# PHYSICS

## BOOKS - MODERN PUBLISHERS PHYSICS (HINGLISH)

## WORK, ENERGY AND POWER

### Solved Examples

**1.** A man carries a suitcase on head by applying a force of 20 N . He travels a horizontal a distance of 10 m and then climbs a vertical distance of 5 m . Calculate the total work done by him .

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**2.** A force $\vec{F} = \left(2\hat{i} - 3\hat{j} + 7\hat{k}\right)$ N is applied on a particle which displaces it by $\vec{S} = \left(4\hat{i} + 5\hat{j} + \hat{k}\right)$ . Find the work done on the particle .

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**3.** A cyclist comes to a skidding stop in $10m$. During this process, the force on the cycle due to the road is $200N$ and is directly opposite to the motion.

a. How much work does the road do on the cycle?

b. How much work does the cycle do on the road?

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**4.** Two forces $\vec{F}_1 = -\hat{i} + 2\hat{j} - 3\hat{k}$ and $\vec{F}_2 = 2\hat{i} - 4\hat{j} + 3\hat{k}$ act on a body and cause it to displace from point A(3,1,2) to $B(-4, -2, 3)$. Calculate the total work done on the particle .

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**5.** A uniform rope of length 3 m and mass 1 kg is kept on a table such that 80 cm of its length hangs freely from the edge of the table . Calculate the

work done in pulling the entire rope on the table .

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**6.** A man of weight 60 kg f is carrying a load of 20 kg of on his head . He moves a distance of 25 m up an incline of 1 in 12 . Calculate the work done by him .

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**7.** Calculate the kinetic energy acquired by a body of mass 5 kg initially at rest , when subjected to a force of 20 N , at the end of 8 s .

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**8.** A toy rocket having mass 0.2 has a small fuel of mass $0.04$ kg which it burna out in 6 s. Starting from rest on a horizontal smooth track , it gets a speed of 40 m/s after the fuel is burnt out completey . What will be the

approximate thrust of the rocket ? What is the energy content per unit mass of the fuel ? (Ignore the small mass variation of the rocket during fuel burning )

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**9.** A bullet of mass 20 g is fired with a velocity of 1000 m/s . After passing through a mud wall 1.5 m thick , its velocity decreases to 400 m/s . Calculate the average resistance offered by the mud wall .

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**10.** It is well known that a rain drop falls under the influence of the downward gravitational force and the opposing resistive force. The latter is known to be proportional to the speed of the drop, but is otherwise undetermined. Consider a drop of mass 1.0g falling from a height of 1.00km. It hits the ground with a speed of $50.0ms^{-1}$ (a) What is the work done by the gravitational force ? (b) What is the work done by the unknown resistive force ?

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**11.** Two identical bodies of mass 4 kg each are approaching each other with a speed of 3 m/s , on a frictionless horizontal surface . When the two bodies collide , they stick together and come to rest . Calculate the work done by the external forces and internal forces on the system of blocks .

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**12.** Calculate the % increase in kinetic energy of a body if its linear momentum increases by 50 % .

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**13.** A lady running on the road has kinetic energy that is half of that of girl . The girl's mass is half of the lady's mass. The lady increases her speed y m/s and then has the same energy as of girl . Calculate the original speeds of the lady and the girl .

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**14.** A block of mass $m = 1kg$ moving on a horizontal surface with speed $v_i = 2ms^{-1}$ enters a rough patch ranging from $x0.10m \to x = 2.01m$. The retarding force $F_r$ on the block in this range ins inversely proportional to x over this range

$F_r = -\frac{k}{x} for 0.1 < x < 2.01m$

$= 0$ for $< 0.1m$ and $x > 2.01m$ where $k = 0.5J$. What is the final K.E. and speed $v_f$ of the block as it crosses the patch?

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**15.** A force $F = p + qx$ acts on a particle in the X - direction , where p and q are constants . If the particle is displaced from x = a to x = b , find the work done by the force .

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**16.** A variable force as shown in the figure given below acts on a body and displaces it from point A to B . What is the amount of work dons ?

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**17.** A particle moves along Y - axis from y = 0 m under the influence of a force $F = (9 + 3y + 5y)^2$ N . Calculate the work done on the particle .

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**18.** A woman pushes a trunk on a railway platform which has a rough surface. She applies a force of 100N over a distance of 10m. Thereafter, she gets progressively tired and her applied force reduces linearly with distance to 50N. The total distance through which trunk has been moved is 20m. Plot the force applied by the woman and the frictional force, which is 50N against the distance. Calculat the work done by the two forces over 20m.

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**19.** A truck of mass 2000 kg climbs up hill of height 250 m . It then moves on a straight road on the top of hill with the speed of 20 m/s . Calculate the potential energy gained by the truck and its total mechanical energy when moving on the top of the hill .

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**20.** A bob of mass 2 kg hangs from a string of length 5 m . It swings from its rest position to one of the sides so that the string makes an angle of $60^\circ$ with the vertical Calculate the gain in potential energy of the bob .

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**21.** A ball initally at rest is dropped from a height of 10 m . In strinking the ground , it loses 20 % of its kinetic energy . Calculate the height to which it bounces . Where does the lost kinetic energy go ?

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**22.** A round pebble is released from the point X inside a frictionless hemispherical ball as shown in the figure such that it just upto edge Y of the bowl . With what speed the pebble is released down inside the bowl ?

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**23.** A wooden bob of mass 1 kg is suspended from a string of length 1 m . It is struck by a bullet of mass 0.02 kg , moving with a speed of 300 m/s , such that the bullet gets embedded inside it . Calculate the maximum height up to which the bob will rise after the impact .

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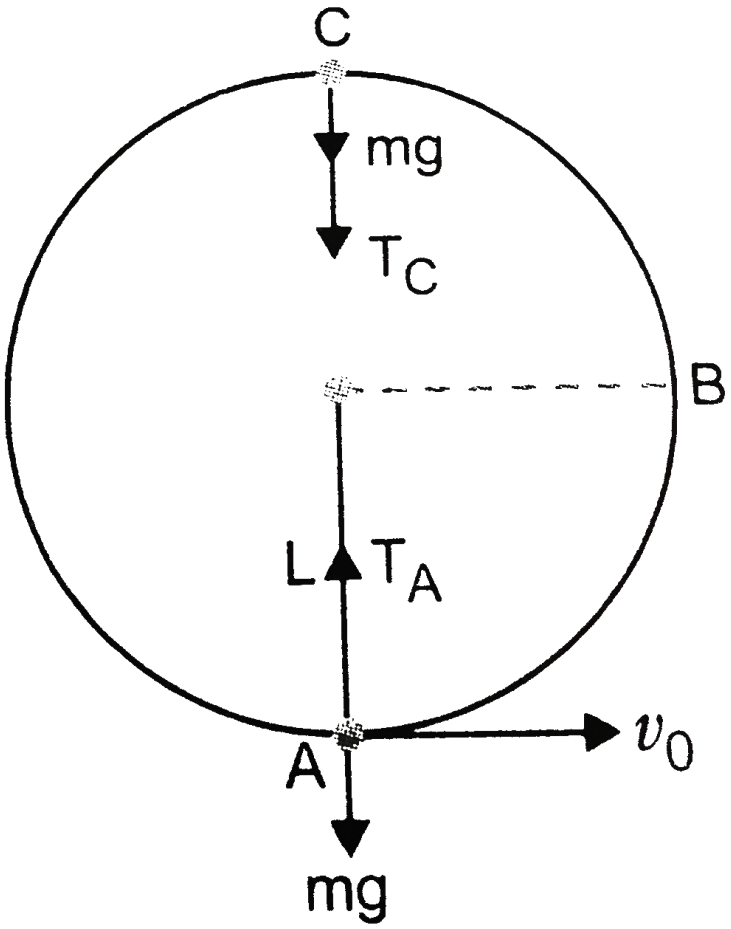
**24.** A bob of mass m is suspended by a light string of length L. It is imparted a horizontal velocity $v_0$ at the lowest point A such that it completes a semi-circular trajectory in the vertical plane with the string

becoming slack on reaching the topmost point C, figure, Obtain an expression for (i) $v_0$ (ii) the speeds at points B and C, (ii) the ration of kinetic energies $(K_B / K_C)$ at B and C.

Comment on the nature of the trajectory of the bob after it reahes the poing C.

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**25.** When a steel wire is loaded with a weight of 3 kg , its length increases y 0.2 cm . Calculate the force constant of the wire and the work done in stretching the wire .

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**26.** To simulate car accidents auto manufactures study the collisions of moving cars with mounted springs of different spring constants . Consider a typical simulation car of mass 1000 kg moving with a speed $18.0 \ \mathrm{km\,h}^{-1}$ on a smooth road and colliding $6.25 \times 10^{3}\mathrm{Nm}^{-1}$ . What is the maximum compression of the spring ?

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**27.** In the figure shown below , a block of mass 4 kg is attached to a spring constant 24 N/m . The coefficient og friction $\mu = 0.5$ . If the system is initially at rest and a constant horizontal force of 50 N is applied on the block , then calculate its speed when it is moved through a distance of 0.6

m .

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**28.** Given figure shows a massless platform kept on a light elastic spring attached to ground from one end .

A small particle of mass 0.2 kg is dropped on the paltform from a height of 0.26 m , which causes a compression of 0.01 m in the spring . Calculate the height from which the particle must be dropped in order to cause a compressin of 0.05 m .

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**29.** A body of mass 0.4 kg is tied to one end of a string and the other end of the string is tied to a small pivot on a vertical wall . Calculate the minimum speed of the body required at its lower most pint to avoid slacking of string at any point in its motion along the vertical circle of radius 1 m .

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**30.** A body of mass 0.6 mg kg is whirled in a vertical circle making 5 revolutions in one second . If the radius of the circle is 1.4 m , find the tension in the string , when the body is (i) at the lower most of the circle point , (ii) at the top of the circle .

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**31.** A bucket of water tied to one end of a rope of length 3 m is rotated in a vertical circle about the other end in such a way that water in it dows not spill . Calculate the minimum velocity of the bucket at which this happens .

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**32.** A stone of mass 0.4 kg is tied to a string and rotated in a vertical circle of radius 1.2 m . Calculate the speed of the stone for which the tension in

the string is zero at the highest point of the circle . What is the tension at the lowest point in this case ?

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**33.** A fighter plane flying in the sky describes a vertical circle of radius 150 m when looping with a speed of 420 km/h . The weight of the pilot sitting inside it is 90 kg . With what force the pilot presses his seat when the plane is at the

(i) highest position of circle

(ii) lowest position of circle

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**34.** How much mass is converted into energy per second in the sun if this power output is $3.6 \times 10^{27}$ W ?

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**35.** 400 kg of water is heated from $30^{\circ}C$ to $100^{\circ}C$ . What will be the increase in mass of water ? Take specific heat of wateer $= 4.2 \times 10^{3}\ \text{J kg}^{-1}.^{\circ}C^{-1}$ .

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**36.** An elevator in a building is designed to carry a load of 5000 kg throgh 10 floors . If height of each floor is 5 cm on an average and it takes 8 seconds to climb 10 floors , calculate the horse power of the lift .

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**37.** A car having mass 4000 kg is lifted up a distance of 60 m by a crane in 2 min . A second crane does the same job in 4 min . How much fuel is consumed by two cranes ? What is the power supplied by each crane ? Ignore power dissipation against friction .

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**38.** A motor of power 10 kW is used to pump water from a well 20 m deep . Calculate the efficiency of the motor if it pumps 200 kg of water every minute . Take $g = 10m / s^2$

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**39.** An elevator can carry a maximum load of $1800kg$ (elevator + passengers) is moving up with a constant speed of $2ms^{-1}$. The friction force opposite the motion is $4000N$.What is minimum power delivered by the motor to the elevator?

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**40.** A 25 m deep well contains water upto 15 m . An engine evacuates the well in 1.5 hrs . If the diameter of the well is 2 m ,calculate the power of the engine .

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**41.** Two balls of masses 10 kg and 20 kg approach each other with velocities 30 m/s and 20 m/s respectively . Calculate their velocities after they undergo a perfectly eleastic collision .

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**42.** A truck of mass 1000 kg moving with a speed of 72 km/hr collides with a stationary truck of the same mass . After the collision , the trucks get stick together and move . Calculate their common speed after collision . Is it elastic or ineleastic collision ?

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**43.** In a nuclear reactor, a neutron of high speed $\left( \approx 10^7 ms^{-1} \right)$ must be slowed down to $10^3 ms^{-1}$ so that it can have a high probality of interacting with isotipe $_{92}U^{235}$ and causing it to fission. Show that a neutron can lose most of its K.E. in an elastic collision with a light nuclei like deuterium or carbon which has a mass of only a fewe times the

neutron mass. The material making up the light nuclei usually heavy water $(D_2O)$ or graphite is called modertaor.

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**44.** A ball is dropped from a heght of 3.6 m and strikes a horizontal surface . It rebounds from the horizontal surface to height h . Calculate h , if coefficient of restitution is 0.6

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**45.** When a ball is dropped from a certain height h , it robounds from the ground , strikes again and rebounds again , a number of times before finally coming to rest . If the coefficient of restitution is e , find the height to which it robunds after $p^{th}$ collision ..

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**46.** A spherical body moving with a speed of 10 m/s strikes another identical body at rest such that after collision , the direction of motion of each ball makes an angle of $15^\circ$ with the original direction of motion . Calculate the speed of each body after collision .

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**47.** Consider the collision depicted in Figure, to be between two billiard balls with equal masses $m_1 = m_2$. The first ball is called the cue and the second ball is called the target. The billiard player wants to sink the target ball in a corner pocket, which is at an angle $\theta_2 = \phi = 37^\circ$. Assume that the collision is elastic and that friction and rotational motion are not important. Obtain $\theta_1 = \theta$ .

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Practice Problems

**1.** A man weighning 60 kg is holding of mass 10 kg on his head . What will be the work done by the man if he travels a distance of 20 m in

(i) vertical direction ( up or down ? )

(ii) horizontal direction

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**2.** On applying a force $\left(\vec{F} = 3\hat{i} - 6\hat{j} + 4\hat{k}\right)$ N on a body , the body is dispalced through along negative direction of X - axis is 2 m . Calculate the work done by this force .

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**3.** What will be the work done by a man weighning 40 kgf and holding a body of 20 kgf on his head and moving a distance of 10 m up an incline of 10 m up an incline of 1 in 5 (Take $g = 9.8ms^{-2}$) ?

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**4.** Two constant forces $\vec{F}_1 = 6\hat{i} + 3\hat{j} - \hat{k}$ and $\vec{F}_2 = 3\hat{i} - 2\hat{j} + \hat{k}$ are acting upon a body along the same direction . Calculate the work done by these forces if the body is displaced from the point (2,1,2) to (3,-4,-5) .

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**5.** A force F = $(10 + 0.25x)$ is acting on a particle moving along positive X direction . Calculate the work done by this force during a displacement from x = 1 m to x = 4 m .

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**6.** Two moving bodies of masses 5 kg and 25 kg have same kinectic energies . Find the ratio of their linear momentum .

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**7.** If momentum of a body is increased by 30 % then find the percentage increase in K.E

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**8.** If K.E of a body is decreased by 20 % then find the percentage change in momentum .

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**9.** A cricket player draws his hands backwards through 10 cm while catching a ball of mass 150 g moving with a velocity of 25 , $ms^{-1}$ . Calculate the work done in catching the ball and the average force exerted by the ball on the hand .

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**10.** A ball weighing 0.3 kg is whirling in a vertical circle of radius 1.5 m . The number of revolutions made by the ball per second is 5 . Calculate the tension in the string at the topmost point and at the lowerment point .

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**11.** The tensile strength of a weightless thread is 4 kg wt . Consider a stone of mass 200 g is tied to it and evolves in a vertical plane of radius 5 m . Calculate the maximum angular velocity of the stone .

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**12.** A bob is attached to one end of weightless string and makes a vertical circle while looping . If the velocity of the bob at the lowest point is $70 \ \mathrm{m\,s^{-1}}$ then calculate the radius of the greatest possible loop .

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**13.** 500 J of work is done in lifting a 30 kg weight to a height of 0.5 m . With what acceleration the weight was raised ?

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**14.** A bullet moving with a speed of $200 \ \mathrm{m\,s^{-1}}$ is absorbed by a wooden block of mass 1500 g suspended by a string . Caclulate the vertical height through which the block will rise . The mass of the bullet is 20 g .

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**15.** A ball of mass m is dropped from a height of 20 m . The ball loses 20 per cent of its kinectic energy in striking the ground . What will be the height to which the ball will bounce ? Where does this lost energy go ?

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**16.** A spring is compressed by 10 cm by a ball of mass 20 g . What will be the potential energy of a spring if the force constant of the spring is 20 N $cm^{-1}$ .

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**17.** The P.E of a spring on stretching through a distance of 5 m is 20 J . Calculate the amount of work done on this spring on stretching it further through a distance of 2 m .

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**18.** If the potential energy of a gas molecules is given by $U = \frac{X}{r^4} - \frac{Y}{r^8}$ where X and Y are constants and are positive. Calculate the otential energy at equilibrium .

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**19.**

Consider a block of mass 6 kg is attached to a spring having constant 16 $Nm^{-1}$ . If the block is at rest initially and then stretched by a constant force of 20 N on frictionless surface as shown in figure . Caclculate the speed of the block when it has moved through a distance of 0.2 m from its initial position . d

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**20.** A boy is cycling with a speed of 10 km $h^{-1}$ on a hill of slope 1/20 . The weight of the boy and the cycle is 120 kg . Calculate the work done by the man per minute . Also find his horse power .

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**21.** A pump of power 20 kW is used to jump out the water from a well 12 m deep . Calculate the efficiency of the pump if 5,000 kg of water is pumped out in 1 minute .

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**22.** The power of a car is 20 hp . The car is facing resistance of 10 kg wt . Due to air and friction . Calculate the maximum speed attained by the car against this resistance .

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**23.** The potential energy of the water is converting into electric energy by making it to fall from a height of 100 m . How many 60 W bulbs can be lit by this electric energy if $2 \times 10^6$ kg of water is falling in 1 hour .

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**24.** A moving particle collides with a stationary particle and imparts kinectic energy to the stationary particle . What percentage of kinectic energy will be transferred to the stationary particle if the mass of stationary particle is 30 times the mass of moving particle ?

