particle is related to x coordinate by equation $x^2 - 2x$. Particle will be in stable equilibrium at :

A. $x = 0.5$

B. $x = 1$

C. $x = 2$

D. $x = 4$

Answer: B

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31. A particle of mass 15 kg has an initial velocity $\overrightarrow{v}_i = \hat{i} - 2\hat{j} m/s$. It collides with another body and the impact time is 0.1s, resulting in a velocity $\overrightarrow{c}_f = 6\hat{i} + 4\hat{j} + 5\hat{k} m/s$ after impact. The average force of impact on the particle is :

A. $15\left[5\hat{i} + 6\hat{j} + 5\hat{k}\right]$

B. $15\left[5\hat{i} + 6\hat{j} - 5\hat{k}\right]$

C. $150\left[5\hat{i} - 6\hat{j} + 5\hat{k}\right]$

D. $150\left[5\hat{i} + 6\hat{j} + 5\hat{k}\right]$

Answer: D

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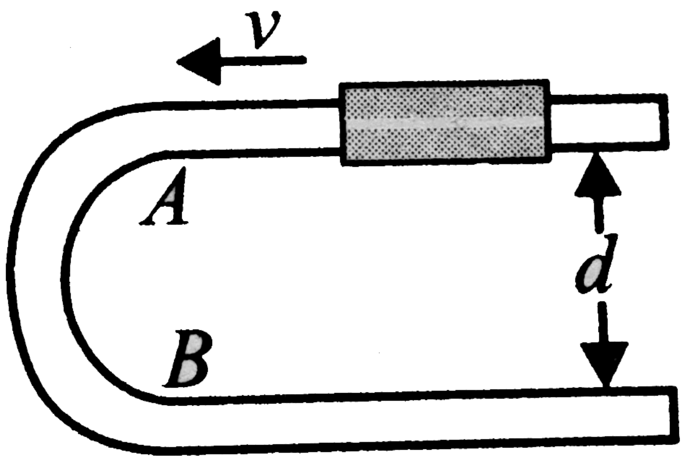
32. A U-shaped wire has a semicircular bending between A and B as shown in Fig. A bead of mass m moving with uniform speed v through a wire enters the semicircular bend at A and leaves at B with velocity $v/2$ after time T. The average force exerted by the bead on the part AB of the wire is



A. 0

B. $\frac{3mv}{2T}$

C. $\frac{3mv}{T}$

D. None of these

Answer: B

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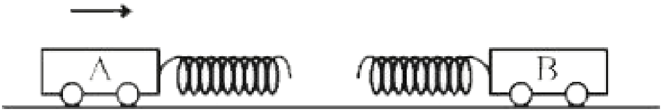
33. Two carts (A and B), having spring bumpers, collide as shown. Cart A has a mass of 2 kg and is initially moving to the right. Cart B has a mass of 3 kg and is initially stationary. When the separation between the carts is a minimum :



A. cart B is still at rest

B. cart A has come to rest

C. both carts have the same kinetic energy

D. the kinetic energy of the system is at a minimum

Answer: D

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34. An open water tight railway wagon of mass 5×10^3 kg coasts at initial velocity of $1.2 m/s$ without friction on a railway track. Rain falls vertically downwards into the wagon. What change then occurred in the kinetic energy of the wagon, when it has collected 10^3 kg of water

A. $1200 J$

B. $300 J$

C. $600 J$

D. $900 J$

Answer: C

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35. A 64-kg woman stands on frictionless ice. She kicks a 0.10-kg stone backwards with her feet so that the stone acquires a velocity of 1.1m/s. The velocity (in m/s) acquired by the woman is :

A. 1.1m/s forward

B. 0.0017m/s backward

C. 0.0017m/s forward

D. 1.1m/s backward

Answer: C

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36. A golf ball of mass m is hit by a golf club so that the ball leaves the tee with speed v. The club is in contact with the ball for time T. The magnitude of the average force on the club on the ball during the time T is :

A. mvT

B. mv/T

C. $(1/2)mv^2T$

D. $mv^2(2T)$

Answer: B

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37. A projectile is moving at $20ms^{-1}$ at its highest point where it breaks into equal parts due to an internal explosion. Just after explosion, one part moves vertically up at $30ms^{-1}$ with respect to the ground. Then the other part will move at :

A. $20m/s$

B. $10\sqrt{13}m/s$

C. $50m/s$

D. $30m/s$

Answer: C

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38. A particle of mass m moving towards west with speed v collides with another particle of mass m movies towards south. If two particles st ich t o each other the speed of the new particle of mass 2 m will be

A. v

B. $v/2$

C. $\frac{v}{\sqrt{2}}$

D. $v\sqrt{2}$

Answer: C

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39. Two particle A and B start moving due to their mutual interaction only. If at any time t, $\overrightarrow{a}_A$ and $\overrightarrow{a}_B$ are their respective accelerations, $\overrightarrow{v}_A$ and $\overrightarrow{v}_B$ are their respective velocities, and upto that time W_A and W_B are the work done on A and B respectively by the mutual force, m_A and m_B are their masses respectively, then which of the following is always correct.

A. $\vec{v}_A + \vec{v}_B = 0$

B. $m_A \vec{v}_A + m_B \vec{v}_B = 0$

C. $W_A + W_B = 0$

D. $\vec{a}_A + \vec{a}_B = 0$

Answer: B

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40. a. A rail road car of mass M is moving without friction on a straight horizontal track with a velocity ct. A man of mass m lands on it normally from a helicopter. What will be the new velocity of the car? ltbgt b. If now the man begins to run on it with speed um with respect to car in a direction opposite to motion of the car, what will be the new velocity of the car?

A. $v_1 = \dfrac{\mu}{(M+m)}$

B. $v_1 = \dfrac{mu}{(M+m)}$

C. $v_1 = \dfrac{\mu}{(M-m)}$

D. $v_1 = \dfrac{Mu}{(M-m)}$

Answer: C

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41. A bullet hits a lock kept at rest on a smooth horizontal surface andgets embedded into it. Which of the following does not change?

A. linear momentum of the block

B. kinetic energy of the block

C. gravitational potential energy of the block

D. temperature of the block

Answer: C

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42. A nucleus moving with velocity $\bar{v}$ emits an α-particle. Let the velocities of the α-particle and the remaining nucleus be $\bar{v}_1$ and $\bar{v}_2$ and their masses be m_1 and (m_2) then,

A. $\overrightarrow{v}, \overrightarrow{v}_1$ and $\overrightarrow{v}_2$ must be parallel to each other

B. None of the two of $\overrightarrow{v}, \overrightarrow{v}_1$ and $\overrightarrow{v}_2$ should be parallel to each other

C. $\vec{v}_1 + \vec{\ }2$ must be parallel to $\vec{v}$

D. $m_1 \vec{v}_1 + m_2 \vec{v}_2$ must be parallel to $\vec{v}$

Answer: D

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43. A bullet of mass $0.01kg$ and travelling at a speed of $500ms^{-1}$ strikes a block of mass $2kg$ which is suspended by a string of length $5m$. The centre of gravity of the block is found to raise a vertical distance of $0.2m$. What is the speed of the bullet after it emerges from the block?

A. $200m / s$

B. $217m / s$

C. $204m / s$

D. $284m / s$

Answer: B

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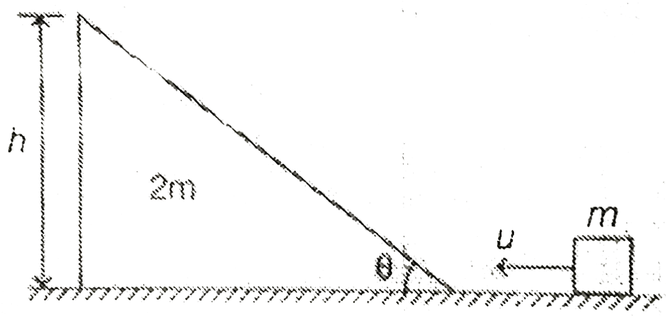
44. A block of mass m is pushed towards a movable wedge of mass 2 m and height h with a velocity u . All surfaces are smooth . The minimum value of u for which the block will reach the top of the wedge is



A. $\sqrt{2gh}$

B. $\eta\sqrt{2gh}$

C. $\sqrt{2gh(1+1/\eta)}$

D. $\sqrt{2gh(1-1/\eta)}$

Answer: C

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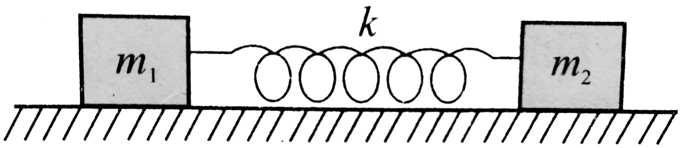
45. Two blocks m_1 and m_2 are pulled on a smooth horizontal surface, and are joined together with a spring of stiffness k as shown in Fig. Suddenly, block m_2 receives a horizontal velocity v_0, then the maximum extension x_m in the spring is



A. $v_0\sqrt{\dfrac{m_1 m_2}{m_1+m_2}}$

B. $v_0\sqrt{\dfrac{2m_1 m_2}{(m_1+m_2)k}}$

C. $v_0\sqrt{\dfrac{m_1 m_2}{2(m_1+m_2)k}}$

D. $v_0\sqrt{\dfrac{m_1 m_2}{(m_1+m_2)k}}$

Answer: D

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46. Blocks A and B are moving towards each other along the x axis. A has mass of 2.0 kg and a velocity of 10 m/s (in the positive x direction), B has a mass of 3.0 kg and a velocity of –5 m/s (in the negative x direction). They suffer an elastic collision and move off along the x axis. After the collision, the velocities of A and B, respectively, are:

A. $-10 \text{ and } +0.5\frac{m}{s}$

B. $-8.0 \text{ and } +7.0\frac{m}{s}$

C. $-9.0 \text{ and } +6.0\frac{m}{s}$

D. $-5.0 \text{ and } +10\frac{m}{s}$

Answer: B

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47. A body of mass M moving with a speed u has a 'head on', perfectly elastic collision with a body of mass m initially at rest. If $M > > m$, the speed of the body of mass m after collision, will be nearly :

A. um / M

B. uM / m

C. $u / 2$

D. $2u$

Answer: D

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48. The first ball of mass m moving with the velocity v collides head on with the second ball of mass m at rest. If the coefficient of restitution is e, then the ratio of the velocities of the first and the second ball after the collision is

A. $\dfrac{1-e}{1+e}$

B. $\dfrac{1+e}{1-e}$

C. $\dfrac{1+e}{2}$

D. $\dfrac{1-e}{2}$

Answer: A

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49. A ball A moving with momentum $2\hat{i}+4\hat{j}$ collides with identical ball B moving with momentum $6\hat{j}$. After collision momentum of ball B is $10\hat{j}$. Which of the following statement is correct?

A. After collision momentum of A is $4\hat{i}$

B. After collision momentum of A is parallel to momentum of B

C. After collision momentum of A is $2\hat{i}$

D. If $\vec{P}_A$ and $\vec{P}_B$ are momenta of balls A and B, then $\Delta\left(\left|\vec{P}_A\right|+\left|\vec{P}_B\right|\right)=0$

Answer: C

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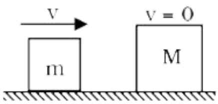
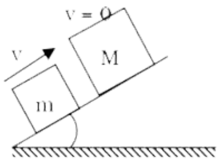
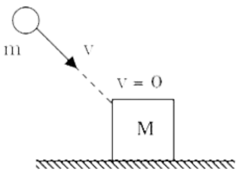
50. In which of the following cases no work is done by the force?

A. 

B. 

C. 

D. None of these

Answer: C

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51. After a totally inelastic collision, two objects of the same mass and same initial speeds are found to move together at half of their initial speeds. The angle between the initial velocities of the objects is

A. 120°

B. 60°

C. 150°

D. 45°

Answer: A

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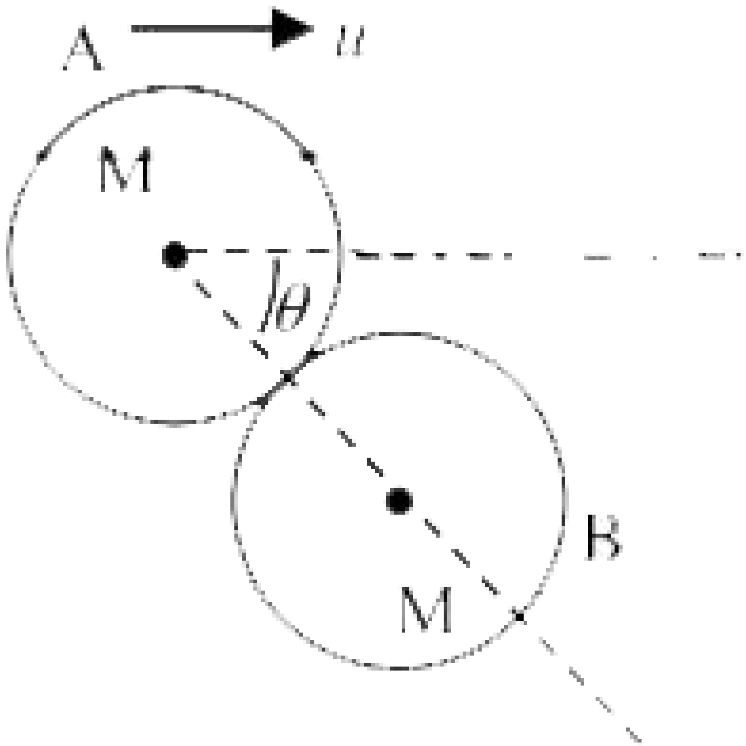
52. A ball A of mass M collides elastically with a similar ball B at rest as shown in figure. Initially velocity of ball A is u m/s. After collision,



A. Speed of ball B is u $\sin\theta$

B. Velocity of ball A is $u\sin^2\theta\hat{i} + u\sin\theta\cos\theta\hat{j}$

C. Speed of ball A is $u\cos\theta$

D. $Velocity of ball B is$u cos theta sin theta hati

+ u cos^2 theta hatj`

Answer: B

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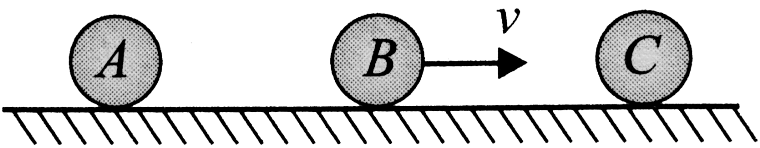
53. Three balls A, B and $C(m_A = m_C = 4m_B)$ are placed onn a smooth horizontal surface. Ball B collides with ball C with an initial velocity v as shown in figure. Find the total number of collision betwenent the balls (all collisions are elastic).



A. one

B. two

C. three

D. four

Answer: B

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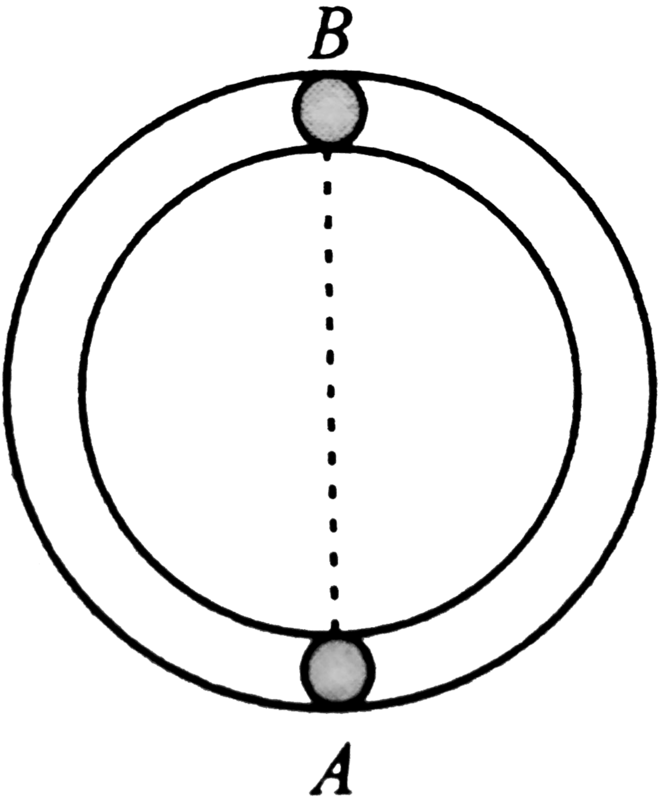
54. Two equal spheres A and B lie on a smooth horizontal circular groove at opposite ends of a diameter. At time $t = 0$, A is projected along the groove and it first impinges on B at time $t = T_1$ and again at time $t = T_2$. If e is the coefficient of restitution, the ratio T_2 / T_1 is



A. The second impact will occur after time T

B. The second impact will occur after time $\frac{2T}{e}$

C. The second impact will occur after time 2T

D. None of these

Answer: B

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55. In an elastic collision

A. the initial kinetic energy is equal to the final kinetic energy

B. the final kinetic energy is less than the initial kinetic energy

C. the kinetic energy remains constant

D. the kinetic energy first increases then decreases

Answer: A

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56. In an inelastic collision

A. the initial kinetic energy is equal to the final kinetic energy

B. the final kinetic energy is less than the initial kinetic energy

C. the kinetic energy remains the constant

D. the kinetic energy first increases then decreases

Answer: B

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57. A ball is projected in a direction inclined to the vertical and bounces on a smooth horizontal plane. The range of one rebound is R. If the coefficient of restitution is e, then range of the next rebound is

A. Angle of projection $\alpha = \tan^{-1}(4)$

B. Angle of projection $\alpha = \tan^{-1}(4e)$ where e is the impact coefficient

C. Angle of projection is 45°

D. Angle of rebound is same as angle of projection

Answer: B

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58. A ball is let fall from a height h_0. There are n collisions with the earth. If the velocity of rebound after n collision is v_n and the ball rises to a height h_n then coefficient of restitution e is given by

A. $e^n = \sqrt{\frac{h_n}{h_0}}$

B. $e^n = \sqrt{\frac{h_0}{h_n}}$

C. $ne = \sqrt{\frac{h_n}{h_0}}$

D. $\sqrt{ne} = \sqrt{\frac{h_n}{h_0}}$

Answer: A

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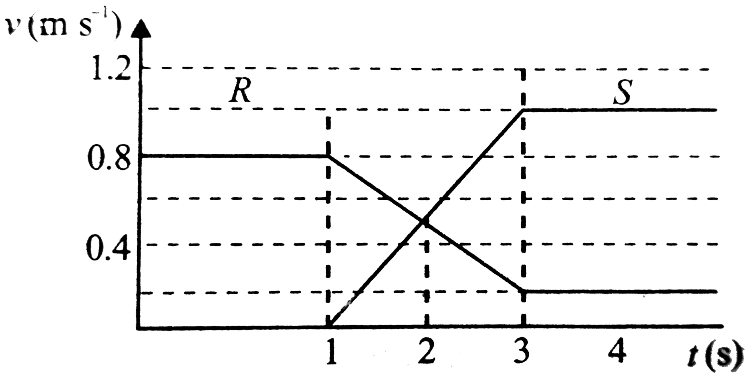
59. Figure shows the velocity-time graph for two masses R and S that collided elastically. Which of the following statements is true?



i. R and S moved in the same direction after the collision.

ii. The velocities of R and S were equal at the mid time of the collision.

iii. The mass of R was greater than mass of S.

Which of the following is true?

A. I only

B. II only

C. I and II only

D. I, II, and III

Answer: D

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60. A particle of mass m, collides with another stationary particle of mass M. If the particle m stops just after collision, then the coefficient of restitution for collision is equal to

A. $\frac{M}{m}$

B. $\frac{m}{M}$

C. $\frac{m}{2M}$

D. Zero

Answer: A

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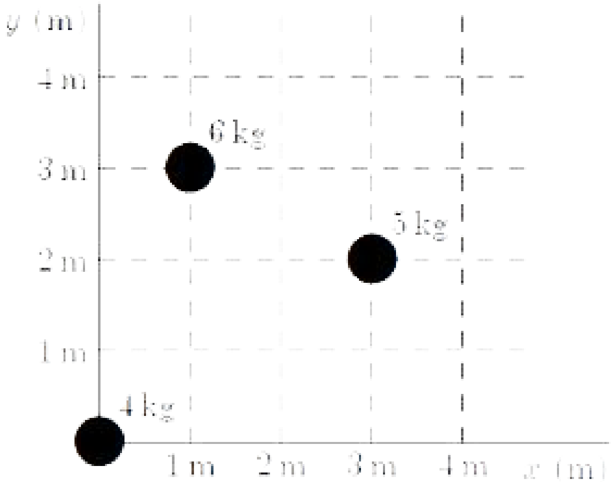
61. The x and y coordinates of the center of mass of the three-particle system shown below are :



A. 0, 0

B. 1.3m, 1.7m

C. 1.4m, 1.9m

D. 1.9m, 2.5m

Answer: B

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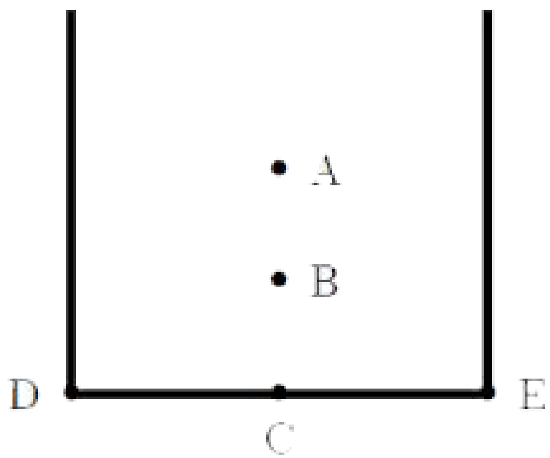
62. A thick uniform wire is bent into the shape of the letter "U" as shown. Which point indicates the location of the center of mass of this wire?



A. A

B. B

C. C

D. D

Answer: B

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63. Which one of the following statements is true ?

