THE GURUKUL INSTITUTE

PLOT 5C, 2ND FLOOR, COMPLEX, SEC-13, OPP. JAIPURIA SCHOOL,
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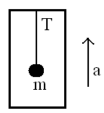
PHYSICS

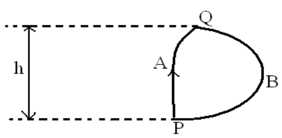
WORK, ENERGY & POWER

WORK

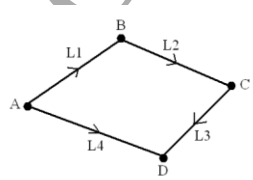
1. A particle is moved by a force $\vec{F} = (3\hat{i} + 4\hat{j})$ N from point (2,3)m to (3,0)m in x- y plane. Find the work done by the force on the particle.
2. A man moves on a straight horizontal road with a block of mass 2 kg in his hand. If he covers a distance of 40 m with an acceleration of 0.5 m/s^2, find the work done by the man on the block during the motion.
3.A block of mass m is suspended by a light thread from an elevator. The elevator is accelerating upward with uniform acceleration 'a'. Find the work done during the first 't' seconds by the tension in the thread.



4.A block of mass m is attached rigidly with a light spring of force constant k. The other end of the spring is fixed to a wall. If the block is displaced by a distance x, find the work done on the block by the spring for this range. (The spring force is given by F = -kx, where k is spring constant and x is displacement of the block from its free length.)
5. Spring A and B are identical except that A is stiffer than B, i.e. force constant $k_A > k_B$. On which spring more work will be done, if
 a) they are stretched by same amount ?
 b) they are stretched by the same force ?
6. A man rowing a boat upstream is at rest with respect to the shore. Is he doing any work with respect to the shore?
Conservative and Non- Conservative Forces
7. Is work done by a non- conservative force always negative ?
8.A particle is taken from point P to point Q via the path PAQ and then placed back to point P via the path QBP. Find the work done by gravity on the body over this closed path. The motion of the particle is in the vertical plane.



9.Force exerted by spring is given by F= -kx where x is elongation or compression in the spring from its natural length. Find potential energy stored in spring when it is elongated or compressed from its natural length.
10. A particle of mass m is moved on a rough horizontal surface on a closed path as shown in the figure. If co-efficient of friction between the particle and the surface is μ, then find the work done by frictional force on the particle over closed path ABCDA.



Mechanical Energy [Kinetic Energy + Potential Energy]

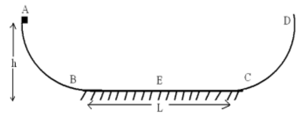
11. A man in an open car moving with high speed, throws a ball with his full capacity along the direction of motion of the car. Now, the same man throws the same ball when the car is not moving. In which case the ball possesses more kinetic energy
a) in ground frame b) in car frame.
12. Can a body have energy without momentum ?
13. Conservation force is given by expression $F = - C/ r^2$. Find the potential energy at a distance r, if potential energy is taken zero at r equal to infinity. The potential energy of a diatomic molecule is given by $U = A/ r^{12} - B/r^6$,where r is the distance between the atoms that make up the molecule and A, B are positive constants. Find the equilibrium separation between the atoms.
15. Can a body have momentum when its energy is negative?

WORK – Energy Theorem

16. A meteorite burns in the atmosphere before it reaches earth's surface, what happens to its momentum ? Is momentum conservation principle violated?

17. A ball of mass m is thrown in air with speed becomes v_2. Find the work done on the ball by the air resistance.

18. A particle slides along a track with elevated ends and a flat central part as shown in the figure. The flat part has a length L = 3m. The curved portions of the track are frictionless. For the flat part, the coefficient of kinetic friction is $\mu_k = 0.2$. The particle is released at point A which is at height h= 1.5 m above the flat part of the track. Where does the particle finally come To rest ?