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**25.** A particle of mass m is strikes on ground at an angle of incidence $30^\circ$ with initial speed of 5 m/s . Calculate (i) its velocity after impact (ii) angle of reflection . Given that the coefficient of restitution is $\frac{1}{\sqrt{3}}$

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**26.** The wooden bob of a simple Pendulum of length 1 m is struck by a bullet of mass $10^{-3}$ kg moving with a speed of 300 m $s^{-1}$ . If the bullet gets embedded into the bob then calculate the height to which the bob will rise before going back to mean position. The mass of bob is 0.8 kg .

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**27.** A ball is falling a height of 50 m . It strikes the ground and rebounds to a height of 10 m . Calculate the velocity of the ball just before and after

the collision . Also find the loss of kinectic energy of the ball during its collisio with ground .

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## Conceptual Questions

**1.** Is it possible for a body to be in accelerated motion under the action of a force but still no work is done by the force? Cite an example in support of your answer.

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**2.** Can we have a body with overall negative energy? Give example.

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**3.** Two identical springs X and Y are compressed by the same amount. If X is stiffier than Y, in which spring more work has to be done?

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**4.** It is observed that water at the foot of a waterfall is of different tampreature than that at the top . Why?

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**5.** Is it true for every force in nature that the work done by it on the undergoing motion in a closed loop is always zero?

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**6.** A big and a small car are moving with the same kinetic energy on a straight road. If engines of both the car are switched off together. Which

one will stop after covering more distance?

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**7.** A bomp thrown with certain speed explodes in mid air before hitting its target. What will be effect on its total kinetic energy?

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**8.** A heavy metal ball is suspaended from a staring from the celling of a room. A boy holds the ball in hand and draws it away from its equilibrum position, at some angle with the vertical , very close to his face. The ball is then released from rest. Will it hit back the boy on its return swing? What will be the case if the ball is given some initial push when released?

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**9.** Is it possible to have a situation where mechnial energy (E ) - potential energy $(E_p)$ is negative, i.e., $(E - E_p) < 0$ ?

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**10.** Give all stages of energy of conversions whwn an athlete performs a pole vailt, starting with the athlete standing at rest, then running , then going up and over the bar, and finally landing on the big foam pad.

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**11.** It is observed that a metal ball rebounds better than a rubber ball. Why?

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**12.** When is the exchange of energy maximum during an elastic collision?

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**13.** Kinetic energy varies as a square of momentum. A rocket expoldes mid air. Its total momentum is conserved but its total kinetic energy increases. How is this possible?

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**14.** In a tug of war, one team is giving way to other. What work is being done and by whom?

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**15.** A spark is produced when two stones strike against each other. Why?

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**16.** An artificial satellite orbiting the earth in very thin atmosphere loses its energy gradually due to small but continuous dissipation against atmospheric resistance. Then explain why its speed increases progressively as it comes closer and closer to the earth.

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**17.** A body undergoing a straight line motion is under the influence of source of constant power. How does its displacement very with time?

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**18.** A skater wearing his skates is oushing a wall. What will be the work done by the contact force on the skater as he moves away from the wall?

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**19.** For a man walking on the floor, the force of friction between the floor and his feet accelerates him forword. What will be work done by the force of friction, postive, negative or zero?

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**20.** Two blocks of masses m and 3m, intially at rest, are pushed from line 1 to line 2 by applying an equal force F as shows in the following figure: Which of the following statements is correct regarding the kinetic energes of the two blocks when they reach the line 2? (a) Both blocks have equal kinetic energy , (b)block of mass 3m has greater kintic energy, (c) block of mass m has greater kinetic energy.

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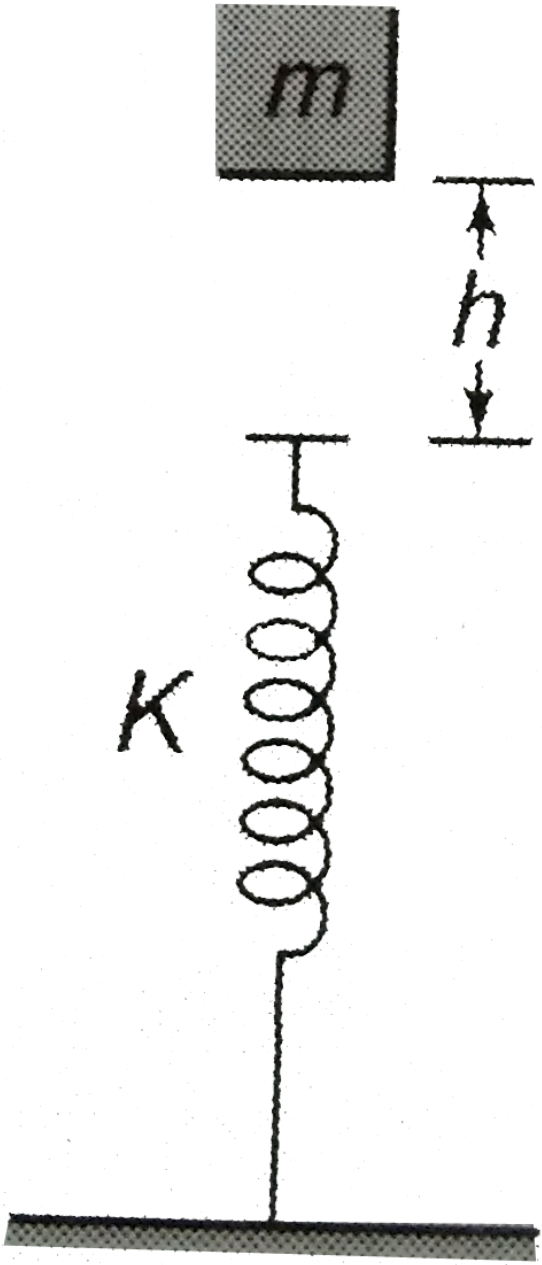
Tough Tricky Problems




1.

A block is released from height $h$, find the maximum compression of spring of spring constant $k$.

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**2.** A smooth hemisphere is kept fixed on a horizontal floor . A small block f mass m is kept on the tip of hemisphere . Block is slightly pushed and it is found that block leaves contact with the spherical surface when radius through the block makes and angle $\theta$ with the vartical . Calculate $\theta$ .

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**3.** Bob of the simple pendulum is at rest at its lowest position , Sharp hit imparts a speed of $\sqrt{9gl}$ to the pendium bob. Calculate tension of the thread when it makes an angle $60^\circ$ with the vertical .

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**4.** A pendulum bob is given an intial velocity v at this bottom most point and it is found that bob loses circular track at a certain point and hits the point of suspension . If l is length of the thread then find v .

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**5.** The bob of a stationary pendulum is given a sharp hit to impart it a horizontal speed of $\sqrt{3gl}$. Find the angle rotated by the string before it becomes slack.

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**6.** Pendulum bob of mass m connected to a string of length l is made to whirl around in a vertical circle . Maximum speed of bob is found to be double of the minimum speed . Calculate tension in the thread when velocity of the bob is directed vertically downward .

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**7.** Bob of the pendulum is at its bottom most point when it is given horizontal velocity $\sqrt{57}$ m/s . Length of the string is $1.5$ m .

(i) Find maximum height attained by the bob above its lowest point .

(b) What will be the answer to part (a) if intial velocity given s $\sqrt{95}$ m/s ?

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**8.** Bob of mass m of the simple pendulum of lngth l is made to go around a vertical circle in such a manner that ratio of the maximum to minimum tension is 3 . Fixed end is at a height 5l above the horizontal floor . If string breaks when bob crosses the lowest position then find horizontal distance covered by the bob before it hits the ground .

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**9.** A small ball is projected with a velocity u at some angle with horizontal towards a smooth vertical wall at a distance d from the point of projection after rebounding from the wall . If e is the coefficient of

restitution then find maximum distance d for which ball may return to point of projection .

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**10.** A ball of mass m is moving with a velocity v and it suffers head - on collision with another identical ball at rest . What should be the coefficient of restitution if one - fourth of initial kinetic energy is lost in collision ?

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**11.** A ball strikes a smooth horizontal floor at an angle $\alpha$ with the normal to the surface and after rebounding from the floor , ball moves at an angle $\beta$ with the normal . Find the relation between $\alpha$ and $\beta$ if coefficient of elasticity is e .

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**12.** A ball is projected from a point on a smooth horizontal floor at an angle $\theta$ with the horizontal . Speed of projection is u . Ball collides with the floor several times . Find the total time and horizontal distance covered by the ball .

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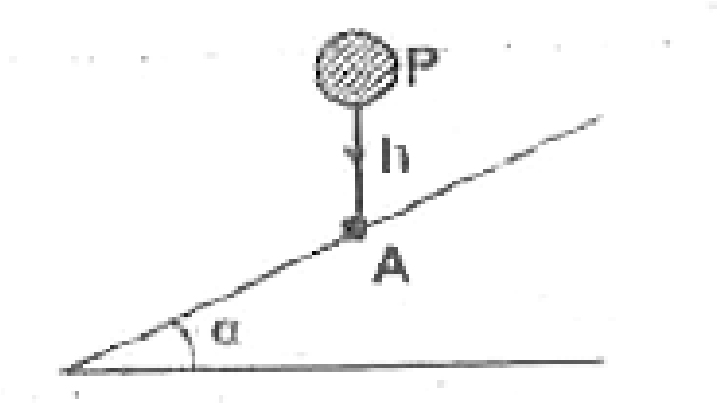
**13.** A ball starts falling freely from a height h from a point on the inclined plane forming an angle $\alpha$ with the horizontal as shown. After collision with the incline it rebounds elastically off the plane. Then it again strikes the incline at

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**14.** A ball of mass 0.1 kg collides head on with another identical ball at rest . Total kinectic energy of the system after collision is found to be 0.2 J . Find minimum and maximum possible speed of first ball before collision .

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**15.** A smooth wedge of mass M is kept at rest on a smooth horizontal surface . Inclined face of the wedge make an angle $\theta$ with the horizontal . A particle of mass m collides normal to inclined face of wedge . If speed of the particle just before collision is u and coefficient of restitution is $e$ then find velocity of wedge after collision .

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Ncert File Ncert Textbook Exercise

**1.** The sign of work done by a force is important to understant. State carefully if the following quantities are positive or negative. (a) Work done by a man in lifting a bucket out of a well by means of a rope tied to the bucket. (b) Work done by the gravitational force in the above case. (c ) Work done by friction on a body sliding down an inclined plane. (d) Work done by an applied froce on a body moving on a rough horizontal plane with uniform velocity. (e ) Work done by the resistive force of air on a vibrating pendulum in bringing it to rest.

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**2.** A body of mass 2 kg initially at rest moves under the action of an applied horizontal force of 7N on a table with coefficient of kinetic friction $= 0.1$. Calculate the

(a) work done by applied force in 10s. (b) work done by friction in 10s.

(c ) work done by the net force on the body in 10s.

(d) change in K.E. of body in 10s, and interpret your result.

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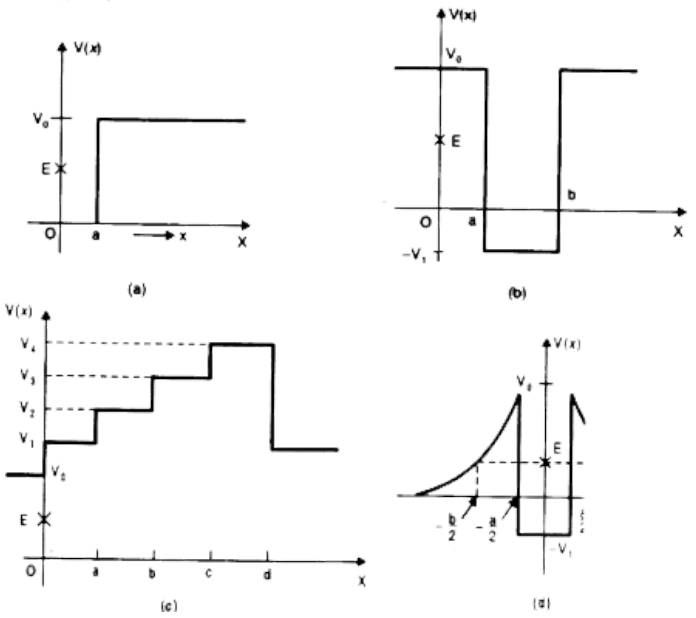
**3.** Given in fig are examples of some potential energy functions in one dimension. The total enrgy of the particle is indicated by a cross on the ordinate axis. In each case, specify the regions, if any, in which the particle cannot be found for the given energy. Also, indicate the minimum total energy the particle must have in each case. Think of simple physical contexts for which these potential energy shapes are relevant.

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**4.** The potential energy function for a particle executing simple harmonic motion is given by $V(x) = \frac{1}{2}kx^2$, where k is the force constant of the oscillatore. For $k = \frac{1}{2}Nm^{-1}$, show that a particle of total energy 1 joule moving under this potential must turn back when it reaches $x = \pm 2m$.

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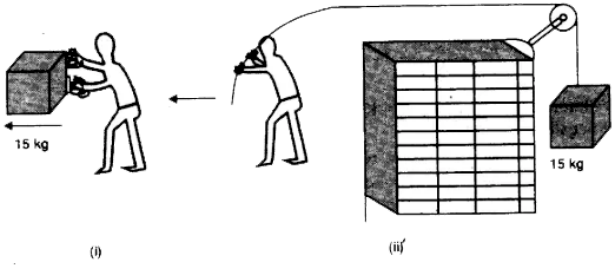
**5.** Answer the following:

a) The casing of a rocket in flight burns up due to friction. At whose expense is the heat required for burning obtained? The rocket or the atmosphere?

b) Comets move around the sun in highly elliptical orbits. The gravitational force on the comet due to the sun is not normal to the comet's velocity in general. Yet the work done by the gravitatonal force over every complete orbit of the comet is zero. Why?

c) An artificial satellite orbiting the earth in very atmosphere loses its energy grdually due to dissipation against atmospheric resistance, howerver small. Why then does its speed increase progressively as it

comes closer and closer tothe earth? d)In fig i) the man walks 2m carrying a mass of 15 kg on his hands. In Fig ii) he walks the same distance pulling the rope behind him. The rope goes over pulley, and a mass of 15 kg hangs at its other end. In which case is the work done greater?

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**6.** Underline the correct alterntaive:

a) when a conservative force does positivie work on a body, the potential energy of the body increase/decreases/remains unaltered.

work done by a body against friction always results in a loss of its kinetic /potential energy.

c) The rate of change of total momentum of a many-particle system is proportional to the external force/ sum of the internal forces on the system.

d) In an inelastic collision of two bodies, the quantities which do not change after the collision are the total kinetic energy/total linear momentum/total enregy of the system of two bodies.

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**7.** State if each of the following statements is true or false. Give reasons for your answer.

a) In an elastic collision of two bodies, the momentum and energy of each body is conserved.

b)Total energy of a systm is always conserved,no matter what internal and external forces on the body are present.

Work done in the motion of a body over a closed loop is zero for every force in nature.

d) In an inelastic collision, the final kinetic energy is always less than the initial kinetic energy of the sytem.

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**8.** 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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**9.** A body is initially at rest. It undergoes one dimensional motion with constant acceleration. The power delivered to it at time t is proportional to

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**10.** A body is moving undirectionally under the influence of a source of constatn power. It displacement in time t is proportional to (i) $t^{1/2}$ (ii) t (iii) $t^{3/2}$ (iv) $t^2$

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**11.** A body constrained to move along the z-axis of a co-ordinate system, is subjected to a constant force $\vec{F}$ given by $\vec{F} = -\hat{i} + 2\hat{j} + 3\hat{k}$ Newton where $\hat{i}, \hat{j}$and $\hat{k}$ represent unit vectors along x-,y-,and z-axes of the system, respectively. Calculate the work done by this force in displacing the body through a distance of $4m$ along the z-axis.

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**12.** An electron and a proton are detected in a cosmic ray experiment, the first with kinetic energy 10 keV, and the second with 100 keV. Which is faster, the electron or the proton ? Obtain the ratio of their speeds.

(Electron mass $= 9.11 \times 10^{-31} kg$, proton mass $= 1.67 \times 10^{-27} kg$, $1eV = 1.60 \times 10^{-19} J$).

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**13.** 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 $10ms^{-1}$ ?

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**14.** A molecules in a gas container hits the wall with speed 200m/s at an angle $30^\circ$ with the normal, and reboudns with the same speed. Is

momentum conserved in the collision ? Is the collision elastic or inelastic ?

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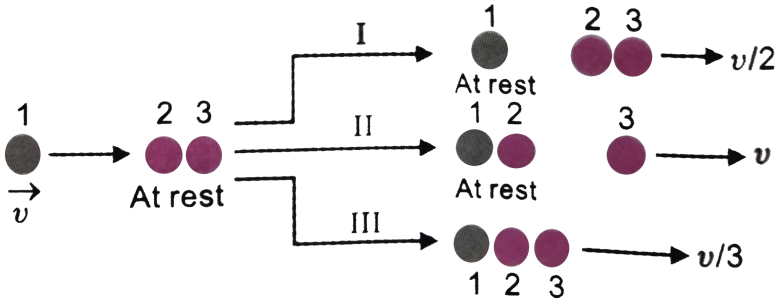
**15.** A pump on the ground floor of a building can pump of water to fill a tank of volume $30ms^3$ in $15\ \min$ . If the tank is $40m$ above the ground and the efficiency of the pump is $30\ \%$ , how much electric power is consumed by the pump? $\left(\text{Take} g = 10ms^2\right)$

Watch Video Solution

**16.** Two identical ball bearings in contact with each other and resting on a frictionless table are hit head on by another ball bearing of the same mass moving initially with a speed v, figure,. If the collision is elastic,

which of the following is a possible result after collisioin?

