PHYSICS

NCERT - FULL MARKS PHYSICS(TAMIL)

WORK, ENERGY AND POWER

Examples

1. Find the angle between force $F = \left(3\hat{i} + 4\hat{j} - 5\hat{k}\right)$ unit and displacement

$d = \left(5\hat{i} + 4\hat{j} + 3\hat{k}\right)$ unit. Also find the projection of F and d.

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2. 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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4. A car comes to a sliding stop in 5 m. During this process, the force on the car due to road is 100 N and is directed opposite to the

motion.

(a) How much work done the road do on the car?

(b) How much work done the car do on the road?

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5. 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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6. In some demonstration, a police officer fires a bullet of mass 50.0g with speed $200ms^{-1}$ on soft plywood of thickness 2.00 cm. The bullet emerges with only 10% of its initial

kinetic energy. What is the emergent speed of the bullet?

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7. 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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8. 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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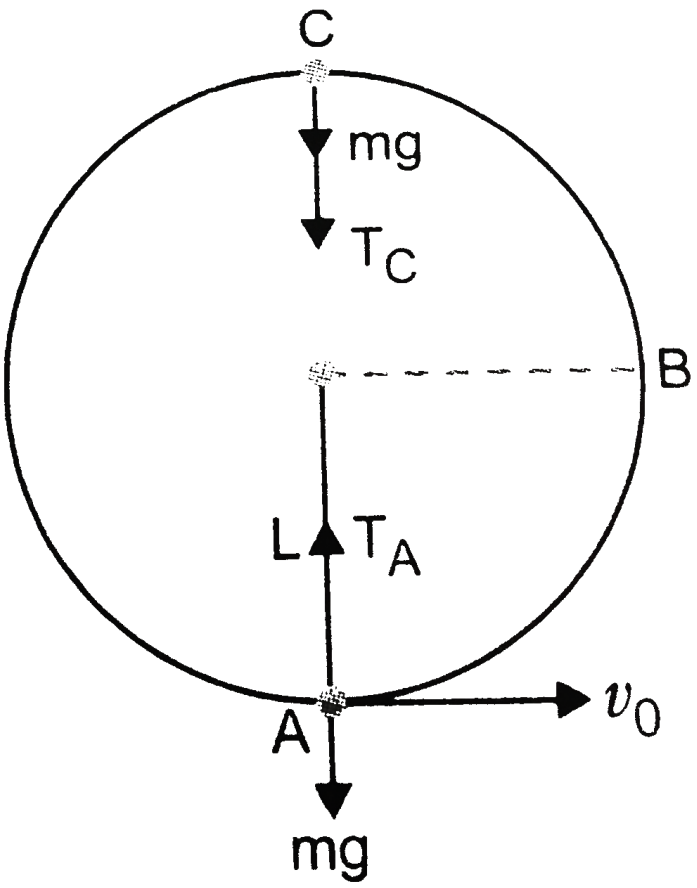
9. A bob of mass m is suspended by a light string of length L. It is imparted a horizontal velocity v_0 at the lowest point A such that it completes a semi-circular trajectory in the

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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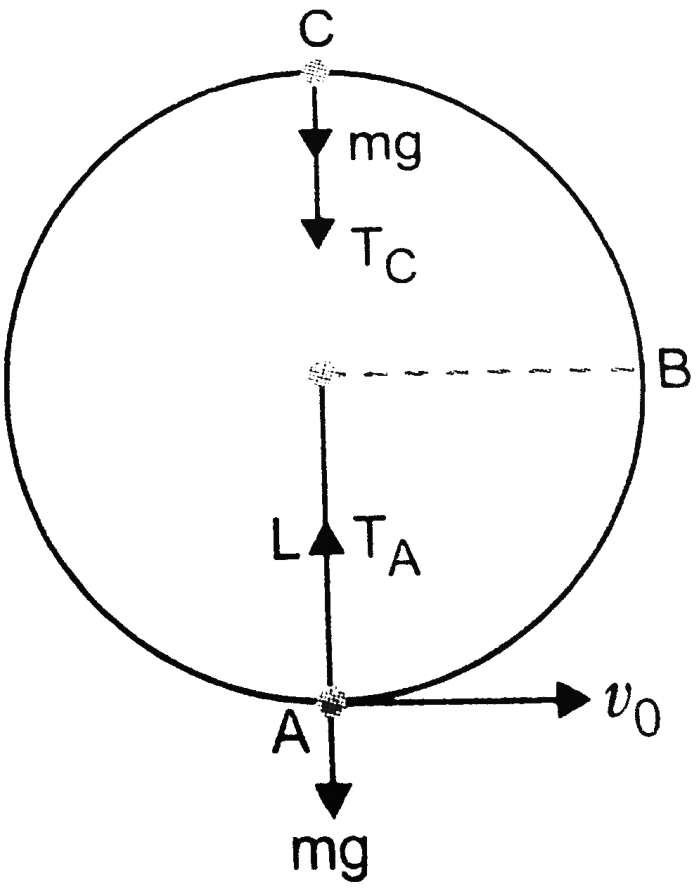