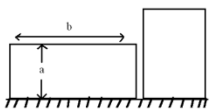


19. State the limitations of work energy theorem?

20. A lorry and a car moving with the same kinetic energy are brought to rest by the application of brakes, which provide equal retarding forces in both the cases. Which of them will come to rest in a shorter distance?

Conservation of Mechanical Energy

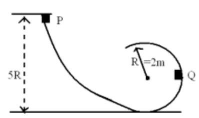
20. A plate of mass m, length b and breath 'a' is initially lying on a horizontal floor with length parallel to the floor and breadth perpendicular to the floor . Find the work done to erect it on its breadth.



Motion in a Vertical Circle

21.A heavy particle hanging from a fixed point by a light inextensible string of length L is projected horizontally with speed $\sqrt{(gL)}$. Find the speed of the particle and the inclination of the string to the vertical at the instant of the motion when the tension in the string is equal to the weight of the particle.

22. A small block of mass m= 1kg slides along the frictionless loop-to-loop track shown in the figure.(a) If it start from rest at P what is the resultant force acting on it at Q? (b)At what height above the bottom of loop should the block be released so that the force it exerts against the track at the top of the loop equals its weight?



POWER

23.Find the average power delivered by weight of a projectile, when it is projected in air at some angle with horizontal. When is the instantaneous power delivered by weight of the projectile zero?

24.An advertisement claims that a certain 1200 kg car can accelerate from rest to a speed of 25 m/s in a time of 8 s. what average power must the motor produce to cause this acceleration? (ignore friction losses)

25.(a) A man of mass 80 kg runs up a staircase completely in 15 s. Another man of same mass runs up the staircase completely in 20 s. Find the ratio of the power developed by them.

(b) A block of mass m is moving with a constant acceleration 'a' on a rough horizontal plane. If the coefficient of friction between the block and ground is μ, Find the power delivered by the external agent after a time t from the beginning.

PROBLEMS

1. A block of mass 10 kg slides down on an incline 5m long and 3m high. A man pushes up on the ice block parallel to the incline so that it slides down at constant speed. The coefficient of friction between the ice and the incline is 0.1. Find:
   a) the work done by the man on the block.
   b) the work done by gravity on the block.
   c) the work done by the surface on the block.
   d) the work done by the resultant forces on the block.
   e) the change in K.E. of the block.

2. Two bodies m_1 and m_2 are kept on a table with coefficient of friction 'μ' and are joined by a spring. Initially, the spring is in its relaxed state. Find the minimum constant force F which will make the other block m_2 move.(k is the spring constant).

3. A chain is held on frictionless table with $(1/n)^{th}$ of its length hanging over the edge. If the chain has a length L and mass M, how much work is required to slowly pull the hanging part back on the table ?

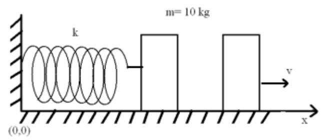
4. A small metallic sphere is suspended by a light spring of force constant k ceiling of a cage. The ratio of mass of the cage to the sphere is 'n'. The cage is accelerated uniformly upward by a force F. Find the potential energy stored in the spring.

5. An ideal mass less spring can be compressed 1 m by a force of 100 N. This same spring is placed at the bottom of a frictionless inclined plane which makes an angle $\theta = 30^0$ with the horizontal. A 10 kg mass is released from rest at the top of the incline and is brought to rest momentarily after compressing the spring 2 meters.

a) Through what distance does the mass slide before coming to rest?

b) What is the speed of the mass just before it reaches the spring?

6. A block of mass 10 kg is pushed against a spring of stiffness k= 100 N/m, fixed at one end to a wall.The block can slide on a frictionless table as shown. The natural length of the spring is 1/2 m, and it is compressed to half its natural length when the block is released . Find the velocity of the block as a function of its distance x from the wall.