A. the center of mass of an object must lie within the object

B. all the mass of an object is actually concentrated at its center of mass

C. the center of mass of an object cannot move if there is zero net force on the object

D. None of the above

Answer: D

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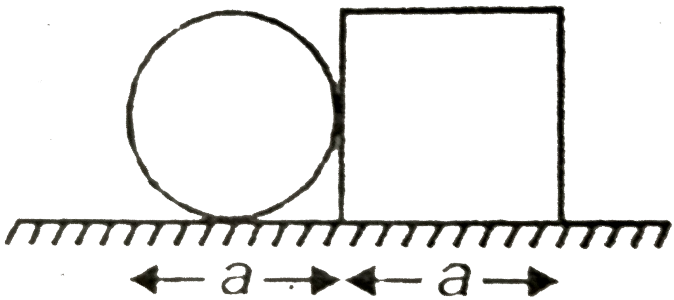
64. A circular plate of diameter $'a'$ is kept in contact with a square plate of side a as shown. The density of the material and the thickness are same everywhere. The centre of mass of composite system will be



A. inside the circular plate

B. inside the square plate

C. at the point of contact

D. outside the system

Answer: B

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65. The center of mass of a system consisting of two spheres is moving in the positive x direction with a speed of 5.0 m/s. One sphere has a mass of 2.5 kg and the other has a mass of 3.5 kg. The total momentum of the system is :

A. 0

B. $(5.0 kgm / s)\hat{i}$

C. $(12.5 kgm / s)\hat{i}$

D. $(30 kgm / s)\hat{i}$

Answer: D

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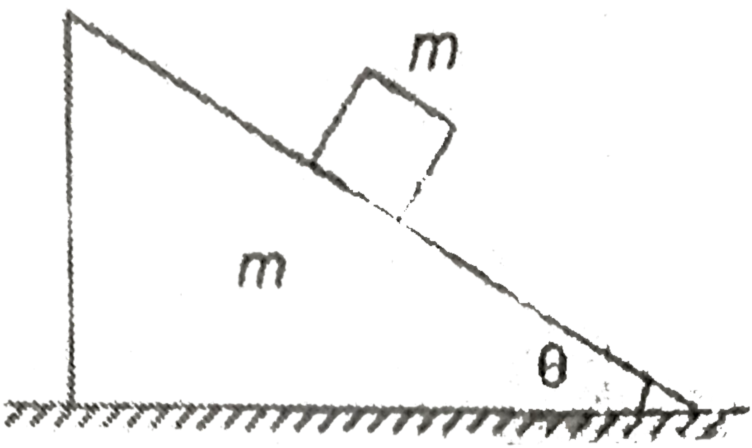
66. A block of mass m slides down on inclined wedge of same mass m as shown in figure . Friction is absent everywhere . Acceleration of centre of mass of the block and wedge is



A. does not move

B. moves horizontally with constant speed

C. moves horizontally with increasing speed

D. moves vertically with increasing speed

Answer: D

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67. A loaded spring gun of mass M fires a bullet of mass m with a velocity v at an angle of elevation θ. The gun is initially at rest on a horizontal smooth surface. After firing, the centre of mass of the gun and bullet system

A. Moves with a velocity $\frac{vm}{M}$ along horizontal

B. Moves with a velocity $\frac{vm}{M \cos \theta}$ in the vertical direction

C. Moves with a velocity $\frac{mv \sin \theta}{M + m}$ along vertical direction

D. Moves with velocity $v(M - m)/(M + m)$ in horizontal direction

Answer: C

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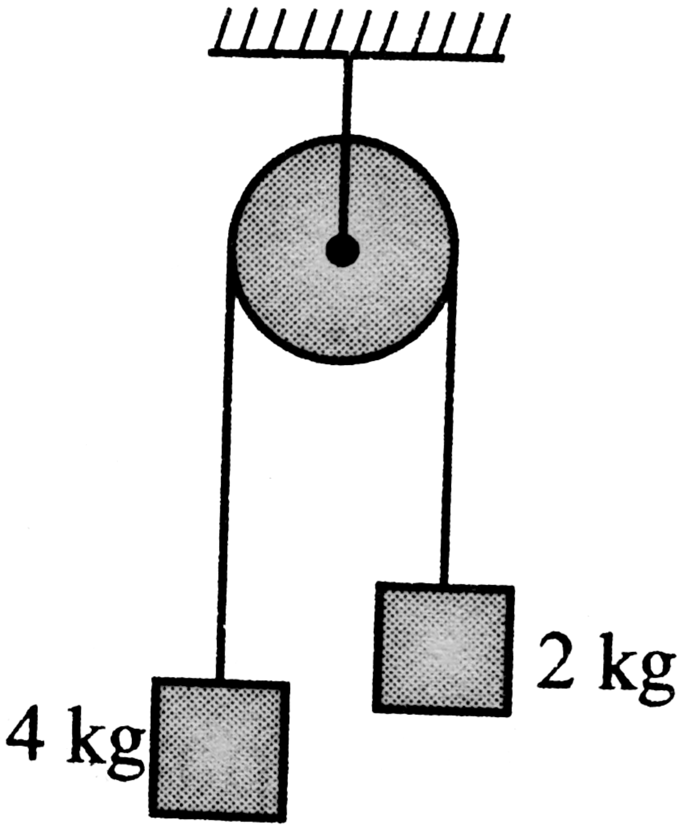
68. For the system shown in Fig. the string is light and pulley is frictionless. The $4kg$ block is given an upward velocity of $1m/s$. The centre of mass of the two blocks will [neglect the impulse duration]



A. accelerate down with g/3

B. initially accelerate with $\vec{g}$ and then after some time accelerate down with g/3

C. initially accelerate with $\vec{g}$ and then the acceleration is 0

D. initially accelerate with $\vec{g}$ and then will accelerate down with g/9

Answer: D

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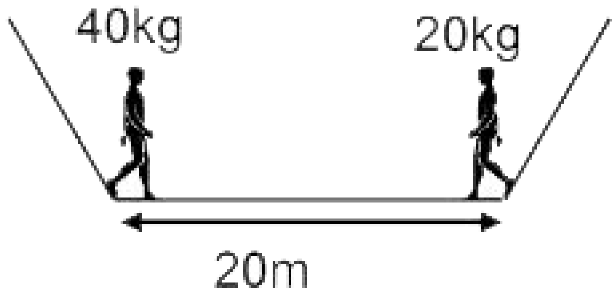
69. Two men of masses 40 kg and 20 kg are standing on a boat of mass 100 kg. Length of boat is 20m. Neglect the friction between water and boat. Find the displacement of the boat when both the persons reach at middle of boat.



A. (a) $\frac{5}{4}m$, towards right

B. (b) $\frac{5}{4}m$, towards left

C. (c) $\frac{5}{8}m$, towards right

D. (d) $\frac{5}{8}m$, towards left

Answer: B

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70. A force exerts an impulse I on a particle changing its speed from u to 2u. The applied force and the initial velocity are oppositely directed along the same line. The work done by the force is

A. $\frac{3}{2}Iu$

B. $\frac{1}{2}Iu$

C. Iu

D. $2Iu$

Answer: B

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71. A sphere is moving with velocity vector $2\hat{i}+2\hat{j}$ immediately before it hits a vertical wall. The wall is parallel to $\hat{j}$ and the coefficient of restitution of the sphere and the wall is $e=\frac{1}{2}$. Find the velocity of the sphere after it hits the wall?

A. $\hat{i}-\hat{j}$

B. $-\hat{i}+2\hat{j}$

C. $-\hat{i}-\hat{j}$

D. $2\hat{i}-\hat{j}$

Answer: B

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72. A ball kept in a close box moves in the box making collisions with the walls. The box is kept on a smooth surface. The velocity of the centre of mass

A. of the box remains constant

B. of the box plus the ball system remains constant

C. of the ball remains constant

D. of the ball relative to the box remains constant

Answer: B

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73. An 8 kg block accelerates uniformly from rest to a velocity of $4ms^{-1}$ in 40 second. The instantaneous power at the end of 8 second is $P \times 10^{-2}$ watt. Find the value of P.

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74. A body of 2 kg mass makes an elastic collision with another body at rest. The velocity of the 2 kg mass is reduced to one-fourth of the original velocity. However, direction remains unchanged. The mass of the body struck is $M \times 10^{-1} kg$. Find the value of M.

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75. Consider an oblique elastic collision between a moving ball and a stationary ball of the same mass. Both the balls move with the same speed after the collision. After the collision, the angle between the directions of motion of two balls is x degree. Find the value of x.

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76. A uniform chain of length L and mass M overhangs a horizontal table with its two third part on the table. The friction coefficient between the table and the chain is μ. The work done by the friction during the period the chain slips off the table is $\left[-\frac{2}{k}\mu MgL\right]$. Find the value of k.

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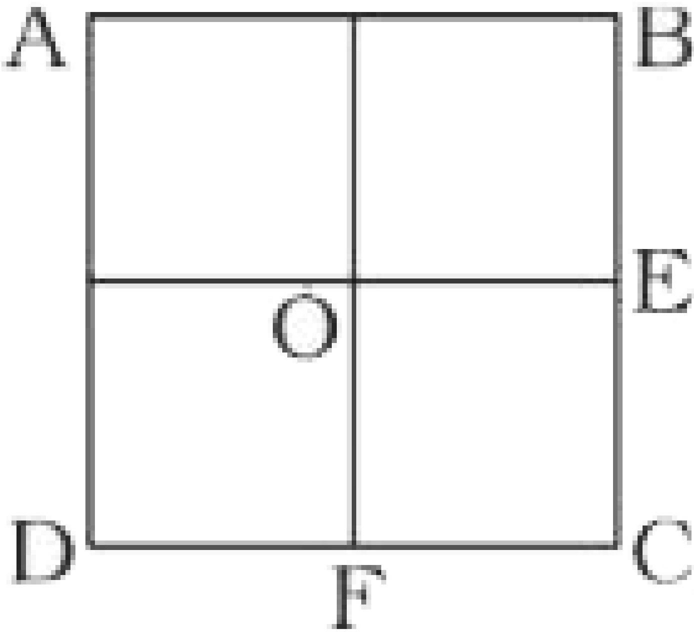
77. A square of side 4 cm and of uniform thickness is divided into four equal squares. If one of them is cut off (OECF), then the position of the centre of mass of the remaining portion from O is $\frac{\sqrt{2}}{k}cm$.

Find the value of K.



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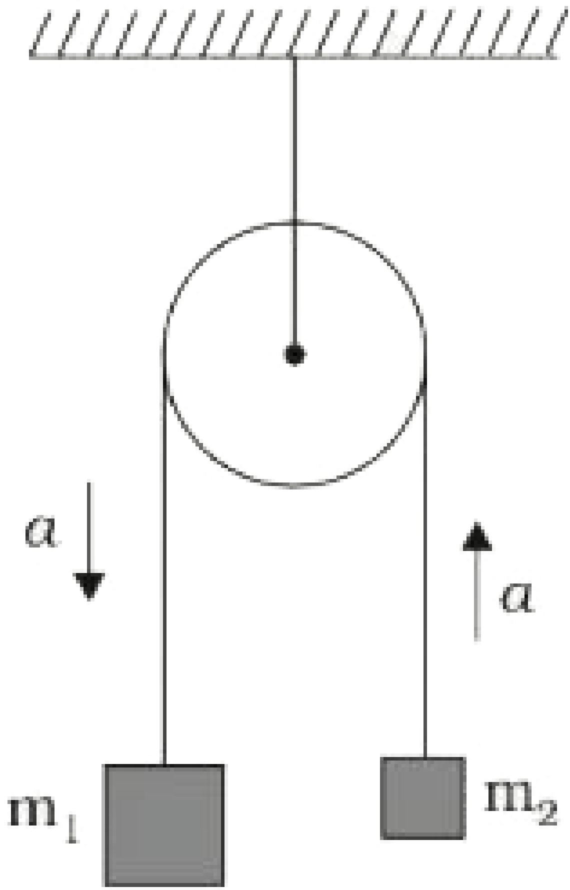
78. Two bodies of masses m_1 and $m_2(< m_1)$ are connected to the ends of a massless cord and allowed to move as shown in figure. The pulley is both massless and frictionless. The acceleration of the centre of mass is $\frac{(m_1 - m_2)^n}{(m_1 + m_2)^2}g$. Find the value of n.



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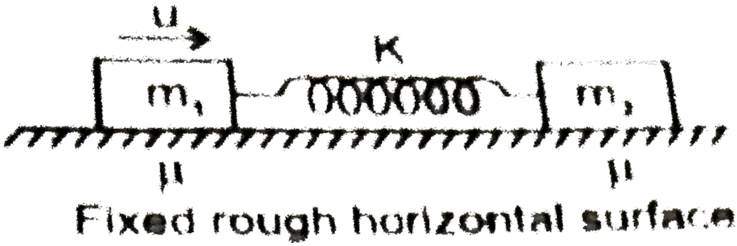
79. The blocks ov mass $m_1 = 1kg$ and $m_2 = 2kg$ are connected by an ideal spring, rest on a rough horizontal surface. The spring is unstressed. The spring constant of spring is $K = 2N/m$. The coefficient of friction between blocks and horizontal surface is $\mu = \frac{1}{2}$. Now the left block is imparted a velocity u towards right as shown. The largest value of $u(\text{ in } m/s)$ such that the block of mass m_2 never moves is (Take $g = 10m / s^2$)



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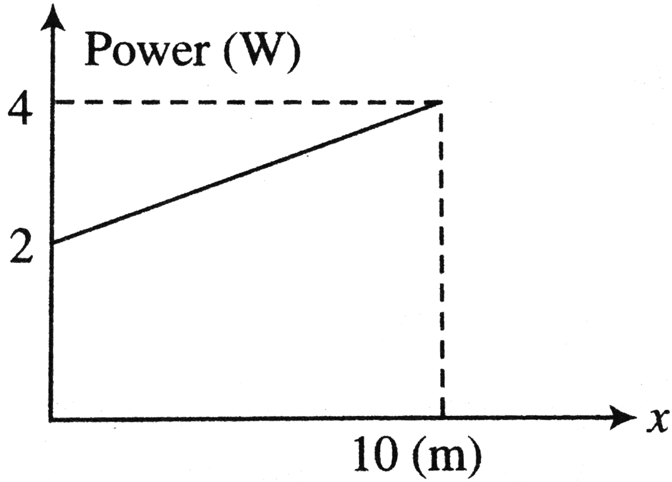
80. A particle A of mass $10 / 7kg$ is moving in the positive direction of $x - a\xi s$. At initial position $x = 0$, its velocity is $1ms^{-1}$, then its velocity at

$x = 10m$ is (use the graph given)



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81. A force $F = \left(3t\hat{i} + 5\hat{j}\right)N$ acts on a body due to which its displacement varies as $S = \left(2t^2\hat{i} - 5\hat{j}\right)m$. Work done by these force in $2s$ is .

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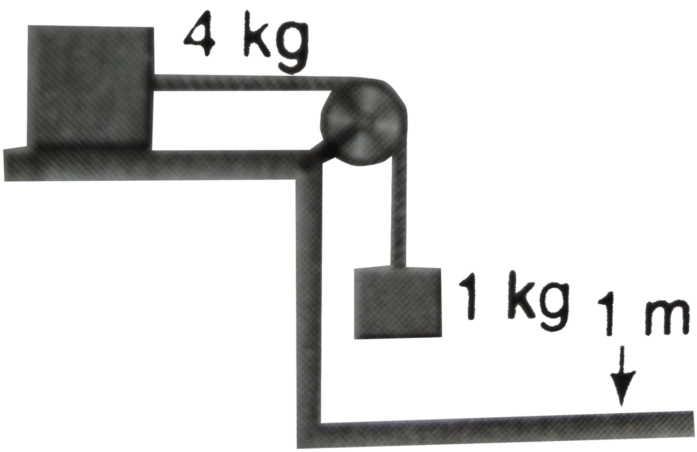
82. A $4kg$ block is on a smooth horizontal table. The block is connected to a second block of mass $1kg$ by a massless flexible taut cord that passes over a frictionless pulley. The $1kg$ block is $1m$ above the floor. The two block are released from rest. With what speed does the $1kg$ block hit the ground?



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83. Work done when a force $F = \left(\hat{i} + 2\hat{j} + 3\hat{k}\right)N$ acting on a particle takes it from the point $r_1 = \left(\hat{i} + \hat{k}\right)$ the point $r_2 = \left(\hat{i} - \hat{j} + 2\hat{k}\right)$ is .

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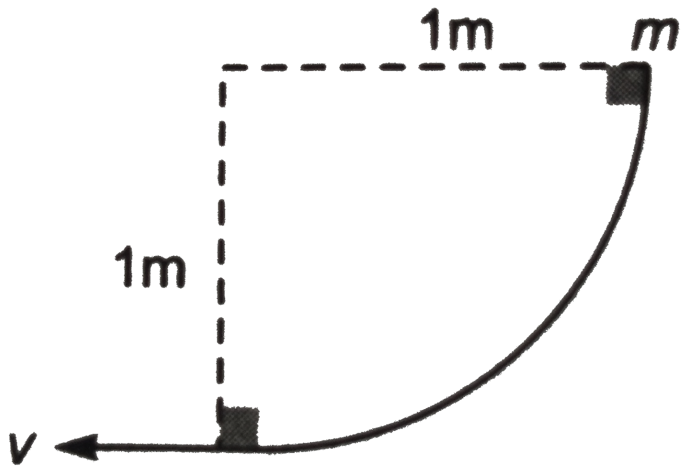
84. A block of mass $1kg$ slides down a curved track which forms one quadrant of a circle of radius $1m$ as shown in figure. The speed of block at the bottom of track is $v = 2ms^{-1}$. The work done by the of friction is



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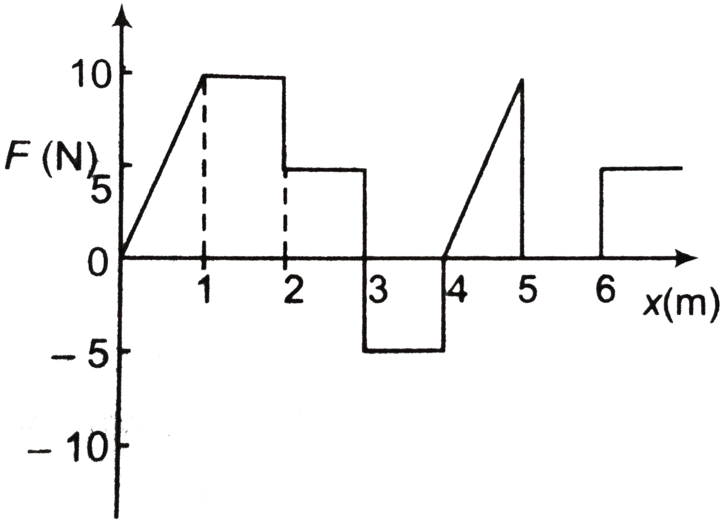
85. The relationship between the force F and position x of body is as shown in figure. The work done in displacing the body in displacing the body from ($x = 1m$ to $x = 5m$) will be



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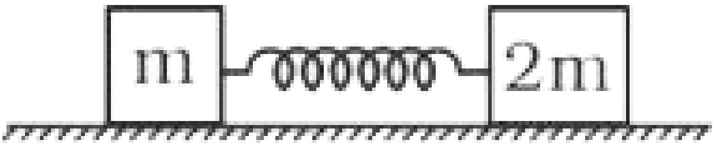
86. A spring is connected between two blocks as shown in the diagram. Initially the blocks are held stationary and suddenly they are released. Find the ratio of maximum kinetic energy with spring compressed the block of mass m to that of mass 2m.



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87. A car of mass M is accelerating on a level smooth road under the action of a single force F acting along the direction of motion. The power delivered to the car is constant and equal to p. If the velocity of the car at an instant is v, then after travelling a distance of $\frac{7Mv^3}{3p}$ the velocity become kv where k is________.

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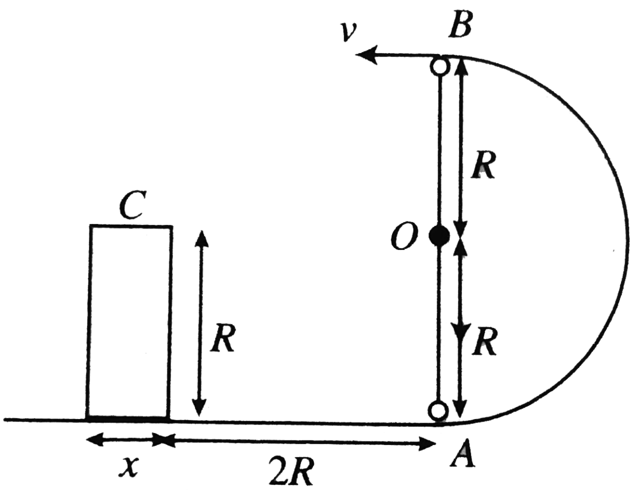
Level - 1 PARAGRAPH QUESTIONS

1. A small ball is given some velocity at point A towards right so that it moves on the semicircular track and does not leave contact up to the highest point B. After leaving the highest point B, it falls at the top of a building of height R and width $x(x < < 2R)$. (All the surfaces are frictionless).



The horizontal distance of the ball from the foot of the builing where the ball strikes the horizontal ground will

A. $\sqrt{4gR}$

B. $\sqrt{2gR}$

C. $\sqrt{7gR}$

D. $\sqrt{6gR}$

Answer: D

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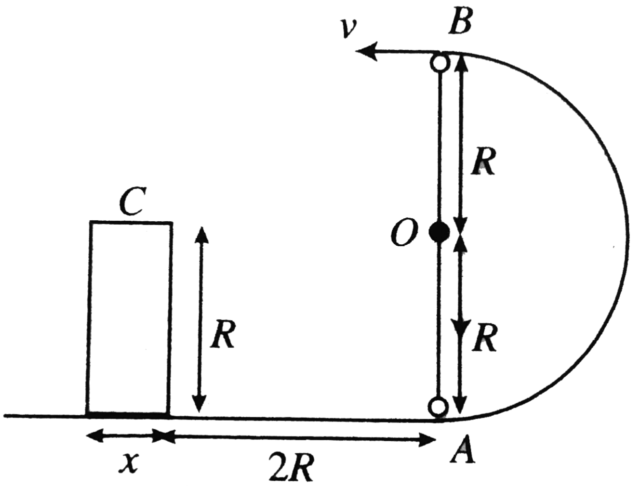
2. A small ball is given some velocity at point A towards right so that it moves on the semicircular track and does not leave contact up to the highest point B. After leaving the highest point B, it falls at the top of a building of height R and width $x(x < < 2R)$. (All the surfaces are frictionless).



The velocity given to the ball at point A so that it may hit the top of the building is

A. 60°

B. 45°

C. 30°

D. None of these

Answer: B

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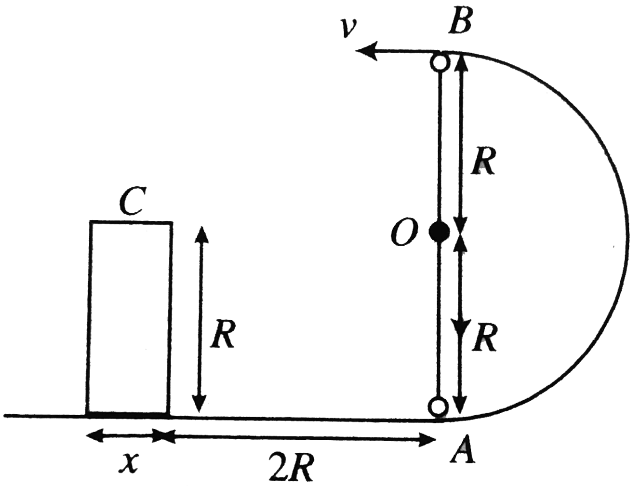
3. A small ball is given some velocity at point A towards right so that it moves on the semicircular track and does not leave contact up to the highest point B. After leaving the highest point B, it falls at the top of a building of height R and width $x(x < < 2R)$. (All the surfaces are frictionless).