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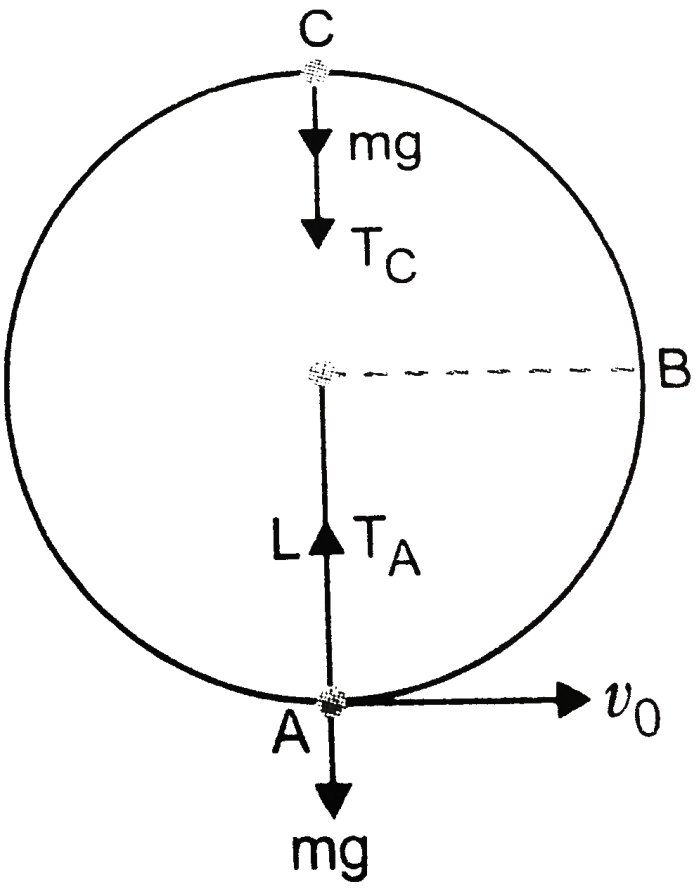

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12. To stimulat car accidents, the auto manufacturers study the collisions of moving cars with mounted springs of different spring constants. Consider a typical simulation with a car of mass 1000kg moving with a speed of $18.0km/h$ on a smooth road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

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13. Consider Example 6.8 taking the coefficient of friction, u, to be 0.5 and calculate the maximum compression of the spring.

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14. Energy required to break one bond in DNA is approximately

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15. Express (a) the energy required to break one bond in DNA $\left(10^{-10} J\right)$ in eV.

(b) the kinetic energy of an air molecule $\left(10^{-21} J\right)$ in eV.

(c) the daily intake of a human adult $\left(10^{7} J\right)$ in kilocalories.

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17. An elevator can carry a maximum load of $1800 kg$ (elevator + passengers) is moving up with a constant speed of $2 m s^{-1}$. The friction force opposite the motion is $4000 N$.What is

minimum power delivered by the motor to the elevator?

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18. 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 $_{}92U^{235}$ 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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19. 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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Exercises

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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4. State the sign of work done by a force in the following .

work done by an applied force on a body moving on a rough horizontal plane with uniform velocity .

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6. 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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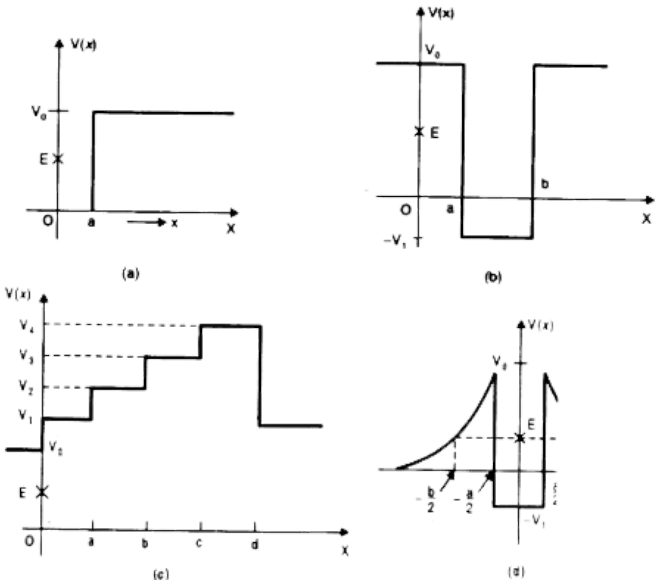
10. Given in fig are examples of some potential energy functions in one dimension. The total enrgy of the particle is indicated by a cross on the ordinate axis. In each case, specify the regions, if any, in which the particle cannot be found for the given energy. Also, indicate the minimum total energy the particle must have in each case. Think of simple physical contexts for which these potential energy shapes are

relevant.