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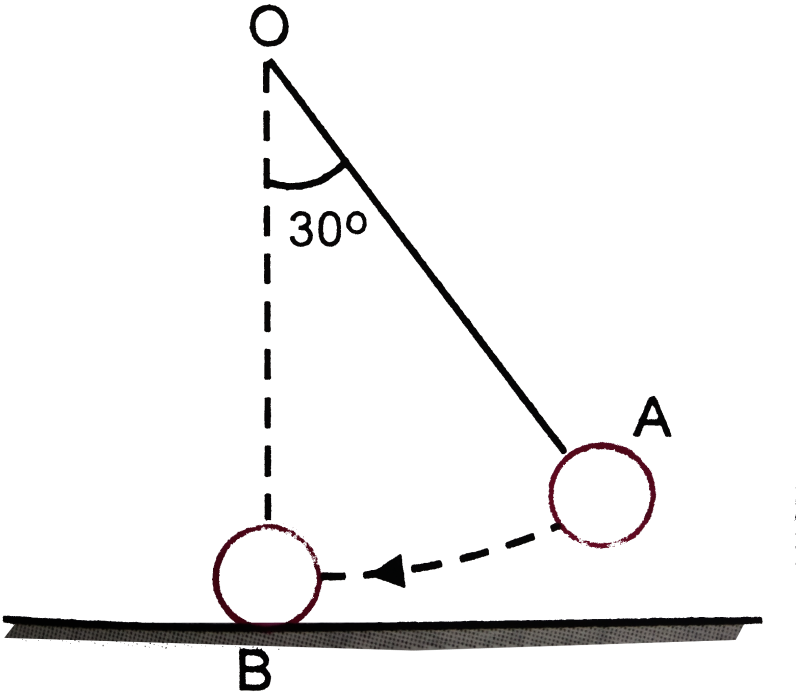
**17.** The bob A of a simple pendulum released from $30^\circ$ to the vertical hits another bobo B of the same mass at rest on a table as shown in figure. How high does the bob A rise after the collision ? Neglect the size of the

bobs and assume the collision to be elastic.

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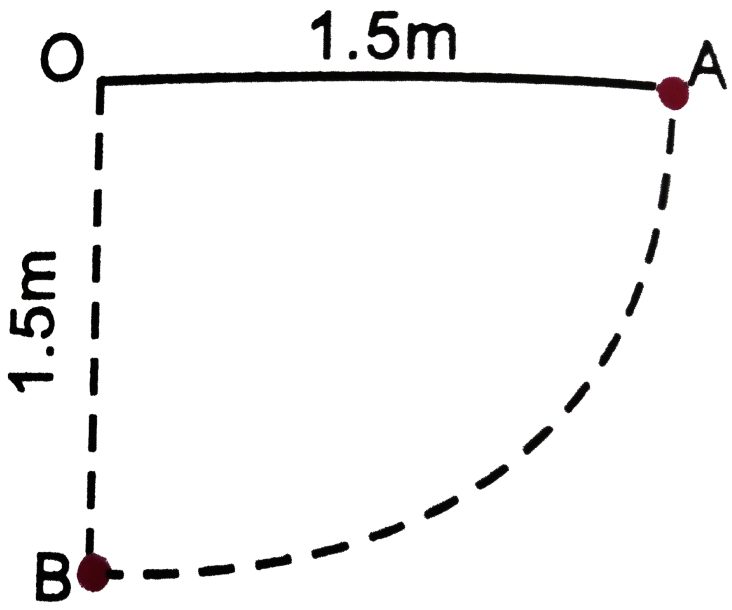
**18.** The bob A of a simple pendulum is released from a horizontal position A as shownin in figure. If the length of the pendulum is 1.5m , what is the speed with which the bob arrives at the lowermost point B, given that it

dissipates $5\%$ of its initial energy against air resistance ?

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**19.** A trolley of mass 300 ks carrying a sand bag of 25 kg is moving uniformly with a speed of $27km/h$ on a frictionless track. After a while, sand starts leaking out of a hole on the trolley's floor at the rate of $0.05kgs^{-1}$. What is the speed of the trolley after the entire sand bag is empty ?

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**20.** A particle of mass $0.5kg$ travels in a straight line with velocity $v = ax^{3/2}$ where $a = 5m^{-1/2}s^{-1}$. What is the work done by the net force during its displacement from $x = 0$ to $x = 2m$?

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**21.** The blades of a windmill sweep out a circle of area A. (a) If the wind flows at a velocity v perpendicular to the circle, what is the mass of the air passing through in time t? (b) What is the kinetic energy of the air? (c) Assume that the windmill converts $25\,\%$ of the wind's energy into electrical energy, and that $A = 30m^2$, $v = 36kmh^{-1}$ and the density of air is $1.2kgm^{-3}$, what is the electrical power produced?

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**22.** A person trying to lose weight (dieter ) lifts a 10 kg mass through 0.5m, 1000 times, A ssume that the potential energy lost each time she lowers the mass is dissipated (a) How much work does she does against

the gravitational force ? (b) Fat supplies $3.8 \times 10^7 J$ of energy per kilogram which is converted to mechanical energy with a $20\%$ efficiency rate. How much fat will the dieter use up ?

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**23.** A family uses 8kW of power. (a) Direct solar energy is incident on the horizontal surface at an average rate of 200 W per square metre. If $20\%$ of this energy can be converted to useful electrical energy, how large an area is needed to supply 8kW? (a) Compare this area to that of the roof of a typical house.

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## Ncert File Ncert Additional Exercise

**1.** A bullet of mass 0.012 kg and horizontal speed $70 ms^{-1}$ strikes a block of wood of mass 0.4 kg and instantly comes to rest with respect to the

block. The block is suspended from the ceiling by thin wire. Calculate the height to which the block rises. Also, estimate the amount of heat produced in the block.

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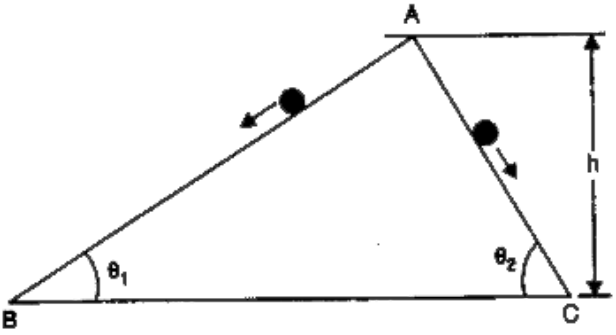
**2.** Two inclined frictionless tracks, one gradual and the other steep meet at A from where to stones are allowed to slide down from rest, one on each track (fig.) Will hte stones reach the bottom at the same time? Will they reach there with the same speed? Explain, given $\theta_1 = 30^\circ$, $\theta_{92}) = 60^\circ$ and h=10m. What are the speeds and time taken by the two stones?

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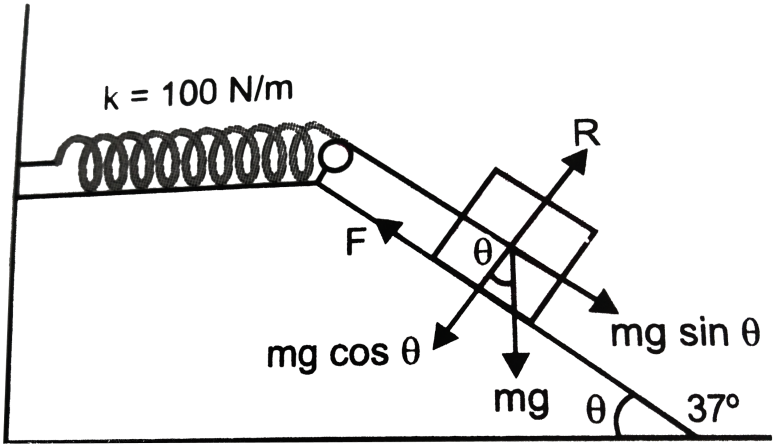
**3.** A 1kg block situated on a rough incline is connected to a spring of spring constant $100Nm^{-1}$ as shown in figure,. The block is released from rest with the spring in the unstretched position. The block moves 10cm down the incline before coming to rest. Find the coefficient of friction between the block and the incline. Assume that the spring has negligible mass and the pulley is frictionless.

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**4.** A bob of mass 0.3 kg falls from the ceiling of an elevator moving down with a uniform speed of $7ms^{-1}$. If hits the floor of the elevator (length of

the elevator $=$ 3m) and does not rebound. What is the heat produced by the impact ? Would your answer be different if the elevator were stationary ?

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**5.** A trolly of mass 200kg moves with a uniform speed of 36 km/h on a frictionless track. A child of mass 20kg runs on the trolly from one end to the other (10m away) with a speed of $4m/s$ relative to the trolly in a direction opposite to the trolly's motion and jumps out of the trolly. How much has teh trolly moved from the time the child begins to run ?

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**6.** Which of the following potential energy curves in figure canot possibly describe the elastic collision f two billiard balls ? Here r is thee distance between centres of the balls .

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**7.** Consider the decay of a free neutron at rest :

$n \rightarrow p + e^-$

Show that the two - body decay of this type must necessarily give an electron of fixed energy and therefore , cannot account for the observed continuous energy distribution in the $\beta$ - decay of a neutron or a nucleus

[ Note : The simple result of this exercise was one among the several arguments advanced by W . Pauli to predict the existence of a third particle in the decay products of $\beta$ - decay . This particle is known as neutrino . We know that it is a particle of intrinsic spin $\frac{1}{2}$ (like e- , p or n ) , but is neutral , and either massless or having an extremely small mass ( compared to the mass of electron ) and which interacts very weakly with matter . The correct decay process of neutron is : $n \rightarrow p + e^- + v$ .

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## Ncert File Exemplar Problems Objective Questions

**1.** An electron and a proton are moving under the influence of mutual forces. In calculating the change in the kinetic energy of the system during motion, one ignores the magnetic force of one on another. This is because,

A. the two magnetic forces are equal and opposite , so they produce no net effect .

B. the magnetic forces do not work on each particle .

C. the magnetic forces do equal and opposite ( but non - zero) work on each particle .

D. the magnetic forces do equal are necessarily negligible .

**Answer: B**

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**2.** A proton is kept at rest. A positively charged particle is released from rest at a distance $d$ in its field. Consider two experiments, one ini which the charged particle is also a proton and in another, a position. In the same time $t$, the work done on the two moving charged particles is

A. same as the same force law is involved in the two experiments .

B. less for the case of a positron , as the positron moves away more rapidly and the force on it weakens .

C. more for the case of a positron , as the positron moves away a larger distance .

D. same as the work done by charged particle on the stationary proton .

**Answer: C**

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**3.** A man squatting on the ground gets straight up and stand. The force of reaction of ground on the man during the process is.

A. constant and equal to mg in magnitude

B. constant and greater than mg in magnitude

C. variable but always greater than mg

D. at first greater than mg , and later becomes equal to mg .

**Answer: D**

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**4.** A cyclist comes to a skidding stop in $10m$. During this process, the force on the cycle due to the road is $200N$ and is directly opposite to the motion.

a. How much work does the road do on the cycle?

b. How much work does the cycle do on the road?

A. $+2000$J

B. $-200J$

C. zero

D. $-20,000$ J

**Answer: C**

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**5.** A body is falling freely under the action of gravity alone in vacuum. Which of the following quantities remain constant during the fall ?

A. Kinetic energy

B. Potential energy

C. Total mechnical energy

D. Total linear momentum

**Answer: C**

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**6.** During inelastic collision between two bodies, which of the following quantities always remain conserved ?

A. Total kinetic energy

B. Total mechanical energy

C. Total linear momentum

D. Speed of each body .

**Answer: C**

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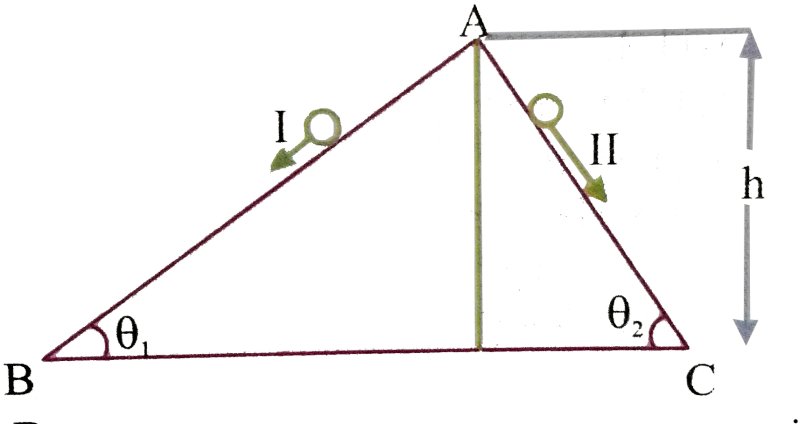
**7.** Two inclined frictionless tracks, one gradual and the other steep meet at $a$ from where two stones are allowed to slide down from rest, one on each track as shown in Figure. Which of the following statement is

correct ?




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

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

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

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

**Answer: C**

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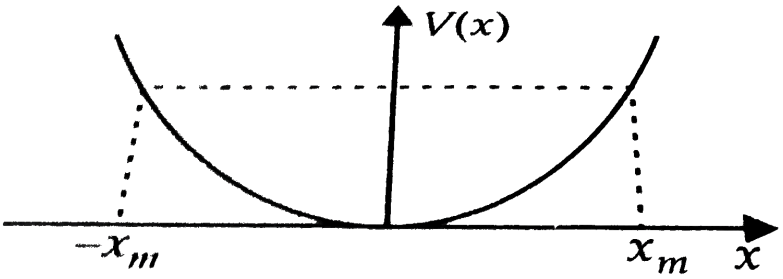
**8.** The potential energy function for a particle executing linear SHM is given by $V(x) = \frac{1}{2}kx^2$ where k is the force constant of the oscillator. For $k = 0.5Nm^{-1}$, the graph of V(x) versus x is shown in the figure A particle of total energy E turns back when it reaches $x = \pm x_m$.if V and K indicate the potential energy and kinetic energy respectively of the particle at $x = +x_m$,then which of the following is correct?




A. $V = 0, K = E$

B. $V = E, K = 0$

C. $V < E, K = 0$

D. $V = 0, K < E$

**Answer: B**

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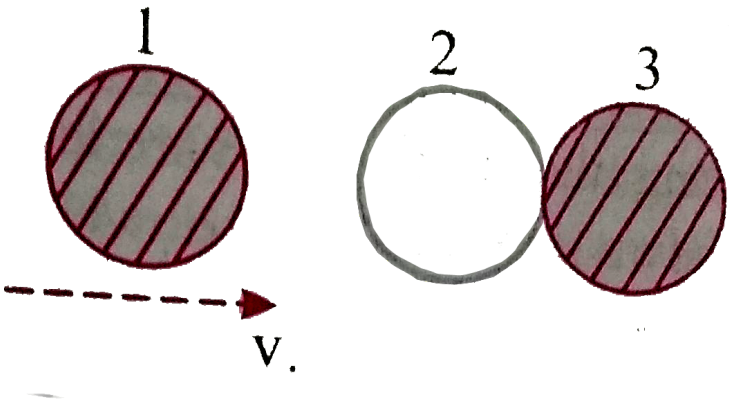
**9.** Two identical ball bearings in contact with each other and resting on a frictionless table are hit heat-on by another ball bearing of the same mass moving initially with a speed $V$ as shown in figure.




If the collision is elastic, which of the following (figure) is a possible result after collision ?

A. 

B. 

C. 

D. 

**Answer: B**

Watch Video Solution

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

A. 1.5 J

B. 50 J

C. 10 J

D. 100 J

**Answer: D**

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**11.** A body is moving unidirectionally under the influence of a source of constant power supplying energy. Which of the diagrams shown in figure. Correctly shows the displacement-time curve for its motion ?

A. 

B. 

C. 

D. 

**Answer: B**

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

A. 

B. 

C. 

D. 

**Answer: D**

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**13.** Which of the diagram shown in figures respresents variation of total mechanical energy of a pendulam oscillation in air as function of time?

A. 

B. 

C. 

D. 

**Answer: C**

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**14.** A mass of $5kg$ is moving along a circular path or radius $1m$. If the mass moves with 300 revolutions per minute, its kinetic energy would be

A. $250\pi^2$

B. $100\pi^2$

C. $5\pi^2$

D. 0

**Answer: A**

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

A. 

B. 

C. 

D. 

**Answer: B**

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**16.** In a shotput event an athlete throws the shotput of mass $10kg$with an initial speed of $1ms^{-1}$ at $45^{\circ}$ from a height $1.5m$ above ground. Assuming air resistance to be negligible and acceleration due to gravity to be $10ms^{-2}$, the kinetic energy of the shotput when it just reaches the ground will be

A. $2.5$J

B. $5.0$J

C. $52.5$J

D. $155.0J$

**Answer: D**

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**17.** Which of the diagrams corectly shows the change in kinetic energy of an iron sphere falling freely in a lake having sufficient depth to impart it a terminal velocity ?

A. 

B. 

C. 

D. 

**Answer: B**

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**18.** A cricket ball of mass $150g$ moving with a speed of $126km/h$ hits at the middle of the bat, held firmly at its position by the batman. The ball moves straight back to the bowler after hitting the bat. Assuming that collision between ball and bat is completely elastic and the two remain in contact for $0.001s$, the force that the batsman had to apply to hold the bat firmly at its place would be

A. 10.5 N

B. 21 N

C. $1.05 \times 10^4$N

D. $2.1 \times 10^4 N$

**Answer: C**

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**19.** A man of mass $m$ , standing at the bottom of the staircase of height $L$ climbs it and stands at its top .

A. Work done by all forces on man is equal to the rise in potential energy mgL .

B. Work done by all forces on man is zero .

C. Work done by the gravitational force on man is mgL .

D. The reaction force from a step does not do work because the point of application of the force does not move while the force exists .

**Answer: B::D**

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**20.** A bullet of mass $m$ fired at $30^\circ$ to the horizontal leaves the barrel of the gun with a velocity $v$. The bullet hits a soft target at a height $h$ above the ground while it is moving downward and emerges out with half the kinetic energy it had before hitting the target.

Which of the following statements are correct in respect of bullet after it emerges out of the target ?

A. The velocity of the bullet will be reduced to half its initial value .

B. The velocity of the bullet will be more than half of its earlier velocity

.

C. The internal energy of the particles of th target will increase .

D. The bullet will move in a different parabolic path .

**Answer: B::C::D**

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**21.** Two blocks $M_1$ and $M_2$ having equal mass are free to move on a horizontal frictionless surface. $M_2$ is attached to a massless spring as shown in figure. Initially $M_2$ is at rest and $M_1$ is moving toward $M_2$ with speed $v$ and collides head-on with $M_2$.

A. While spring is fully compressed all the K.E of $M_1$ is stored as P.E of

spring

B. While spring is fully compressed the system momentum is not conserved , though final momentum is equal to initial momentum .

C. If spring is masless, the final state of the $M_1$ is state or rest .

D. If the surface on which blocks are moving has friction , then collision cannot be elastic .

**Answer: C::D**

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## Ncert File Ncert Exemplar Problems Very Short Answer Type Questions

**1.** A rough inclined plane is placed on a cart moving with a constant velocity u on horizontal ground. A block of mass M rest on the incline. Is any work done by force of friction between the block and incline ? Is there then a dissipation of energy ?