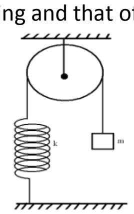


7. In the figure shown, stiffness of the spring is k and mass of the block is m.The pully is fixed. Initially the block m is held such that the elongation in the spring is zero and then released from rest. Find:

a) the maximum elongation in the spring, and

b) the maximum speed of the block m.

Neglect the mass of the spring and that of the string. Also neglect the friction.



8.A heavy particle is suspended by a string of length L from a fixed point O. The particle is given a horizontal velocity v_0. The string slacks at some angle and the particle proceeds on a projectile path. Find the value of v_0, if the particle passes through the point of suspension.

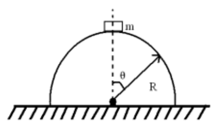
9.A point mass m starts from rest and slides down the surface of a fixed frictionless solid hemisphere of radius R as shown in the figure. Measure angles from the vertical and potential energy from the top. Find

a) the change in potential energy of the mass with angle,

b) the kinetic energy as a function of angle,

c) the radial and tangential accelerations as a function of angle, and

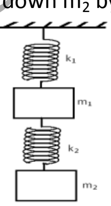
d) the angle at which the mass flies off the sphere.



10. Given k_1=1500 N/m, k_2= 500N/m, m_1=2kg, m_2= 1kg. Find:

a) potential energy stored in the springs in equilibrium, and

b) work done in slowly pulling down m_2 by 8 cm.



OBJECTIVE

1. An object is acted upon by the forces $\vec{F_1} = 4\hat{i}$ N and $F_2 = (\hat{i} - \hat{j})$ N. If the Displacement of the object is D= $(\hat{i}+6\hat{j}-6k)$ m, the kinetic energy of the object

a) remains constant b) increases by 1J

c) decreases by 1J d) decreases by 2J

2. A 5kg block is kept on a horizontal platform at rest. At time t= 0, the platform Starts moving with a constant acceleration of $1 m/s^2$. The coefficient of Friction μ between the block and the platform is 0.2. The work done by the force of friction on the block in the fixed reference frame in 10s is

a) +250J b) – 250J c)+500J d) - 500J

3. In the previous problem, if μ= 0.02, the work done by the force of friction on The block in the fixed reference frame in 10 sec. is

a) +10Jb) -10J c) +250J d) -250J

4. A body of mass 3 kg is under a force which causes a displacement in it, given By s = $t^2/3$ (in metres). The work done by the force in 2 sec is

a) 2J b) 3.8J c) 5.2J d) 2.6J

5. A body of mass 1 kg thrown upwards with a velocity of 10m/s comes to rest (momentarily) after moving up by 4m. The work done by air drag in this Process is (Take g= 10m/s^2)

a) -20J`b) -10J c) -30J d)0J

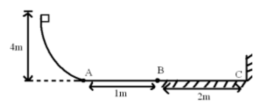
6.A particle of mass m is projected with velocity u at an angle θ with horizontal. During the period when the particle descends from highest point to the Position where its velocity vector makes an angle θ/2 with horizontal, work Done by the gravity force is

a)$(1/2)\ mu^2\tan^2(\theta/2)$ b) $-(1/2)\ mu^2\tan^2\theta$ c)$-(1/2)\ mu^2\cos^2\theta\tan^2(\theta/2)$

d)$-(1/2)mu^2\ \cos^2(\theta/2)\ \sin^2\theta$

7.A block of mass m= 0.1 kg is released from a height of 4m on a curved smooth Surface. On the horizontal surface, path AB is smooth and path BC offers Coefficient of friction μ= 0.1. If the impact of block with the vertical wall at C be perfectly elastic, the total distance covered by the block on the horizontal Surface before coming to rest will be (Take g= $10ms^{-2}$)

a) 29 m b) 49m c) 59m d) 109m



8.A block is suspended by an ideal spring of the force constant K. If the block is Pulled down by applying a constant force F and if maximum displacement of The block from its initial position of rest is δ, then

a) F/K < δ < 2F/K b) δ= 2F/K c) δ= F/K d) Increases in potential energy of the spring is $1/2\ K\delta^2$