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11. 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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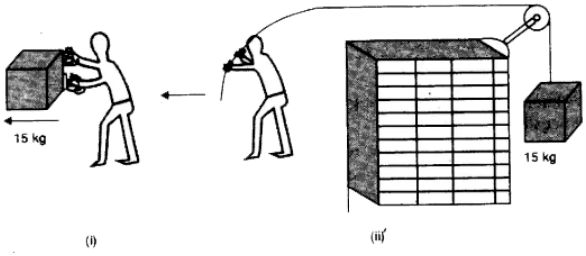
12. Answer the following:

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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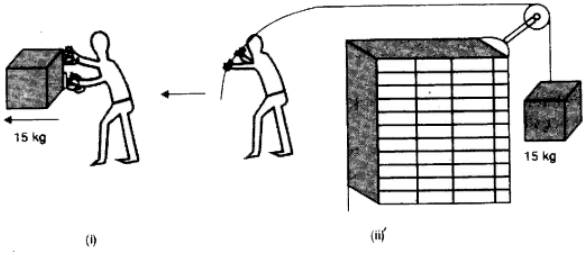

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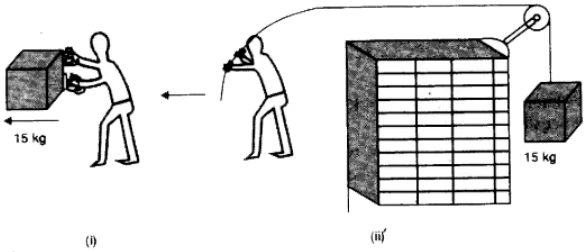

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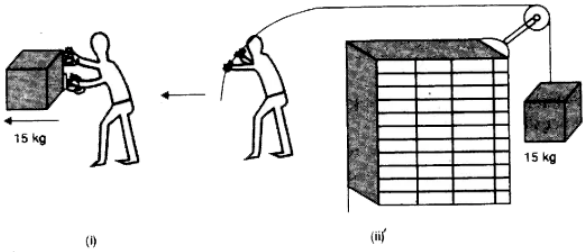

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16. When a conservative force does positive work on a body, the potential energy of the body

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17. The work done by a body against friction always results in

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18. 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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20. 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.

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24. In an elastic collision of two billiard balls, is the total kinetic energy conserved during the

short time of collision of the ball (i.e when they are in contact)?

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25. 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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28. 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 (i) $t^{1/2}$ (ii) t (iii) $t^{3/2}$ (iv) t^2

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

B. t

C. $t^{\frac{3}{2}}$

D. t^2

Answer: B

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29. 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

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

B. t

C. $t^{\frac{3}{2}}$

D. t^2

Answer: C

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30. A body constrained to move along the Z-axis of a co-ordinate system is subject to a constant forece $\vec{F} = -\hat{i} + 2\hat{j} + 3\hat{k}$, where $\hat{i}, \hat{j}, \hat{k}$ are unit vectors along the X-,Y- and Z-axis of the system respectively. What is the

work done by this force in moving the body a distance of 4 m along the Z-axis ?

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31. 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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32. 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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33. A molecule in a gas container hits a horizontal wall with a speed of $200ms^{-1}$ and angle 30° with the normal and rebounds with the same speed. Is momentum conserved in

the collision? Is the collision elastic or inelastic.

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34. 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? $\left(\text{Take} g = 10ms^2\right)$

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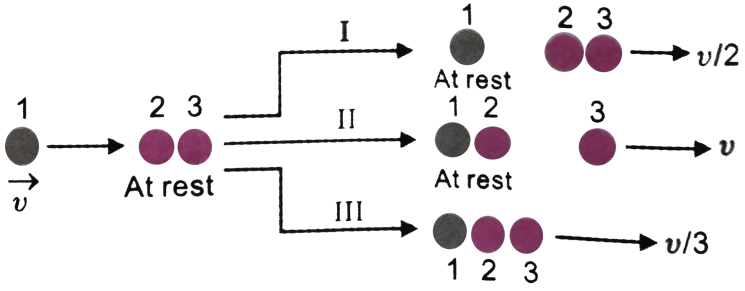
35. Two identical ball bearings in contact with each other and resting on a frictionless table are hit head on by another ball bearing of the same mass moving initially with a speed v, figure,. If the collision is elastic, which of the following is a possible result after collisioin?



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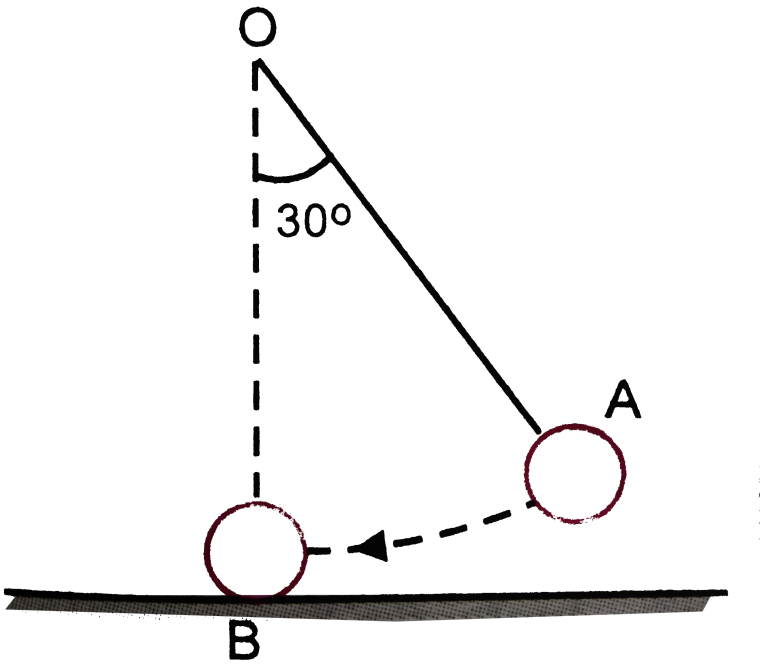
36. The bob A of a simple pendulum released from 30° to the vertical hits another bobo B of the same mass at rest on a table as shown in figure. How high does the bob A rise after the collision ? Neglect the size of the bobs and assume the collision to be elastic.