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**2.** Why is electrical power required at all when the elevatore is descending ? Why should there be a limit on the number of passengers in this case ?

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**3.** A body is being raised to a height h from the surface of earth. What is the sign of work done by

(a) applied force (b) gravitational force ?

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**4.** Calculate the work done by a car against gravity in moving along a straight horizontal road. The mass of the car is 400 kg and the distance moved is 2m.

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**5.** A body falls towards earth in air. Will its total mechanical energy be conserved during the fall ? Justify.

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**6.** A body is moved along a closed loop. Is the work done in moving the body necessarily zero ? If not, state the condition under which work done over a closed path is always zero.

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**7.** In an elastic collision of two billiard balls, which of the following quantities remain conserved during the short time of collision of the balls (i.e., when they are in contact).

(a) Kinetic energy . (b) Total linear momentum ?

Give reason for your answer in each case.

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**8.** Calculate the power of a crane in watts, which lifts a mass of $100kg$ to a height of $10m$ in $20s$.

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**9.** The average work done by a human heart while it beats once is $0.5J$. Calculate the power used by heart if it beats $72$ times in a minute.

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**10.** Give example of a situation in which an applied force does not result in a change in kinetic energy.

Watch Video Solution

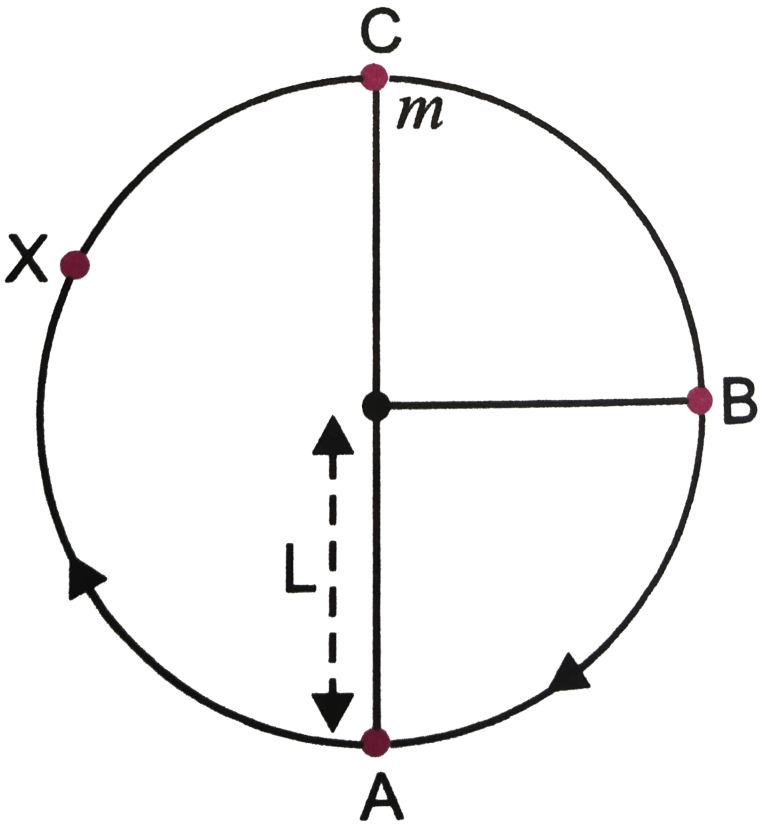
**11.** Two bodies of unequal mass are moving in the same direction with equal kinetic energy. The two bodies are brought to rest by applying

retarding force of same magnitude. How would the distance moved by them before coming to rest compare ?

Watch Video Solution

**12.** A bob of mass m suspended by a light string of length L is whirled into a vertical circle as shown in figure . What will be the trajectory of the particle if the string is cut at

(a) Point B ? (b) Point C? (c) Point X?

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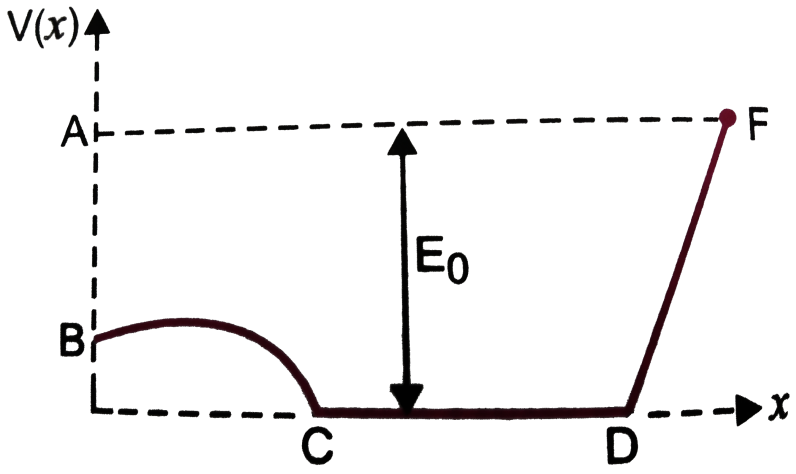
## Ncert File Ncert Exemplar Problems Short Answer Type Questions

**1.** A graph of potential energy $V(x)$ verses x is shown in figure. A particle of energy $E_0$ is executing motion in it. Draw graph of velocity and kinetic

energy versus x for one complete cycle AFA.

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**2.** A ball of mass m$m$, moving with a speed $2v_0$, collides inelasticaly $(e > 0)$ with an identical ball at rest. Show that $(a)$ For head - on collision, both the balls move forward.

(b) For a genergcollision, the angle between the two velocities of scattered balls is less that $90^\circ$.

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

State with reason in each case whether a particle can be found in the given region or not .

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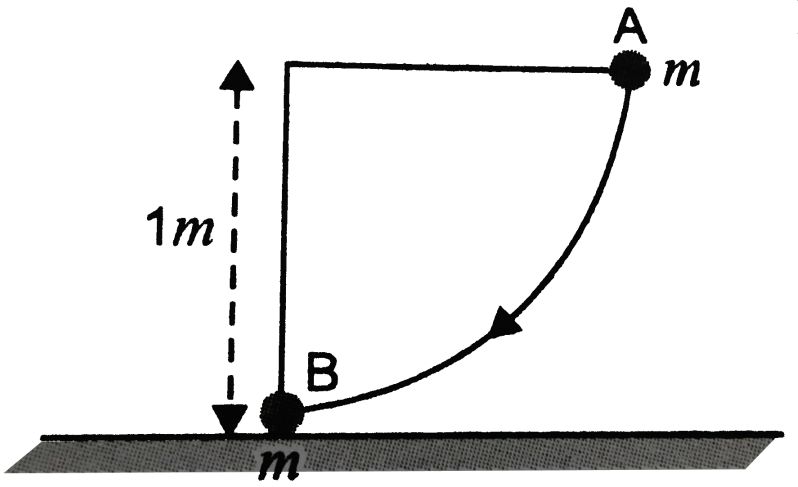
**4.** The bob A of a pendulum released from horizontal to the vertical hits another bob B of the same mass at rest on a table as shown in figure.

If the length of the pendulum is 1m, calculate

(a) the height to which bob $A$ will rise after collision.

(b) the speed with which bob $B$ starts moving.

Neglect the size of the bobs and assume the collision to be elastic.

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**5.** Araindrop of mass 1 . 00 g falling from a height of 1 km hits the ground with a speed of 50 $ms^{-1}$ . Calculate

(a) the loss of the drop .

(b) the gain in K.E of the drop

(c ) Is the gain in K.E equal to loss of P.E ? If not why ? Take $g = 10\text{ms}^{-2}$ .

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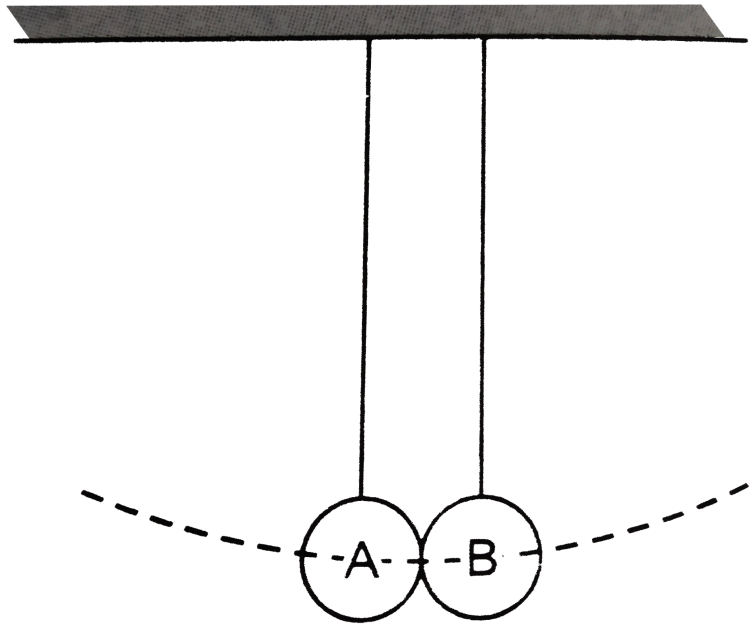
**6.** Two pendulums with identical bobs and lengths are suspended from a common support such that in rest position, the two bobs are in constact, . One of the bobs is released after being displaced by $10^{\circ}$ so that it collides elastically head - on with the other bob.

(a) Describe the motion of two bobs.

(b) Draw a graph showing variation in energy of either pendulum with time,for $0 \leq t \leq 2T$ , where $T$ is the period of each pendulum.

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**7.** Suppose the average mass of raindrops is $3.0 \times 10^{-5} kg$ and their average terminal velocity $9ms^{-1}$. Calculate the energy transferred by rain to each square metre of the surface at the place which receives 100 cm of rain in a year.

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**8.** An engine is attahed to a wagon through a shock absorber of length 1.5m. The system with a total mass of 50,000kg is moving with a speed of $36kmh^{-1}$ when the brakes are applied to bring it to rest. In the process of the system being brought to rest, the spring of the shock absorber gets compressed by $1.0m$. If $90\ \%$ of energy of the wagon is lost due to friction, calculate the spring constant.

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**9.** An adult weighing 600N raises the centre of gravity of his body by 0.25m while taking each step of 1m lenth in jogging. If he jogs for 6km,

calculate the energy utilised by him in jogging assuming that there is no energy loss dur to friction of ground and air. Assuming that the body of the adult is capable of converting $10\,\%$ of energy intake in the form of food, calculate the energy equivalent fo food that would be required to compensate energy utilised for jogging.

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**10.** On complete combustion , a litre of petrol gives off heat equivalent to $3 \times 10^7 J$ . In a test drive, a car weighing 1200kg, including the mass of driver, runs 15kg per litre while moving with a uniform speed on a straight track. Assuming that friction offered by the road surface and air to be uniform, calculate the force of friction acting on the car during the test drive. If the efficiency of the car engine were `0.5.

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## Higher Order Thinking Skills Advanced Level

**1.** A force $F = \alpha + \beta x$ acts on a particle of mass m along the X . Axis . Here $\alpha$ and $\beta$ are constants . Find the work done by this force when particle moves form x = 0 to x = d .

Watch Video Solution

**2.** Block of mass m is pushed towards a horizontal spring as shown in figure , with initial speed u .

Spring constant of the spring is K and floor is smooth . Calculate maximum possible compression of the spring .

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**3.** A particle of mass 1 kg is moving along X - aixs . Its X - coordinate is given by $x = t^2$ . Where t is in secoonds and x in metres . Find the work done by thef orce on the particle in time interval t = 1s to t = 3 s .

Watch Video Solution

**4.** A particle of mass m is moving in a stright line , If x is the distance travelled by the particle then its velocity is given as v = $\alpha x$ , here $\alpha$ is a constant . Calculate work done by all the forces acting on the body when particle is displaced from x = 0 to x = d .

Watch Video Solution

**5.** A block of mass 20 kg tied to a string is being brough down strating from state of rest . Block axquires a speed of 1 m/s after descending a height of 5 m . Calculate work done by tension of string during the process .

Watch Video Solution

**6.** An ideal spring with spring constant k is hung from the ceiling and a block of mass M is attached to its lower end. The mass is released with

the spring initially unstretched. Then the maximum extension in the spring is

Watch Video Solution

**7.** Refer to two blocks of masses $m_1$ and $m_2$ attached to each other by a string passing over smooth light pulley as shown in figure .

If $\mu$ is coefficient of friction between $m_2$ and table , then find common velocity acquired by both the blocks when $m_1$ has descended through a height h . Assume initially both the blocks were at rest .

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**8.** A block of mass m moving at a speed v compresses as spring thrugh a distance x before its speed is halved. Find the spring constant of the spring.

Watch Video Solution

**9.** A small block of mass m is kept on the top of a smooth hemisphere hept on a horizontal floor as shown in figure .

Hemisphere is moved with a constant acceleration a as shown in figure . Find the velocity of block relative to hemisphere as a function of $\theta$ it slides on the hemisphere . Assume radius of hemisphere is R .

View Text Solution

**10.** A uniform chain of mass $M$ and length $L$ is lying on a frictionless table in such a way that its $1/3$ parts is hanging vertically down. The work done in pulling the chain up the table is

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**11.** A person lifts a stone of mass 100 g from the ground to a height of 1.5 m and projects it with a speed 4 m/s . If the process takes 1.5 s then

calculate power of the person .

Watch Video Solution

**12.** A pendulum bob is suspended through the ceiling of a rail car at rest as shown in figure .

The car starts with constant acceleration a . Find maximum deflection suffered by the pendulum with the vertical .

View Text Solution

**13.** One end of a light rod is clamped in such a manner that rod can be rotated in a vertical plane . A block of mass mis attached to the other ened of rod and the block stays at rest at its lowest position . What minimum speed should be imparted to the bock so that it may complete its circle ? Assume length of rod to be l .

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**14.** A uniform chain of length L and mass M overhangs a horizontal table with its two third part n the table. The friction coefficient between the table and the chain is $\mu$. Find the work done by the friction during the period the chain slips off the table.

Watch Video Solution

**15.** Blocks of masses m and M are connected to the two ends of a spring constant K . System is kept on a horizontal floor as shown in figure . Block of mass m is pushed down to compress the spring by a certain amount . What should be the minimum compression of the spring so that block (m) once released then anther block (M) is able to leave the horizontal surface ?

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Revision Exercise Very Short Answer Questions

**1.** What will be the work done in carrying a suitcase of 10 kg while standing on the platform ?

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**2.** Does the work done in moving a body depend on the time in which the work is done ?

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**3.** What is the anglee between force and displacement for maximum work ?

Watch Video Solution

**4.** Can kinetic energy be negative? Explain.

Watch Video Solution

**5.** Can work done by a non - conservative force be positive ?

Watch Video Solution

**6.** Which physical quantity represents the area under the force displacement curve ?

Watch Video Solution

**7.** The correct relation between joule and erg is

Watch Video Solution

**8.** What is the work done by the sun on the earth when the earth revolves around the sun in a circular orbit ?

Watch Video Solution

Watch Video Solution

**9.** Can P.E. of an object be negative?

Watch Video Solution

**10.** Is the mechanical energy always conserved ?

View Text Solution

**11.** What will happen to the potential energy of an air bubble in water when it rises in water ?

Watch Video Solution

**12.** A spring of spring constant k is cut in three equal pieces. The spring constant of each part will be

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**13.** When is KE of a planet revolving around the sun maximum?

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**14.** If K.E of a body is made three times , how will the momentum change ?

Watch Video Solution

**15.** If the momentum of a body is made three times , how will the kinetic energy will change ?

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**16.** A bullet gets embedded in a wooden block. Where does its KE go?

Watch Video Solution

**17.** One horse power is equal to

Watch Video Solution

**18.** What is the power ? Write its dimensional formula .

Watch Video Solution

**19.** How can you say that friction is a non - conservative force ?

View Text Solution

**20.** The work done by the centripetal force in quarter revolution would be,

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**21.** Can we change K.E of a system without changing its momentum ?

View Text Solution

**22.** What will happen to potential energy of a spring when it is compressed ?

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**23.** What wil happen to potential energy of a spring when it is streched ?

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**24.** What changes in uniform circular motion , momentm or K.E ?

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**25.** What is an elastic collision ?

Watch Video Solution

**26.** Inelastic collision is the-

Watch Video Solution

**27.** Which physical quantity is conserved in both, elastic and inelastic collision?

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**28.** In which collision , the two bodies stick together after collision ?

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**29.** COEFFICIENT OF RESTITUTION

Watch Video Solution

**30.** The coefficient of restitution e for a perfectly elastic collision is

Watch Video Solution

**31.** What is coefficient of restitution for a perfectly inelastic collision ?

Watch Video Solution

## Revision Exercise Additional Questions

**1.** What is the minimum energy released in the annhilation of an electron positron pair?

A. 1.02 eV

B. 1.02 MeV

C. 2.04 MeV

D. 931.2 MeV

**Answer: B**

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**2.** The dimensional formula of power is

A. $ML^2T^{-1}$

B. $ML^2T^{-3}$

C. $MLT^{-2}$

D. $MLT^{-1}$

**Answer: B**

Watch Video Solution

**3.** A spring of spring constant k is cut in three equal pieces. The spring constant of each part will be

A. 3 K

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

C. 4 K

D. 9 K

**Answer: A**

Watch Video Solution

## Revision Exercise Fill In The Blanks

**1.** Work done by a force is zero when a body gets displaced along a direction . . . . . to the direction of applied force .

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**2.** The force is . . . . . if the work done by the force in displacing a particle from one point to another is independent of the path followed

by the particle .

Watch Video Solution

**3.** The potential energy of a spring . . . . . when it is compressed .

Watch Video Solution

**4.** When the momentum of a body is doubled , its kinetic energy becomes . . . . . times the initial kinetic energy .

Watch Video Solution

**5.** Nuclear fission and fusion reactions are examples of conversion of . . . . . into . . . . . .

Watch Video Solution

**6.** In an inelastic collision , . . . . . is conserved but . . . . . is not conserved .

Watch Video Solution

**7.** . . . . . is the physical quantity which is expressed as force times velocity and is a . . . . . quantity .

Watch Video Solution

**8.** Work done by friction in a closed loop is . . . . . .

View Text Solution

**9.** Spring constant is a . . . . . force set up in the spring per unit extension and its SI unit is . . . . . .

Watch Video Solution

**10.** . . . . . energy of a falling rain drop changes gradually into their . . . . . energy .

Watch Video Solution

## Revision Exercise Short Answer Questions

**1.** A light body and a heavy body have same linear momentum. Which one has a greater kinetic energy ?

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**2.** Two bodies one light and one heavy have same kinetic energy . Which will have more momentum and why ?