The horizontal distance of the ball from the foot of the builing where the ball strikes the horizontal ground will

A. $\sqrt{2}R$

B. $(1+\sqrt{2})R$

C. $2(1+\sqrt{2})R$

D. $12R$

Answer: C

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LEVEL - 2

1. A uniform chain of length l and mass m is placed on a smooth table with one-fourth of its length hanging over the edge. The work that has to be done to pull the whole chain back onto the table is :

A. $\frac{1}{4}mgl$

B. $\frac{1}{8}mgl$

C. $\frac{1}{16}mgl$

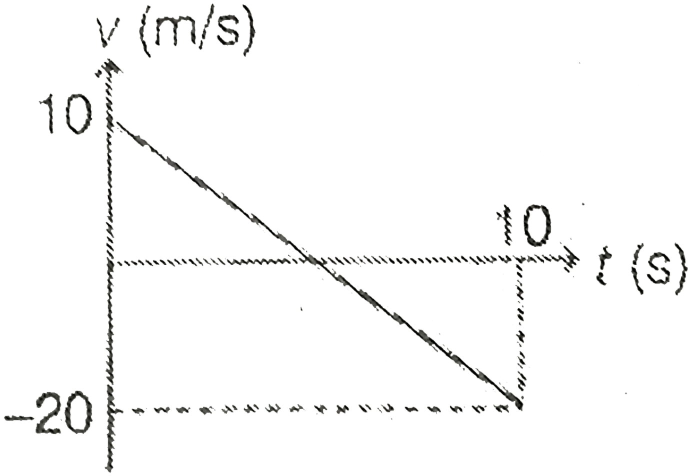
D. $\frac{1}{32}mgl$

Answer: D

Watch Video Solution

2. Velocity-time graph of a particle moving in a straight line is as shown in figure. Mass of the particle is 2 kg. Work done by all the forces acting on the particle in time interval between t = 0 to t =

10 s is



A. 300 J

B. $-300J$

C. $400J$

D. $-400J$

Answer: A

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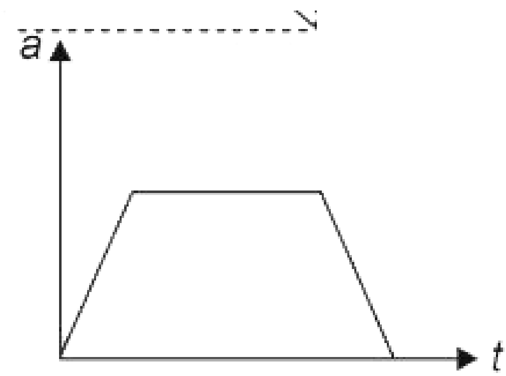
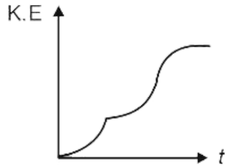
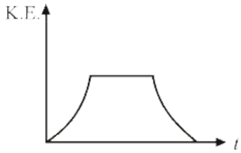
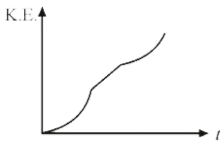
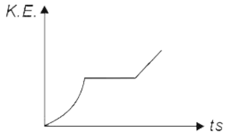
3. Acceleration versus time graph of a particle moving in a straight line is as shown in adjoining figure. If initially particle was at rest. Then corresponding kinetic energy versus time graph will be :



A. 

B. 

C. 

D. 

Answer: A

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4. A particle moving along the x axis is acted upon by a single force F = $F_0 e^{-kx}$, where F_0 and k are constants. The particle is released from rest at x = 0. It will attain a maximum kinetic energy of :

A. F_0 / k

B. F_0 / e^k

C. kF_0

D. $ke^k F_0$

Answer: A

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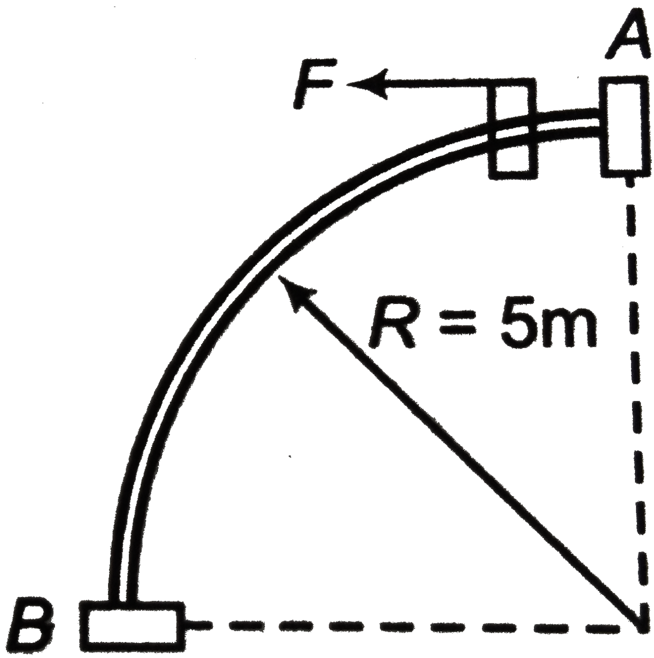
5. A bead of mass $\frac{1}{2}kg$ starts from rest from A to move in a vertical place along a smooth fixed quarter ring of radius $5m$, under the action of a constant horizontal force $f = 5N$ as shown. The speed of bead as it reaches the point (B) is [Take $g = 10ms^{-2}$]



A. 14.14 m/s

B. 7.07 m/s

C. 5 m/s

D. 25 m/s

Answer: A

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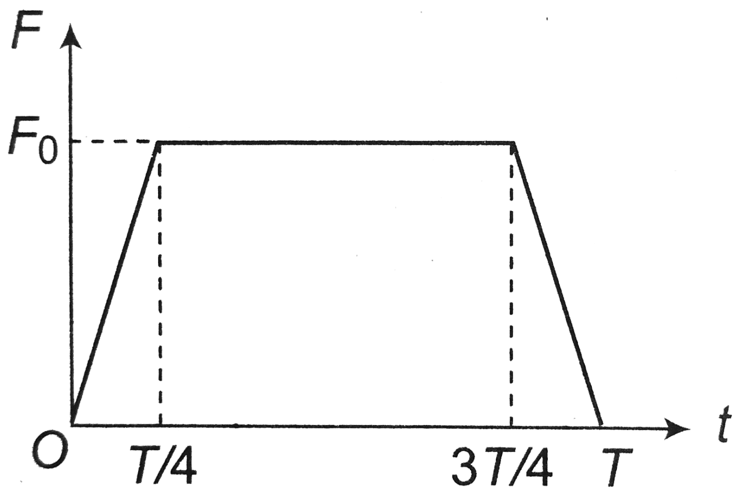
6. A particle of mass m moving with a velocity u makes an elastic one-dimensional collision with a stationary particle of mass m establishing a contact with it for extermely small time. T. Their force of contact increases from zero to F_0 linearly in time $T/4$, remains constant for a further time $T/2$ and decreases linearly from F_0 to zero in further time $T/4$ as shown. The magnitude possessed by F_0 is.



A. $\dfrac{mu}{T}$

B. $\dfrac{2mu}{T}$

C. $\frac{4mu}{3T}$

D. $\frac{3mu}{4T}$

Answer: C

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7. 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. The kinetic energy of the particle increases 40 J in a given interval of time. Then, $\left(g = 10m / s^2\right)$

A. Tension in the string is 40 N

B. Displacement of the block in the given interval of time is 2m

C. Workdone by gravity is –20 J

D. Workdone by tension is 80 J

Answer: A::B::D

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8. Kinetic energy of a particle moving in a straight line is proportional to the time t. The magnitude of the force acting on the particle is :

A. Directly proportional to the speed of the particle

B. Directly proportional to $\sqrt{t}$

C. Inversely proportional to the speed of the particle

D. Inversely proportional to $\sqrt{t}$

Answer: C::D

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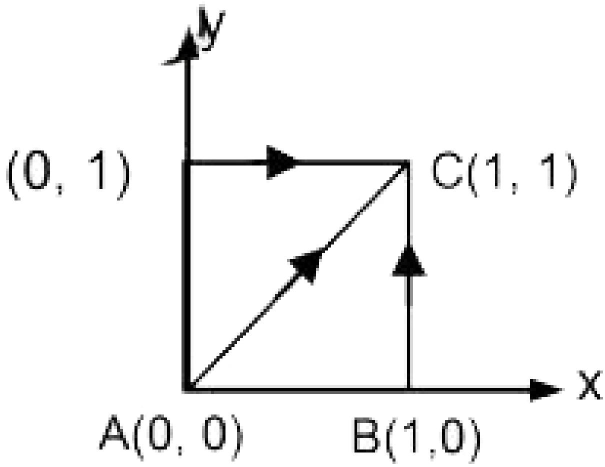
9. A particle of mass m moves from A to C under the action of force $\overrightarrow{F} = 2xy\hat{i} + y^2\hat{j}$, along different paths as shown in figure.



A. Force is conservative in nature

B. Work done by force is $\frac{1}{3}$ when particle moves along path ABC

C. Force is non conservative in nature and work done along path AC is 1 J

D. Work done along path ADC is $\frac{14}{5}J$

Answer: B::C

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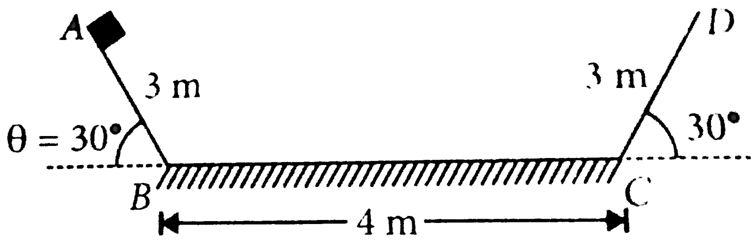
10. A track has two inclined surface AB and DC each of length 3 m and angle of inclination of 30° with the horizontal and a central horizontal part of length 4m shown in figure. A block of mass 0.2 kg slides from rest from point A. The inclined surfaces are frictionless. If the coefficient of friction between the block and the horizontal flat surface is 0.2, where will the block finally come to rest ? [in $10^{-1} m$]



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11. A heavy particle hangs from a point O, by a string of length a. It is projected horizontally with a velocity $u = \sqrt{(2+\sqrt{3})ag}$. The angle with the downward vertical, string makes where string becomes slack is :

A. $\theta = \sin^{-1}\left(\frac{-1}{\sqrt{3}}\right)$

B. $\theta = \cos^{-1}\left(-\frac{1}{\sqrt{3}}\right)$

C. $\theta = \sin^{-1}\left(\frac{1}{\sqrt{2}}\right)$

D.

Answer: B

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12. A stone of 1 kg tied up with 10/3 m long string rotated in a vertical circle. If the ratio of maximum and minimum tension in string is 4 then speed of stone at highest point of circular path will be ($g = 10ms^2)$

A. $20ms^{-1}$

B. $10\sqrt{3}ms^{-1}$

C. $5\sqrt{2}ms^{-1}$

D. $10ms^{-1}$

Answer: D

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13. 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 one each mass is

A. $\frac{1}{2}kx^2$

B. $-\frac{1}{2}kx^2$

C. $\frac{1}{4}kx^2$

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

Answer: D

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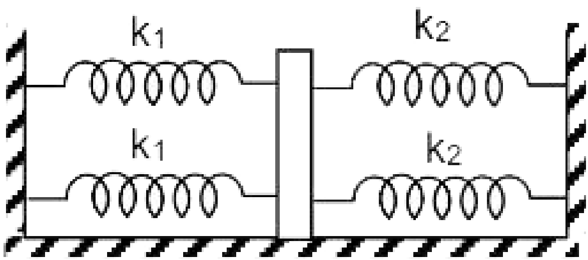
14. A block of mass m is attached to four unstretched massless springs of spring constant k_1 and k_2 as shown in figure. The block is displaced towards right through distance x and is released. Speed of block when displacement of block is x/2 from mean position is :



A. $\sqrt{2(k_1+k_2)\frac{x}{m}}$

B. $\sqrt{\frac{3(k_1+k_2)x^2}{2m}}$

C. $\sqrt{\frac{(k_1k_2)}{3(k_1+k_2)m}}$

D. $\sqrt{\frac{(k_1+k_2)x}{(k_1+k_2)m}}$

Answer: B

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15. A constant power P is applied to a particle of mass m. The distance traveled by the particle when its velocity increases from v_1 to v_2 is (neglect friction):

A. $\frac{3P}{m}\left(v_2^2 - v_1^2\right)$

B. $\frac{m}{3P}(v_2 - v_1)$

C. $\frac{m}{3P}\left(v_2^3 - v_1^3\right)$

D. $\frac{m}{3P}\left(v_2^2 - v_1^2\right)$

Answer: C

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16. An engine pumps water continously through a hole. The speed with which water pases through the hole nozzle is v and k is the mass per unit length of the water jet as it leaves the nozzle. Find the rate at which kinetic energy is being imparted to the water.

A. $\frac{1}{2} k v^{2}$

B. $\frac{1}{2} k v^{3}$

C. $\frac{v^{2}}{2k}$

D. $\frac{v^{3}}{2k}$

Answer: B

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17. In a projectile motion, power of the gravitational force

A. is constant throughout

B. in negative for first half, zero at topmost point and positive for rest half

C. varies linearly with time

D. is positive for complete path

Answer: B::C

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18. The potential energy U in joule of a particle of mass 1 kg moving in x-y plane obeys the law $U = 3x + 4y$, where (x,y) are the co-ordinates of the particle in metre. If the particle is at rest at (6, 4) at time t = 0, then

A. The particle has constant acceleration

B. The particle has zero acceleration

C. The speed of particle when it crosses the y-axis is 10 m/s

D. co-ordinates of particle at t = 1s are (4.5, 2)

Answer: A::C::D

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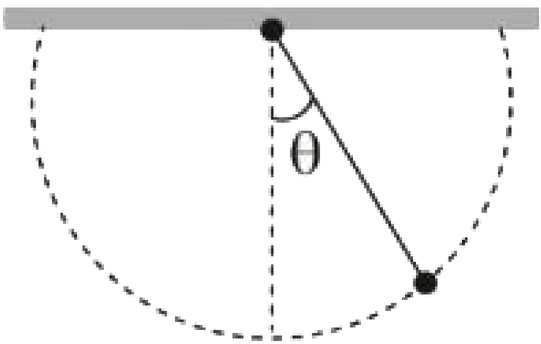
19. A simpel pendulum is vibrating with an angular amplitdue of as shown in figure, then:



A. $\theta = 0$, acceleration directed downward

B. $\theta = 0$,acceleration directed upward

C. $\theta = 90^{\circ}$, acceleration directed downward

D. $\theta = \cos^{-1}\left(\frac{1}{\sqrt{3}}\right)$,acceleration directed horizontal

Answer: B::C::D

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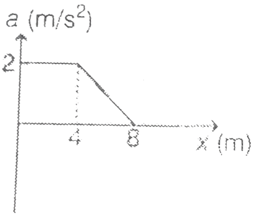
20. Acceleration versus x and potential energy versus x graph of a particle moving along x-axis is as shown in figure. Mass of the particle is 1 kg and velocity at x = 0 is $4m / s$. Match the following at x =

8 m.



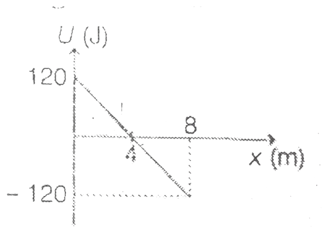


Table-1	Table-2
(A) Kinetic energy	(P) 120 J
(B) Work done by conservative forces	(Q) 240 J
(C) Total work done	(R) 128 J
(D) Work done by forces other than gravity	(S) 112 J
	(T) None

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21. A pendulum consists of a wooden bob of mass m and length l. A bullet of mass m_1 is fired towards the pendulum with a speed v_1. The bullet emerges out of the bob with a speed of $(v_1)/3$ and the bob just completes motion along a vertical circle, then

v_1 is

A. $\left(\frac{m}{m_1}\right)\sqrt{2gl}$

B. $\frac{3}{2}\left(\frac{m}{m_1}\right)\sqrt{5gl}$

C. $\frac{3}{2}\left(\frac{m_1}{m}\right)\sqrt{5gl}$

D. $\left(\frac{m_1}{m}\right)\sqrt{gl}$

Answer: B

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22. A block of mass m is pushed up against a spring, compressing it a distance x, and the block is then released. The spring projects the block along a frictionaless horizontal surface, grving the block a speed v. The same spring projects a second block of mass $4m$, giving it a speed $3v$. What distance was the spring compressed in the second case ?

A. $6x$

B. $x/6$

C. $36x$

D. $12x$

Answer: A

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23. A man of mass m stands on a long flat car of mass M , moving with velocity V.If he now begins to run with velocity u, with respect to the car , in the same direction as V, the the velocity of the car will be

A. (a)$V - mu / M$

B. (b)$V - mu / (m + M)$

C. (c)$V + mu / (m + M)$

D. (d)$V - ut(M - m)/(M + m)$

Answer: B

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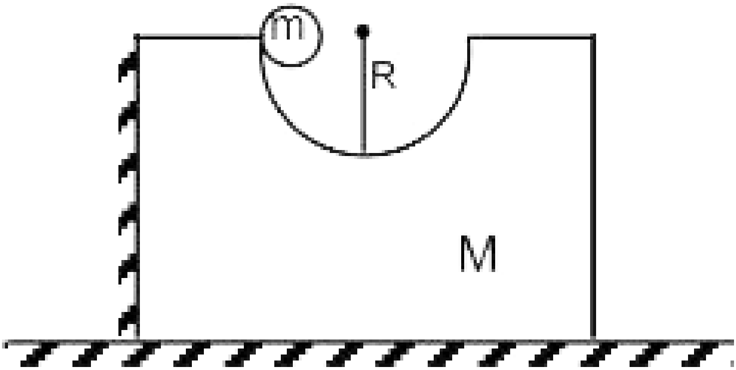
24. The system shown is released from rest. Mass of ball is m kg and that of wedge is M kg respectively. When ball reaches at highest point on other side of the wedge, velocity of ball and wedge is (initially wedge is kept at rest against a wall and there is no friction anywhere) :



A. $\dfrac{M\sqrt{2gR}}{m+M}$

B. $\dfrac{M\sqrt{2gR}}{M}$

C. $\dfrac{M}{m}\sqrt{2gR}$

D. $\dfrac{m\sqrt{2gR}}{m+M}$

Answer: D

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25. A continuous stream of particles, of mass m and velocity r, is emitted from a source at a rate of n per second. The particles travel along a straight line, collide with a body of mass M and get embedded in the body. If the mass M was originally at rest, its velocity when it has received N particles will be

A. $\dfrac{mvN}{Nm+n}$

B. $\dfrac{mvN}{Nm+M}$

C. $\dfrac{mv}{Nm+M}$

D. $\frac{Nm + M}{mv}$

Answer: B

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26. Displacement of a particle of mass 2 kg moving in a straight line varies with time as

$s = (2t^3 + 2)$ m

Impulse of the force acting on the particle over a time interval between t = 0 and t = 1 s is

A. $10N - s$

B. $12N - s$

C. $8N - s$

D. $6N - s$

Answer: B

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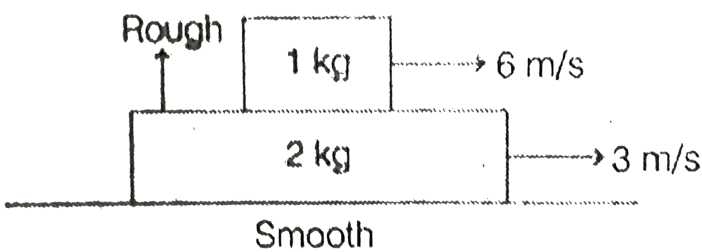
27. In the figure shown, upper block is given a velocity of $6m/s$ and lower block. $3m/s$. When relative motion between them is stopped



A. Work done by friction on upper block is –10 J

B. Work done by friction on lower block is + 10 J

C. Net work done by friction on the system is zero

D. Net work done by friction on the system is – 3 J

Answer: A::D

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28. An object of mass 5 kg is projected with a velocity of $20ms^{-1}$ at an angle of 60° to the horizontal. At the highest point of its path, the projectile explodes and breaks up into two fragments of masses 1 kg and 4 kg. The fragments separate horizontally after the explosion, which releases internal energy such that K.E. of the system at the highest point is doubled Find the separation between the two fragments when they reach the ground.

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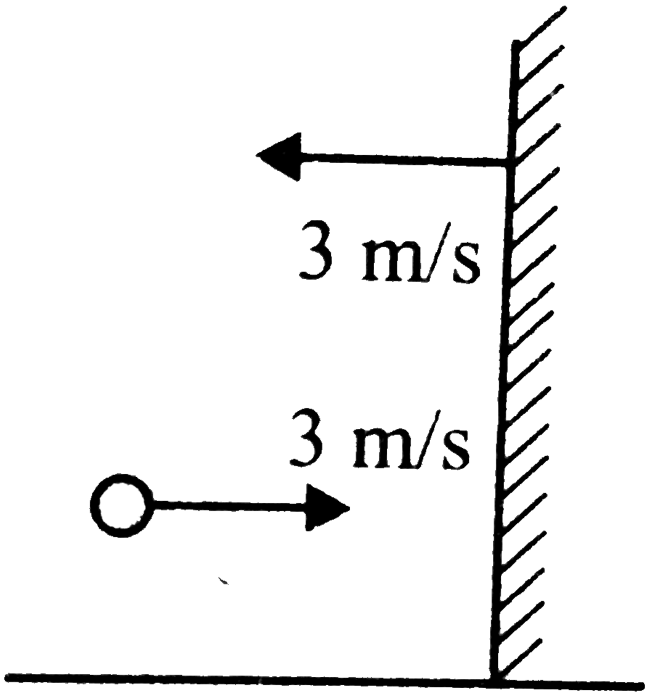
29. A highly elastic ball moving at a speed of $3m/s$ approaches a wall moving towards it with a speed of $3m/s$. After the collision. the speed of the ball will be



A. 3 m/s

B. 6 m/s

C. 9 m/s

D. zero

Answer: C

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30. Two identical balls are dropped from the same height onto a hard surface, the second ball being released exactly when the first ball bollides with the surface. If the first ball has made two more collisions by the time the second one collides. Then the coefficient of restitution between the ball and the surface satisfies :

A. $e > 0.5$

B. $e = 0.5$

C. $e = \frac{\sqrt{3}-1}{2}$

D. $e < \frac{\sqrt{3}-1}{2}$

Answer: D

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31. A ball impinges directly on another ball at rest. The first ball is brought to rest by the impact. If half of the kinetic energy is lost by the impact, the value of coefficient of restitution is

A. $1/\sqrt{2}$

B. $1/2$

C. $1/3$

D. zero

Answer: C

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32. A mass m moves with a velocity v and collides inelastically with another identical mass. After collision the 1st mass moves with velocity $\frac{v}{\sqrt{3}}$ in a direction perpendicular to the initial direction of motion. Find the speed of the second mass after collision

A. $\frac{2v}{\sqrt{3}}$

B. $\frac{v}{\sqrt{3}}$

C. v

D. $\sqrt{3}v$

Answer: A

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33. Statement I: In an elastic collision between two bodies, the relative speed of the bodies after collision is equal to the relative speed before the collision.

Statement II: In an elastic collision, the linear momentum of the system is conserved.

A. Statement-I is True, Statement-II is True and Statement-II is a correct explanation for Statement-I.

B. Statement-I is True, Statement-II is True and Statement-II is NOT a correct explanation for Statement-I.

C. Statement-I is True, Statement-II is False.

D. Statement-I is False, Statement-II is True.

Answer: B

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34. A sphere of mass m falls on a smooth hemisphere of mass M resting with its plane face on smooth horizontal table, so that at the moment of impact, line joining the centres makes an angle with the vertical. The velocity of sphere just before impact is u and e is the coefficient of restitution.

A. The velocity of hemisphere after impact will be zero

B. The hemisphere will move with a velocity $v = \frac{mu \sin \alpha}{M \cos^2 \alpha}$

C. The hemisphere will move with a velocity $v = \frac{mu \cos \alpha (1+e)}{(M+m)}$

D. None of these

Answer: C

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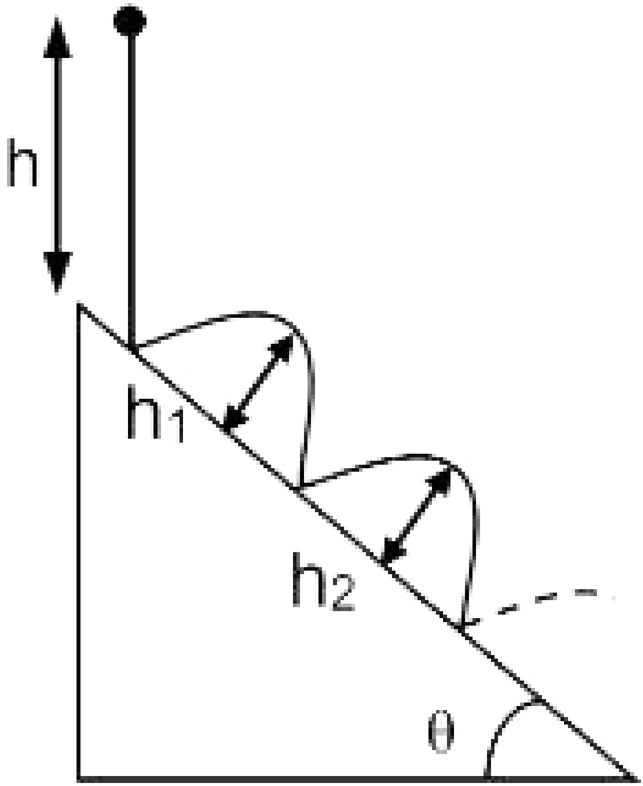
35. A ball falls on an inclined plane as shown. The ball is dropped from height h. Coefficient of restitution for collision is e and the surface is frictionless. If $h_1, h_2, \ldots\ldots h_n$ are heights of projectile from inclined and $t_1, t_2, \ldots . t_n$ are their corresponding time of flights, then choose the

correct options.