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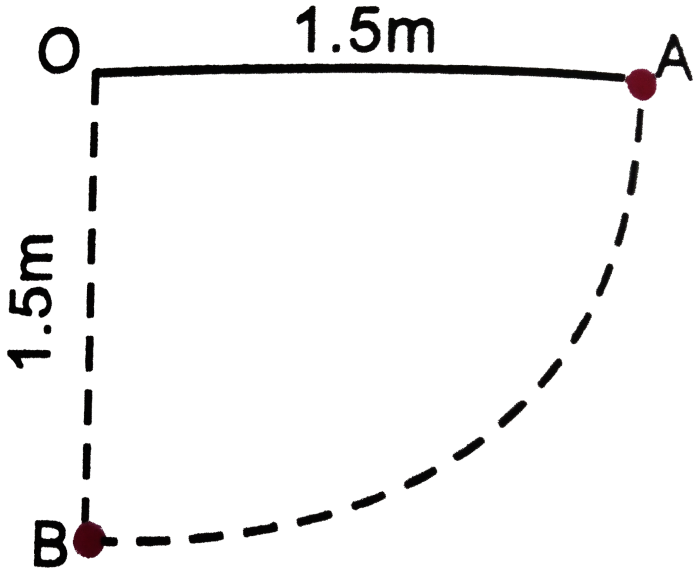
37. The bob A of a simple pendulum is released from a horizontal position A as shownin in figure. If the length of the pendulum is 1.5m , what is the speed with which the bob arrives at the lowermost point B, given that it dissipates 5% of its initial energy against air

resistance ?



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38. 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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39. 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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40. 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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What is the kinetic energy of the air?

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42. 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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43. 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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45. 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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Exercises Additional Exercises

1. A bullet of mass 0.012 kg and horizontal speed $70ms^{-1}$ 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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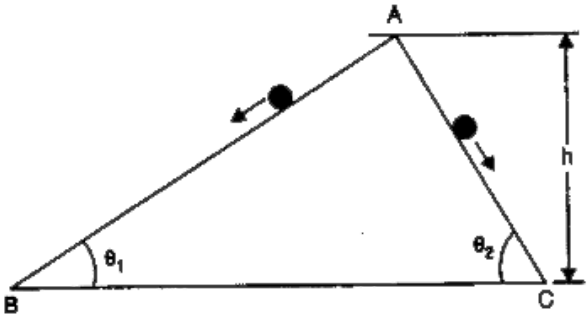
2. Two inclined frictionless tracks, one gradual and the other steep meet at A from where to

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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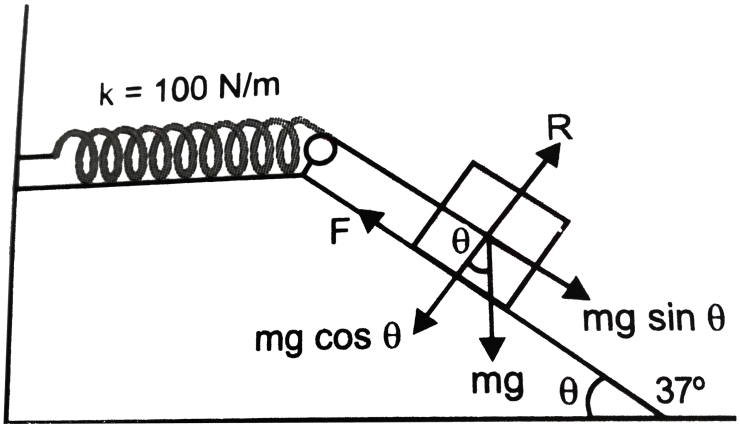
3. A 1kg block situated on a rough incline is connected to a spring of spring constant $100Nm^{-1}$ as shown in figure,. The block is released from rest with the spring in the unstretched position. The block moves 10cm down the incline before coming to rest. Find the coefficient of friction between the 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 (trolley + child) of total mass 200 kg is moving with a uniform speed of 36 km/h on a frictionless track. The child of mass 20 kg starts running on the trolley from one end to the other (10 m away) with a speed of 10 ms^{-1} relative to the trolley in the direction of the

trolley's motion and jumps out of the trolley with the same relative velocity. What is the final speed of the trolley? How much has the trolley moved from the time the child begins to run?

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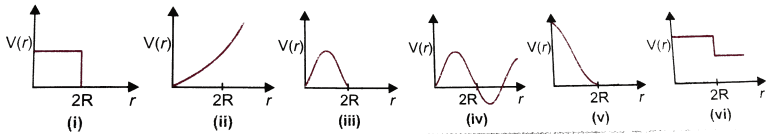
6. Which of the following potential energy curves in figure., cannot possibley describly describe the elastic collision of two billiard balls ? Here r is distance between centres of

the balls.