Watch Video Solution

**3.** The miniumum amount of energy released in annihilation of electron-Positron is

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**4.** What do you mean by kinetic energy ? Derive an expression for the kinetic energy of an object of mass m moving with velocity, $v$.

Watch Video Solution

**5.** What is meant by mass energy equivalence ? Discuss its significance in Physics.

Watch Video Solution

**6.** What are absolute units of work in S.I and c.g.s systems ?

Watch Video Solution

**7.** Derive an expression for the potential energy of a stretched spring .

Watch Video Solution

**8.** Two springs A and B are identical to each other . The spring A is harder than the spring B . On which spring more work will be done if they are streched by same force ?

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**9.** By what facter should the velocity of a moving particle be changed so that its kinetic energy becomes 1/16 of its intial value ?

Watch Video Solution

**10.** Show that the wor done by a force is equal to change in potential energy .

Watch Video Solution

**11.** State and prove law of conservation of energy .

Watch Video Solution

**12.** What do you mean by collision ? What are its types ?

Watch Video Solution

**13.** What is elastic collision ? Write its properties .

Watch Video Solution

**14.** What do you mean by elastic collision ? What are its properties ?

Watch Video Solution

**15.** Distinguish between elastic collision and an inelastic collision .

Watch Video Solution

**16.** Show that in a perfectly elastic collision , the relative velocity of seperation after collision is equal to relative velocity of approach before collision .

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## Revision Exercise Long Answer Questions

**1.** What is meant by positive , negative and zero work done ? Give an example of each of them .

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**2.** What are conservative and non-conservative forces, explain with examples. Mention some of their properties.

Watch Video Solution

**3.** WORK ENERGY THEOREM

Watch Video Solution

**4.** What do you mean by gravitational potential energy ? Derive an expression for the gravitational potential energy of an object raised to a height h .

Watch Video Solution

**5.** What is potential energy ? Derive an expression for the gravitational potential energy .

Watch Video Solution

**6.** (a) Discuss briefly various forms of energy .

(b) Show that for a freely falling body the sum of kinetic energy and potential energy remains same at every point of its motion .

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**7.** Show that the loss of kinetic energy occurs in an inelastic collision . How will you justify this loss of energy ?

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**8.** Show that the two bodies of same masses exchange their velocities after an elastic head on collision .

Watch Video Solution

**9.** (a) Can a body with negative energy have momentum ?

(b) Two bodies having identical masses of 2 kg are moving towards each ther with same speed of 3 m/s along frictionless horizontal surface . The bodies stick together and come to rest . calculate the work done by external and internal forces on combined system of these two bodies .

(c ) Can a body have energy without momentum ?

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## Revision Exercise Numerical Problems

**1.** A man of mass 20 kg is carrying a mass of 3 kg on his head. Calculate the work done by the man in moving a distance of 10 m up an incline of 1 in 5 ?

Watch Video Solution

**2.** What will be work done by a force $\vec{F} = 2\hat{i} + 2\hat{j} - 4\hat{k}$ when it moves a body from the point (2,0,-3) to (1,1,-5)

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**3.** Under the action of a force $\vec{F} = (3x)\hat{i}N$ , a particle is moving in anticlockwise direction is a square loop of side 3m in x - y plane . What will be the total amount of work done ?

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**4.** If the momentum of a body is increased by 50%, then the percentage increase in its kinetic energy is

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**5.** IF the K.E of a body increases by 200 % then what will be the parcentage increases of momentum ?

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**6.** The bob of a pendulum is moving with a speed of 5 m/s while passing through mean position . Calculate its speed at the position when it makes an angle of $30^\circ$ with the vertical . The length of pendulum is 0.6 m / Use $g = 10m/s^2$

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**7.** Calculate the increase in mass of water if 200 kg of water is heated from $0^\circ C$ to $50^\circ C$ .

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**8.** A ball of mass 0.1 kg is thrown vertically upwards with a speed of $7ms^{-1}$ . Calculte the kinetic and potential ebergies after half second .

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**9.** A spring gets compressed when a body of mass 5 g is dropped on it from a height of 2 m . Calculate the maximum distance s through whichthe spring is compressed. The force constant of spring is $100Nm^{-1}$ .

Watch Video Solution

**10.** A platform having no mass is kept on a light elastic spring . When a small particle of 0.1 kg is dropped on this spring from a height of 0.50 m , the spring is compressed by 0.02 m . From which height the particle should be dropped to produce a compression of 0.05 m ?

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**11.** Calculate the total amount of energy released if 20 g of given mass is completely converted into energy .

Watch Video Solution

**12.** $5000cm^3$ of blood per minute is fored by heart through the arteries under a pressure of 150 mm. What will be the horse power of heart if density of blood is $1.03 \ \text{g} \ cm^{-3}$ ?

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**13.** Calculate the input power of a machine if it can take out 500 kg of wet clay hour from a depth of 200 m with an efficiency of 0.7 .

Watch Video Solution

**14.** A bus of mass 1500 kg is accelerating from rest to a velocity of $2ms^{-1}$ in 10 sec . What will be (a) acceleration (b) gain in K.E (c ) average power ?

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**15.** A ball A of mass 0.2 strikes another ball B of unknown mass at rest . If the ball A makes an elastic head on collision and then rebounds at one half of its original speed , then calculate the mass of ball B .

Watch Video Solution

**16.** A body of mass $m$ falls from a height $h$ and collides with another body of same mass at rest. After collision, the two bodies combine and move through distance $(d)$ till they come to rest. Find the work done against the resistive force.

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**17.** A body of mass m moving with a velocity strikes a stationary body having same mass . What will be the ratio of velocity of two bodies after the collision if the coefficient of restitution is e .

Watch Video Solution

**18.** A body of mass $m$ falls from a height $h$ and collides with another body of same mass at rest. After collision, the two bodies combine and move through distance $(d)$ till they come to rest. Find the work done against the resistive force.

Watch Video Solution

**19.** A body of mass 3 kg moving with a velocity of 5 m/s collides inelastically with another body of some mass at rest . Calculate the amount of heat evolved during collision .

Watch Video Solution

**20.** If a spring of spring constant K is vcut into two parts A and B having lengths in the ratio of 1 : 4 .Calculate the ratio of spring constants of Aand B .

Watch Video Solution

**21.** A body A collides elastically with another body B at rest . The bodies A and B move in opposite directions with same speeds . Calculate the ratio of masses of A and B .

Watch Video Solution

**22.** 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

Watch Video Solution

**23.** A bullet moving with a speed of 120 m/s is able to penetrate through 5 cm into a thick wooden board. Calculate the required velocity of bullet to penetrate through 8 cm in the same wooden board .

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## Objective Type Questions A Multiple Choice Questions

**1.** A body at rest is moved in a stright line by supplying constant power to it . Distance moved by the body in time t is found to be proportional to $t^n$ Value of n is .

A. $3/2$

B. $2/3$

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

D. $3/4$

**Answer: A**

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**2.** Consider the following two statements:

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

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

A. A implies B , and B implies A .

B. A does not imply B , and B does not imply A .

C. A implies B , but B does not imply A .

D. B implies A , but A does not imply B.

**Answer: B**

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**3.** A toy gun uses a spring of spring constant 1000 N/m . If spring is compressed by an amount 10 cm before fire then how high can be bullet be fired if mass of each bullet is 10 g .

A. 30 m

B. 40 m

C. 50 m

D. 60 m

**Answer: C**

Watch Video Solution

**4.** Consider the following two statements .

A : Kinetic energy depends on frame of reference .

B : Linear momentum does not depend on frame of reference .

A. Both A and B are false .

B. Both A and B are true .

C. A is true and B is false .

D. B is true and A is false .

**Answer: C**

Watch Video Solution

**5.** A particle of mass m is moving on a circular path of radius r . Centripetal acceleration of the particle or radius r . Centripetal acceleration of the particle depends on time t according to relation $a_c = kt^2$ . What power is delievered to the particle ?

A. mrkt

B. $mrkt^2$

C. $mr^2kt$

D. zero

**Answer: A**

Watch Video Solution

**6.** During elastic collision

A. KE remains constant .

B. KE first increases then decreases

C. KE first decreases then increases

D. KE before collision is greater than kinetic energy after collision .

**Answer: C**

Watch Video Solution

**7.** Internal forces can change

A. Linear momentum as well as kinetic energy

B. Linear momentum but not the kinetic energy

C. Kinetic energy but not the linear momentum

D. Neither kinetic energy nor linear momentum

**Answer: C**

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**8.** Three particles A, B and C are thrown from the top of a tower with the same speed. A is thrown up, B is thrown down and C is horizontally. They hit the ground with speeds $v_A, v_B$ and $v_C$ respectively then,

A. $V_A > V_B > V_C$

B. $V_A < V_B < V_C$

C. $V_A = V_B > V_C$

D. $V_A = V_B = V_C$

**Answer: D**

Watch Video Solution

**9.** A ball of mass m is moving with velocity u and collides head on with another identical body at rest . What is the maximum possible loss of kinetic energy due to collision ?

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

B. $\frac{1}{3}mu^2$

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

D. $\frac{1}{5}mu^2$

**Answer: C**

Watch Video Solution

**10.** A particle moves along the X - axis with velocity $v = k\sqrt{x}$ . What will be work done by the forces acting on particle during interval it moves from x = 0 to x = d ? (Assume mass of the aprticle is m ) .

A. $\frac{1}{2}mk^2d$

B. $\frac{1}{4}mk^2d$

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

D. $\frac{1}{4}mkd^2$

**Answer: A**

Watch Video Solution

**11.** A force of constant magnitude acts on a particle in such a way that it always remains perpendicular to velocity . If motion is taking place in a plane then

A. Velocity of the particle remians constant

B. Acceleration of the particle remains constant

C. Kinetic energy of the particle remains constant

D. Particle moves on a parabolic path

**Answer: C**

Watch Video Solution

**12.** A pendulum bob is rotated in a vertical circle with one end of string of length l fixed at a position . At a certain instant bob is at its lowest position and is moving with speed u . Calculate the magnitude of change in velocity when string becomes horizontal for a moment .

A. $\sqrt{(u^2 - gl)}$

B. $\sqrt{2(u^2 - gl)}$

C. $\sqrt{3(u^2 - gl)}$

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

**Answer: B**

Watch Video Solution

**13.** A shell is fired from a gun and it explodes in two pieces at the highest point of trajectory . One piece retraces its apth to gun . What will be the

velocity of other part just after explosion if shell is fired with a speed u at an angle $\theta$ with the horizontal ?

A. $u \cos \theta$

B. $2u \cos \theta$

C. $3u \cos \theta$

D. $4u \cos \theta$

**Answer: C**

Watch Video Solution

**14.** A particle is projected vertically upwards with a speed of $16ms^{-1}$. After some time, when it again passes through the point of projection, its speed is found to be $8ms^{-1}$. It is known that the work done by air resistance is same during upward and downward motion. Then the maximum height attained by the particle is (take $g = 10ms^{-2}$)

A. 4 m

B. 8 m

C. 16 m

D. 10 m

**Answer: B**

Watch Video Solution

**15.** An object is kept at rest . Object explodes in two parts of unequal masses .

A. Both parts move in the same direction

B. Both parts move in same direction but along different lines .

C. Both parts move in opposite directions with same speed .

D. Both parts move in opposite directions with different speed .

**Answer: D**

Watch Video Solution

**16.** There are two springs P and Q . Spring constant for P is K and that for Q is 3K . Both the springs are elongated by applying force of same magnitude . If U is energy stored in spring P then energy stores in spring Q is

A. 3U

B. U/3

C. 9U

D. U/9

**Answer: B**

Watch Video Solution

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

A. K/2

B. 3K/2

C. 2K/3

D. 2K

**Answer: B**

Watch Video Solution

**18.** Change in potential energy of the system is equal to

A. Negative of the work done by external forces .

B. Negative of the work done by internal conservative forces .

C. Negative of the work done by all forces

D. None of these

**Answer: B**

Watch Video Solution

**19.** A ball collides with an inclined plane of inclination $\theta$ after falling through a distance h. if it moves horizontal just after the impact, the coefficient of restitution is

A. $\tan^2\theta$

B. $\cot^2\theta$

C. $\tan\theta$

D. $\cot\theta$

**Answer: A**

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**20.** Change in kinetic energy of the system is equal to

A. Work done by all the forces ( internal and external )

B. Work done by external forces .

C. Work done by internal conservative forces .

D. None of these

**Answer: A**

Watch Video Solution

**21.** A body kept at rest explodes in four identical fragments and it is found that three of them move along mutually perpendicular directions with same kinetic energy K . Total energy released in the explosion is

A. 3k

B. 4K

C. 6K

D. 8K

**Answer: C**

Watch Video Solution

**22.** Two particles of equal masses moving with same collide perfectly inelastically. After the collision the combined mass moves with half of the speed of the individual masses. The angle between the initial momenta of individual particle is

A. $30^\circ$

B. $6^\circ$

C. $120^\circ$

D. None of these

**Answer: C**

Watch Video Solution

**23.** Change in total energy of the system is equal to

A. Work done by all the forces ( internal and external )

B. Work done by external forces .

C. Work done by internal conservative forces .

D. None of these

**Answer: B**

Watch Video Solution

**24.** If P represents linear momentum , K represents kinetic energy and T temperature, then quantities remaining constant in collision are

A. P,K and T

B. P only

C. K and T

D. T only

**Answer: B**

Watch Video Solution

**25.** A ball of mass $m_1$ moving with a certain speed collides elastically with another ball of mass $m_2$ kept at rest . If the first ball starts moving in reversed direction after the impact then

A. $m_1 = m_2$

B. $m_1 > m_2$

C. $m_1 < m_2$

D. None of these

**Answer: C**

Watch Video Solution

**26.** A block of mass m moving with speed v , collides head on with another block of mass 2m at rest .

If coefficient of restitution is $\frac{1}{2}$ then what is velocity of first block after the impact ?

A. Zero

B. v/2

C. v/4

D. v/6

**Answer: A**

Watch Video Solution

**27.** If resultant of forces acting on a system is zero then

A. Work done by each force must be zero .

B. Total work done by all forces must be zero .

C. Total work done by all the forces may be non - zero

D. Kinetic energy of the system must remain constant .

**Answer: C**

Watch Video Solution

**28.** Consider two observers moving with respect to each other at a speed v along·a straight line. They observe a block of mass m moving a distance 1 on a rough surface. The following quantities will be same as observed by the observers

A. Total work done by all the forces

B. Work done by force of friction

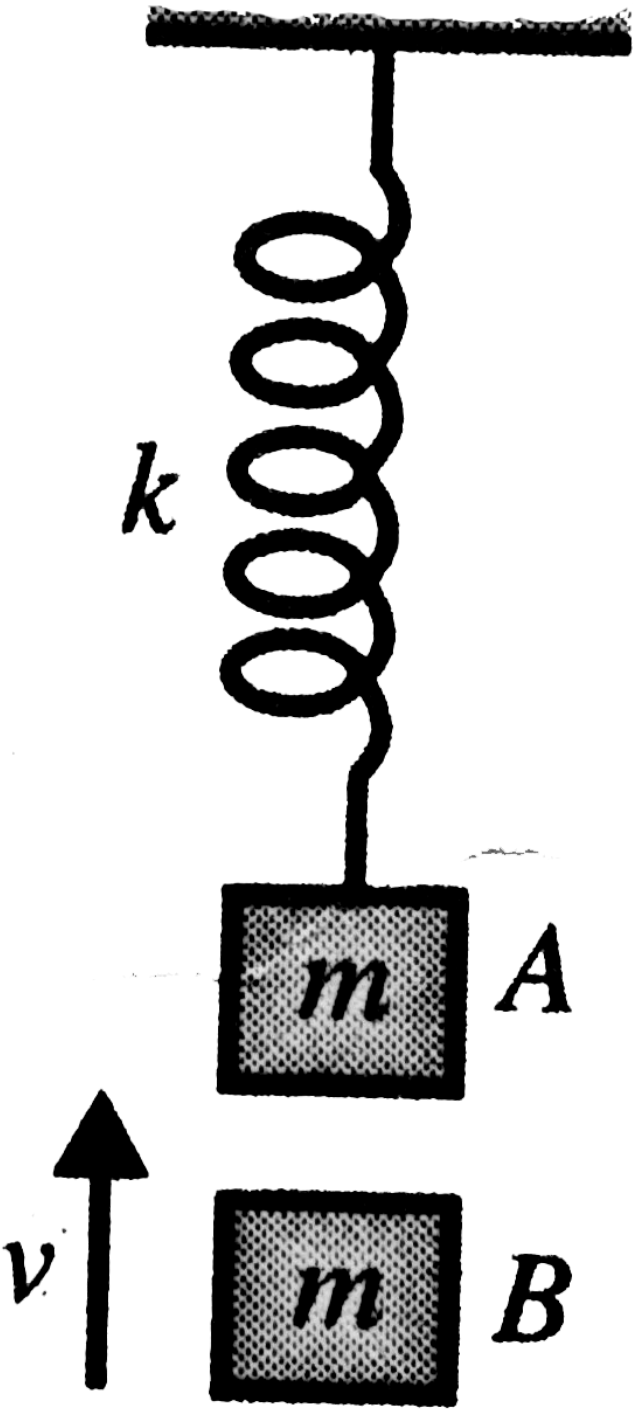
C. Acceleration of the block

D. Kinetic energy of the block at a certain instant

**Answer: C**

Watch Video Solution

**29.** Block $A$ is hanging from a vertical spring and is at rest. Block $B$ strikes the block $A$ with velocity $v$ and sticks to it. Then the value of $v$ for which the spring just attains natural length is


k
m
A
v
m
B

A. $\sqrt{\frac{6mg^2}{K}}$

B. $\sqrt{\frac{3mg^2}{K}}$

C. $\sqrt{\frac{12mg^2}{K}}$

D. $2\sqrt{\frac{mg^2}{K}}$

**Answer: A**

Watch Video Solution

## Objective Type Questions B Multiple Choice Questions

**1.** A 25 kg crate starting from rest at the top slides down a plane that makes an angle of $30^\circ$ with the horizontal . Whe it reaches the bottom of the 10 m long slide , its velocity is 8 m/s . The work done by the fore of friction is closest to a value of :

A. $17 \times 10^2$J

B. $8.5 \times 10^2$J

C. $6.5 \times 10^2$J

D. $4.5 \times 10^2$J

**Answer: D**

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

A. E/4

B. E/2

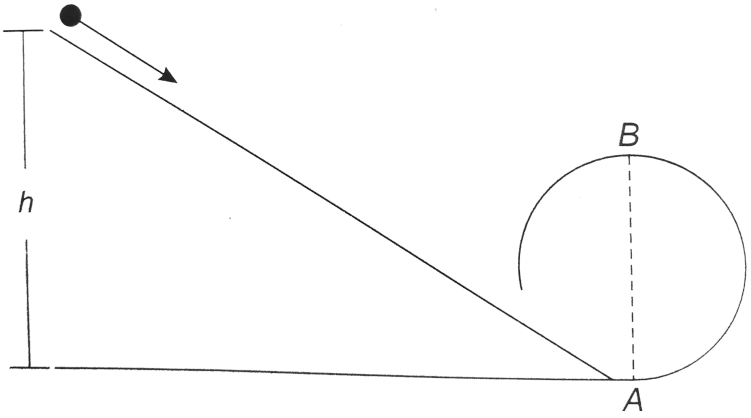
C. E

D. 2E

**Answer: B**

Watch Video Solution

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




A. $\frac{7}{5}$D

B. D

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

D. $\frac{5}{4}$D

**Answer: D**

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**4.** A particle of mass $m$ moving with velocity $v$ strikes a stationary particle of mass $2m$ and sticks to it. The speed of the system will be.