A. $t_1, t_2, \ldots\ldots t_n$ form a geometric progression

of common ratio e

B. $h_1 > h_2 > h_3 > \ldots\ldots > h_n$

C. $t_1, t_2, \ldots\ldots t_n$ form a geometric progression of common ratio e^2

D. $h_1, h_2 \ldots\ldots\ldots h_n$ form a geometric progression of common ratio e^2

Answer: A::B::D

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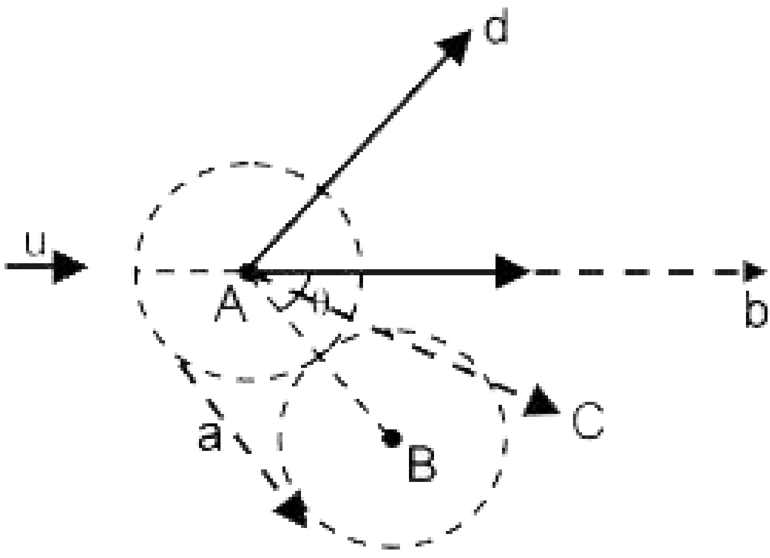
36. An elastic collision takes place between two smooth, rubber balls of same radius as shown. Initially, one ball is at rest and the other is moving with velocity u. At maximum compression :

I. Ratio of potential to initial kinetic energy of the system is $\frac{\cos^2\theta}{2}$

II. Ball B is moving along direction a

III. Ball A is moving along direction d

Evaluate the above statements and choose the correct option from the following:



A. Statements I, II are true and III is false

B. Statements I, III are false and II is true

C. All statements are true

D. All statements are false

Answer: A

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37. A ball of mass 1 kg moving with velocity $\vec{v} = 3\hat{i} + 4\hat{j}$ collides with a wall and after collision velocity of the ball is $-2\hat{i} + 6\hat{j}$. Which of the following unit vectors is perpendicular to wall?

A. $\frac{1}{5}\left(-3\hat{i}-4\hat{j}\right)$

B. $\frac{1}{\sqrt{29}}\left(5\hat{i}+2\hat{j}\right)$

C. $\frac{1}{\sqrt{40}}-\left(2\hat{i}+6\hat{j}\right)$

D. $\frac{1}{\sqrt{40}}\left(5\hat{i}-2\hat{j}\right)$

Answer: B

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38. A ball is projected at $t=0$ with velocity v_0 at angle θ with horizontal. It strikes a smooth wall at a distance from it and then falls at a distance d from the wall. Coefficient of restitution is 'e' then :

A. (a)Ball will return to ground at $t = \dfrac{2v_0 \sin\theta}{g}$

B. (b)$d = e(R - L)\left(\text{where}R\text{is}\dfrac{v_0 \sin 2\theta}{g}\right)$

C. (c)maximum height during motion $= \dfrac{v_0^2 \sin^2\theta}{2g}$

D. (d)it will return to ground at $t < \dfrac{2v_0 \sin\theta}{g}$

Answer: A::B::C

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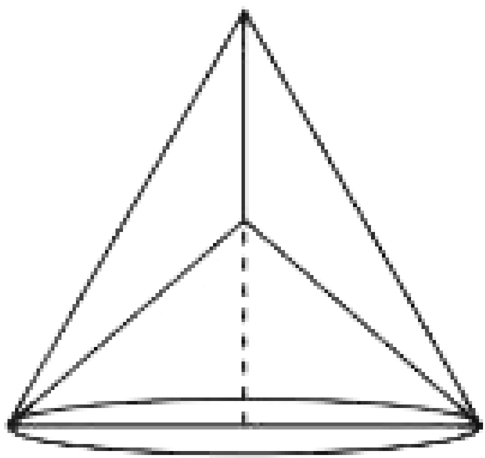
39. A uniform solid right circular cone has its base cut out in conical shape shown in figure such that the hollow portion is a right circular cone on the same base. Find what should be the height of the hollow portion so that the centre of mass of the remaining portion may coincide with the vertex of the hollow portion.



A. $\frac{h}{3}$

B. $\frac{h}{4}$

C. $\frac{2h}{3}$

D. $\frac{h}{6}$

Answer: A

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40. A square plate of edge d and a circular disc of diameter d are placed touching each other at the midpoint of an edge of the plate as shown in figure. Locate the centre of mass of the combination assuming same mass per unit area for the two plates.

A. $\frac{2d}{2+\pi}$ left to the center of the disc

B. $\frac{2d}{2+\pi}$ right to the center of the disc

C. $\frac{4d}{4+\pi}$ right to the center of the disc

D. $\frac{4d}{4+\pi}$ left to the center of the disc

Answer: C

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41. At the same instant that a 0.50-kg ball is dropped from a high building, a second ball, with a mass of 0.25 kg, is thrown straight upward from Earth's surface with an initial velocity of 19.6 m/s.

They move along nearby lines and pass without colliding. When the second ball is at its highest point the velocity of the center of mass of the two-ball system is :

A. 0

B. 13 m/s down

C. 20 m/s, down

D. 27 m/s, down

Answer: B

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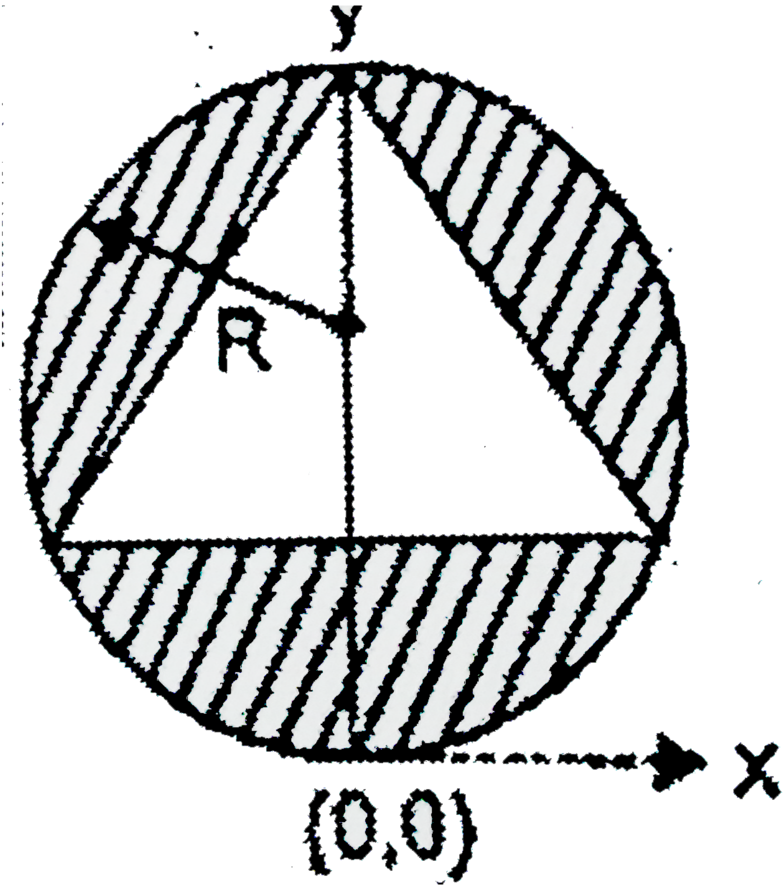
42. From a uniform disc of radius R, an equilateral triangle of side $\sqrt{3}R$ is cut as shown in the figure. The new position of centre of mass is :



A. $(0, 0)$

B. $(0, R)$

C. $\left(0, \dfrac{\sqrt{3}R}{2}\right)$

D. none of these

Answer: B

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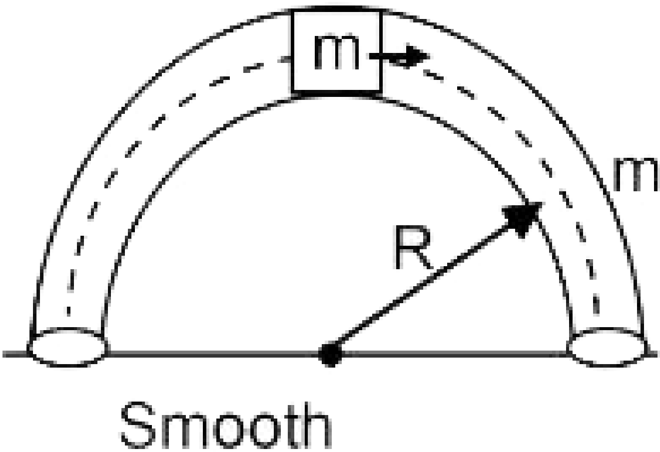
43. In a vertical smooth hollow thin tube, a block of same mass as that of tube is released as shown. When it is slightly disturbed it moves towards right. By the time the block reaches the right end of the tube, the displacement of the tube will be (where ‘R’ is the mean radius of tube, assume that the tube remains in vertical plane).



A. (a) $\frac{2R}{\pi}$

B. (b) $\frac{4R}{\pi}$

C. (c) $\frac{R}{2}$

D. (d) R

Answer: C

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44. In which of the following cases the centre of mass of a rod is certainly not at its centre?

A. the density continuously increases from left to right

B. the density continuously decreases from left to righ

C. the density decreases from left to right upto the centre and then increases

D. the density increases from left to right upto the centre and then decreases

Answer: A::B

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45. A cannon shell is fired to hit a target at a horizontal distance R. However, it breaks into two equal parts at its highest point. One part (A) returns to the cannon. The other part:

A. (a)Will fall at a distance of R beyond the target

B. (b)Will fall at a distance of 3R beyond the target

C. (c)Will hit the target

D. (d)Have nine times the kinetic energy of A just after explosion

Answer: A::D

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46. A nonzero external force on a system of particles. The velocity and the acceleration of the cente of mass are found to be v_0 and a_0 at an instant t. It is possible that

A. $v_0 = 0, a_0 = 0$

B. $v_0 = 0, a_0 \neq 0$

C. $v_0 \neq 0, a_0 = 0$

D. $v_0 \neq 0, a_0 \neq 0$

Answer: B::D

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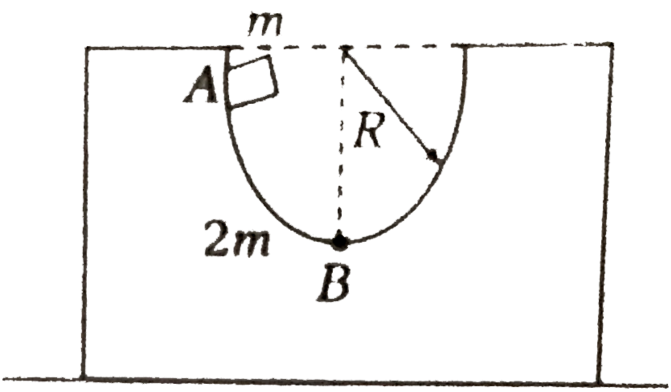
47. In the system shown in figure, mass m is released from rest from position A. Suppose potential energy of m at point A with respect to point B is E. Dimensions of m negligible and all surfaces are smooth. When mass reaches at point B.



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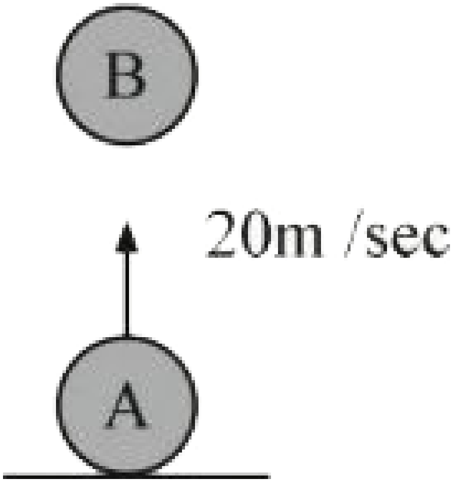
48. A sphere A is thrown up with velocity 20m/sec from the ground. Sphere B of same mass is dropped from a height of 80 m simultaneously, at time t = 0 so that both collide in air and stick together. Find the time (in second) after which the combined mass will fall on the ground. (Calculate from t = 0) $\left(g = 10m/\sec^2\right)$



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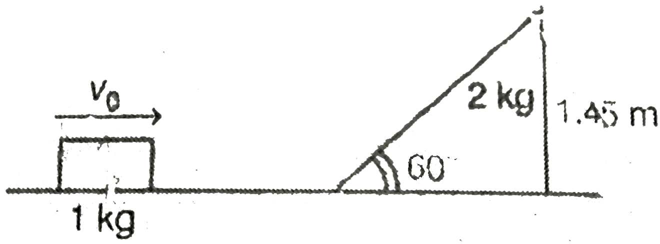
LEVEL - 2 PARAGRAPH QUESTIONS

1. A block of mass 1 kg is moving towards a movable wedge of mass 2 kg as shown in figure. All surfaces are smooth. When the block leaves the wedge from top, its velocity is making an angle $\theta = 30^\circ$ with horizontal.



The value of v_0 in m/s is

A. 4

B. 7

C. 10

D. 9

Answer: B

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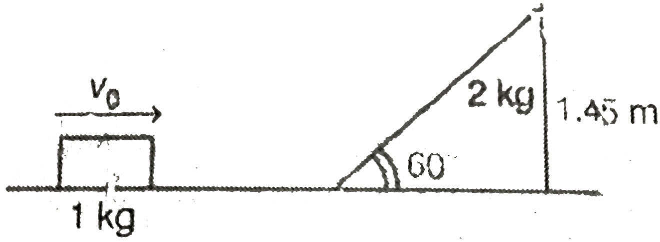
2. A block of mass 1 kg is moving towards a movable wedge of mass 2 kg as shown in figure. All surfaces are smooth. When the block leaves the wedge from top, its velocity is making an angle $\theta = 30^\circ$ with horizontal.



The value of v_0 in m/s is

A. 1.9 m

B. 2.7 m

C. 1.6 m

D. 1.45 m

Answer: C

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1. A spring of force constant 800 N/m has an extension of 5 cm. The work done in extending it from 5 cm to 15 cm is:

A. 16 J

B. 8 J

C. 32 J

D. 24 J

Answer: B

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2. Two masses of 1 kg and 16 kg are moving with equal kinetic energy. The ratio of magnitude of the linear momentum is:

A. $1:2$

B. $1:4$

C. $1:\sqrt{2}$

D. $\sqrt{2}:1$

Answer: B

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3. Two identical particles move towards each other with velocity 2v and v, respectively. The velocity of the centre of mass is:

A. v

B. $v/3$

C. $v/2$

D. zero

Answer: C

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4. A bomb of mass 9 kg explodes into 2 pieces of mass 3 kg and 6 kg. The velocity of mass 3 kg is 1.6 m/s, the K.E. of mass 6 kg is:

A. (a)3.84 J

B. (b)9.6 J

C. (c)1 . 92 J

D. (d)2. 92 J

Answer: C

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5. A spring of spring constant $5 \times 10^3 N/m$ is stretched initially by 5 cm from the unstretched position. The work required to further stretch the spring by another 5 cm is .

A. 6.25 N-m

B. 12. 50 N-m

C. 18. 75 N-m

D. 25.00 N-m

Answer: C

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6. Consider the following two statements:

A. Linear momentum of a system of particles is zero.

B. Kinetic energy of a system of particles is zero.

A. I implies II and II implies I.

B. I does not imply II and II does not imply I.

C. I implies II but II does not imply I

D. I does not imply II but II implies I.

Answer: D

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7. which a U^{238} nucleus original at rest , decay by emitting an alpha particle having a speed u , the recoil speed of the residual nucleus is

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8. A particle moves in a straight line with retardation proportional to its displacement. Its loss in kinetic energy for any displacement x is proportional to

A. (a)X

B. (b)e^{x}

C. (c)x^2

D. (d)$\log_e x$

Answer: C

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9. A force $\overrightarrow{F} = \left(5\overrightarrow{i} + 3\overrightarrow{j} + 2\overrightarrow{k}\right)N$ is applied over a particle which displaces it from its origin to the point $\overrightarrow{r} = \left(2\overrightarrow{i} - \overrightarrow{j}\right)m$. The work done on the particle in joules is.

A. $+10$

B. $+7$

C. -7

D. $+13$

Answer: B

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10. A uniform chain of length 4m is kept on a table such that a length of 120 cm hangs freely from the edge of the table. The total mass of the chain is 4 kg What is the work done in pulling the entire chain on the table ?

A. 7.2 J

B. 3.6 J

C. 120 J

D. 1200 J

Answer: B

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11. A body of mass m, accelerates uniformly from rest to V_1 in time t_1. The instantaneous power delivered to the body as a function of time t is.

A. $\dfrac{mv_1t^2}{t_1}$

B. $\dfrac{mv_1^2t}{t_1^2}$

C. $\dfrac{mv_1t}{t_1}$

D. $\dfrac{mv_1^2t}{t_1}$

Answer: B

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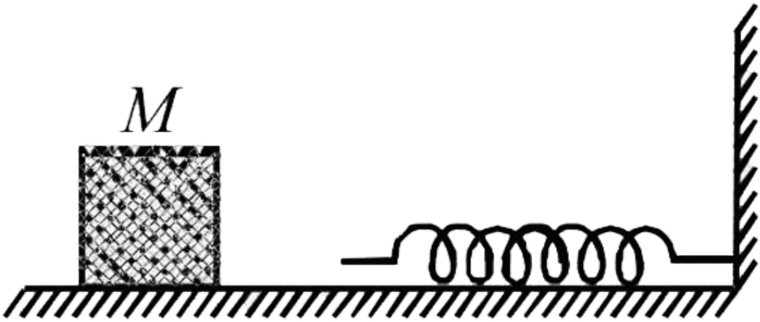
12. The block of mass M moving on the frictionless horizontal surface collides with the spring constant k and compresses it by length L. The maximum momention of the block after collision is



A. $M\frac{L^2}{K}$

B. zero

C. $K\frac{L^2}{2}M$

D.

Answer: D

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13. A spherical ball of mass 20 kg is stationary at the top of a hill of height 100 m. It rolls down a smooth surface to the ground then climbs up another hill of height 30 m and finally rolls down to a horizontal base at a height of 20 m above the ground. Find the velocity attained by the ball, when moving at horizontal base.

A. $10\sqrt{30}m / s$

B. $10m / s$

C. $20m / s$

D. $40m / s$

Answer: D

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14. A body A of mass M while falling wertically downwards under gravity brakes into two parts, a body B of mass $\frac{1}{3}$ M and a body C of mass $\frac{2}{3}$ M. The center of mass of bodies B and C taken together shifts compared to that of body A towards

A. (a)depends on height of breaking

B. (b)does not shift

C. (c)body C

D. (d)body B

Answer: B

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15. A bullet fired into a fixed target loses half of its velocity after penetrating 3 cm. How much further it will penetrate before coming to rest assuming that it faces constant resistance to motion?

A. 3.0 cm

B. 2.0 cm

C. 1.5 cm

D. 1.0 mc

Answer: D

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16. A particle of mass $100g$ is thrown vertically upwards with a speed of $5m/s$. The work done by the force of gravity during the time the particle goes up is

A. (a)1.25 J

B. (b)0.5 J

C. (c)$-0.5J$

D. (d)$-1.25J$

Answer: D

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17. The potential energy of a $1kg$ particle free to move along the x- axis is given by $V(x)=\left(\frac{x^4}{4}-\frac{x^2}{2}\right)J$

The total mechainical energy of the particle is $2J$.

Then , the maximum speed (in m//s) is

A. (a) $\frac{1}{\sqrt{2}}$

B. (b) 2

C. (c) $\frac{3}{\sqrt{2}}$

D. (d) $\sqrt{2}$

Answer: C

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18. A mass of M kg is suspended by a weightless string. The horizontal force required to displace it until string makes an angle of 45° with the initial vertical direction is:

A. (a)$\frac{Mg}{\sqrt{2}}$

B. (b)$Mg(\sqrt{2}-1)$

C. (c)$Mg(\sqrt{2}+1)$

D. (d)$Mg\sqrt{2}$

Answer: B

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19. Consider a two particle system with the particles having masses m_1 and m_2. If the first particles pushed towards the centre of mass through a distance d, by what distance should the second particle be moved so as the keep the centre of mass

at the same position?

A. $\frac{m_2}{m_1}d$

B. $\frac{m_1}{m_1 + m_2}d$

C. $\frac{m_1}{m_1}d$

D. d

Answer: C

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20. A 2 kg block slides on a horizontal floor with a speed of 4 m/s. It strikes an uncompressed spring, and compresses it till the block is motionless. The kinetic friction force is 15 N and spring constant is 10000 N/m. The spring is compressed by (in cm):

A. (a)2.5

B. (b)11.0

C. (c)8.5

D. (d)5.5

Answer: D

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21. A circular disc of radius R is removed from a bigger circular disc of radius $2R$ such that the circumferences of the discs coincide. The center of mass of new disc is αR from the center of the bigger disc. The value of α is

A. (a)$1/2$

B. (b)$1/6$

C. (c)$1/4$

D. (d)$1/3$

Answer: D

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22. A block of mass 0.50 kg is moving with a speed of 2.00 m/s on a smooth surface. It strikes another mass of 1.00 kg and then they move together as a single body. The energy loss during the collision is

A. 0.16 J

B. 1.00 J

C. 0.67 J

D. 0.34 J

Answer: C

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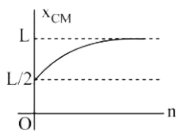
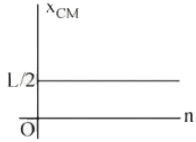
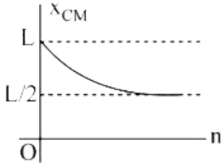
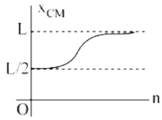
23. A thin rod of length L is lying along the x-axis with its ends at x=0 and x=L its linear (mass/length) varies with x as $k\left(\frac{x}{L}\right)^{n}$, where n can be zero of any positive number. If to position x_{CM} of the centre of mass of the rod is plotted against 'n', which of the following graphs best apporximates the dependence of x_{CM} on n?

A. 

B. 

C. 

D. 

Answer: A

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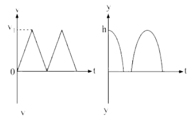
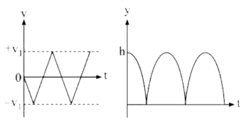
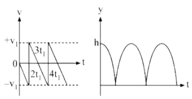
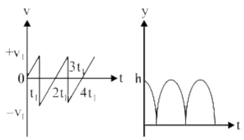
24. Consider a rubber ball freely falling from a height h = 4.9 m onto a horizontal elastic plate.