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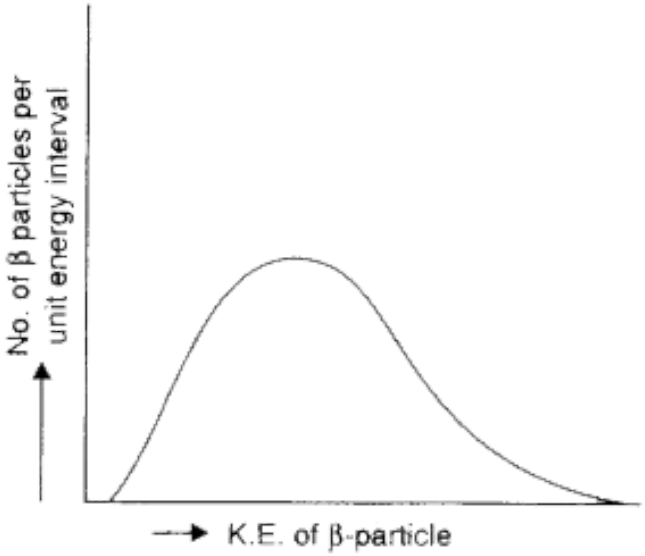
7. Consider the decay of a free neutron at rest: n $\top$ $+e^{-}$ Show that the tow-body dacay of this type must necessarily give an electron of fixed energy and, therefore, cannot for the observed continous energy distribution in the

β-decay of a neutron or a nucleus.



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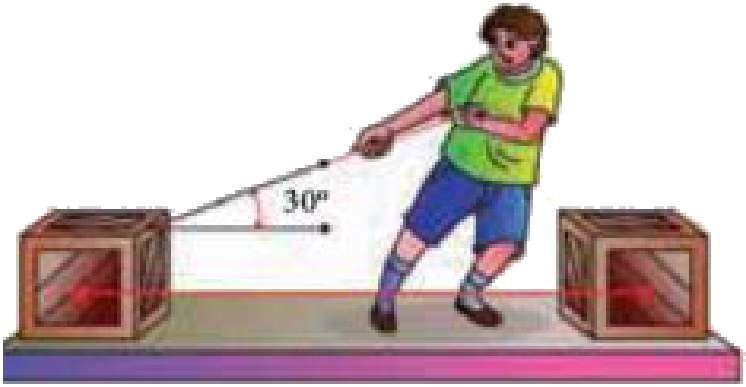
Example

1. A box is pulled with a force of 25 N to produce a displacement of 15 m. If the angle between the force and displacement is 30°, find the work done by the force.



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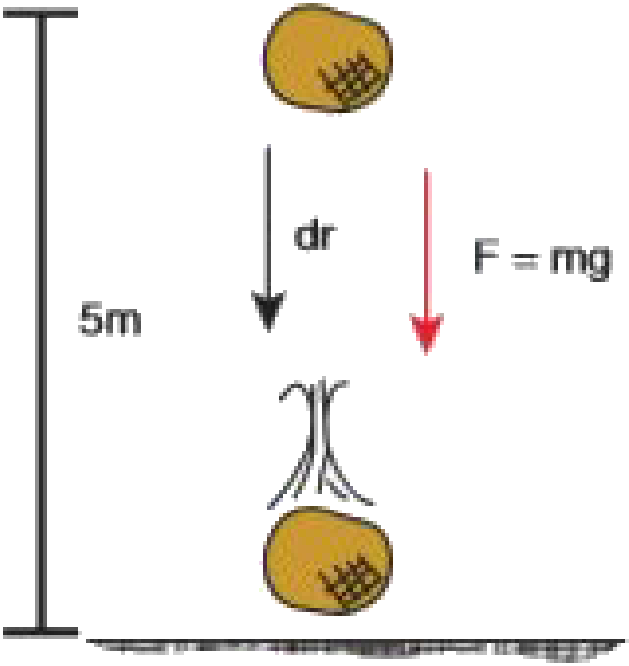
2. An object of mass 2 kg falls from a height of 5 m to the ground. What is the work done by the gravitational force on the object? (Neglect air resistance, Take g = 10 m s^{-2})



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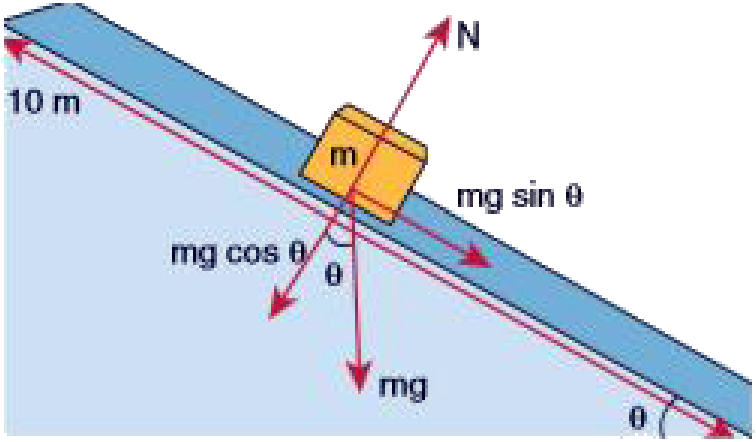
3. An object of mass m = 1 kg is sliding from top to bottom in the frictionles inclined plane of inclinationangle $\theta = 30^\circ$ and the lengthh of inclined plane is 10 m as shown in the figure. Calculate the work done by gravtiational force and normal force on the object. Assume acceleration due to gravity, g =

10 m s^{-2}



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4. If an object of mass 2 kg is thrown up from the ground reaches a height of 5 m and falls back to the Earth (neglect the air resistance). Calculate

The work done by gravity when the object reaches 5 m height

View Text Solution

5. If an object of mass 2 kg is thrown up from the ground reaches a height of 5 m and falls back to the Earth (neglect the air resistance). Calculate

The work done by gravity when the object comes back to Earth

View Text Solution

6. If an object of mass 2 kg is thrown up from the ground reaches a height of 5 m and falls back to the Earth (neglect the air resistance). Calculate

Total work done by gravity both in upward and downward motion and mention the physical significance of the result.