A. 3v

B. v/3

C. 2v

D. v/2

**Answer: B**

Watch Video Solution

**5.** An ideal spring with spring constant k is hung from the ceiling and a block of mass M is attached to its lower end. The mass is released with the spring initially unstretched. Then the maximum extension in the spring is

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

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

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

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

**Answer: B**

Watch Video Solution

**6.** 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 the acceleration due to gravity, the work required to pull the hanging part on to the table is

A. Mgl

B. Mg/9

C. Mgl/3

D. Mgl/18

**Answer: D**

Watch Video Solution

**7.** A machine which is 75 percent efficient, uses 12 joules of energy in lifting up a 1 kg mass through a certain distance. The mass is then allowed to fall through that distance. The velocity at the end of its fall is (in $ms^{-1}$)

A. $\sqrt{24}$

B. $\sqrt{32}$

C. $\sqrt{18}$

D. $\sqrt{9}$

**Answer: C**

Watch Video Solution

**8.** A moving block having mass m, collides with another stationary block having mass 4m. The lighter block comes to rest after collision. When the initial velocity of the lighter block is v, then the value of coefficient of restitution (e) will be

A. 0.8

B. 0.25

C. 0.5

D. 0.4

**Answer: B**

Watch Video Solution

**9.** A block of mass $m$ at rest is acted upon by a force $F$ for a time t. The kinetic energy of block after time t is

A. $\frac{P^2t^2}{m}$

B. $\frac{P^2t^2}{2m}$

C. $\frac{P^2T^2}{3m}$

D. $\frac{Pt}{2m}$

**Answer: B**

Watch Video Solution

**10.** A car of mass 1000kg accelerates uniformly from rest to a velocity of $54km/h$ in 5 seconds. Calculate (i) its acceleration (ii) its gain in KE (iii) average power of the engine during this period.

A. 2000 W

B. 22500 W

C. 5000 W

D. 2250 W

**Answer: B**

Watch Video Solution

**11.** A quarter horse power motor runs at a speed of 600 r . p . m . Assuming 40% efficiency the work done by the motor in one rotation will be

A. $7.46$ J

B. 7400 J

C. $7.46$ ergs

D. $74.6$J

**Answer: A**

Watch Video Solution

**12.** A body of mass $M_1$ collides elastically with another mass $M_2$ at rest. There is maximum transfer of energy when :

A. $M_1 > M_2$

B. $M_1 < M_2$

C. $M_1 = M_2$

D. Same for all values of $M_1$ and $M_2$

**Answer: C**

Watch Video Solution

**13.** A machine is delivering constant power to drive a body along a straight line. What is the relation between the distance travelled by the body against time ?

A. $t^{3/4}$

B. $t^{3/2}$

C. $\sqrt{t}$

D. t

**Answer: B**

Watch Video Solution

**14.** A toy gun a spring of force constant $k$. When changed before being triggered in the upward direction, the spring is compressed by a distance $x$. If the mass of the shot is $m$, on the being triggered it will go up to a height of

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

B. $\frac{kx^2}{mg}$

C. $\frac{kx}{mg}$

D. $\frac{kx^2}{2mg}$

**Answer: D**

Watch Video Solution

**15.** A particle of mass m1 is moving with a velocity $v_1$ and another particle of mass $m_2$ is moving with a velocity v2. Both of them have the same momentum but their different kinetic energies are E1 and E2 respectively. If $m_1 > m_2$ then

A. $\frac{E_1}{E_2} = \frac{m_1}{m_2}$

B. $E_1 > E_2$

C. $E_1 = E_2$

D. $E_1 < E_2$

**Answer: D**

Watch Video Solution

**16.** A ball is dropped form a height of 20 cm . Ball rebounds to a height of 10 cm . What is the loss of energy ?

A. 0.25

B. 0.75

C. 0.5

D. 1

**Answer: C**

Watch Video Solution

**17.** The power of a water pump is 2 kW. If $g = 10m/s^2$, the amount of water it can raise in 1 min to a height of 10 m is :

A. 2000 lit

B. 1000 lit

C. 1000 lit

D. 1200 lt

**Answer: D**

Watch Video Solution

**18.** Water falls from a height of $60m$ at the rate $15kg/s$ to operate a turbine. The losses due to frictional forces are $10\%$ of energy . How much power is generated to by the turbine? (g=10 m//s^(2))`.

A. 10.2 kW

B. 12.3 kW

C. 7.0 kW

D. 8.1 kW

**Answer: D**

Watch Video Solution

**19.** 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. $1:4:9$

C. $1:3:5$

D. $1:5:3$

**Answer: C**

Watch Video Solution

**20.** A shell of mass $200g$ is ejected from a gun of mass $4kg$ by an explosion that generate $1.05kJ$ of energy. The initial velocity of the shell is

A. $80 \text{ m } s^{-1}$

B. $40 \text{ m } s^{-1}$

C. $120 \text{ m} s^{-1}$

D. $100 \text{ m } s^{-1}$

**Answer: D**

Watch Video Solution

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

A. $mg(h+d)-\frac{1}{2}Kd^2$

B. $mg(h-d)+\frac{1}{2}Kd^2$

C. $mg(h-d)-\frac{1}{2}Kd^2$

D. $mg(h+d)+\frac{1}{2}Kd^2$

**Answer: A**

Watch Video Solution

**22.** A body of mass $3kg$ is under a constant force which causes a displacement $s$ metre in it, given by the relation $s = \frac{1}{3}t^2$, where $t$ is in seconds. Work done by the force in 2 seconds is

A. $\frac{19}{5}$ J

B. $\frac{5}{19}$ J

C. $\frac{3}{8}$J

D. $\frac{8}{3}$ J

**Answer: B**

Watch Video Solution

**23.** 300J of work is done in slinding a 2 kg block up an inclined plane of height 10m. Taking g =$10m/s^2$ , work done against friction is

A. 1000 J

B. 200 J

C. 100 J

D. Zero

**Answer: C**

Watch Video Solution

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

A. 30 J

B. 40 J

C. 10 J

D. 20 J

**Answer: D**

Watch Video Solution

**25.** A ball moving with velocity $2ms^{-1}$ collides head on with another stationary ball of double the mass. If the coefficient of restitution is $0.5$, then their velocities (in $ms^{-1}$) after collision will be

A. 1,0.5

B. 0,2

C. 0,1

D. 1,1

**Answer: C**

Watch Video Solution

**26.** The kinetic energy of a body becomes four times its initial value.The new linear momentum will be:

A. four times the initial value

B. thrice the initial value

C. twice the initial value

D. same as the initial value

**Answer: C**

Watch Video Solution

**27.** If the potential energy of a spring is V on stretching it by $2cm$, then its potential energy when it is stretched by $10cm$ will be

A. $\frac{U}{25}$

B. $\frac{U}{5}$

C. 25 U

D. 5 U

**Answer: C**

Watch Video Solution

**28.** The potential energy of a body is given by $U = A - Bx^2$ (where x is the displacement). The magnitude of force acting on the partical is

A. inversely proportional to x

B. proportional to $x^2$

C. proportional to $x^2$

D. constant

**Answer: C**

Watch Video Solution

**29.** An open knife of mass m is dropped from a height h on a wooden floor. If the blade penetrates up to the depth d into the wood. The average resistance offered by the wood to the knife edge is .

A. $mg\left(1 + \frac{h}{d}\right)$

B. $mg\left(1+\frac{h}{d}\right)^2$

C. $mg\left(1-\frac{h}{d}\right)$

D. mg

**Answer: A**

Watch Video Solution

**30.** An elevator is run by the cables at constant speed . The total work done by the elevator is :

A. negative

B. positive

C. zero

D. positive or negative depending on the direction of motion .

**Answer: D**

Watch Video Solution

**31.** A stationary partical explodes into two partical of a masses $m_1$ and $m_2$ which move in opposite direction with velocities $v_1$ and $v_2$. The ratio of their kinetic energies $E_1 / E_2$ is

A. $m_2 / m_1$

B. $m_1 / m_2$

C. 1

D. $m_1 \frac{v_2}{m_2} v_1$

**Answer: A**

Watch Video Solution

**32.** A neutron makes a head-on elastic collision with a stationary deuteron. The fraction energy loss of the neutron in the collision is

A. 16/81

B. $8/9$

C. $8/27$

D. $2/3$

**Answer: B**

Watch Video Solution

**33.** A mass of $0.5kg$ moving with a speed of $1.5m/s$ on a horizontal smooth surface, collides with a nearly weightless spring of force constant $k = 50N/m$ The maximum compression of the spring would be.

A. $0.12$m

B. $1.5$m

C. $0.5$m

D. $0.15$m

**Answer: D**

Watch Video Solution

**34.** A radioactive nucleus of mass number A, initially at rest, emits an $\alpha -$ particle with a speed v. What will be the recoil speed of the daughter nucleus ?

A. $\frac{2v}{A+4}$

B. $\frac{4v}{A+4}$

C. $\frac{4v}{A-4}$

D. $\frac{2v}{A-4}$

**Answer:**

Watch Video Solution

**35.** A bomb of mass $3.0kg$ explodes in air into two pieces of masses $2.0kg$ and $1.0kg$. The smaller mass goes at a speed of $80m/s$. The total energy imparted to the two fragments is :

A. 1.07 kJ

B. $2.14kJ$

C. 2.4 kJ

D. 4.8 kJ

**Answer: B**

Watch Video Solution

**36.** The particle executing simple harmonic motion has a kinetic energy $K_0 \cos^2 \omega t$. The maximum values of the potential energy and the energy are respectively

A. $\frac{K_0}{2}$ and $K_0$

B. $K_0$ and $2K_0$

C. $K_0$ and $K_0$

D. $0$ and $2K_0$

**Answer: D**

Watch Video Solution

**37.** An engine pumps water continously through a hose. Water leave the hose with a velocity $v$ and $m$ is the mass per unit length of the Water jet. What is the rate at Which kinetic energy is imparted to water?

A. $mv^2$

B. $\frac{1}{2}mv^2$

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

D. $\frac{1}{2}mv^3$

**Answer: C**

Watch Video Solution

**38.** The potential energy of a system increased if work is done

A. upon the system by a noncenservative force

B. by the system against a canservative force

C. by the system against a nonconservative force

D. upon the system by a conservative force

**Answer: D**

Watch Video Solution

**39.** An object of mass 500 g , initially at rest , is acted upon by a variable force whose X - component varies with X in the manner shown . The velocites of the object at the points X = 8 m and X = 12 m , would have the respective values of (nearly )

A. 18 m/s and 20.6 m/s

B. 18 m/s and 24.4 m/s

C. 23 m/s and 24.4 m/s

D. 23 m/s and 20.6 m/s

**Answer: B**

View Text Solution

**40.** Two sphere $A$ and $B$ of masses $m_1$ and $m_2$ respectivelly colides. A is at rest initally and $B$ is moving with velocity $v$ along x-axis. After collision $B$ has a velocity $\frac{v}{2}$ in a direction perpendicular to the original direction. The mass $A$ moves after collision in the direction.

A. $\theta = \tan^{-1}\left(-\frac{1}{2}\right)$ to the X - axis

B. same as that of B

C. opposite to that of B

D. $\theta = \tan^{-1}\left(\frac{1}{2}\right)$ to the X - axis

**Answer: D**

Watch Video Solution

**41.** The potential energy of a particle in a force field is:

$U = \frac{A}{r^2} - \frac{B}{r}$,. Where $A$ and $B$ are positive constants and $r$ is the distance of particle from the centre of the field. For stable equilibrium the distance of the particle is

A. B/A

B. B/2A

C. 2A/B

D. A/B

**Answer: A**

Watch Video Solution

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

A. $W_P = W_Q, W_P > W_Q$

B. $W_P = W_Q, W_P = W_Q$

C. $W_P > W_Q, W_Q > W_P$

D. $W_P < W_Q, W_Q < W_P$

**Answer: C**

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**43.** A partical of mass $m$ is driven by a machine that deleveres a constant power $k$ watts. If the partical starts from rest the force on the partical at time $t$ is

A. $\sqrt{\frac{mk}{2}}t^{-1/2}$

B. $\sqrt{mk}t^{-1/2}$

C. $\sqrt{2mk}t^{-1/2}$

D. $\frac{1}{2}\sqrt{mk}t^{-1/2}$

**Answer: C**

Watch Video Solution

**44.** Body $A$ of mass $4m$ moving with speed $u$ collides with another body $B$ of mass $2m$ at rest, the collision is head on and elastic in nature. After the collision the fraction of energy lost by colliding body $A$ is :

A. $\frac{1}{9}$

B. $\frac{8}{9}$

C. $\frac{4}{9}$

D. $\frac{5}{9}$

**Answer: A**

Watch Video Solution

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

A. 30 J

B. 5 J

C. 25 J

D. 20 J

**Answer: B**

Watch Video Solution

**46.** A particle of mass 5 m at rest suddenly breaks on its own into three fragments . Two fragments of mass m of each move along mutully perpendicular direction with speed v each . The energy released suring the process is

A. $\frac{4}{3}mv^2$

B. $\frac{3}{5}mv^2$

C. $\frac{5}{3}mv^2$

D. $\frac{3}{2}mv^2$

**Answer: A**

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## Objective Type Questions Jee Main Other State Boards For Engineering Entrance

**1.** 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)

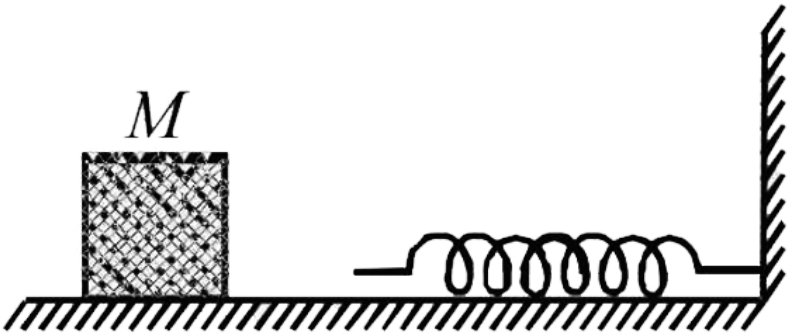
C. (0.89,0.28)

D. (0.28,0.89)

**Answer: C**

Watch Video Solution

**2.** 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. $\sqrt{MK}$ L

B. $\frac{KL^2}{2M}$

C. zero

D. $\frac{ML^2}{K}$

**Answer: A**

Watch Video Solution

**3.** An oscillator of mass M is at rest in its equilibrium position in a potential $V = \frac{1}{2}k(x - X)^2$. A particle of mass m comes from right with speed u and collides completely inelastically with M and sticks to it. The process repeats every time the oscillator crosses its equilibrium position. The amplitude of oscilllations after 13 collisions is : (M=10, m=5, u=1 ,k=1)

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

B. $\frac{1}{\sqrt{3}}$

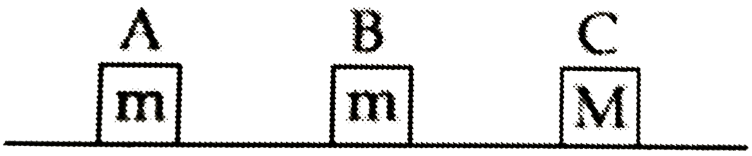
C. $\sqrt{\frac{3}{5}}$

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

**Answer:**

Watch Video Solution

**4.** 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. 4

C. 5

D. 3

**Answer: B**

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**5.** A ball of mass 0.2 kg is thrown vertically upwards by applying a force by hand. If the hand moves 0.2 m while applying the force and the ball goes upto 2 m height further, find the magnitude of the force. (Consider $g = 10m/s^2$).

A. 4N

B. 16 N

C. 20 N

D. 22 N

**Answer: B**

Watch Video Solution

**6.** A locomotive of mass m starts moving so that its velocity varies according to the law $v = a\sqrt{s}$, where a is a constant, and s is the distance covered. Find the total work performed by all the forces which are acting on the locomotive during the first t seconds after the beginning of motion.