Assume that the duration of collision is negligible and the collision with the plate is totally elastic. Then the velocity as a function of time the height as function of time will be

A. 

B. 

C. 

D. 

Answer: C

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25. Assertion Two particles moving in the same direction do not lose all their energy in completely inelastic lcollision.

Reason Principle of conservation of momentum holds true for all kinds of collisions.

A. Statement-1 is True, Statement-2 is True and Statement-2 is a correct explanation for Statement-1.

B. Statement-1 is True, Statement-2 is True and Statement-2 is NOT a correct explanation for

Statement-1.

C. Statement-1 is True, Statement-2 is False.

D. Statement-1 is False, Statement-2 is True.

Answer: A

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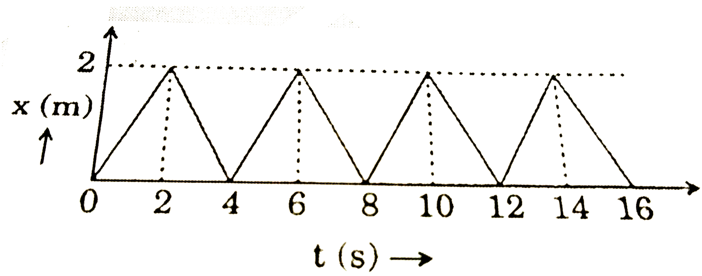
26. The figure shows the position - time (x - t) graph of one-dimensional motion of a body of mass 0.4

kg. The magnetic of each impulse is



A. 0.4 Ns

B. 0.8 Ns

C. 1.6 Ns

D. 0.2 Ns

Answer: B

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27. The potential energy function for the force between tow atoms in a diatomic molecule is approximately given by $U(x) = \frac{a}{x^{12}} - \frac{b}{x^6}$, where a and b are constants and x is the distance between the atoms. If the dissociation energy of the molecule is $D = [U(x = \infty) - U_{\text{at equilibrium}}]$, D is

A. $\frac{b^2}{2a}$

B. $\frac{b^2}{12a}$

C. $\frac{b^2}{4a}$

D. $\frac{b^2}{6a}$

Answer: C

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28. This question has Statement I and Statement II. Of the four choices given after the Statements, choose the one that best describes the two Statements.

Statement - I : A point particle of mass m moving with speed v collides with stationary point particle of mass M. If the maximum energy loss possible is given as $f\left(\frac{1}{2}mv^2\right)$ then $f = \left(\frac{m}{M+m}\right)$.

Statement - II : Maximum energy loss occurs when the particles get stuck together as a result of the collision.

A. Statement-1 is True, Statement-2 is True and Statement-2 is a correct explanation for Statement-1.

B. Statement-1 is True, Statement-2 is True and Statement-2 is NOT a correct explanation for Stateme

C. Statement-1 is True, Statement-2 is False.

D. Statement-1 is False, Statement-2 is True.

Answer: D

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29. When a rubber band is streched by a distance x, if exerts restoring force of magnitube $F = ax + bx^2$ where a and b are constant . The work in streached the unstreched rubber - band by L is

A. $\dfrac{aL^2}{2} + \dfrac{bL^3}{3}$

B. $\dfrac{1}{2}\left(\dfrac{aL^2}{2} + \dfrac{bL^3}{3}\right)$

C. $aL^2 + bL^2$

D. $\dfrac{1}{2}(aL^2 + bL^2)$

Answer: A

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30. A particle of mass m moving in the x direction with speed 2v is hit by another particle of mass 2m moving in the y direction with speed v. If the collision is perfectly inelastic, the percentage loss in the energy during the collision is close to

A. 0.44

B. 0.5

C. 0.56

D. 0.62

Answer: C

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31. Distance of the centre of mass of a solid uniform cone from its vertex is Z_0. If the radius of its base is R and its height is h then Z_0 is equal to :

A. $\frac{h^2}{4R}$

B. $\frac{3h}{4}$

C. $\frac{5h}{8}$

D. $\frac{3h^2}{8R}$

Answer: B

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32. It is found that if a neutron suffers an elastic collinear collision with deuterium at rest, fractional loss of its energy is p_d, while for its similar collision with carbon nucleus at rest, fractional loss of energy is p_c. The values of p_d and p_c are respectively.

A. (0,0)

B. (0,1)

C. (.89, .28)

D. (28, .89)

Answer: C

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33. In a collinear collision, a particle with an initial speed v0 strikes a stationary particle of the same mass. If the final total kinetic energy is 50% greater than the original kinetic energy, the magnitude of the relative velocity between the two particles, after collision, is :

A. $\frac{v_0}{2}$

B. $\frac{v_0}{\sqrt{2}}$

C. $\frac{v_0}{4}$

D. $\sqrt{2}v_0$

Answer: D

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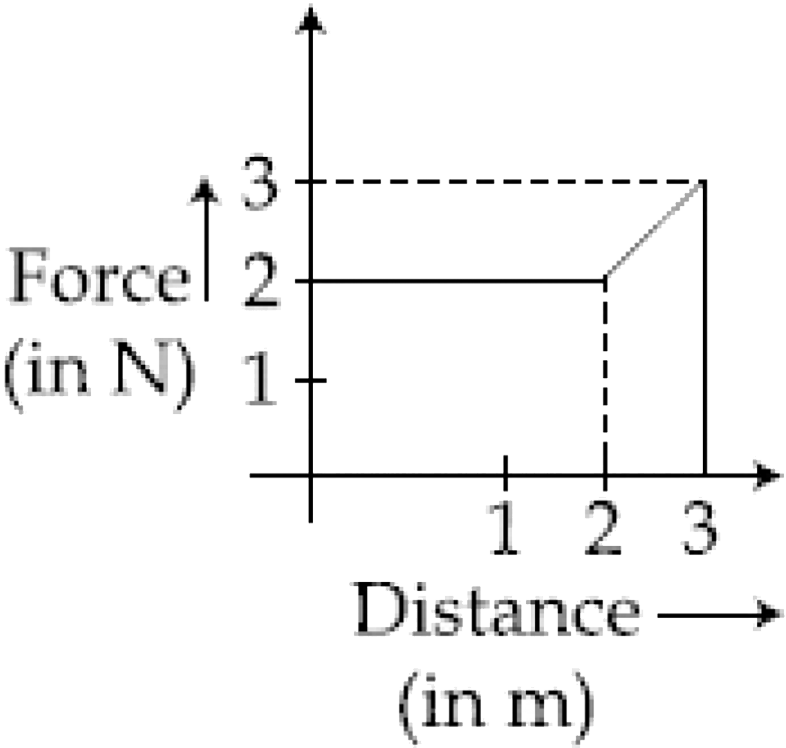
34. A particle moves in one dimension from rest under the influence of a force that varies with the distance travelled by the particle as shown in the figure. The kinetic energy of the particle after it has travelled $3m$ is:



A. 2.5 J

B. 5 J

C. 6.5 J

D. 4 J

Answer: C

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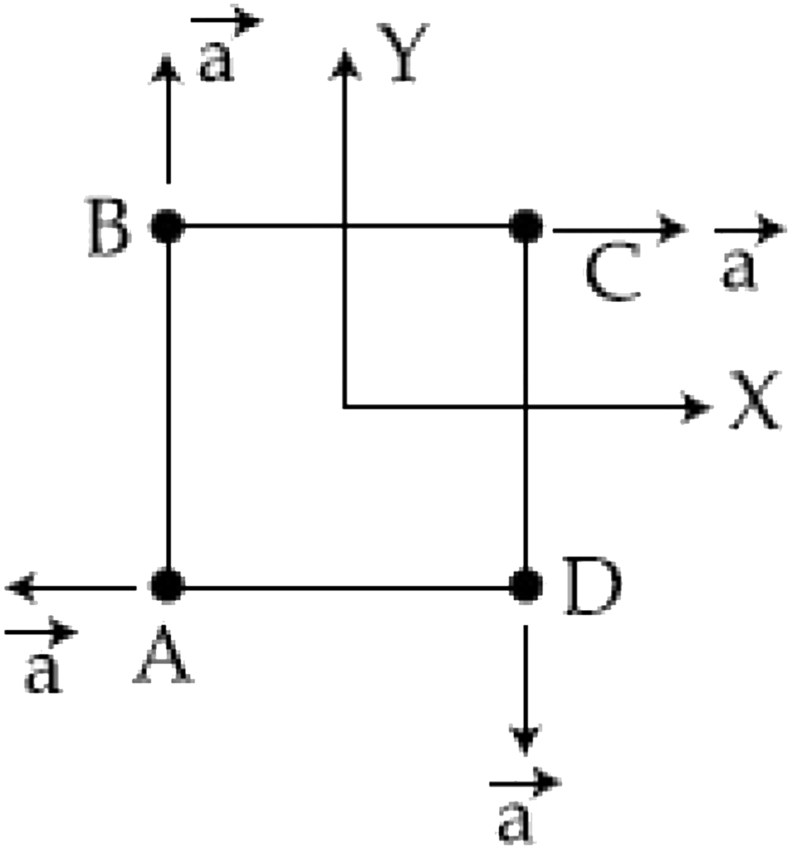
35. Four particles A, B, C and D with masses $m_A = m, m_B = 2m, m_C = 3m$ and $m_D = 4m$ are at the comers of a square. They have accelerations of equal magnitude with directions as shown. The acceleration of the centre of mass of the particles is :



A. $\frac{a}{5}\left(\hat{i}-\hat{j}\right)$

B. $a\left(\hat{i}+\hat{j}\right)$

C. $\frac{a}{5}\left(\hat{i}+\hat{j}\right)$

D. zero

Answer: A

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36. A body of mass m_1 moving with an unknown velocity of $v_1\hat{i}$, undergoes a collinear collision with a body of mass m_2 moving with a velocity $v_2\hat{i}$. After collision , m_1 and m_2 move with velocities of $v_3\hat{i}$ and $V_4\hat{i}$, respectively. If $m_2 = 0.5m_1$ and $v_3 = 0.5v_1$, then v_1 is :

A. $v_4 - \frac{v_2}{2}$

B. $v_4 - v_2$

C. $v_4 - \frac{v_2}{4}$

D. $v_4 + v_2$

Answer: B

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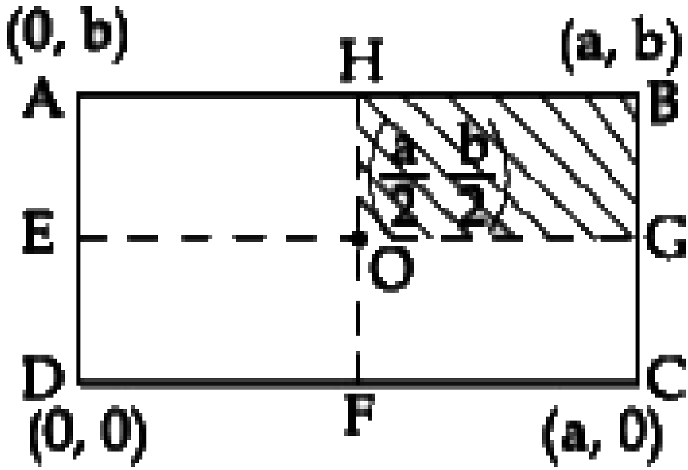
37. A uniform rectangular thin sheet ABCD of mass M has length a and breadth b, as shown in the figure. If the shaded portion $HBGO$ is cut-off, the coordinates of the center of mass of the remaining portion will be:



A. $\left(\frac{5a}{3}, \frac{5b}{3}\right)$

B. $\left(\frac{5a}{12}, \frac{5b}{12}\right)$

C. $\left(\frac{2a}{3}, \frac{2b}{3}\right)$

D. $\left(\frac{3a}{4}, \frac{3b}{4}\right)$

Answer: B

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38. A body of mass 2 kg makes an elastic collision with a second body at rest and continues to move in the original direction but with one fourth of its original speed. What is the mass of the second body?

A. 1.0 kg

B. 1.5 kg

C. 1.8 kg

D. 1.2 kg

Answer: D

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39. A uniform cable of mass 'M' and length 'L' is placed on a horizontal surface such that its $\left(\frac{1}{n}\right)^{th}$ part is hanging below the edge of the cable upto the surface, the work done should be :

A. $\frac{MgL}{2n^2}$

B. $\frac{MgL}{n^2}$

C. $nMgL$

D. $\frac{2MgL}{n^2}$

Answer: A

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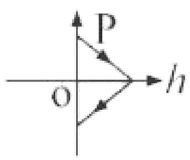
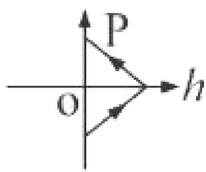
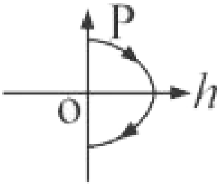
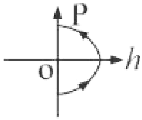
40. A ball is through vertically up (taken as +z-axis) from the ground. The correct momentum-height (p-h) diagram is :

A. 

B. 

C. 

D. 

Answer: C

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41. A wedge of mass M=4m lies on a frictionless plane. A particle of mass m approaches the wedge with speed v. there is no friction between the particle and the plane or between the particle and the wedge. The maximum height climbed by the particle on the wedge is given by

A. $\frac{2v^2}{5g}$

B. $\frac{v^2}{g}$

C. $\frac{2v^2}{7g}$

D. $\frac{v^2}{2g}$

Answer: A

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42. Two particles, of masses M and 2M, moving as shown, with speeds of $10 m/s$ and $5 m/s$, collide elastically at the origin.After the collision, they move along the indicated directions with speeds v_1 and v_2 , respectively.The values of v_1 and v_2 are nearly :

A. 6.5 m/s and 6.3 m/s

B. 3.2 m/s and 6.3 m/s

C. 3.2 m/s and 12.3 m/s

D. 6.5 m/s and 3.2 m/s

Answer: A

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43. A bullet of mass 20 g has a n initial speed of $1ms^{-1}$ just before it starts penetrating a mud wall of thichness 20cm. If the wall offers a mean resistance of $2.5 \times 10^{-2}N$ the speed of the bullet after emerging from the other side of the wall is close to:

A. $0.7ms^{-1}$

B. $0.4ms^{-1}$

C. $0.1ms^{-1}$

D. $0.3ms^{-1}$

Answer: A

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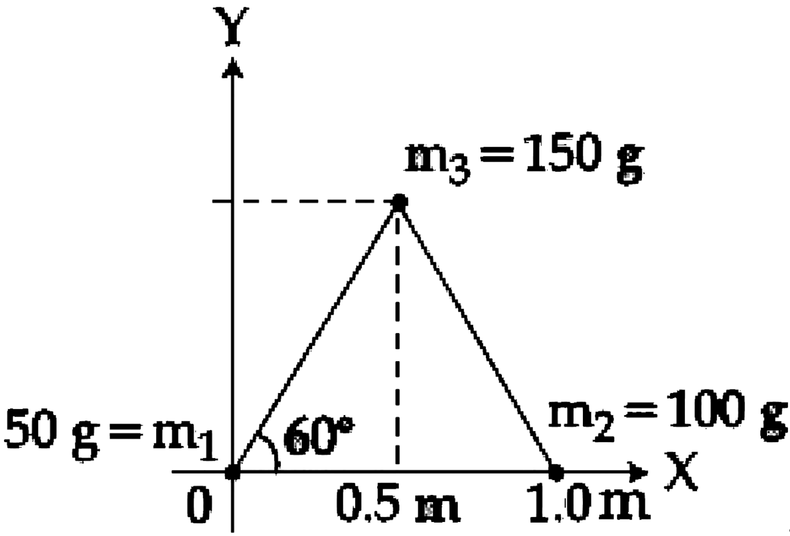
44. Three particles of masses $50g$, $100g$ and $150g$ are placed at the vertices of an equilateral triangle of side $1m$ (as shown in the figure). The (x,y) coordinates of the centre of mass will be :



A. $\left(\frac{7}{12} m, \frac{\sqrt{3}}{4} m\right)$

B. $\left(\frac{\sqrt{3}}{4} m, \frac{5}{12} m\right)$

C. $\left(\frac{7}{12} m, \frac{\sqrt{3}}{8} m\right)$

D. $\left(\frac{\sqrt{3}}{8} m, \frac{7}{12} m\right)$

Answer: A

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45. A person of mass M is setting on a swing of length L and swinging with an angular amplitude θ_0 if the person stands up when the swing passes through its lowest point, the work done by him, assuming that his centre of mass moves by a distance $l(< < L)$

A. Mgl

B. $Mgl(1-\theta_0^2)$

C. $Mgl\left(1+\frac{\theta_0^2}{2}\right)$

D. $Mgl(1+\theta_0^2)$

Answer: D

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46. A man (mass $= 50kg$) and his son (mass $= 20kg$) are standing on a frictionless surface facing each other , the man pushes his son so that he start moving at a speed of $0.70ms^{-1}$ with respect to the man. The speed of the man with respect to the surface is:

A. $0.14ms^{-1}$

B. $0.47ms^{-1}$

C. $0.28 ms^{-1}$

D. $0.20 ms^{-1}$

Answer: D

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47. A force acts on a 2 kg object so that its position is given as a function of time as $x = 3t^2 + 5.$ What is the work done by this force in first 5 seconds ?

A. 950 J

B. 900 J

C. 875 J

D. 850 J

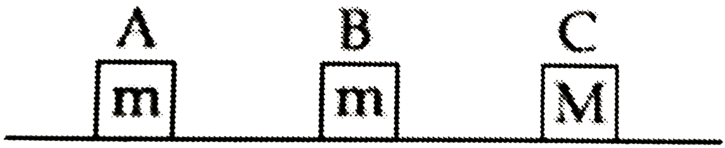
Answer: B

Watch Video Solution

48. Three blocks A, B and C are lying on a smooth horizontal surface, as shown in the figure. A and B have equal masses, m while C has mass M. Block A is given an inita speed v towards B due to which it collides with B perfectly inelastically. The combined mass collides with C, also perfectly inelastically $\frac{5}{6}th$

of the initial kinetic energy is lost in whole process.

What is balue of M/m?



A. 2

B. 5

C. 3

D. 4

Answer: D

Watch Video Solution

49. A particle which is experiencing a force, given by $\overrightarrow{F} = 3\overrightarrow{i} - 12\overrightarrow{j}$, undergoes a displacement of $\overrightarrow{d} = 4\overrightarrow{i}$. If the particle had a kinetic energy of 3 J at the beginning of the displacement

A. 9 J

B. 10 J

C. 15 J

D. 12 J

Answer: C

Watch Video Solution

50. A piece of wood of mass 0.03 kg is dropped from the top of a 100 m height building. At the same time, a bullet of mass 0.02 kg is fired vertically upward, with a velocity 100 ms^{-1}, from the ground. The bullet gets embedded in the wood. Then the maximum height to which the combined system reaches above the top of the bulding before falling below is :

$(g = 10ms^{-2})$

A. 40 m

B. 30 m

C. 10 m

D. 20 m

Answer: A

Watch Video Solution

51. A particle of mass is moving in a straight line with momentum p. Starting at time t= 0, a force F= kt acts in the same direction on the moving particle during time interval T so that its momentum changes from p to 3p. Here k is constant . The value of T is :

A. $\sqrt{\frac{2p}{k}}$

B. $2\sqrt{\dfrac{k}{p}}$

C. $\sqrt{\dfrac{2k}{p}}$

D. $2\sqrt{\dfrac{p}{k}}$

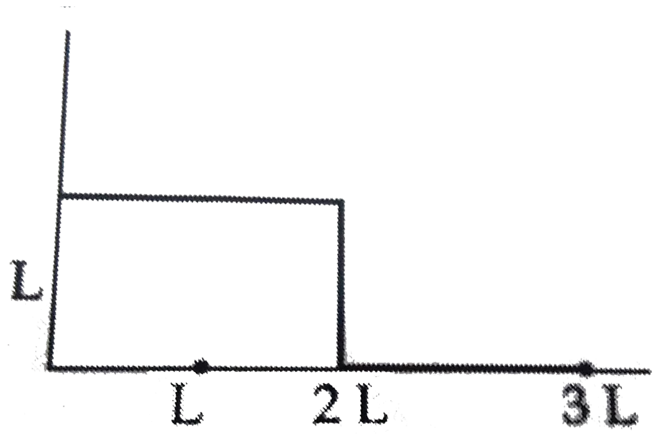
Answer: D

Watch Video Solution

52. the position vector of the centre of mass lt

$\rightarrow$

r cm of an asymmetric uniform bar of negligible area of cross - section as shown in figure is :



A. $\overrightarrow{F}cm = \frac{3}{8}L\widehat{x} + \frac{11}{8}L\hat{y}$

B. $\overrightarrow{F}cm = \frac{11}{8}L\widehat{x} + \frac{3}{8}L\hat{y}$

C. $\overrightarrow{F}cm = \frac{13}{8}L\widehat{x} + \frac{5}{8}L\hat{y}$

D. $\overrightarrow{F}cm = \frac{5}{8}L\widehat{x} + \frac{13}{8}L\hat{y}$

Answer: C

Watch Video Solution

53. A particle of mass 'm' is moving with speed '2v' and collides with a mass '2m' moving with speed 'v' in the same direction. After collision, the first mass is stopped completely while the second one splits into two particles each of mass 'm' which move at angle 45° with respect to the original direction. The speed of each of the moving particle will be

A. $2\sqrt{2}v$

B. $v/\left(2\sqrt{2}\right)$

C. $\sqrt{2}v$

D. $v/\sqrt{2}$

Answer: A

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JEE ADVANCE (ARCHIVE)

1. Two masses of 1 g and 4 g are moving with equal kinetic energies. The ratio of the magnitudes of their momenta is

A. $4:1$

B. $\sqrt{2}:1$

C. $1:2$

D. $1:16$

Answer: C

Watch Video Solution

2. Two particles A and B intiallly at rest, move towards each other under a mutual force of attraction. AT the instant when the speed of A is v and the speed of B is 2 v, the speed of the centre of mass of the system is

A. 3 v

B. v

C. 1.5 v

D. zero

Answer: D

Watch Video Solution

3. A body is moved along a straight line by a machine delivering constant power. The distance moved by the body in time t is proportional to

A. $t^{3/4}$

B. $t^{3/2}$

C. $t^{1/4}$

D. $t^{1/4}$

Answer: B

Watch Video Solution

4. 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

A. MgL

B. $MgL/3$

C. $MgL/9$

D. $MgL/18$

Answer: D

Watch Video Solution

5. A ball hits a floor and rebounds after an inelastic collision. In this case

A. the momentum of the ball just after collision is same as that just before the collision

B. the mechanical energy of the ball remains the same in collision

C. the total momentum of the ball and the earth is conserved

D. The total mechanical energy of the ball and the earth is conserved

Answer: C

Watch Video Solution

6. A shell is fired from a cannon with a velocity V at an angle θ with the horizontal direction. A the highest point i its path, it explodes into two pieces of equal masses. One of the pieces retraces its path to the cannon. The speed of the other priece immediately after the explocison is

A. $3v \cos \theta$

B. $2v \cos \theta$

C. $\frac{3}{2} v \cos \theta$

D. $\sqrt{\frac{3}{2}} v \cos \theta$

Answer: A

Watch Video Solution

7. The particle of mass m is moving in a circular path of constant radius r such that its centripetal acceleration a_c is varying with time t as $a_c = k^2$, Where k is a constant .The power delivered to particle by the forces actingon it is

A. $2\pi mk^2r^2t$

B. mk^2r^2t

C. $\frac{(mk^4r^2t^5)}{3}$

D. zero

Answer: B

Watch Video Solution

8. An isolated particle of mass m is moving in horizontal planexy along the x-axis, at a certain height above the ground. It suddenly explodes into two fragment of masses $m/4$ and $3m/4$. An instant later, the smaller fragment is at $y = +15$ cm. The larger fragment at this instant is at

A. $y = -5cm$

B. $y = +20cm$

C. $y = +5cm$

D. $y = -20cm$

Answer: A

Watch Video Solution

9. A stone tied to a string of length L 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 lowest position and has a speed u . Find the magnitude of the change in its velocity as it reaches a position, where the string is horizontal.