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7. A weight lifter lifts a mass of 250 kg with a force 5000 N to the height of 5 m.

What is the workdone by the weight lifter?

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8. A weight lifter lifts a mass of 250 kg with a force 5000 N to the height of 5 m.

What is the workdone by the gravity?

View Text Solution

9. A weight lifter lifts a mass of 250 kg with a force 5000 N to the height of 5 m.

What is the net workdone on the object?

View Text Solution

10. A variable force $F = kx^2$ acts on a particle which is initially at rest. Calculate the work done by the force during the displacement of the particle form x = 0 m to x = 4 m.

(Assume the constant k = 1 N m^{-2})

View Text Solution

11. Two objects of masses 2 kg and 4 kg are moving with the same momentum of 20 kg ms^{-1}.

Will they have same kinetic energy?

View Text Solution

12. Two objects of masses 2 kg and 4 kg are moving with the same momentum of 20 kg

ms^{-1}.

Will they haved same speed?

View Text Solution

13. An object of mass 2 kg is taken to a height 5 m from the ground (g = 10 m s^{-2}).

Calculate the potential energy stored in the object.

View Text Solution

14. An object of mass 2 kg is taken to a height 5 m from the ground (g = 10 m s^{-2}).

Where does this potential energy come from?

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15. An object of mass 2 kg is taken to a height 5 m from the ground (g = 10 m s^{-2}).

What external force must act to bring the mass to that height?

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16. An object of mass 2 kg is taken to a height 5 m from the ground (g = 10 m s^{-2}).

What is the net force that acts on the object while the object is taken to the height 'h'?

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17. Let the two springs A and B be such that $k_A > k_B$. On which spring will more work has to be done if they are stretched by the same force?

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18. A body of mass m is attached to the spring which is elongated to 25 cm by an applied force from its equilibrium position.

Calculate the potential energy stored in the spring-mass system?

View Text Solution

19. A body of mass m is attached to the spring which is elongated to 25 cm by an applied force from its equilibrium position.

What is the work done by the spring force in this elongation?

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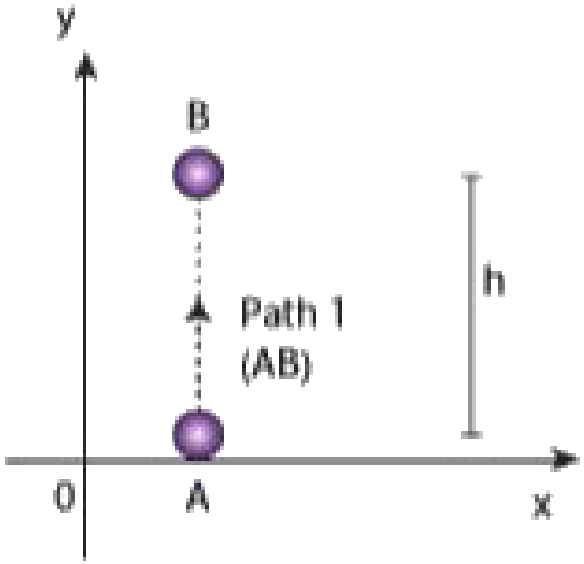
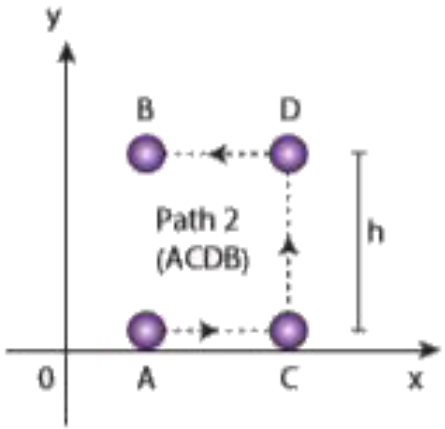
20. A body of mass m is attached to the spring which is elongated to 25 cm by an applied force from its equilibrium position.

Suppose the spring is compressed to the same 25 cm, calculate the potential energy stored and also the work done by the spring force during compression. (The spring constant, k = 0.1 N m^{-1}).