A. $8ma^4t^2$

B. $\frac{1}{4}ma^4t^2$

C. $4ma^4t^2$

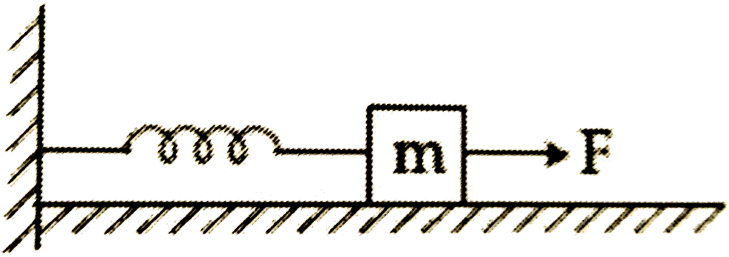
D. $\frac{1}{8}ma^4t^2$

**Answer: C**

Watch Video Solution

**7.** A block of mass m, lying on a smooth horizontal surface, is attached to a spring (of negligible mass) of spring constant k. The other end of the spring is fixed, as shown in the figure. The block is initally at rest in its

equilibrium position. If now the block is pulled withe a constant force F, the maximum speed of the block is :




A. $\frac{F}{\pi\sqrt{mk}}$

B. $\frac{\pi F}{\sqrt{mk}}$

C. $\frac{F}{\sqrt{mk}}$

D. $\frac{2F}{\sqrt{mk}}$

**Answer: D**

Watch Video Solution

**8.** 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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**9.** A particle is moving in a circular path of radius a under the action of an attractive potential $U = -\frac{k}{2r^2}$. Its total energy is :

A. Zero

B. $-\frac{3}{2}\frac{k}{a^2}$

C. $-\frac{k}{4a^2}$

D. $\frac{k}{2a^2}$

**Answer: C**

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**10.** A spherical ball of mass $20kg$ is stationary at the top of a hill of height $100m$ , it rolls down a smooth surface to the ground , then climbs up another bill of height of $30m$ and final rolls down to a horizontal base at a height of $20m$ about the ground . The velocity attained by the ball is

A. 40 m/s

B. 20 m/s

C. 10 m/s

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

**Answer: A**

Watch Video Solution

**11.** 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. 850 J

B. 900 J

C. 875 J

D. 950 J

**Answer: A**

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**12.** 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. Constant

B. t'

C. $\frac{1}{\sqrt{t}}$

D. $\sqrt{t}$

**Answer: B**

Watch Video Solution

**13.** When a rubber-band is stretched by a distance x, it exerts a restoring force of magnitude $F = ax + bx^2$ where a and b are constants. The work done in stretching the unstretched rubber band by L is :

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

B. $aL^2 + bL^3$

C. $\frac{1}{2}(aL^2 + bL^2)$

D. $\frac{aL^2}{2} + \frac{bL^3}{3}$

**Answer: C**

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

A. 0.5

B. 0.56

C. 0.62

D. 0.44

**Answer: D**

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**15.** 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. v

B. $\sqrt{3}$v

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

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

**Answer: B**

Watch Video Solution

**16.** A block of mass $m = 0.1kg$ is connceted to a spring of unknown spring constant k. It is compressed to a distance x from its equilibrium position and released from rest. After approaching half the distance $\left(\frac{x}{2}\right)$ from the euilibrium position, it hits another block and comes to rest momentarily, while the other block moves with velocity $3ms^{-1}$. The total initial energy of the spring is :

A. 0.3 J

B. 0.6 J

C. 0.8 J

D. 1.5 J

**Answer: C**

Watch Video Solution

**17.** Three masses m , 2m and 3m are moving in X-Y plane with speed 3u , 2u and u respectively as shown in figure . The three masses collide at the same point at P and stick together . The velocity of resulting mass will be :

A. $\frac{u}{12}\left(\hat{i}+\sqrt{3}\hat{j}\right)$

B. $\frac{u}{12}\left(\hat{i}-\sqrt{3}\hat{j}\right)$

C. $\frac{u}{12}\left(-\hat{i}+\sqrt{3}\hat{j}\right)$

D. $\frac{u}{12}\left(-\hat{i}-\sqrt{3}\hat{j}\right)$

**Answer: B**

View Text Solution

**18.** The upper half of an inclined plane with inclination $\phi$ is perfectly smooth while the lower half is rough. A body starting from rest at the top will again come to rest at the bottom if the coefficient of friction for the lower half is given by

A. $2\sin\phi$

B. $2\cos\phi$

C. $2\tan\phi$

D. $\tan\phi$

**Answer: C**

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**19.** A block of mass 'm' is connected to another block of mass 'M' by a spring (massless) of spring constant 'k' The blocks are kept on a smooth

horizontal plane. Initially the blocks are at rest and the spring is unstretched Then a constant force 'F' starts acting on the block of mass 'M' to pull it. Find the force on the block of mass 'm' :

A. $\frac{(M+m)F}{m}$

B. $\frac{mF}{(m+M)}$

C. $\frac{MF}{(m+M)}$

D. $\frac{mF}{M}$

**Answer: B**

Watch Video Solution

**20.** A mass of M kg is suspended by a weightless string. The horizontal force that is required to displace it until the string makes an angle of $45^\circ$ with the initial vertical direction is

A. $Mg\left(\sqrt{2}+1\right)$

B. Mg

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

D. $Mg\left(\sqrt{2}-1\right)$

**Answer: D**

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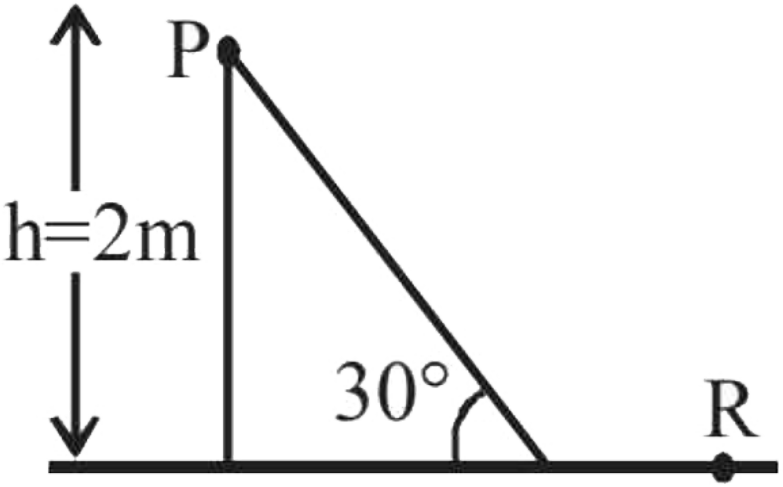
**21.** A point particle of mass m, moves long the uniformly rough track PQR as shown in figure. The coefficient of friction, between the particle and the rough track equals $\mu$. The particle is released, from rest from the point P and it comes to rest at a point R. The energies, lost by the ball, over the parts, PQ and QR, of the track, are equal to each other, and no energy is lost when particle changes direction from PQ to QR.

The value of the coefficient of friction $\mu$ and the distance x $(=QR)$, are,

respectively close to:




A. 0.2and 6.5 m

B. 0.2 and 3.5 m

C. 0.29 and 3.4 m

D. 0.29 and 6.5 m

**Answer: B**

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Watch Video Solution

**22.** A body of mass $m = 10^{-2}kg$ is moving in a medium and experiences a frictional force $F = -Kv^2$. Its initial speed is $v_0 = 10ms^{-2}$. If , after $10s$, its energy is $\frac{1}{8}mv_0^2$, the value of $k$ will be

A. $10^{-3}$ $\mathrm{kg\,m^{-1}}$

B. $10^{-3}$ $\mathrm{kg\,s^{-1}}$

C. $10^{-4}$ $\mathrm{kg\,m^{-1}}$

D. $10^{-1}$ $\mathrm{kg\,m^{-1}}$

**Answer: C**

Watch Video Solution

**23.** A time dependent force $F = 6t$ acts on a particle of mass $1kg$. If the particle starts from rest, the work done by the force during the first $1\,\mathrm{sec.}$ will be

A. 4.5 J

B. 22 J

C. 8 J

D. 18 J

**Answer: A**

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**24.** An object is dropped from a height h from the ground . Every time it it hits ground it loses 50 % of its kinetic energy . The total distance covered as $t \to \infty$ is :

A. 3h

B. $\infty$

C. $\frac{5}{3}$ h

D. $\frac{8}{3}$ h

**Answer: A**

View Text Solution

**25.** A conical pendulum of length 1 m makes an angle $\theta = 45^\circ$ w.r.t . Z - axis and moves in a circle in the Xy plane . The radius of the circle in the XY plane . The radius of the circle is 0.4 m and its centre is vertically below O . The speed of the pendulum , in its circular path , will be : (Take $g = 10 \ \ \mathrm{m} \ \ s^{-2}$)

A. 0.4 m/s

B. 4 m/s

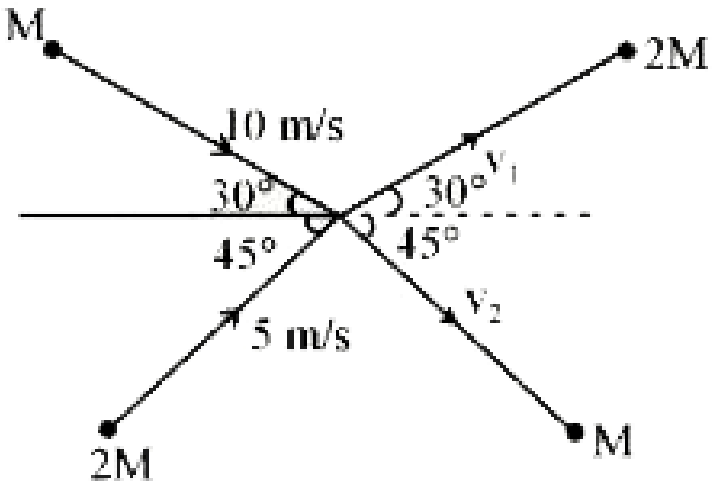
C. 0.2 m/s

D. 2 m/s

**Answer: D**

View Text Solution

**26.** 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 diretions with speeds $v_1$ and $v_2$ respectively. The value 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. 6.5 m/s and 3.2 m/s

D. 3.2 m/s and 12.6 m/s

**Answer: A**

Watch Video Solution

**27.** A car weight W is on an inclined road that rises by 100 m over a distance of 1 km and applies a constant frictional force $\frac{W}{20}$ on the car . While moving uphill on the road at a speed of $10 \text{ m } s^{-1}$, the car needs power P . If it needs power $\frac{P}{2}$ while moving downwill at speed v then value of v is :

A. $20 \text{ m} s^{-1}$

B. $15 \text{ m } s^{-1}$

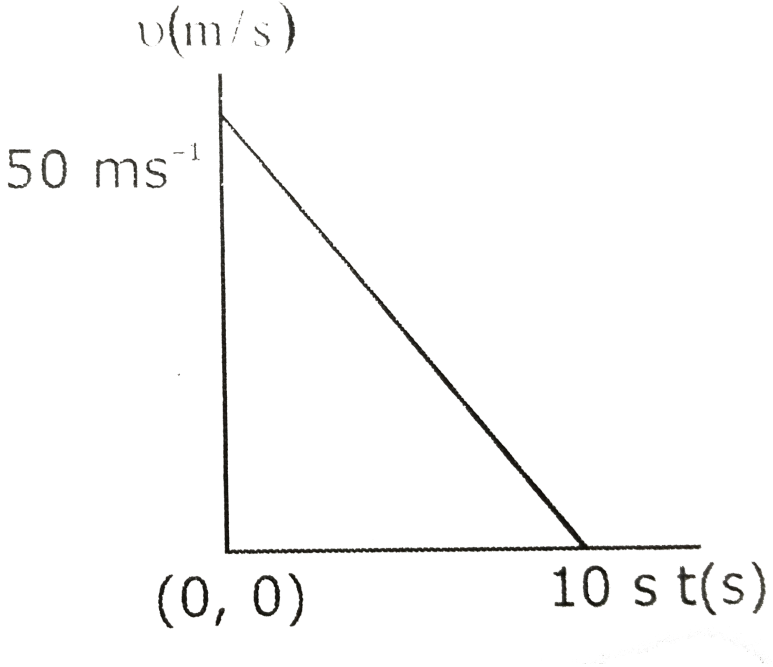
C. $10 \text{ m } s^{-1}$

D. $5 \text{ m } s^{-1}$

**Answer: B**

Watch Video Solution

**28.** Velocity -time graph for a body of mass 10 kg is shown in figure. Work - done on the body in first two seconds of the motion is :




A. 12000 J

B. $-12000$ J

C. $-4500$ J

D. $-9300$

**Answer: C**

Watch Video Solution

Watch Video Solution

**29.** 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. $\sqrt{2v_0}$

**Answer: D**

Watch Video Solution

**30.** 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. $\frac{v^2}{2g}$

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

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

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

**Answer: C**

Watch Video Solution

**31.** 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 $45^\circ$ 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. $v/\sqrt{2}$

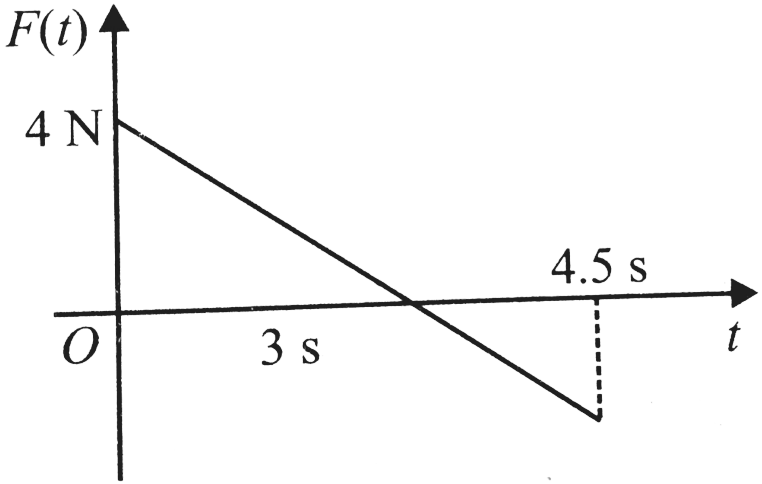
**Answer: A**

Watch Video Solution

## Objective Type Questions Jee Advanced For Iit Entrance

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

energy of the block after $4.5$ seconds is




A. 4.50 J

B. 7.50 J

C. 5.06 J

D. 14.06 J

**Answer: C**

Watch Video Solution

**2.** One end of a horizontal thick copper wire of length $2L$ and radius $2R$ is welded to an end of another horizontal thin copper wire of length $L$ and radius $R$ .When the arrangement is stretched by applying forces at two ends , the ratio of the elongation in the thin wire to that in the thick wire is

A. 0.25

B. $0.50$

C. $2.00$

D. $4.00$

**Answer: C**

Watch Video Solution

**3.** The work done an a particle of mass $m$ by a force

$$K\left[\frac{x}{\left(x^2+y^2\right)^{3/2}}\hat{i}+\frac{y}{\left(x^2+y^{2^{3/2}}\right)}\hat{j}\right](Kbe\in gacons\tan tofap\propto riate\ dir$$

(a,0) $\rightarrow$ $thep\oint$(0,a)` along a circular path of radius a about the origin in x - y plane is

A. $\frac{2K\pi}{a}$

B. $\frac{K\pi}{a}$

C. $\frac{K\pi}{2a}$

D. 0

**Answer: D**

Watch Video Solution

**4.** A tennis ball dropped on a barizoontal smooth surface , it because back to its original postion after hiting the surface the force on the bell during the collision is propertional 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. 

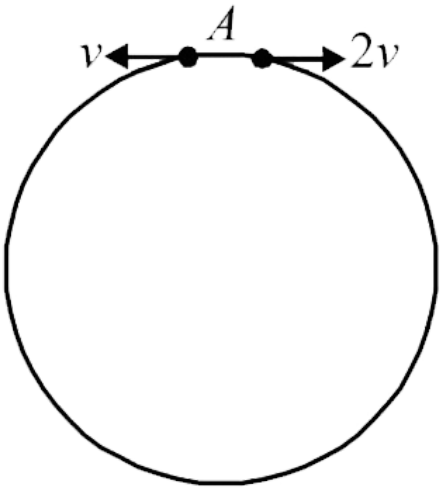
D. 

**Answer: B**

Watch Video Solution

**5.** Two small particles of equal masses stant moving in opposite direction from a point $A$ in a burtizonetal circule orbic their tangention velocity are $V$ and $2V$ , respectively as shown in the figure between collsions , the particals move with constant speed After making how many elastic collition , other the then that at $A$ these two partical will again reach the

point $A$ ?




A. 4

B. 3

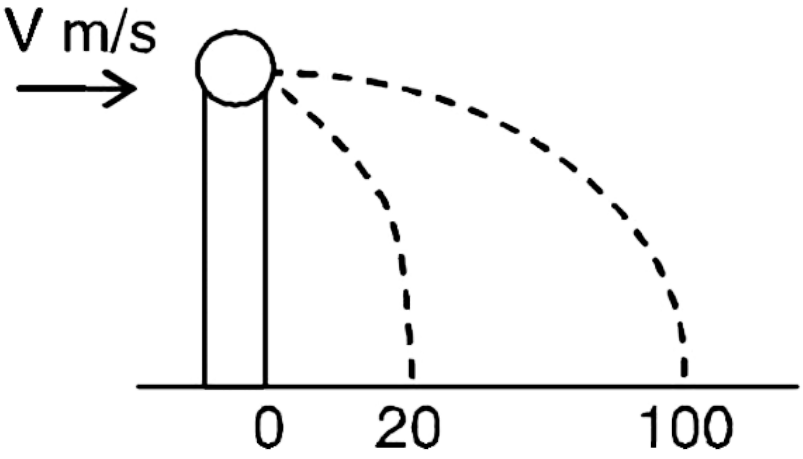
C. 2

D. 1

**Answer: C**

Watch Video Solution

**6.** A ball of mass 0.2 kg rests on a vertical post of height 5 m. A bullet of mass 0.01 kg, travelling with a velocity $Vm/s$ in a horizontal direction, hits the centre of the ball. After the collision, the ball and bullet travel independently. The ball hits the ground at a distance of 20 m and the bullet at a distance of 100 m from the foot of the post. The velocity V of the bullet is




A. 250 m/s

B. $256\sqrt{2}$ m/s

C. 400 m/s

D. 500 m/s

**Answer: D**

Watch Video Solution

**7.** A particle of mass m is projected from the ground with an initial speed $u_0$ at an angle $\alpha$ 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. $\frac{\pi}{4}$

B. $\frac{\pi}{4} + \alpha$

C. $\frac{\pi}{4} - \alpha$

D. $\frac{\pi}{2}$

**Answer: A**

Watch Video Solution

## Objective Type Questions C Multiple Choice Questions

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

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

C. The particles kinetic energy increases by a factor of 4 when the piston is moved inward from $\vec{L}_0 \text{ to} \frac{1}{2} L_0$

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

**Answer: B::C**

Watch Video Solution

**2.** A ball moving with velocity u strikes a smooth horizontal floor at an angle $\alpha$ with the normal to the surface at the point of contact . After collision , ball moves with velocity v at an angle $\beta$ with the normal . Assume e as the coefficient of restitution .