A. $\sqrt{u^2 - 2gL}$

B. $\sqrt{2gL}$

C. $\sqrt{u^2 - gL}$

D. $\sqrt{2(u^2 - gL)}$

Answer: D

Watch Video Solution

10. A force $F = -k\hat{i} + x\hat{j}$ where k is a positive constant, acts on a praricle 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 formce on the particle is

A. $-2Ka^2$

B. $2Ka^2$

C. $-Ka^2$

D. Ka^2

Answer: C

Watch Video Solution

11. A spring of force constant k is cut into two pieces such that one piece is double the length of the other. Then the long piece will have a force constant of

A. $\left(\frac{2}{3}\right)k$

B. $\left(\frac{3}{2}\right)k$

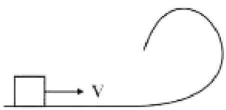
C. $3k$

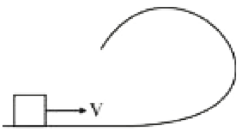
D. $6k$

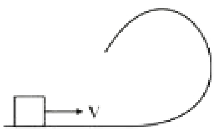
Answer: B

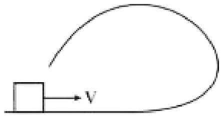
Watch Video Solution

12. A small block is shot into each of the four track as shown in Fig 15.7.1. Each of the track rises to the same height. The speed with which the block enters the track is the same in all cases. At the highest point of the track, the normal reaction is maximum in

A. 

B. 

C. 

D. 

Answer: A

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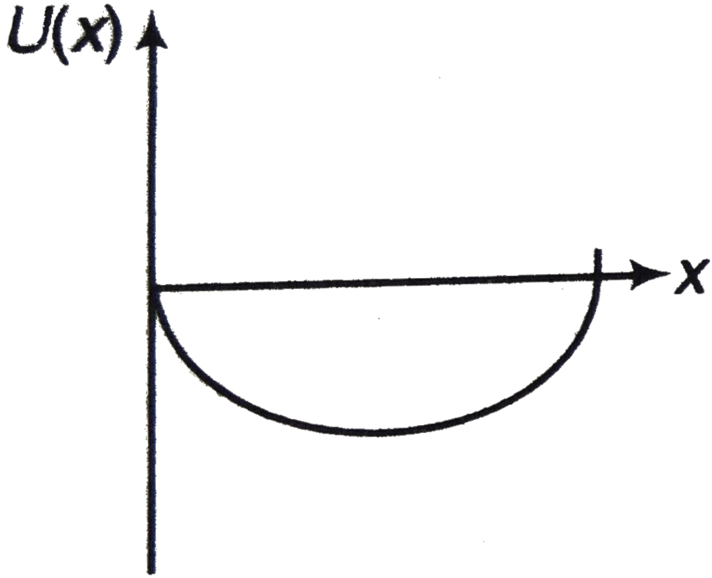
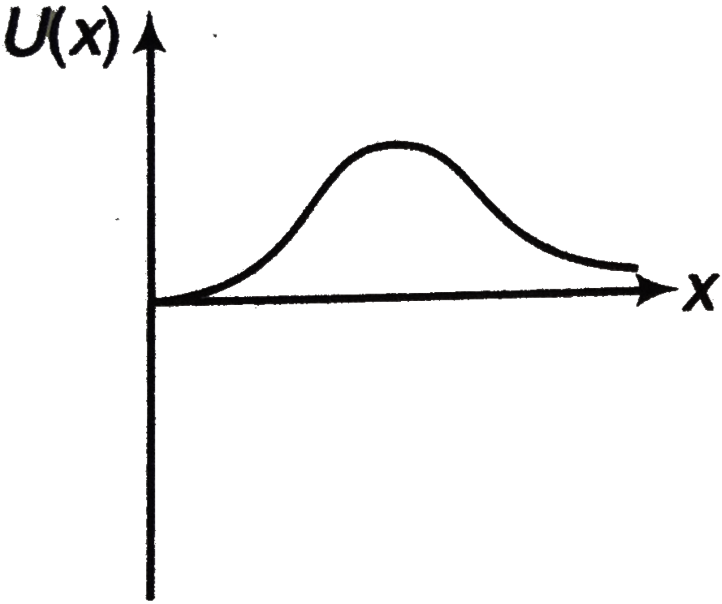
13. A particle, which is constrained to move along x-axis, is subjected to a force in the some direction which varies with the distance x of the particle from the origin an $F(x) = -kx + ax^3$. Here, k and a are positive constants. For $x(\geq 0,$ the functional form of the potential energy (u) U of the U (x) the particle is.



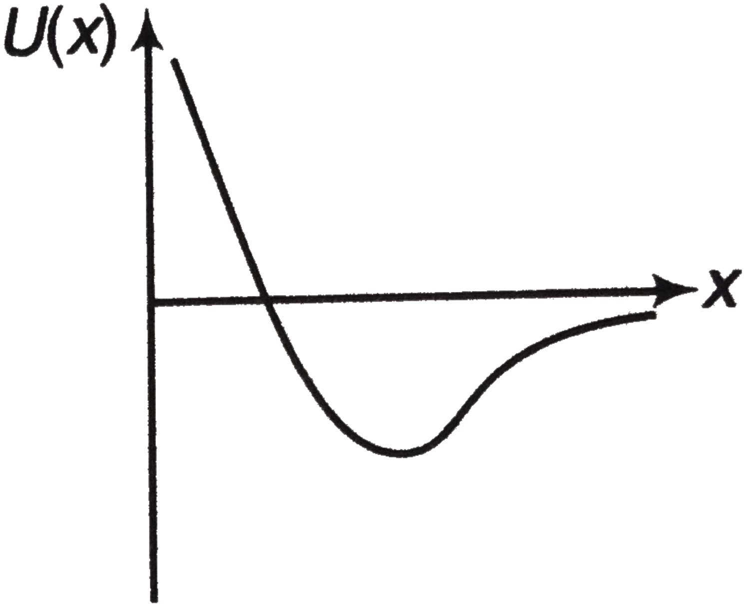
(a)

(a) , (b)



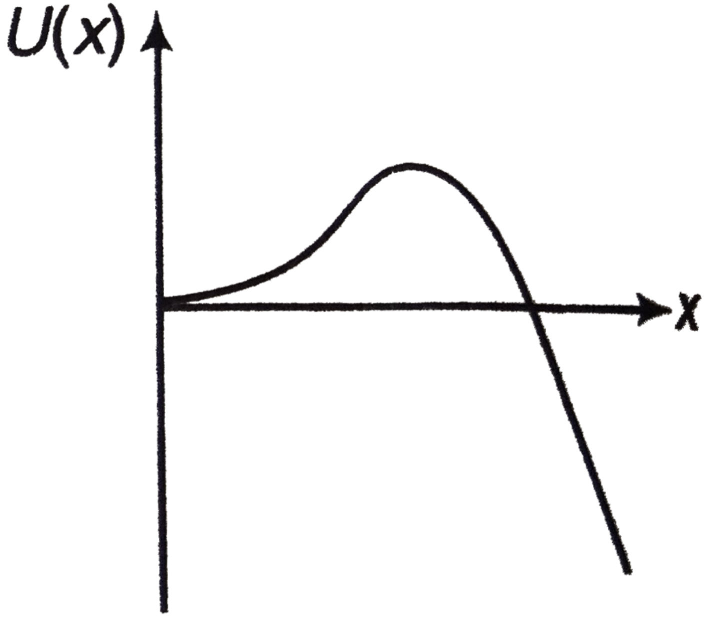
(b)

, (c)



(c)

, (d)



(d)

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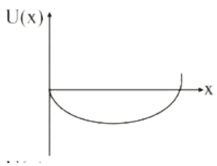
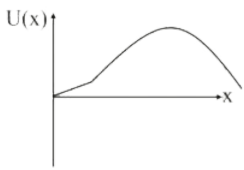
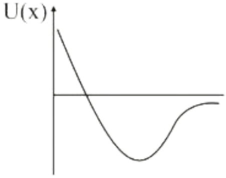
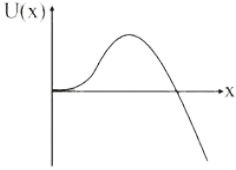
A. 

B. 

C. 

D. 

Answer: D

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14. A block of mass M is attached to the lower end of a verticle spring. The spring is hung from a ceiling and has force constant value k. The mass is released form rest with the spring intially unstretched. The maximum extension produced in the length of the spring will be

A. $\frac{4Mg}{k}$

B. $\frac{2Mg}{k}$

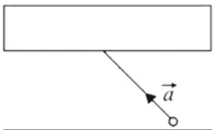
C. $\frac{Mg}{k}$

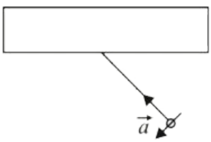
D. $\frac{Mg}{2k}$

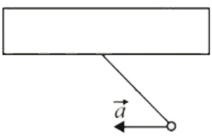
Answer: B

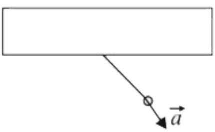
Watch Video Solution

15. A simple pendulum is oscillating without damping. When the displacement of the bob is less than maximum, its acceleration vector $\vec{a}$ is correctly shown in

A. 

B. 

C. 

D. 

Answer: C

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16. Two blocks of masses $10kg$ and $4kg$ are connected by a spring of negligible mass and placed on a frictionless horizontal surface. An impulse gives a velocity of $14m/s$ to the heavier block in the direction of the lighter block. The velocity of the centre of mass is

A. $30m/s$

B. $20m/s$

C. $10m/s$

D. $5m/s$

Answer: C

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17. A wind - powered generator converts wind energy into electrical energy . Assume that the generator convents a fixed fraction of the wind energy intercepted by to blades into electrical energy for wind speed V , the electrical power output will be propertional to

A. V

B. V^2

C. V^3

D. V^4

Answer: C

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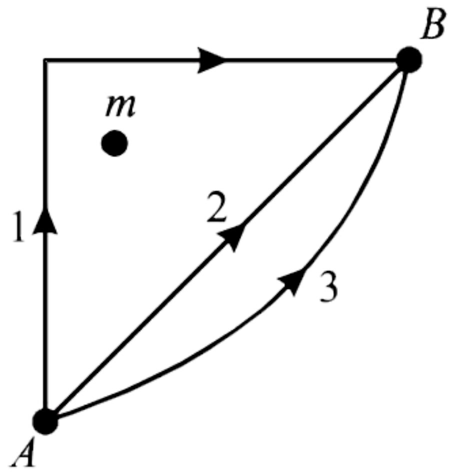
18. If $W_1 W_2$ and W_3 represent the work done in moving a particle from A to B along three different paths 1.2 and3 respectively (asshown) in the gravitational fieled of a point mass m, find the correct relation between W_(1) W_(2) and W_(3)`



A. (a)$W_1 > W_2 > W_3$

B. (b)$W_1 = W_2 = W_3$

C. (c)$W_1 < W_2 < W_3$

D. (d)$W_2 < W_1 < W_3$

Answer: B

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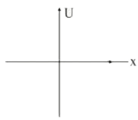
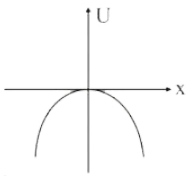
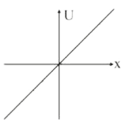
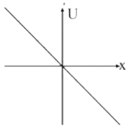
19. A particle is acted by x force $F = Kx$ where K is $a(+ve)$ constant its potential energy at $x = 0$ is zero . Which curve correctly represent the variation of potential energy of the block with respect to x

A. 

B. 

C. 

D. 

Answer: B

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20. A particle moves in the xy plane under the influence of a force such that its linear momentum is $\overrightarrow{P}(t) = A\left[\hat{i}\cos(kt) - \hat{j}\sin(kt)\right]$, where A and k are constants. The angle between the force and momentum is

A. 0°

B. 30°

C. 40°

D. 90°

Answer: D

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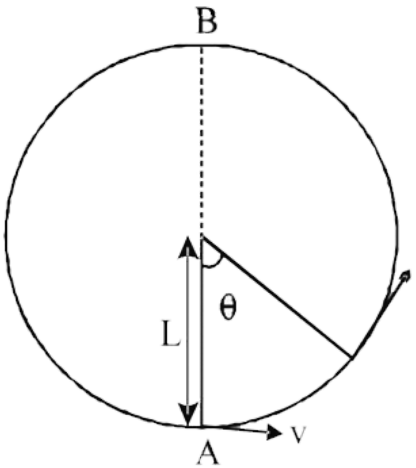
21. A bob of mass M is suspended by a massless string of length L. The horizontal velocity v at position A is just sufficient to make it reach the point B. The angle θ at which the speed of the bob is half of that at A, satisfies



A. $\theta = \frac{\pi}{4}$

B. $\frac{\pi}{4} < \theta < \frac{\pi}{2}$

C. $\frac{\pi}{2} < \theta < \frac{3\pi}{4}$

D. $\frac{3\pi}{4} < \theta < \pi$

Answer: D

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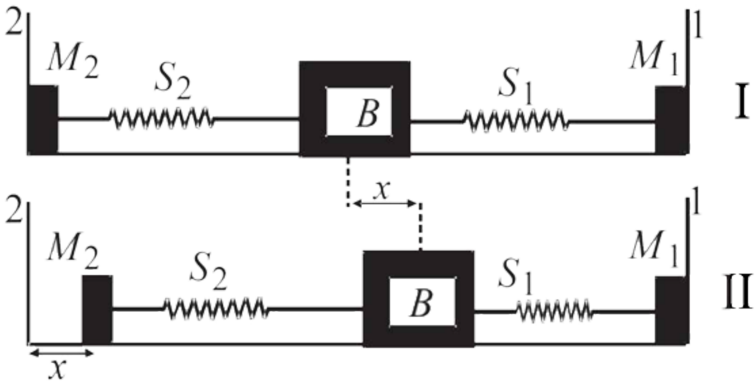
22. A block (B) is attached to two unstriched sprig S_1 and S_2 with spring constant K and $4K$, respectively (see fig 1) The other ends are atteched in identical support M_1 and M_2 not attached in the walls . The springs and supports have negligible mass . There is no friction anywhere . The block B is displaced toword wall 1 by a small distance x (figure (ii)) and released . The block return and moves a maximum distance y towards wall 2.Displacements x and y are measured w.r.to the equalibrum of the block B and the ratio y/x is



A. 4

B. 2

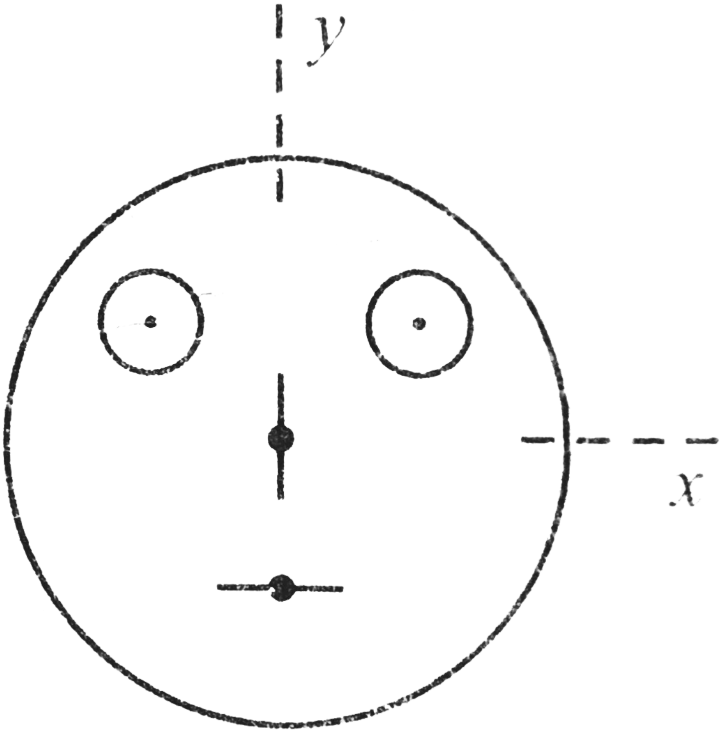
C. $\frac{1}{2}$

D. $\frac{1}{4}$

Answer: C

Watch Video Solution

23. Look at the drawing given in the figure which has been drawn with ink of uniform line-thickness. The mass of ink used to draw each of the two inner circles, and each of the two line segments is m. The mass of the ink used to draw the outer circle is $6m$. The coordinates of the centres of the different parts are: outer circle $(0, 0)$, left inner circle $(-a, a)$, right inner circle (a, a), vertical line $(0, 0)$ and horizontal line $(0, -a)$. The y-coordinate of the centre of mass of the ink in this drawing is



A. $\frac{a}{10}$

B. $\frac{a}{8}$

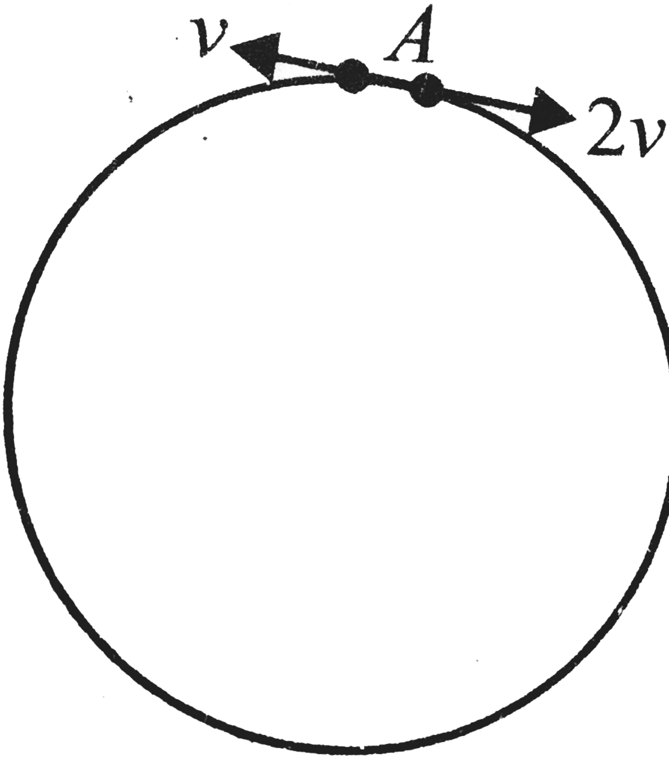
C. $\frac{a}{12}$

D. $\frac{a}{3}$

Answer: A

Watch Video Solution

24. Two small particles of equal masses start moving in opposite directions from a point A in a horizontal circular orbit. Their tangential velocities are v and 2, respectively. As shown in the figure. Between collisions, the particles moves with constant speeds. After making how many elastic collisions, other than that at A. these two particles will again reach the point A?



A. 4

B. 3

C. 2

D. 1

Answer: C

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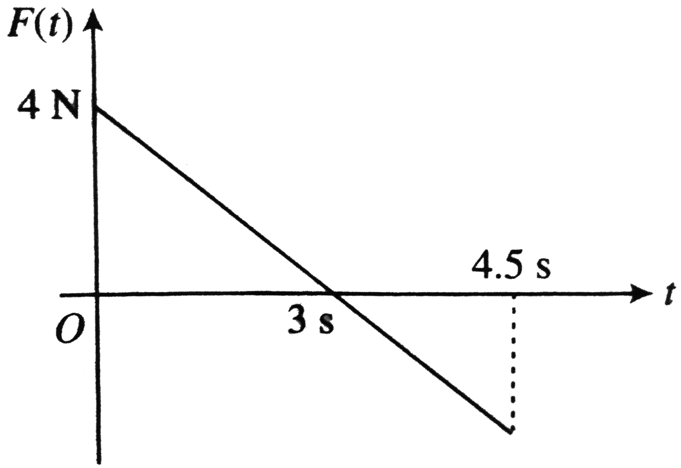
25. A block of mass $2kg$ is free to move along the x-axis. It is at rest and from $t=0$ onwards, it is subjected to a time-dependent force $F(t)$ in the x-direction. The force $F(t)$ vaies with t as shown in figure. The kinetic energy of the block after $4.5 s$ is



A. 4.50 J

B. 7.50 J

C. 5.06 J

D. 14.06 J

Answer: C

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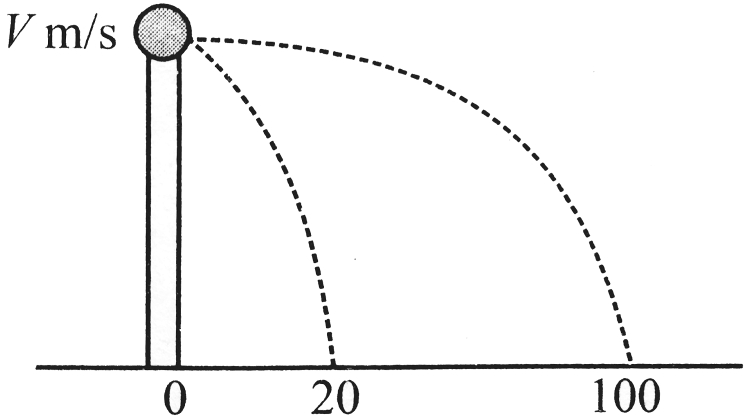
26. A ball of mass 0.2 kg rests on a vertical post of height $5m$. A bullet of mass $0.01kg$, travelling with a velocity Vm/sin a horizontal direction, hits the centre of the ball.

After the collision. the ball and the bullet travel independently. The ball hits the ground at a distance of $20m$ and the bullet at a distance of $100m$ from the foot of the post. The initial velocity

V of the bullet is



A. $250 m / s$

B. $250\sqrt{2} m / s$

C. $400 m / s$

D. $500 m / s$

Answer: D

Watch Video Solution

27. The work done an a particle of mass m by a force

$$K\left[\frac{x}{\left(x^2+y^2\right)^{3/2}}\hat{i}+\frac{y}{\left(x^2+y^{2^{3/2}}\right)\hat{j}}\right]$$

(K being a constant of appropriate dimensions), when the partical is taken from the point (a,0) to the point (0,a) along a circular path of radius a about the origin in x - y plane is

A. $\dfrac{2Kx}{a}$

B. $\dfrac{Kx}{a}$

C. $\dfrac{Kx}{2a}$

D. 0

Answer: D

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28. A particle of mass m is projected from the ground with an initial speed u_0 at an angle α with the horizontal. At the highest point of its trajectory, it makes a completely inelastic collision with another identical particle, which was thrown vertically upward from the ground with the same initial speed u_0. The angle that the composite system makes with the horizontal immediately after the collision is

A. (a) $\frac{\pi}{4}$

B. (b) $\frac{\pi}{4}+\alpha$

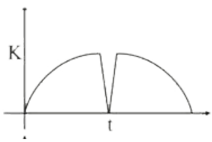
C. (c) $\frac{\pi}{4}-\alpha$

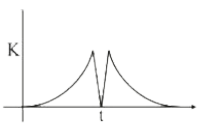
D. (d) $\frac{\pi}{2}$

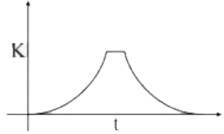
Answer: A

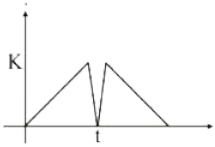
Watch Video Solution

29. A tennis ball dropped on a horizontal smooth surface , it because back to its original position after hitting the surface the force on the bell during the collision is proportional to the length of compression of the bell . Which one of the following skethes desches discribe the variation of its kinetic energy K with time 1 mass apporiandly ? The figure as only illistrative and not to the scale .