View Text Solution

21. Compute the work done by the gravitational force for the following cases.





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22. Consider an object of mass 2 kg moved by an external force 20 N in a surface having coefficient of kinetic friction 0.9 to a distance 10 m. What is the work done by the external force and kinetic friction ? Comment on the result. (Assume g = 10 ms^{-2})

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23. An object of mass 1 kg is falling from the height h = 10 m. Calculate

The total energy of an object at h = 10 m

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

View Text Solution

24. An object of mass 1 kg is falling from the height h = 10 m. Calculate

Potential energy of the object when it is at h = 4 m

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

View Text Solution

25. An object of mass 1 kg is falling from the height h = 10 m. Calculate

Kinetic energy of the object when it is at h = 4 m

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

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26. An object of mass 1 kg is falling from the height h = 10 m. Calculate

What will be the speed of the object when it

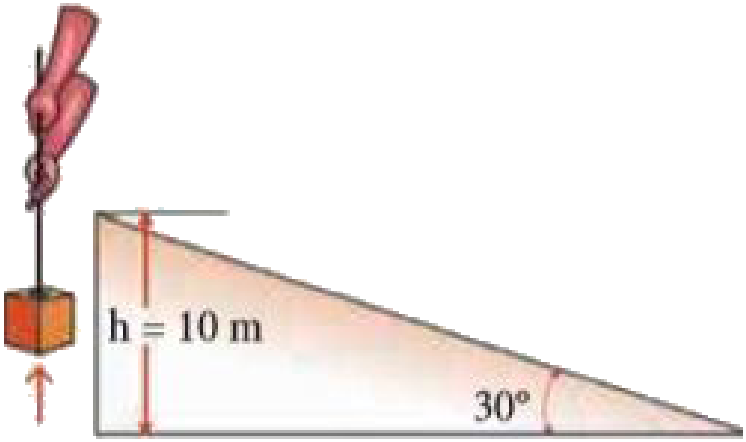
hits the ground?

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

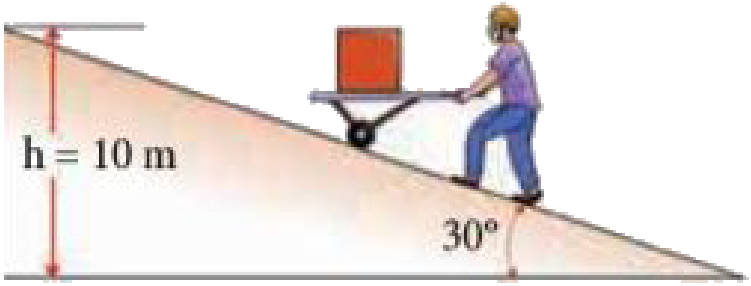
View Text Solution

27. A body of mass 100 kg is lifted to a height 10 m from the ground in two different ways as shown in the figure. What is the work done by the gravity in both the cases? Why is it easier

to take the object through a ramp?



Path (1) straight up



Path (2) along the ramp

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28. An object of mass m is projected from the ground with initial speed v_0

Find the speed at height h.

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29. An object of mass 2 kg attached to a spring is moved to a distance x = 10 m from its equilibrium position. The spring constant k = 1 N m^{-1} and assume that the surface is frictionless.

When the mass crosses the equilibrium position, what is the speed of the mass?

View Text Solution

30. An object of mass 2 kg attached to a spring is moved to a distance x = 10 m from its equilibrium position. The spring constant k = 1 N m^{-1} and assume that the surface is frictionless.

What is the force that acts on the object when

the mass crosses the equilibrium position and extremum position $x = \pm 10m$.

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31. Water in a bucket tied with rope is whirled around in a vertical circle of radius 0.5 m. Calculate the minimum velocity at the lowest point so that the water does not spill from it in the course of motion.

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

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32. Calculate the energy consumed in electrical units when a 75 W fan is used for 8 hours daily for one month (30 days).

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33. A vehicle of mass 1250 kg is driven with an acceleration 0.2 ms^{-2} along a straight level road against an external resistive force 500 N. Calculate the power delivered by the vehicle's

engine if the velocity of the vehicle is 30 ms^{-1}

.

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34. A lighter particle moving with a speed of 10 m s^{-1} collides with an object of double its mass moving in the same direction with half its speed. Assume that the collision is a one dimensional elastic collision. What will be the speed of both particles after the collision?

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35. A bullet of mass 50 g is fired from below into a suspended object of mass 450 g. The object rises through a height of 1.8 m with bullet remaining inside the object. Find the speed of the bullet. Take $g = 10ms^{-2}$.

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36. Show that the ratio of velocities of equal masses in an inelastic collision when one of the masses is stationary is $\frac{v_1}{v_2} = \frac{1-e}{1+e}$.

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Exercise Multiple Choice Questions

1. A uniform force of $\left(2\hat{i}+\hat{j}\right)N$ acts on a particle of mass 1 kg. The particle displaces from position $\left(3\hat{j}+\hat{k}\right)m$ to $\left(5\hat{i}+3\hat{j}\right)m$. The work done by the force on the particle is

A. 9 J

B. 6 J

C. 10 J

D. 12 J

Answer: C

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2. A ball of mass 1 kg and another of mass 2 kg are dropped from a tall building whose height is 80 m. After, a fall of 40 m each towards Earth, their respective kinetic energies will be in the ratio of

A. $\sqrt{2}:1$

B. $1:\sqrt{2}$

C. $2:1$

D. $1:2$

Answer: D

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3. A body of mass 1 kg is thrown upwards with a velocity 20 m s^{-1}. It momentarily comes to rest after attaining a height of 18 m. How

much energy is lost due to air friction?