9. A particle of mass m starts from rest and moves in a circular path of radius R with a uniform angular acceleration α. The kinetic energy of the particle after n revolutions is

a)$n\alpha mR^2$ b)$2\pi\ n\alpha mR^2$ c)$(1/2)\ mn\alpha R^2$ d) $mn\alpha R^2$

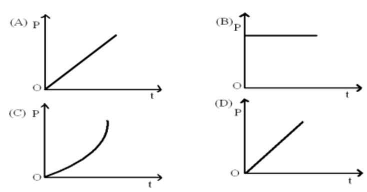
10. A car accelerates from rest to a speed of 10m/s. Let the energy spent be E. If we accelerates the car from 10m/s to 20m/s, then the energy spent will be

a) E b) 2E c) 3E d) 4E

11. A particle moves on a rough horizontal ground with some initial velocity say V_0. If $(3/4)^{th}$ of its kinetic energy is lost in time t_0, then coefficient of friction between the particle and the ground is

a) $\frac{V_0}{2gt_0}$ b) $\frac{V_0}{4gt_0}$ c) $\frac{3V_0}{4gt_0}$ d) $\frac{V_0}{gt_0}$

12. A vehicle is driven along a straight horizontal track by a motor, which exerts a constant driving force. The vehicle starts from rest at t=0 and the effects of friction and air resistance are negligible. If kinetic energy of vehicle at time t is E and power developed by the motor is P, which of the following graph is/ are correct?



13. A block of mass m initially at rest dropped from a height h on a massless spring of force constant k, the maximum compression in the spring is h/4 then spring constant k is

a) 32 mg/h b) 20 mg/h c) 30 mg/h d) 40 mg/h

14. A particle of mass m is moving in a circular path of constant radius r such that its centripetal acceleration 'a' is varying with time t as $a_C = k^2\ rt^2$, where k is a constant. The power delivered to the particle by the forces acting on it is

a) zero b) $mk^2r^2t^2$ c) $mk^2r^2t^2$ d) mk^2rt

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

a) $\frac{3P}{m}(v_2^2 - v_1^2)$ b) $\frac{m}{3P}\ (v_2 - v_1)$ c) $\frac{m}{3P}(v_2^3 - v_1^3)$ d) $\frac{m}{3P}(v_2^2 - v_1^2)$

ASSIGNMENT

SECTION – I

PART- A

Level – 1

1. Can normal force do a non- zero work on an object? If yes, given an example. If no, give reason.

2.A particle moves from a point r_1= (2î+ 3ĵ) to another point r_2= (3î+2ĵ) during which a certain force F= (5î+5ĵ) acts on it. Calculate work done by the force on the particle during this displacement.

3. A person lift a block of mass m through a vertical height h, and then walks horizontally a distance d with holding the block. Determine work done by the person.

4. When you push your bicycle up an incline, the potential energy of the bicycle and yourself increases. Where does this energy come from?

5. A 16 kg block moving on a frictionless horizontal surface with a velocity of 4m/sec compresses an ideal spring and comes to rest, momentarily. If the force constant of the spring be 100 N/m, then how much is the spring compressed?

6. When you lift a box from the floor and put it on a flat table, the potential energy of the box increases, but there is no change in its kinetic energy. Is it a violation of conservation of energy?

7.A block is lifted from the floor and is kept in an almirah. One person says that the potential energy of the block is increased by 30J and the other says it is increased by 50 J. Is one of them necessarily wrong?

8. What is the largest practical unit and the smallest practical unit of energy?

9. When momentum of a body is increased by 50%, what is the percentage increment in kinetic energy?

10. 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.

[Given: $m_e = 9.11\times10^{-31}$ kg; $m_p= 1.67\times10^{-27}$kg; 1 keV=1.6×10^{-16} J.]