A. 

B. 

C. 

D. 

Answer: B

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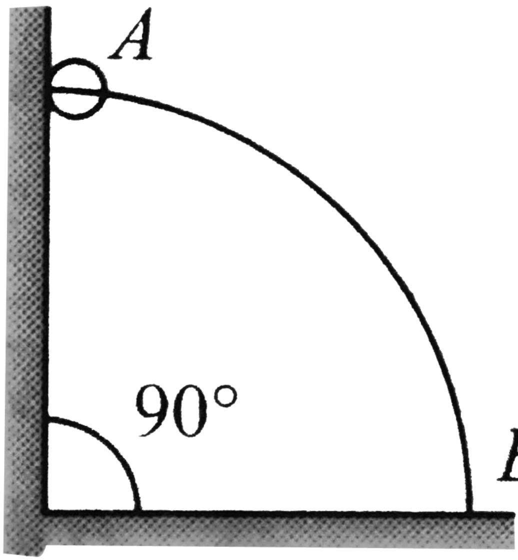
30. A wire, which passes through the hole in a small bead, is bent in the form of quarter of a circle. The wire is fixed vertically on ground as shown in the figure. The bead is released from near the top of the wire and it slides along the wire without friction. As the bead moves from A to B, the force it applies on the wire is



A. always radially outwards

B. always radially inwards

C. radially outwards initially and radially inward later

D. radially inwards initially and radially outwards later

Answer: D

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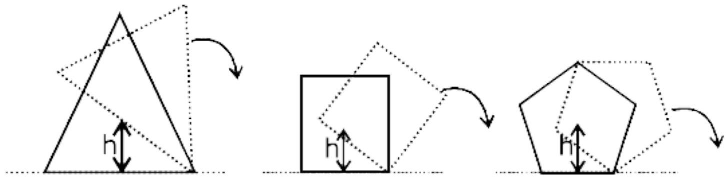
31. Consider regular polygons with number of sides n = 3, 4, 5 ...... as shown in the figure, The center of mass of all the polygons is at height h from the ground. They roll on a horizontal surface about the leading vertex without slipping and sliding as depicted,. The maximum increase in height of the locus of the center of mass for each polygton is Δ.

Then Δ depends on n and h as



A. $\Delta = h\sin^2\left(\frac{\pi}{n}\right)$

B. $\Delta = h\sin^2\left(\frac{2\pi}{n}\right)$

C. $\Delta = h\sin^2\left(\frac{\pi}{2n}\right)$

D. $\Delta = h\left(\frac{1}{\cos\left(\frac{\pi}{h}\right)} - 1\right)$

Answer: D

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32. 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

A. its velocity is constant

B. its acceleration is constant

C. its kinetic energy is constant

D. its moves in a circular path

Answer: C::D

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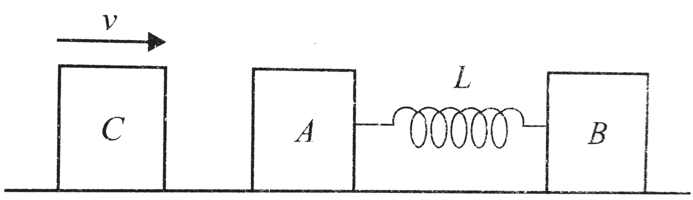
33. Two blocks A and B. each of mass m, are connected by a massless spring of natural length I. and spring constant K. The blocks are initially resting in a smooth horizontal floor with the spring at its natural length, as shown in Fig. A third identical block C, also of mass m, moves on the floor with a speed v along the line joining A and B. and collides elastically with A. Then



A. the kinetic energy of the A – B system at maximum compression of the spring, is zero.

B. the kinetic energy of the A – B system, at maximum compression of the spring, is $\frac{mv^2}{4}$

C. the maximum compression of the spring is $v\sqrt{\frac{m}{K}}$

D. the maximum compression of the spring is $v\sqrt{\frac{m}{2K}}$

Answer: B::D

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34. Two balls having linear momenta $\overrightarrow{p}_1 = p\hat{i}$ and $\overrightarrow{p}_2 = -p\hat{i}$, undergo a collision in fre space. There is no external force acting on the ball. Let $\overrightarrow{p}'_1$ and $\overrightarrow{p}'_2$ be their final moment. Which of the following option(s) is (are) NOT ALLOWED for an non zero value of p, a_1, a_2, b_1, b_2, c_1 and c_2.

A. $\overrightarrow{P}'_1 = a_1\hat{i} + b_1\hat{j} + a_1k$, $\overrightarrow{p}'_2 = a_2\hat{i} + b_2\hat{j}$

B. $\overrightarrow{P}'_1 = c_1k$, $\overrightarrow{p}'_2 = c_2k$

C.

$\overrightarrow{P}'_1 = a_1\hat{i} + b_1\hat{j} + a_1k$, $\overrightarrow{p}'_2 = a_2\hat{i} + b_2\hat{j} - c_2k$

D. $\overrightarrow{P}'_1 = a_1\hat{i} + b_1\hat{j}$, $\overrightarrow{p}'_2 = a_2\hat{i} + b_2\hat{j}$

Answer: A::D

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35. A point mass of $1kg$ collides elastically with a stationary point mass of $5kg$. After their collision, the $1kg$, mass reverses its direction and moves with a speed of $2ms^{-1}$. Which of the following statement(s) is (are) correct for the system of these two masses?

A. Total momentum of the system is $3kgms^{-1}$

B. Momentum of 5 kg mass after collision is

$4kgms^{-1}$

C. Kinetic energy of the centre of mass is 0.75 J

D. Total kinetic energy of the system is 4 J

Answer: A::C

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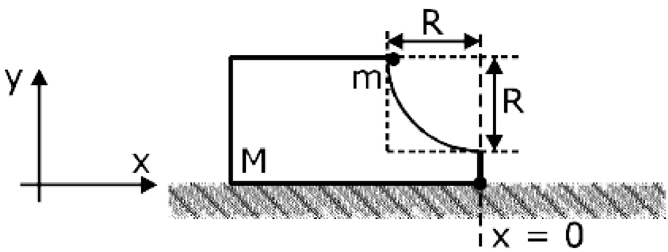
36. A block of mass M has a circular cut with a frictionless surface as shown. The block rests on the horizontal frictionless surface of a fixed table. Initially the right edge of the block is at x = 0, in a co-ordinate system fixed to the table. A point mass m is released from rest at the topmost point of the path as shown and it slides down. When the mass loses contact with the block, its position is x and the velocity is v. At that instant, which of the following options is/are correct?



A. (a)The velocity of the point mass m is:

$$v = \sqrt{\frac{2gR}{1 + \frac{m}{M}}}$$

B. (b)The velocity of the block M is:

$$v = -\frac{m}{M}\sqrt{2gR}$$

C. (c)The position of the point mass is:

$$x = -\sqrt{2}\frac{mR}{M+m}$$

D. (d)The x component of displacement of the center of mass of the block M is: $\frac{mR}{M+m}$

Answer: A::D

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37. A particle of mass m is initially at rest at the origin. It is subjected to a force and starts moving along the x-axis. It kinetic energy K changes with time as $dK/dt = \gamma t,$ where γ is a positive constant of appropriate dimensions. Which of the following statement is (are) true?

A. (a)The force applied on the particle is constant

B. (b)The speed of the particle is proportional to time

C. (c)The distance of the particle from the origin increases linearly with time

D. (d)The force is conservative

Answer: A::B::D

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38. A small particle of mass m moving inside a heavy, hollow and straight tube along the tube axis undergoes elastic collision at two ends. The tube has no friction and it is closed at one end by a flat surface while the other end is fitted with a heavy movable flat piston as shown in figure. When the distance of the piston from closed end is $L = L_0$ the particle speed is $v = v_0$ The piston is moved inward at a very low speed V such that $V < < \frac{dL}{L} v_0$, where dL is the infinitesimal displacement of the piston. Which of the following statements(s) is(are) correct?

A. After each collision with the piston, the particle speed increases by 2V

B. If the piston moves inward by dL, the particle speed increases by $2v \frac{dL}{L}$

C. The rate at which the particle strikes the piston is v/L

D. The particle's kinetic energy increases by a factor of 4 when the piston is moved inward from $L_0 \text{to} \frac{1}{2} L_0$

Answer: A::D

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39. Statement I: In an elastic collision between two bodies, the relative speed of the bodies after collision is equal to the relative speed before the collision.

Statement II: In an elastic collision, the linear momentum of the system is conserved.

A. Statement-I is True, Statement-II is True and Statement-II is a correct explanation for Statement-I.

B. Statement-I is True, Statement-II is True and Statement-II is NOT a correct explanation for Statement-I.

C. Statement-I is True, Statement-II is False.

D. Statement-I is False, Statement-II is True

Answer: B

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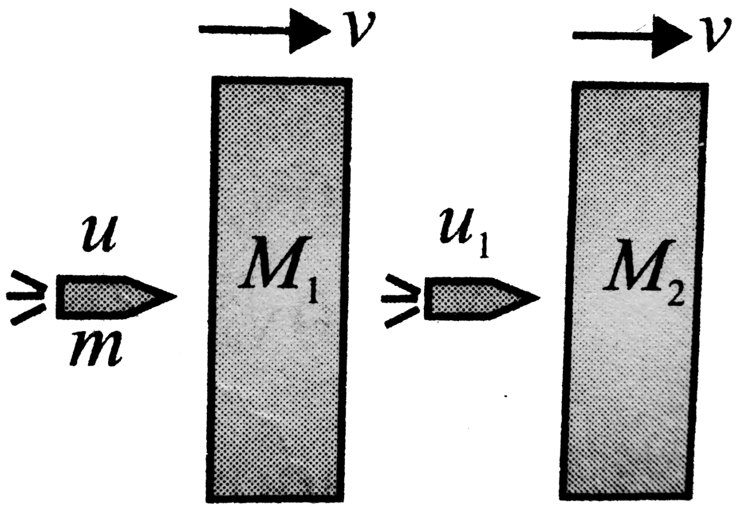
40. A $20g$ bullet pierces through a plate of mass $M_1 = 1kg$ and then comes to rest inside a second plate of mass $M_2 = 2.98kg$ as shown in Fig. It is found that the two plates, initially at rest, now move with equal velocities. Find the percentage loss in the initial velocity of the bullet when it is between M_1 and M_2. Neglect any loss of material of the plates due to the action of bullet.



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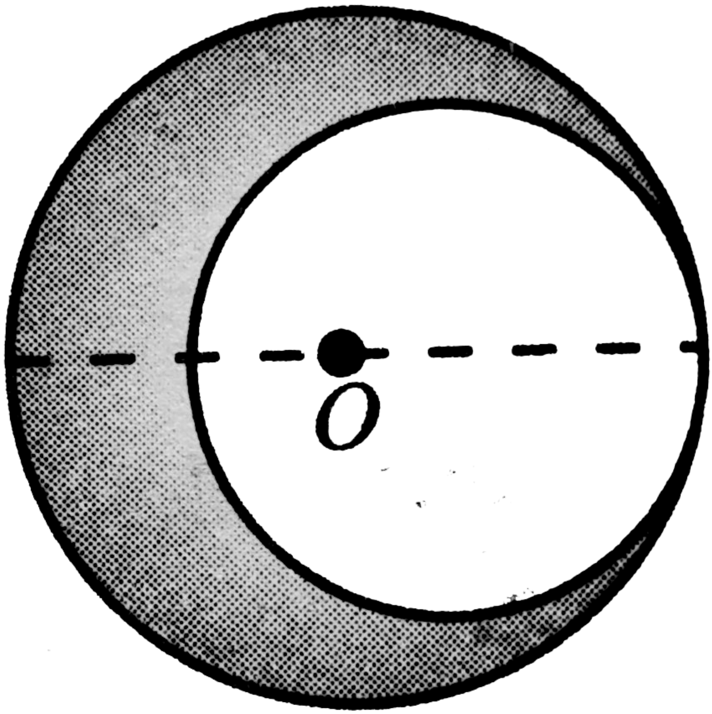
41. A circular plate of uniform thickness has a diameter of $28cm$. A circular portion of diameter $21cm$ is removed from the plate as shown. $O$is the centre of mass of complete plate. The position of centre of mass of remaining portion will shift towards left from $'O'$ by



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42. A body of mass $1kg$, initially at rest, explodes and breaks into three fragments of masses in the ratio $1:1:3$. The two pieces of equal mass fly off perpendicular to each other with a speed of $30m/s$ each. What is the velocity of the heavier fragment?

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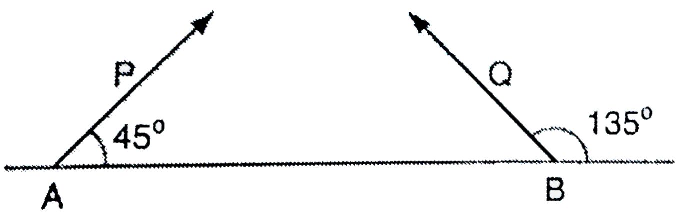
43. Particles P and Q of mass 20g and 40g respectively are simu ltaneously proejected from points A and B on the ground. The initial velocities of P and Q make 45° and 135° angles respectivley with the horizontal AB as shown in the Fig. 5.44

Each particle has an initial speed of 49m/s . the separation AB is 249m. both particles travel in the same vertical plane and undergo a collision. After collision P retraces its path. Determine the position of q when it hits the grou.d How much time after the collision does the particle Q take to reach the ground? (Take g $= 9.8 m/s^2$)



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44. A $0.5kg$ block slides from the point A on a horizontal track with an initial speed $3m/s$ towards a weightless horizontal spring of length $1m$ and force constant $2N/m$. The part AB of the track is frictionless and the part BC has the coefficient of static and kinetic friction as '0.22' and 0.20 respectively. If the distances AB and BD are $2m$ and $2.14m$ respectively, find total distance through which the block moves before it comes to rest completely. `(g=10 m//s^(2)).

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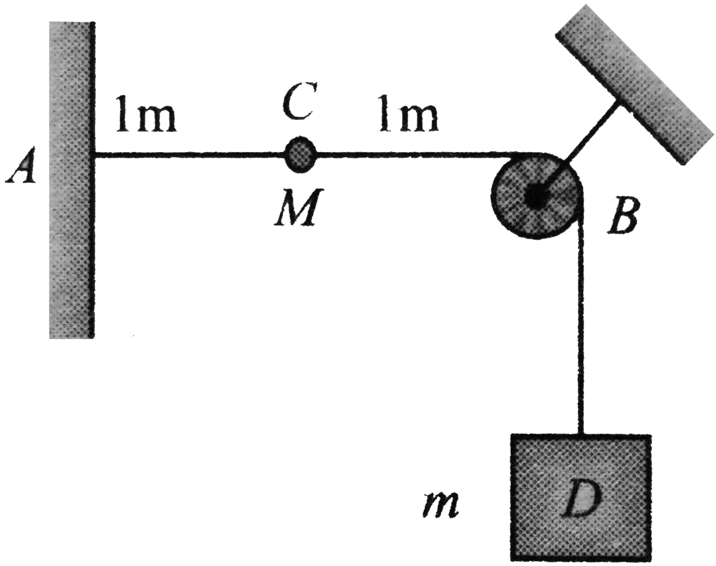
45. A string with one end fixed on a rigid wall, passing over a fixed frictionless pulley at a distance of $2m$ from the wall, has a point mass M of $2kg$ attached to it at a distance of $1m$ from the wall. A mass m of $0.5kg$ is attached to the free end. The system is initially held at rest so that the stirng is horizontal between wall and pulley and vertical beyond the pulley as shown in figure.



What will be the speed with which point mass M will hit the wall when the system is released? $(g = 10 m s^{-2})$

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46. If a sphere of mass m moving with velocity u collides with another identical sphere at rest on a frictionless surface, then which of the following is correct ?

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47. If a sphere of mass m moving with velocity u collides with another identical sphere at rest on a frictionless surface, then which of the following is correct ?

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48. A ball of mass 100 gm is projected vertically upwards from the ground with a velocity of $49m / \sec$. At the same time another identical ball is dropped from a height of 98 m to fall freely along the same path as that followed by the first ball. After some time the two balls collide and stick together and finally fall to the ground. Find the time of flight of the masses.

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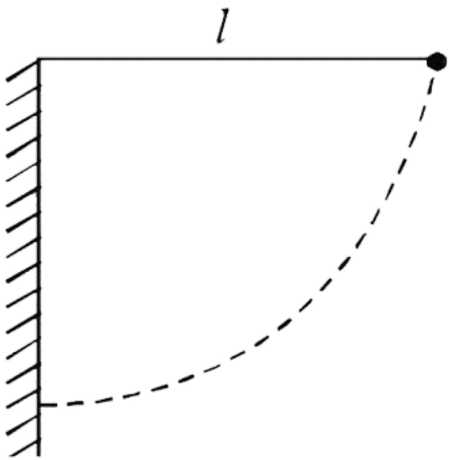
49. A simple pendalum is suspended from a peg on a verticle wall . The pendulum is pulled away from the well is a horizental position (see fig) and released . The bell his the well the coefficient of resitution being $\dfrac{2}{\sqrt{5}}$



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50. An object of mass 5 kg is projected with a velocity of $20ms^{-1}$ at an angle of 60° to the horizontal. At the highest point of its path, the projectile explodes and breaks up into two fragments of masses 1 kg and 4 kg. The fragments separate horizontally after the explosion, which releases internal energy such that K.E. of the system at the highest point is doubled Find the separation between the two fragments when they reach the ground.

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51. Two towers AB and CD are situated a distance d apart as shown in figure. AB is 20 m high and CD is 30 m high from the ground. An object of mass m is thrown from the top of AB horizontally with a velocity of 10 m/s towards CD. Simultaneously another object of mass 2 m is thrown from the top of CD at an angle 60° below the horizontal towards AB with the same magnitude of initial velocity as that of the first object. The two objects move in the same vertical plane, collide in mid-air and stick to each other.

Calculate the distance d between the towers.

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52. Two towers AB and CD are situated a distance d apart as shown in figure. AB is 20 m high and CD is 30 m high from the ground. An object of mass m is thrown from the top of AB horizontally with a velocity of 10 m/s towards CD. Simultaneously another object of mass 2 m is thrown from the top of CD at an angle 60° below the horizontal towards AB with the same magnitude of initial velocity as that of the first object. The two objects move in the same vertical plane, collide in mid-air and stick to each other.

Find the distance from B where the objects hit the ground.

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53. A small sphere of radius R is held against the inner surface of a larger sphere of radius 6R. The mass of large and small spheres are 4M and M respectively. This arrangement is placed on a horizontal table. There is no friction between any surface of contact. The small sphere is now released. The x coordinate of the centre of the larger sphere when the smaller sphere reaches the other extreme position, is found to be $(L + nR)$, find n.

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54. A cart is moving along +x direction with a velocityof $4m/s$. A person on the cart throws a stone with a velocity of $6m/s$ relative to himself. In the frame of reference of the cart the stone is thrown in y-z plane making an angle of 30° with vertical z-axis. At the highest point of its trajectory, the stone hits an object of equal mass hung vertically from the branch of a tree by means of a string of length L. A completely inelastic collision occurs, in which the stone gets embedded in the object. Determine :

(i) The speed of the combined mass immediately after the collision with respect to an observer on the ground,

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(i) The speed of the combined mass immediately after the collision with respect to an observer on the ground,

(ii) The length L of the string such that the tension in the string becomes zero when the string becomes horizontal during the subsequent motion of the combined mass.

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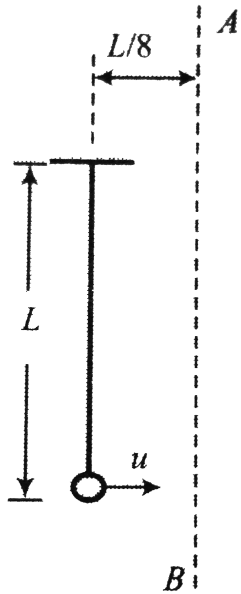
56. A particle is suspended vertically from a point O by an inextensible massless string of length L. A vertical line AB is at a distance $L/8$ from O as shown in figure. A horizontal velocity u is imparted to tha particle. At horizontal velocity u is imparted to the particle. At some point, its motion ceases to be circular and eventually the object passes through line AB. At the instant of crossing AN, its velocity is horizontal. Find out the value of u.



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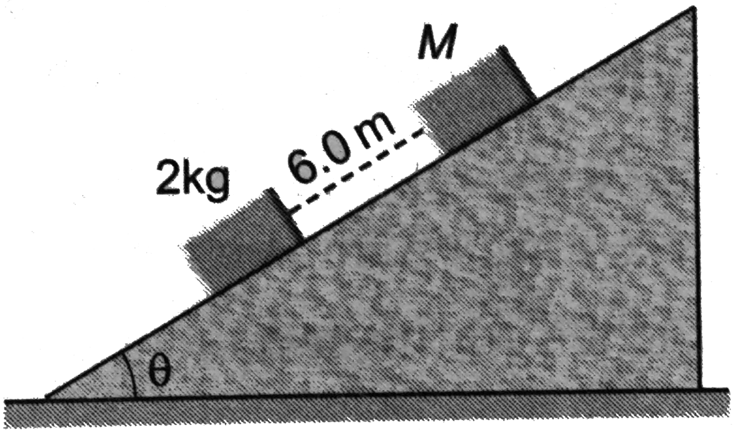
57. Two blocks of masses $2kg$ and M are at rest on an inclined plane and are separated by a distance of $6.0m$ as shown. The coefficient of friction between each block and the inclined plane is 0.25. The $2kg$ block is given a velocity of $10.0m/s$ up the inclined plane. It collides with M, comes back and has a velocity of $1.0m/s$ when it reaches its initial position. The other block M after the collision moves $0.5m$ up and comes to rest. Calculate the coefficient of restitution between the blocks and the mass of the block M.

[Take $\sin\theta = \tan\theta = 0.05$ and $g = 10m/s^2$]



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58. A car P is moving with a uniform speed $5\sqrt{3}m/s$ towards a carriage of mass 9 kg at rest kept on the rails at a point B as shown in the figure. The height AC is 120 m. Cannon balls of 1 kg are

fired from the car with an initial velocity 100 m/s with respect to the car at an angle 30° with the horizontal.

The first cannon ball hits the stationary carriage after a time t_0 and sticks to it. Determine t_0. (in sec)

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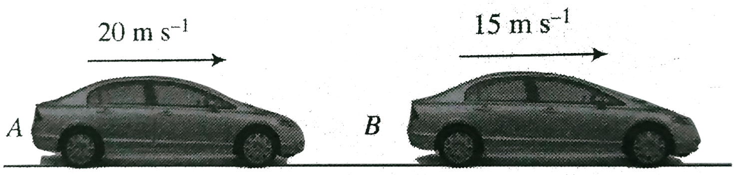
59. A car A moves with velocity $20 ms^{-1}$ and car B with velocity $15 ms^{-1}$ as shown is. Find the relative velocity of B$w.r.t.$ A, $\text{and } Aw.r.t.$ B`.