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

A. 20 J

B. 30 J

C. 40 J

D. 10 J

Answer: A

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

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

B. mv^3

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

D. $\frac{5}{2}mv^2$

Answer: A

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5. A body of mass 4 m is lying in xy-plane at rest. It suddenly explodes into three pieces. Two pieces of mass m move perpendicular to each other with equal speed v. The total kinetic energy generated due to explosion is

A. mv^2

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

C. $2mv^2$

D. $4mv^2$

Answer: B

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6. The potential energy of a system increases, if work is done

A. by the system against a conservative force

B. by the system against a non-conservative force

C. upon the system by a conservative force

D. upon the system by a non-conservative force

Answer: A

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7. What is the minimum velocity with which a body of mass m must enter a vertical loop of radius R so that it can complete the loop?

A. $\sqrt{2gR}$

B. $\sqrt{3gR}$

C. $\sqrt{5gR}$

D. $\sqrt{gR}$

Answer: C

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8. The work done by the conservative force for a closed path is

A. always negative

B. zero

C. always positive

D. not defined

Answer: B

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9. If the linear momentum of the object is increased by 0.1%, then the kinetic energy is increased by

A. $0.1\ \%$

B. $0.2\ \%$

C. $0.4\ \%$

D. $0.01\ \%$

Answer: B

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10. If the potential energy of the particle is $\alpha - \frac{\beta}{2}x^2$, then force experienced by the particle is

A. $F = \frac{\beta}{2}x^2$

B. $F = \beta x$

C. $F = -\beta x$

D. $F = -\frac{\beta}{2}x^2$

Answer: C

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11. A wind-powered generator converts wind energy into electric energy. Assume that the generator converts a fixed fraction of the wind energy intecepted by its blades into electrical energy. For wind speed v, the electrical power output will be proportional to

A. v

B. v^2

C. v^3

D. v^4

Answer: C

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12. Two equal masses m_1 and m_2 are moving along the same straight line with velocities $5ms^{-1}$ and $-9ms^{-1}$ respectively. If the collision is elastic, then calculate the velocities after the collision of m_1 and m_2, respectively

A. $-4ms^{-1}$ and $10ms^{-1}$

B. $10ms^{-1}$ and $0ms^{-1}$

C. $-9ms^{-1}$ and $5ms^{-1}$

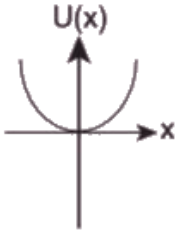
D. $5ms^{-1}$ and $1ms^{-1}$

Answer: C

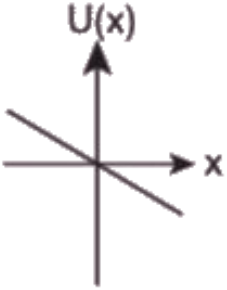
View Text Solution

13. A particle is placed at the origin and a force F = kx is acting on it (where k is a positive constant). If U (0) = 0, the graph of U (x) versus x will be (where U is the potential energy function)

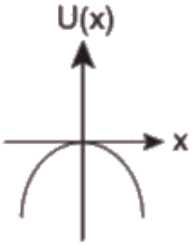
A.



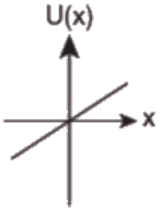
B.



C.



D.



Answer: C

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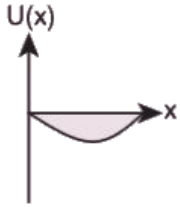
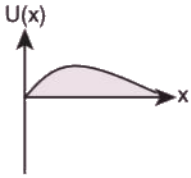
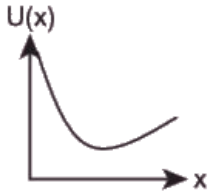
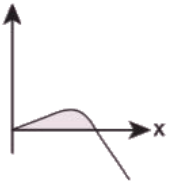
14. A particle which is constrained to move along x-axis, is subjected to a force in the same direction which varies with the distance x of the particle from the origin as $F(x) = -kx + ax^3$. Here, k and a are positive constants. For $x \geq 0$, the functional form of the potential energy U(x) of the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

A. 

B. 

C. 

D. 

Answer: D

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

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

B. $\frac{3}{2}k$

C. 3k

D. 6k

Answer: B

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Exercise Iv Numerical Problems

1. Calculate the work done by a force of 30 N in lifting a load of 2kg to a height of 10m $(g = 10ms^{-2})$

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2. A ball with a velocity of 5 ms^{-1} impinges at angle of 60° with the vertical on a smooth

horizontal plane. If the coefficient of restitution is 0.5, find the velocity and direction after the impact.

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3. A bob of mass m is attached to one end of the rod of negligible mass and length r, the other end of which is pivoted freely at a fixed center O as shown in the figure. What initial speed must be given to the object to reach the top of the circle? (Hint: Use law of

conservation of energy). Is this speed less or greater than speed obtained in the section 4.2.9?

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4. Two different unknown masses A and B collide. A is initially at rest when B has a speed v. After collision B has a speed v/2 and moves at right angles to its original direction of motion. Find the direction in which A moves after collision.

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5. A bullet of mass 20 g strikes pendulum of mass 5 kg. The centre of mass of pendulum rises a vertical distance of 10 cm. If the bullet gets embedded into the pendulum, calculate its initial speed.

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