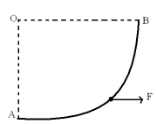
LEVEL- II

1.A force F= a+bx acts on a particle in the x direction, where a and b are constants. Find the work done by this force during a displacement from x=0 to x= d.

2. The figure shows a smooth circular path of radius R in the vertical plane which subtends an angle (π/2) at O. A block of mass m is taken from position A to B under the action of a constant horizontal force F.

(a) Find the work done by this force.

(b) In part (a) if the block is being pulled by a force F which is always tangential to the surface , find the work done by the force F between A and B.



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

4.An observer and a vehicle, both start moving together from rest with acceleration $5m/s^2$ and $2m/s^2$, respectively. There is a 2 kg block on the floor of the vehicle, and μ= 0.3 between their surfaces. Find the work done by frictional force on the 2 kg block as observed by the running observer, during first 2 seconds of the motion.

5. In the above problem, if the observer and vehicle start moving in opposite directions, from rest, then find the direction and magnitude of frictional force acting between the surface of the block and floor of vehicle, as seen by the observer. Also, calculate the work done by the frictional force during first 2 seconds of motion.

6. A stone with weight W is thrown vertically upwards into the air with initial speed v_0. If a constant force f due to air drag acts on the stone throughout its flight,

a) show that the maximum height reached by the stone is $h= \dfrac{v_0^2}{2g[1+(f/w)]}$

b)show that speed of the stone upon impact with the ground is $v= v_0\dfrac{(w-f)^{1/2}}{(w+f)^{1/2}}$

7. A block of mass m is attached to two unstretched springs of spring constants k_1 and k_2 as shown in the figure. The block is displaced towards right through a distance 'x' ans is released. Find the speed of the block as it passes through a distance x/4 from its mean position.

8.A particle is hanging from a fixed point O by means of a string of length 'a'. There is a small nail 'Q' in the same horizontal line with O at a distance b(b= a/3) from O. Find the minimum velocity with which the particle should be projected so that it may make a complete revolution around the nail without being slackened.

9. An automobile of mass 'm' accelerates starting from rest, while the engine supplies constant power P. Show that:

a) the velocity is given as a function of time by $v= (2Pt/m)^{1/2}$

b) the position is given as a function of time by $s = (8P/9m)^{1/2}t^{3/2}$

10. A particle of mass m moves along a circle of radius R with a normal acceleration varying with time as $a_n=at^2$, where 'a' is a constant.Find the time dependence of the power developed by all the forces acting on the particle, and the mean value of this power averaged over the first t seconds after the beginning of motion.

11. a) Two blocks of different masses are hanging on two ends of a string passing over a frictionless pulley. The heavier block has a mass twice as that of the lighter one. The tension in the string is 60N. The decreases in potential energy during the first second after the system is released 15K. Then find the value of K.

b) A block of mass 2.0 kg is pulled up on a smooth incline of angle 30^0 with the horizontal. If the block moves with an acceleration of 1.0 m/s^2. The power delivered by the pulling force at a time 4.0 s after the motion starts is 12 K. Find the value of K.

PART – B

OBJECTIVE(Multi Choice Single Correct)

1. A chain of mass m and length L is placed on a table with one – sixth of it hanging freely from the table edge. The amount of work done to pull the chain on the table is:

a) mgL/4 b) mgL/6 c) mgL/72 d) mgL/36

2. A bucket tied to a string is lowered at a constant acceleration of g/4. If the mass of the bucket is m and it is lowered by a distance d, the work done by the string will be (Assume the string to be massless):

a) 1/4mgd b) -1/3 mgd c) -3/4 mgd d) 4/3 mgd

3. A rod of mass M and length L is lying on a horizontal table. Work done in making it stand on one end will be

a) MgL b) MgL/2 c) MgL/4 d) 2 MgL

4. A body is acted upon by a force which is proportional to the distance covered. If distance covered is represented by s, then work done by the force will be proportional to

a) s b) s2 c) √s d) none of the above

5.A car is moving along a straight horizontal road with a speed v0. If the coefficient of friction between the tyres and the road is μ, the shortest distance in which the car can be stopped is

a) $\frac{v^2_0}{2\mu g}$ b) $\frac{v^2_0}{\mu g}$ c) $\frac{2v^2_0}{\mu g}$ d) $\frac{v^2_0}{3\mu g}$