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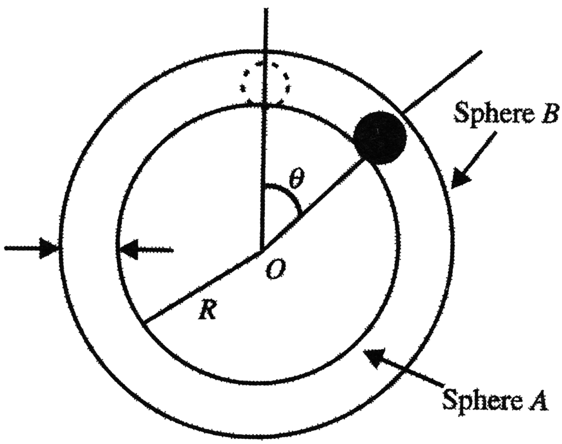
60. A sphercial ball of mass m is kept at the highest point in the space between two fixed, concentric spheres A and B (figure). The small sphere A has a radius R, and the space between the two spheres has a width d. The ball has a diameter very slightly less than d. All surfaces are frictionless. The ball is given a gentle push (towards the right figure). The angle made by the radius vector of the ball with the upward vertical is denoted by θ (shown in figure).



a. Express the total normal reaction force exerted by the sphere on the ball as a function of angle θ.

b. Let N_A and N_B denote the magnitudes of the normal reaction forces on the ball exerted by spheres A and B, respectively. Sketch the variations of N_A and N_B as functions of $\cos\theta$ in the range $0 \leq \theta \leq \pi$ by drawing two separate graphs in your answer book, taking $\cos\theta$ on the horizontal axes.

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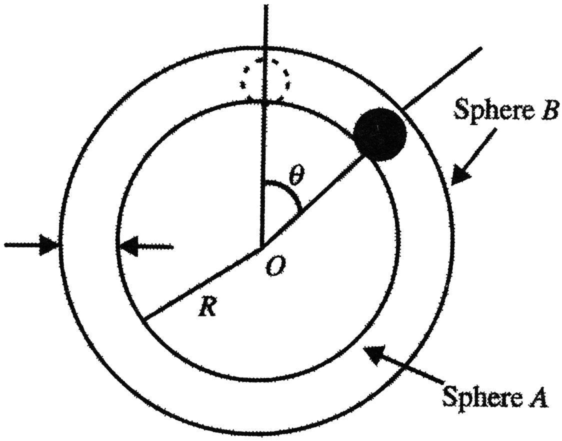

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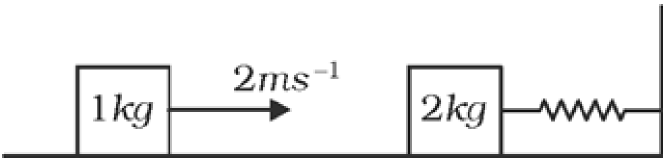
62. A spring-block system is resting on a frictionless floor as shown in the figure. The spring constant is $2.0 Nm^{-1}$ and the mass of the block is 2.0 kg. Ignore the mass of the spring. Initially the spring is in an unstretched condition. Another block of mass 1.0 kg moving with a speed of $2.0 ms^{-1}$ collides elastically with the first block. The collision is such that the 2.0 kg block does not hit the wall. The distance, in metres, between the two blocks when the spring returns to its unstretched position for the first time after the collision is



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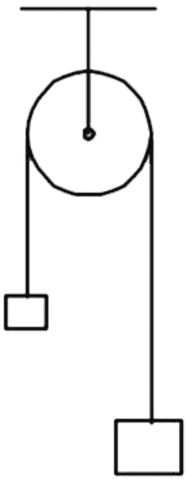
63. A light inextensible string that gas over a smoth fixed polley as shown in the figure connect two blocks of mases it 0.36 kg and 0.72 kg Taking $g = 10ms^{-2}$, find the work done by the string on the block of mass 0.36 kg doring the first second after the system is released from rest ,



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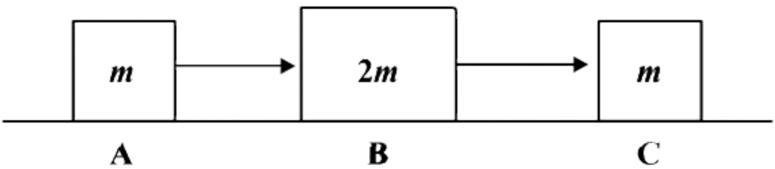
64. There object A, B and C are kept is a straing line a frictionless horizontal surface . These have masses have increase on $2m$ and m respectively . The object A move toward B with a speed 9 m//s and makes as elastic collision with a there after B makes completely inclesis with C . All motion over on the same straight line . Find the first speed of the object C



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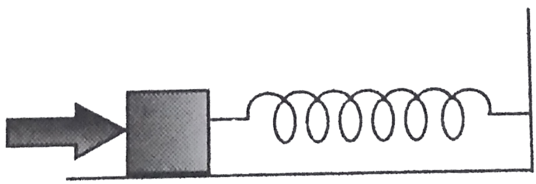
65. A block of mass $0.18kg$ is attached to a spring of force constant $2Nm^{-1}$. The coefficient of friction between the block and the floor is 0.1. Initially the block is at rest and the spring is unstretched. An impulse is given to the block as shown in figure. The block slides a distance of $0.06m$ and comes to rest for the first time. The initial velocity of the block in ms^{-1} is $V = N/10$. Then N is



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66. A bob of mass m, suspended by a string of length l_1 is given a minimum velocity required to complete a full circle in a vertical plane. At the highest point, it collides elastically with another bob of mass m suspended by a string of length l_2, which is initially at rest. Both the strings are mass-less and inextensible. If the second bob, after collision acquires the minimum speed required to complete a full circle in the vertical plane, the ratio l_1 / l_2 is

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67. A particle of mass $0.2kg$ is moving in one dimension under a force that delivers a constant power $0.5W$ to the particle. If the initial speed (in m/s) of the particle is zero, the speed (in ms^{-1}) after $5s$ is

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68. Consider an elliptically shaped rail PQ in the vertical plane with OP = 3 m and OQ = 4 m. A block of mass 1 kg is pulled along the rail from P to Q with a force of 18 N, which is always parallel to line PQ (see the figure given). Assuming no frictional

losses, the kinetic energy of the block when it reaches Q is: $(n \times 10)$ joules. The value of n is (take acceleration due to gravity = $10 m s^{-2}$)

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69. A particle is moved along a path $AB - BC - CD - DE - EF - FA$, as shown in figure, in presence of a force $\vec{F} = \left(\alpha y \hat{i} + 2\alpha x \hat{j}\right) N$, where x and y are in meter and $\alpha = -1 N m^{-1}$. The work done on the particle by this by this force will be Joule.

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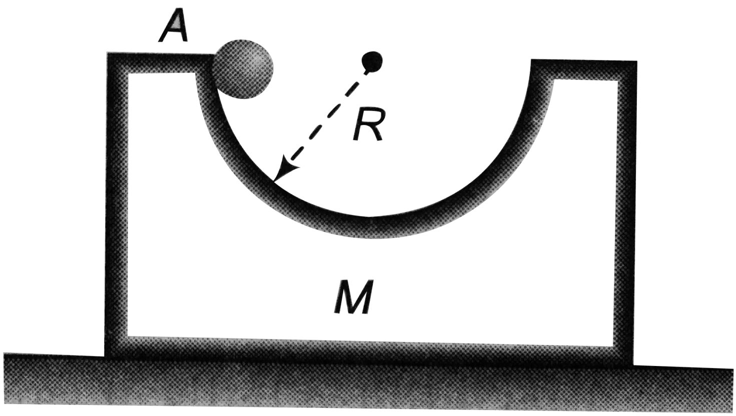
70. A block of mass M with a semicircular track of radius R rests on a horizontal frictionless surface shown in figure. A uniform cylinder of radius r and mass m is released from rest at the point A. The cylinder slips on the semicircular frictionless track. How far has the block moved when the cylinder reaches the bottom of the track? How fast is the block moving when the cylinder reaches the bottom of the track?



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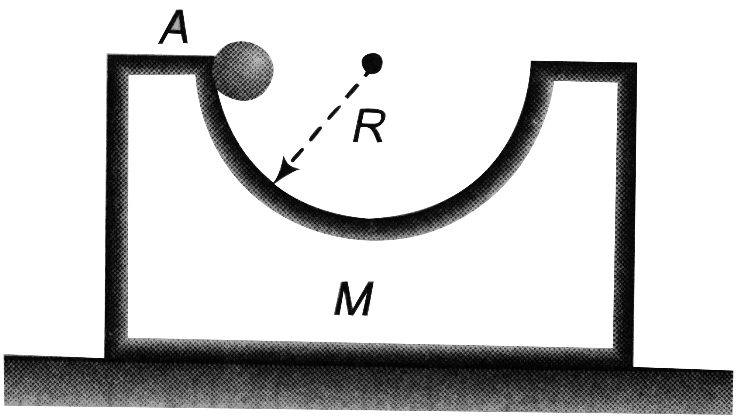

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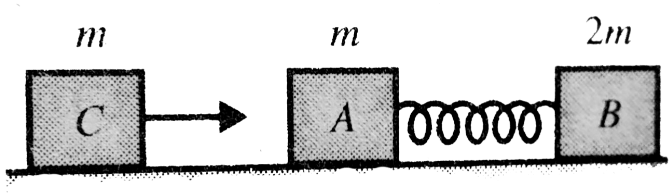
72. Two blocks A and B of masses in and $2m$ respectively placed on a smooth floor are connected by a spring. A third body C of mass m moves with velocity v_0 along the line joining A and B and collides elastically with A. At a certain instant of time after collision it is found that the instantaneous velocities of A and B are same then:



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73. A particle of mass $4m$ which is at rest explodes into masses m, m & $2m$. Two of the fragments of masses m and $2m$ are found to move with equal

speeds v each in opposite directions. The total mechanical energy released in the process of explosion is :-

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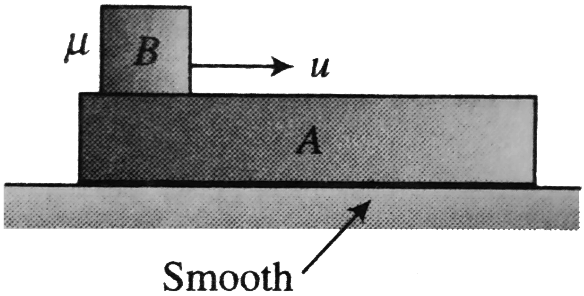
74. A long block A is at rest on a smooth horizontal surface. A small block B whose mass is half of mass of A is placed on A at one end and is given an initial velocity u as shown in figure. The coefficient of friction between the blocks is μ.



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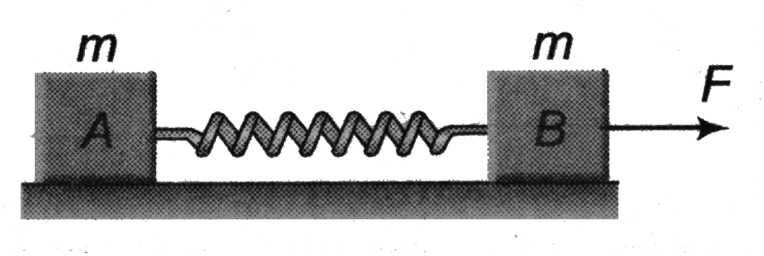
75. Two identical blocks A and B of mass m joined together with a massless spring as shown in figure are placed on a smooth surface. If the block A moves with an acceleration a_0, then the acceleration of the block B is



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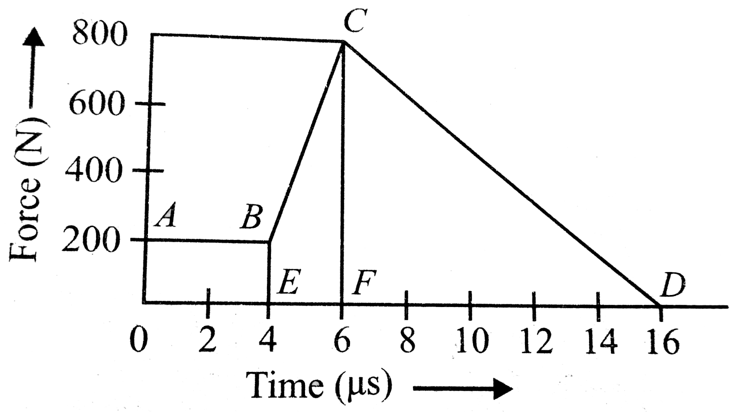
76. The magnitude of force (in newtons) acting on a body varies with timer t (in microseconds) as shown in Fig. AB, BC and CD are straight line segments. The magnitude of total impulse of the force on the body from $t = 4s$ to $t = 16s$ is__________ Ns



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77. Two point masses m_1 and m_2 are connected by a spring of natural length l_0. The spring is compressed such that the two point masses touch each other and then they are fastened by a string. Then the system is moved with a velocity v_0 along positive x-axis. When the system reached the origin, the string breaks $(t=0)$. The position of the point mass m_1 is given by $x_1 = v_0 t - A(1-\cos\omega t)$ where A and ω are constants. Find the position of the second block as a function of time. Also, find the relation between A and l_0.

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78. Two point masses m_1 and m_2 are connected by a spring of natural length l_0. The spring is compressed such that the two point masses touch each other and then they are fastened by a string. Then the system is moved with a velocity v_0 along positive x-axis. When the system reached the origin, the string breaks $(t = 0)$. The position of the point mass m_1 is given by $x_1 = v_0 t - A(1 - \cos \omega t)$ where A and ω are constants. Find the position of the second block as a function of time. Also, find the relation between A and l_0.

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79. A particle of mass m, moving in a circular path of radius R with a constant speed v_2 is located at point (2R, 0) at time t = 0 and a man starts moving with a velocity v_0 along the positive y-axis from origin at time t = 0. Calculate the linear momentum

of the particle w.r.t. man as a function of time

_____________.

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80. Two blocks A and B are connected to each other by a string and a spring, the string passes over a frictionless pulley as shown in the figure. Block B slides over the horizontal top surface of a stationary block C and the block A slides along the vertical side of C, both with the same uniform speed. The coefficient of friction between the surfaces of blocks is 0.2. Force constant of the

spring is 1960 newtons/m. If mass of block A is 2 kg. The mass of block B and the energy stored in the spring are ____ kg and ____ J.

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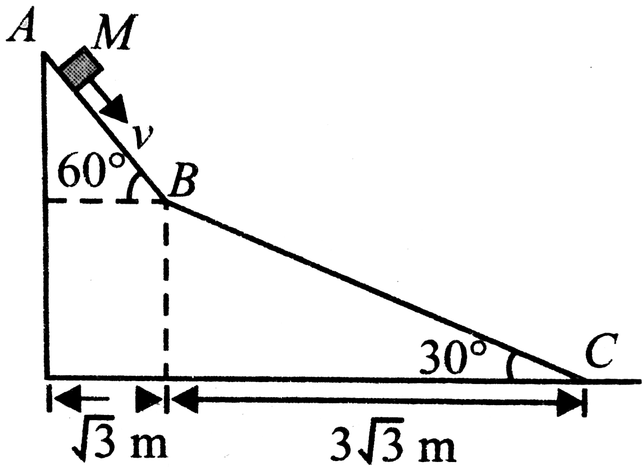
JEE ADVANCE (ARCHIVE) - PARAGRAPH QUESTIONS

1. A small block of mass M moves on a frictionless surface of an inclined plane, as shown in the figure. The angle of the incline suddenly changes from 60° to 30° at point B. The block is many at rest at A.

Assume that collisions between the block id the incline are totally inelastic.

The speed of the block at point C, immediately before it leaves the second incline



A. $\sqrt{60}m/s$

B. $\sqrt{45}m/s$

C. $\sqrt{30}m/s$

D. $\sqrt{105}m/s$

Answer: B

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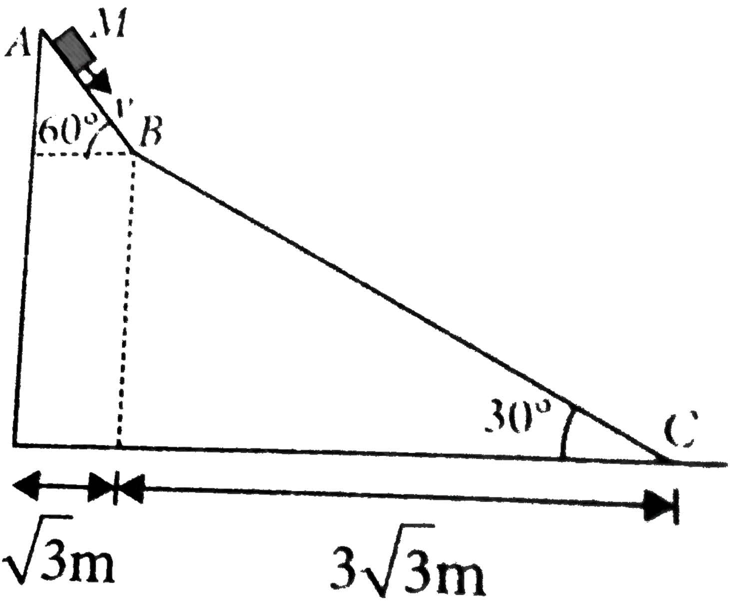
2. A small block of mass M moves on a frictionless surface of an inclined plane as shown in the figure. The angle of the incline suddenly changes from 60° to 30° at point B. The block is initially at rest at A. Assume that collisions between the block and the incline are totally inelastic. The speed of the block at point B immediately after it strikes the second incline is



A. $\sqrt{120}m/s$

B. $\sqrt{105}m/s$

C. $\sqrt{90}m/s$

D. $\sqrt{75}m/s$

Answer: B

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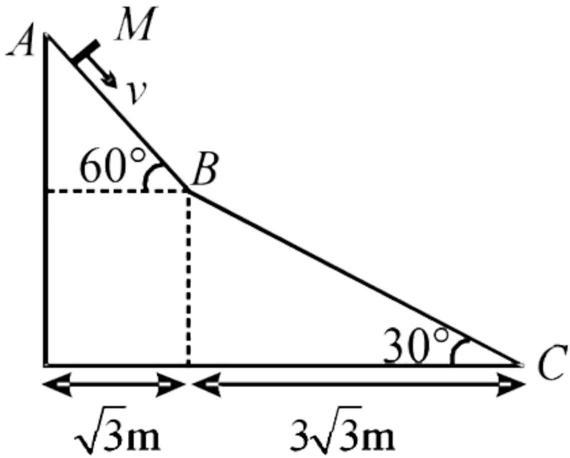
3. A small block of mass M move on a frictionless surface of an inclimed from as down is figure . The engle of the inclime suddenly change from 60° to 30° at point B . The block is initally at rest at A Assume the collsion between the block and the incline are totally inclassic $(g = 10m / s^2)$



If collision between the block and the incline is completely elestic , then the vartical (apward) component of the of the block at point B immediatly after it stricess the scond indine is -

A. $\sqrt{30}m / s$

B. $\sqrt{15}m / s$

C. 0

D. $-\sqrt{15}m / s$

Answer: C

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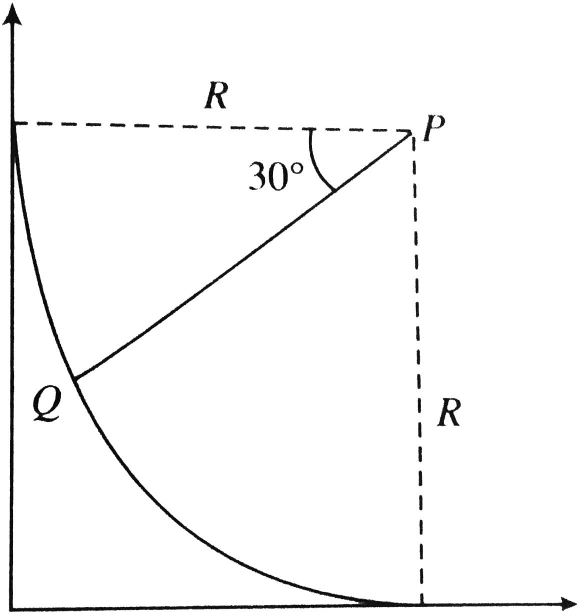
4. A small block of mass $1kg$ is released from rest at the top of a rough track. The track is circular arc of radius $40m$. The block slides along the track without toppling and a frictional force acts on it in the direction opposite to the instantaneous velocity. The work done in overcoming the friction up to the point Q, as shown in figure. is $150J$. (Take the acceleration due to gravity, $g = 10ms^{-2}$)



The speed of the block when it reaches the point Q

is

A. $5 ms^{-1}$

B. $10 ms^{-1}$

C. $10\sqrt{3} ms^{-1}$

D. $20 ms^{-1}$

Answer: B

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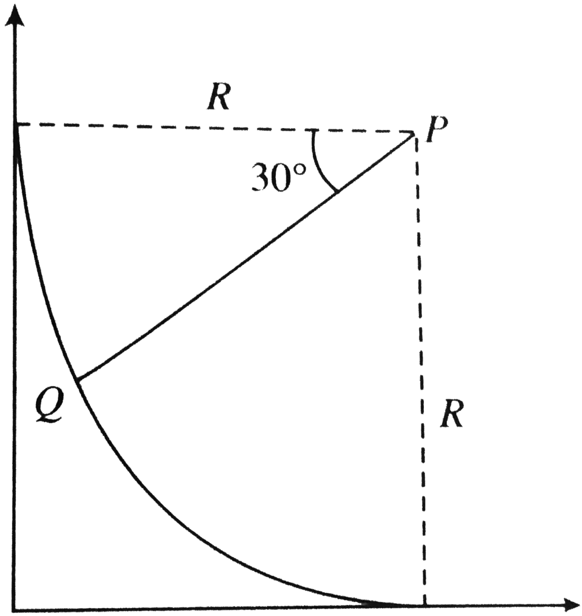
5. A small block of mass $1kg$ is released from rest at the top of a rough track. The track is circular arc of radius $40m$. The block slides along the track without toppling and a frictional force acts on it in the direction opposite to the instantaneous velocity. The work done in overcoming the friction up to the point Q, as shown in figure. is $150J$. (Take the acceleration due to gravity, $g = 10ms^{-2}$)



The magnitude of the normal reaction that acts on the block at the point Q is

A. 7.5 N

B. 8.6 N

C. 11.5 N

D. 22.5 N

Answer: A

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JEE ADVANCE (ARCHIVE) - ASSERTION & REASON TYPE

1. These questions consists of two statements each printed as Assertion and Reason. While answering these question you are required to choose any one of the following five reponses

(a) If both Assertion and Reason arecorrect and Reason is the correct explanation of Asserrtion.

(b) If both Assertion and Reason are correct but

Reason is not the correct explanation of Assertion.

(c) If Assertion is true but Reason is false.

(d) If Assertion is false but Reason is true.

Assertion A block of mass m starts moving on a rough horizontal surface with a velocity v. It stops due to friction between the block and the surface after moving through a certain distance.

The surface is now tilted to an angle of 30° with the horizontal and the same block is made to go up on the surface with the same initial velocity v. The decrease in the mechanical energy in the second situation is smaller than that in the first situation.

Reason The coefficient of friction between the block and the surface decreases with the increase in the anglle of inclination.

A. Statement-I is True, Statement-II is True and Statement-II is a correct explanation for Statement-I.

B. Statement-I is True, Statement-II is True and Statement-II is NOT a correct explanation for Statement-I.

C. Statement-I is True, Statement-II is False.

D. Statement-I is False, Statement-II is True

Answer: C

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JEE ADVANCE (ARCHIVE) - MATCH MATRIX TYPE

1. A particle moves along the X-axis x=0 to x=5 m under the influence of a force given by $F = 10 - 2x + 3x^2$. Work done in the process is

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JEE ADVANCE (ARCHIVE) - FILL IN THE BLANKS TYPE

1. Three particles A, B and C of equal mass move with equal speed 10 m/sec along the medians of an equilateral triangle as shown in the figure. They collide at the centroid G of the triangle. After the collision, A comes to rest, B retraces its path with the speed 10 m/sec. The velocity of C is ______ m/sec.

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JEE ADVANCE (ARCHIVE) - TRUE/FALSE TYPE

1. Two particles of mass 1 kg and 3 kg move towards each other under their mutual force of attraction. No other force acts on them. When the relative velocity of approach of the two particles is 2m/s, their centre of mass has a velocity of 0.5 m/s. When the relative velocity of approach becomes 3m/s, the velocity of the centre of mass is 0.75 m/s.

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