A. $\tan\alpha = e\tan\beta$

B. Impulse applied by the surface on the ball is mu(1+e)cos `

C. $v = u\sqrt{(\sin^2\alpha + e^2\cos^2\alpha)}$

D. v=$\tan\alpha$

**Answer: A::B::C::D**

Watch Video Solution

**3.** A body is projetced from of a top of a tower . Speed with which the body hits the ground

A. Must be dependent on angle of projection

B. Must be dependent on speed of projection

C. Must be greater than speed of projection

D. May be less than speed of projection depending on direction of projection .

**Answer: B::C**

Watch Video Solution

**4.** When two bodies of equal masses collide elastically then

A. Linear momenta are exchanged

B. Velocities are exchanged

C. Speeds are exchanged

D. Slower body speeds up for and faster body slows down .

**Answer: A::B::C::D**

Watch Video Solution

**5.** In a perfectly elastic collision between two bodies

A. Kinetic energy of the system remains constant .

B. Mechanical energy of the system remains constant .

C. Kinetic energy first decreases and then ncreases .

D. Kinetic energy before collision is equal to kinetic energy after collision .

**Answer: B::C::D**

Watch Video Solution

**6.** In a perfectly inelastic collision between two bodies

A. There is maximum possible loss of energy .

B. Mechanical energy of the system remains constant .

C. Kinetic energy first decreases and then becomes constant .

D. Kinetic energy before collision is greater than kinetic energy after collision .

**Answer: A::C::D**

Watch Video Solution

**7.** A body moving with a certain speed collide with another body of finite mass kept at rest . Which of the following is/are possible ?

A. Both bodies move after collision .

B. Both the bodies come to rest after collision .

C. Moving body comes to rest and body at rest starts moving .

D. Body at rest remains at rest whereas moving body rebounds and reverses its direction of motion .

**Answer: A::C**

Watch Video Solution

**8.** If a body of mass m collides head on, elastically with velocity u with another identical boday at rest. After collision velocty of the second body will be

A. Moving body comes to rest and body at rest starts moving .

B. Both the bodies continue moving

C. Both the bodies move at right angle after the collision .

D. Kinetic energy after collision is less than before collision .

**Answer: A::B::C**

Watch Video Solution

**9.** When a body of mass $m_1$ collides with another body of mass $m_2$ kept at rest , then it is found that moving body comes to rest and body at rest starts moving . Which of the following options are possible ?

A. $\frac{m_1}{m_2} < 1$

B. $\frac{m_1}{m_2} > 1$

C. $\frac{m_1}{m_2} = 1$

D. $e < 1$

**Answer: A::C::D**

Watch Video Solution

**10.** 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 $\gamma$ is a positive constant of appropriate dimensions. Which of the following statement is (are) true?

A. The force applied on the particle is constant

B. The speed of the particle is proportional to time

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

D. The force is conservative

**Answer: A::B::D**

Watch Video Solution

**11.** A heavy nucleous of masss M kept at rest in laboratory rejects a light particle of mass m .

A. Linear momentum of particle is more than linear momentum of remaining nucleus

B. Velocity of particle is more than velocity of nucleus .

C. Kinetic energy of the partcle is more than kinetic energy of the nucleus .

D. Kinetic energy of the nucleus is more than that of the particle .

**Answer: B::C**

Watch Video Solution

**12.** Two blocks are connected to the two free ends of a spring of spring constant K . Both the blocks are moved apart to extend the psring beyond its natural length and then released . In subsequent motion

A. Accelerations of both the objects are equal and opposite of each other .

B. Velocities of both the bjects are equal and opposite of each other .

C. Forces acting on both the objects are equal and opposite of each other

D. Linear momenta of both the objects are equal and opposite of each other .

**Answer: C::D**

Watch Video Solution

**13.** Which of the following statements (s) is/are correct ?

A. In an inertial frame

$$W_{\text{conservative}} + W_{\text{non-conservative}} + W_{\text{other -force}} = K_2 - K_1$$

B. In a non - inertial frame :

$$W_{\text{conservative}} + W_{\text{non conservative}} + W_{\text{other -force}} + W_{\text{pseudo - force}} = K_2 -$$

C. Work done by conservative forces is independent of path followed .

D. Work done by non - conservative forces depends on path followed .

**Answer: A::B::C::D**

Watch Video Solution

**14.** Kinetic energy of a particle is found to increase continuously with time . Select correct statement (s) .

A. Resultant force acting on the particle must always be at angle less than $90^\circ$ with the velocity of particle .

B. Resultant force may always bee parallel to velocity of the particle .

C. Magnitude of linear momentum of the aprticle increases with time .

D. Resultant force must always be parallel to velocity of the particle .

**Answer: A::B::C**

Watch Video Solution

**15.** A force of constant magnitude acts on a particle in such a way that it always remains perpendicular to its velocity .

A. Kinetic energy of the particle remains constant .

B. Velocity of the particle remains constant .

C. Acceleration of particle changes continuously

D. Particle moves on a circular path .

**Answer: A::C::D**

Watch Video Solution

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

A. Total momentum of the sustem is 3 kg $ms^{-1}$

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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## Objective Type Questions D Multiple Choice Questions

**1.** The distance x of a particle moving in one dimensions, under the action of a constant force is related to time t by the equation, $t = \sqrt{x} + 3$, where x is in metres and t in seconds. Find the displacement of the particle when its velocity is zero.

A. 0 m

B. 2 m

C. 4 m

D. 6 m

**Answer: A**

Watch Video Solution

**2.** The displacement $x$ of particle moving in one dimension, under the action of a constant force is related to the time $t$ by the equation $t = \sqrt{x} + 3$

where $xis \in meters$ and $t \in \sec onds$ . Find

(i) The displacement of the particle when its velocity is zero , and

(ii) The work done by the force in the first $6 \sec onds$.

A. 0 J

B. 2 J

C. 4 J

D. 6 J

**Answer: A**

Watch Video Solution

**3.** Consider a case of fixed smooth sphere of radius R . A block of mass m is placed at the most poit of the sphere . A sharp impulse is applied on the block to impart it a speed v .

What is the normal reaction between block and the sphere just after the impulse is applied ?

A. $\frac{mv^2}{R}$

B. $mg - \frac{mv^2}{R}$

C. mg

D. 0

**Answer: B**

Watch Video Solution

**4.** Consider a case of fixed smooth sphere of radius R . A block of mass m is placed at the most poit of the sphere . A sharp impulse is applied on the block to impart it a speed v .

What si the maximum possible value of v so that block does not lose contact with the sphere at the top point ?

A. $\sqrt{5gR}$

B. $\sqrt{3gR}$

C. $\sqrt{gR}$

D. 0

**Answer: C**

Watch Video Solution

**5.** Consider a case of fixed smooth sphere of radius R . A block of mass m is placed at the most poit of the sphere . A sharp impulse is applied on the block to impart it a speed v .

If a speed given at top is $\sqrt{\frac{gR}{3}}$ , then what is the angle made by radius through block when it leaves the sphere ?

A. $\cos^{-1}\left(\frac{2}{3}\right)$

B. $\cos^{-1}\left(\frac{3}{4}\right)$

C. $\cos^{-1}\left(\frac{5}{9}\right)$

D. $\cos^{-1}\left(\frac{7}{9}\right)$

**Answer: D**

Watch Video Solution

**6.** A small block moves on a frictionless surface of an inclined plane as shown in the figure .

PQR is the inclined plane which changes its angle suddenly from $60^\circ \ \text{to} 30^\circ$ at the point q . Block is initially at rest at point P . Assume that collision between block and the surface is completely inelastic . Take g = $10 m / s^2$ Distances shown in figure are measured in metre .

What is the normal reaction between block and the sphere just after the impulse is applied ?

A. $\sqrt{60}$

B. $\sqrt{45}$

C. $\sqrt{30}$

D. $\sqrt{15}$

**Answer: B**

View Text Solution

**7.** A small block moves on a frictionless surface of an inclined plane as shown in the figure .

PQR is the inclined plane which changes its angle suddenly from $60^\circ \ \text{to} 30^\circ$ at the point q . Block is initially at rest at point P . Assume that collision between block and the surface is completely inelastic . Take g = $10 m / s^2$ Distances shown in figure are measured in metre .

What is the maximum possible value of v so that block does not lose contact with the sphere at the top point ?

A. $\sqrt{120}$

B. $\sqrt{105}$

C. $\sqrt{90}$

D. $\sqrt{75}$

**Answer: B**

View Text Solution

**8.** A small block moves on a frictionless surface of an inclined plane as shown in the figure .

PQR is the inclined plane which changes its angle suddenly from $60^\circ \ \text{to} 30^\circ$ at the point q . Block is initially at rest at point P . Assume that collision between block and the surface is completely inelastic . Take g = $10 m / s^2$ Distances shown in figure are measured in metre .

Now assume collision between block and the surface to be completely elastic . What will be the vertical component of velocity of block immediately after it strikes the second incline at the point R ?

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

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

C. zero

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

**Answer: C**

View Text Solution

**9.** A small block of mass 1 kg is released from rest at the top of a rough rtack . The track is a circular arc of radius 40 m. 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 the figure is 150 J . (Take $g = 10 \ \mathrm{m} \ \ s^{-2}$)

The speed of the block when it reaches the point Q is .

A. $5 \ \mathrm{m} \ \ s^{-1}$

B. $10\ \mathrm{m}\ s^{-1}$

C. $10\sqrt{3}\ \mathrm{m}\ s^{-1}$

D. $20\ \mathrm{m}\ s^{-1}$

**Answer: B**

View Text Solution

**10.** A small block of mass 1 kg is released from rest at the top of a rough rtack . The track is a circular arc of radius 40 m. 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 the figure is 150 J . (Take $g = 10\ \mathrm{m}\ s^{-2}$)

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**

View Text Solution

## Objective Type Questions Assertion Reason Type Questions

**1.** Assertion : When two real bodies collide then K.E of the system first decreases and then increases .

Reason : At the time collision bodies are first deformed and then due to elasticity bodies try to reform again.

A. If both assertion and reason are corret and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is ot the correct explanation of assertion .

C. If assertion is correct but reason is incorrect .

D. If both assertion and reason are incorrect .

**Answer: A**

Watch Video Solution

**2.** Assertion : In case of elastic collision between two objects , speed of approach is same as speed of separation .

Reason : In case of elastic collision between two objects , linear momentum of the system remains conserved .

A. If both assertion and reason are corret and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is ot the correct explanation of assertion .

C. If assertion is correct but reason is incorrect .

D. If both assertion and reason are incorrect .

**Answer: B**

Watch Video Solution

**3.** Assertion : Object A of mass collides elastically with another object B of same mass at rest and if found that A and B move perpendicular to each other after collision .

Reason : Collision between A and B is not head on .

A. If both assertion and reason are corret and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is ot the correct explanation of assertion .

C. If assertion is correct but reason is incorrect .

D. If both assertion and reason are incorrect .

**Answer: A**

Watch Video Solution

**4.** Assertion : Internal forces acting on the system cannot change linear momentum of the system .

Reason : Internal forces can change kinetic energy of the system.

A. If both assertion and reason are corret and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is ot the correct explanation of assertion .

C. If assertion is correct but reason is incorrect .

D. If both assertion and reason are incorrect .

**Answer: B**

Watch Video Solution

**5.** Assertion : When pendulum bob is rotating in a circle around the point of suspension then work done by tension and the weight is zero .

Reason : Work done by a force is defined as dot product of force vector and displacement vector .

A. If both assertion and reason are corret and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is ot the correct explanation of assertion .

C. If assertion is correct but reason is incorrect .

D. If assertion is incorrect and reason is incorrect .

**Answer: D**

Watch Video Solution

**6.** Assertion : Work done by conservative forces is independent of path followed by the body .

Reason : Work done by non conservative forces depends on the path followed by the body .

A. If both assertion and reason are corret and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is not the correct explanation of assertion .

C. If assertion is correct but reason is incorrect .

D. If both assertion and reason are incorrect .

**Answer: B**

View Text Solution

**7.** Assertion : Net external force acting on a system of particles is zero but it possible that kinetic energy of the system increases .

Reason : Kinetic energy of the system can be changed by internal forces of the system .

A. If both assertion and reason are corret and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is ot the correct explanation of assertion .

C. If assertion is correct but reason is incorrect .

D. If both assertion and reason are incorrect .

**Answer: A**

Watch Video Solution

**8.** Assertion : It is possible that work done by a force on an object is different for different observes .

Reason : Work done by a force depends on frame of reference of observer .

A. If both assertion and reason are corret and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is ot the correct explanation of assertion .

C. If assertion is correct but reason is incorrect .

D. If both assertion and reason are incorrect .

**Answer: A**

Watch Video Solution

**9.** Assertion: The relative velocity of the two particles in head-on elastic collision is unchanged both in magnitude and direction.

Reason: The relative velocity is unchanged in magnitude but gets reversed in direction.

A. If both assertion and reason are corret and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is ot the correct explanation of assertion .

C. If assertion is correct but reason is incorrect .

D. If both assertion and reason are incorrect .

**Answer: D**

Watch Video Solution

**10.** Assertion: During head on collision between two bodies let $\Delta p_1$ is change in momentum of first body and $\Delta p_2$ the change in momentum of the other body, then $\Delta p_1 = \Delta p_2$.

Reason: Total momentum of the system should remain constant.

A. If both assertion and reason are corret and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is ot the correct explanation of assertion .

C. If assertion is correct but reason is incorrect .

D. If both assertion and reason are incorrect .

**Answer: D**

Watch Video Solution

**11.** This question has statement $1$ and statement $2$ . Of the four choice given after the Statement , choose the one that best describe the two Statement .

If the spring $S_1$and $S_2$ of force constant $k_1$ and $k_2$ respectively , are streached by the same force , it is found that more work is done on spring $S_1$ then on spring $S_2$

Statement -1: If statement by the same answer work done on $S_1$ work on $S_1$ is more then $S_2$

Statement - 2 : $k_1 < k_2$

A. If both assertion and reason are corret and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is ot the correct explanation of assertion .

C. If assertion is correct but reason is incorrect .

D. If both assertion and reason are incorrect .

**Answer: A**

Watch Video Solution

**12.** 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 glven 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. If both assertion and reason are corret and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is ot the correct explanation of assertion .

C. If assertion is correct but reason is incorrect .

D. If both assertion and reason are incorrect .

**Answer: D**

Watch Video Solution

**13.** Statement 1 : Two particles moving in the same direction do not lose all their energy in a completely inelastic collision.

Statement 2 : The principle of conservation of momentum holds true for all kinds of collisions.

A. If both assertion and reason are corret and reason is a correct explanation of the assertion .

B. If both assertion and reason are correct but reason is ot the correct explanation of assertion .

C. If assertion is correct but reason is incorrect .

D. If both assertion and reason are incorrect .

**Answer: A**

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## Objective Type Questions Matrix Match Type Questions

**1.** Each question contains statements given in two columns , which have to be matched . Statements is column - I are labelled as A,B ,C and D whereas statements in column - Ii are labelled as p,q,r and s . Match the entries of column - I with appropriate entries of column - II .Each entry in column - I may have one or more than one correct option from column - II .The answers to these questions have to be appropariately bubbled as illustrated in the given example , if the correct matches are $A \to (q, r), B \to (p, s), C \to (r, s)$ and $D \to (q)$ .

Match the two columns

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**2.** A particle of unit mass is moving along the X - axis under the influence of a force and its total energy is conserved . Four possible forms of the

potential energy of the particle are given in column I ($\alpha$ and $U_0$ are constants ) . Match the potential energies in column I to the corresponding statements (s) in column II .

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## Objective Type Questions Integer Type Questions

**1.** There is an object of mass 5m kept at rest in space. Suddenly it explodes in three parts of masses m , 2m and 2m . Two parts of equal masses are found to move with equal speeds v along perpendicular directions . If energy released in explosion is $nmv^2$ , then find value of n .

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**2.** A block of mass m is connected to a light rod of length l . One end of the rod is pivoted to a point in such a way that it can be rotated in a

vertical plane . Initially rod is vertical with the block a its lowest position . If velocity given to the block is $\sqrt{ngl}$ then it is found to complete the circle successfully . Find the value of n .

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**3.** A block moves with a certain speed and collides with another identical block kept at rest . There is maximum possible loss of kinetic energy in this collision . Find the ratio initial kinetic energy of the sustem to that with final kinetic enegy of the system .

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**4.** A super dense ball of very large mass is moving with a certain velocity in a particular direction . This heavy ball collides with a very light ball elastically . Calculate the approximate ratio of velocity of light object after collision to that with velocity of heavy ball .

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**5.** A block of mass m moving with a certain speed collides with another identical block at rest . If coefficient of restitution is $\frac{1}{\sqrt{2}}$ then find ratio of intial kinetic energy to kinetic energy lost in collision .

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**6.** A particle of mass $0.2kg$ is moving in one dimension under a force that delivers constant power $0.5W$ to the particle.If the initial speed =0 then the final speed (in $ms^{-1}$) after $5s$ is.

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**7.** A spring - block system is resting on a frictionless floor as shown in the figure . The spring constant is $2.0Nm^{-1}$ and the mass of the block is 2.0 kg . Ignore the mass of the spring . Initially the spring is in normal length . Another block of mass 1.0 kg moving with a speed of $2.0\ \mathrm{m}\ s^{1-}$ collides elastically with the first block . The collision elastically with thef irst block .

The collision is such that the 2.0 kg block does not hot the wall . the disatnce , in metres between the two blocks when the spring retrns to its normal state for the first time after the collision is _____ .

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## Chapter Practice Test

**1.** Is work done by a non conservative force always negative ? Comment.

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**2.** When is KE of a planet revolving around the sun maximum?

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**3.** What is the work done by centripetal force in moving a body through half of the cycle ?

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**4.** What will happen to potential energy of a spring when it is compressed ?

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**5.** What will happen to the K.E oa a body if its momentum is doubled ?

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**6.** A light body and a heavy body have same linear momentum. Which one has a greater kinetic energy ?

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**7.** Two springs A and B are identical to each other . The spring A is harder than the spring B . On which spring more work will be done if they are stretched by same force ?

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**8.** If the momentum of a body is increased by 50%, then what will be the perentage increase in the kinetic energey of the body?

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**9.** Can a body have momentum without energy?

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**10.** A bus of mass 1500 kg is accelerating from to rest to a velocity of $20 \ \mathrm{m} \ s^{-1}$ in 10 sec . (a) acceleration (b) gain in K.E ?

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**11.** EXPRESSION FOR GRAVITATIONAL POTENTIAL ENERGY

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**12.** State and prove work - energy theroem .

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**13.** A ball of mass 0.1 kg is thrown vertically with a speed of $7 \ \mathrm{m} \ s^{-1}$ . Calculate the kinetic energies after half second .

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**14.** Prove that the energy remains constant in case of a freely falling body.

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**15.** Obtain graphically and mathematically work done by a variable force.

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**16.** Discuss briefly the elastic collision in one dimension . Also , analyse their special cases .

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