6. A rail road car is moving with a constant acceleration of 1 m/s^2. A block of 5kg is put on a horizontal rough floor in the car. At time t= 0, velocity of the car is 5 m/s. Considering that friction is sufficient and block is not slipping on the floor, the work done on the block by friction force during t=0 to t= 2 sec will be (Coefficient of friction is μ_s)

a) 60J b)-60J c) 10J d) 600 μ_sJ

7.A horizontal massive platform is moving with a constant velocity v_0. At time t=0, a small block of mass m is gently placed on the platform. If the coefficient of friction between the block and the platform is μ, the work done by the force of friction on the block in the fixed ground reference frame (from t= 0 to a sufficiently long time) is

a) + ½ mv^2_0 b)- ½ mv^2_0 c)+ $1/2\mu mv^2_0$ d) zero

8.A constant force F= -k(yî+xĵ), where k is a constant , acts on a particle moving in the x-y plane. Starting from the origin, the particle is moved along the x-axis to a point(a,0) and form there it is moved parallel to y-axis to the point(a,a).The total work done in the whole process will be

a) $-ka^2$ b) ka^2 c) $2ka^2$ d) $-2ka^2$

9. A ball looses 15% of its kinetic energy after it bounces back from a concrete slab. The speed with which one must throw it vertically down from a height of 12.4 m to have it bounce back to the same height is

a) 2.5m/s b)4.38m/s c)6.55m/s d)8.25m/s

10.A body is dropped from a certain height in the effect of conservative force only. When it loses 'U' amount of potential energy, it subsequently acquires a velocity 'v'.The mass of the body is:

a) $\frac{2U}{v^2}$ b) $\frac{U}{2v^2}$ c) $\frac{2v}{U}$ d) $\frac{U^2}{2v}$

11.A block of mass m is released on top of a wedge which is free to move on a horizontal surface. Neglecting friction between the surfaces in contact, which of the following statement is true?

a) The kinetic energy of the block when it reaches the bottom of the wedge is mgH.
b) The kinetic energy of the wedge when the block reaches the bottom is mgH.
c)The work of normal reaction on the block in the ground reference is not zero.
d)The potential energy of the wedge continuously changes.

12.A particle of mass m moves on x-axis in a conservative force field where the potential energy U varies with position coordinate x as U= U_0(1- cos ax), U_0 and a are positive constants. Which of the following statement is true regarding its motion

a) The acceleration is constant.
b) The kinetic energy is constant.
c) The acceleration is directed along the position vector.
d)The acceleration is directed opposite to the position vector.

13. A running man has half the K.E. that a chiled half of his mass has.The man speeds up by 1m/sec and then has the same K.E. as that of the child. The original speeds of the man and the child (in m/sec) are:

a) $(\sqrt{2}+1),(\sqrt{2}-1)$ b) $(\sqrt{2}+1),2(\sqrt{2}+1)$ c) $\sqrt{2}, \sqrt{2}$ d) $(\sqrt{2}+1),2(\sqrt{2}-1)$

14.A motor boat is travelling with a speed of 3.0 m/sec.If the force on it due to water flow is 500 N, the power of the boat is:

a) 150 kW   b) 15kW   c) 1.5 kW   d) 150 W

15.A particle of mass m moves under the influence of the force $F= a(\sin \omega t\hat{i} + \cos \omega t\hat{j})$ where a, ω are constants and t is time.The particle is initially at rest at the origin. The instantaneous power given to the particle is

a) zero   b) $a^2\sin \omega t/m\omega$ c) $a^2\cos \omega t/m\omega$ d) $a^2(\sin \omega t + \cos \omega t)/m\omega$

16. If v,p and E denote the velocity, momentum and kinetic energy of a particle, then

a) p= dE/dv   b) p= dE/dt   c) p= dv/dt   d) none of these

17.A elastic string of un stretched length L and force constant k is stretched by a small amount x it is further stretched by another small length y. What is the work done in seconds stretching?

a) $k/2\ (y^2-x^2)$ b) $ky/2\ (2x+y)$ c) $k/2\ y^2$ d) $k/2\ (x^2+y^2)$

18. Under the action of a force, a 2kg body moves such that its position x as a function of time is given by $x= t^3/3$, where x is in meter and t in seconds. The work done by force in first two seconds is

a) 1.6J   b) 16J   c) 160J   d) 1600J

19. A stone of mass 1 kg tied to a light inextensible string of length L= 10/3 m is whirling in a circular path of radius L in vertical plane. If the ratio of the maximum tension to the minimum tension in the string is 4. What is the speed of stone of the highest point of the circle? (g= 10 m/s2)

a) 10m/s   b)$5\sqrt{2}$ m/s   c) $10\sqrt{3}$m/s   d) 20m/s

20. A triangle formed using three wires AB, BC and CA and is placed in a vertical plane. Coefficient of friction for all the three wires is same. If w1 and w2 is the work done by the friction in moving an object from A to B through C' and C respectively.

a) w1=w2   b) w1<w2   c) w1>w2   d) the relation depends on the length AC and BC

21. A block of mass 1kg slides down a curved track that is one quadrant of a circle of radius 1m. Its speed at the bottom is 2 m/s.

a) -8J   b) +8J   c) 9J   d) -9J

22.With what minimum speed v must a small ball should be pushed inside a smooth vertical tube from a height h so that it may reach the top of the tube? Radius of the tube is R.

a) $\sqrt{2g(h+2R)}$ b) 5/2R   c)$\sqrt{g(5R-2h)}$ d)$\sqrt{2g(2R-h)}$

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

a) $g\sqrt{10}$ b) g   c) $g\sqrt{2}$ d) $g\sqrt{6}$

MULTI CHOICE MULTI CORRECT

1.One end of a light spring of spring constant k is fixed to a wall and the other end is tied to a block placed on a smooth horizontal surface. In a displacement, the work done by the spring is $1/2kx^2$ The possible cases are:

a) The spring was initially compressed by a distance x and was finally in its natural length.
b) It was initially in its natural length and finally in a compressed position
c) It was initially stretched by a distance x and finally was in its natural length
d) It was initially in its natural length and finally in a stretched position

2.The kinetic energy of a particle continuously increases with time

a) The resultant force on the particle must be parallel to the velocity at all instants
b)The resultant force on the particle must be at an angle less than 90^0 all the time
c)The magnitude of its linear momentum is increasing continuously.
d) Its height above the ground level must continuously decreases.

3.If the potential energy between an electron and a proton at a distance r is given by $U = -\left[\frac{ke^2}{3r^3}\right]$ The law of force is

a) $F= ke^2/ r^2$ b) $F= -3/4\times ke^2/r^4$ c) $F= ke^2/ r^4$ d) $F= ke^2/r$

NUMERICAL BASED TYPE

1.A particle slides down from the top outside smooth surface of a fixed sphere of radius a= 10m. The initial horizontal velocity to be imparted to the particle'at the top' is 10K m/s^2, if it leaves the surface at a point whose vertical height above the centre of sphere is 3a/4. Find the value of K.

2.A horse pulls a wagon of 3075 kg from rest against a constant resistance of 90 N. The pull exerted initially is 600 N and it decreases uniformly with the distance covered to 400 N at a distance of 15 m from start. Find the velocity (in m/s) of wagon at this point.

3. Two masses 10 kg and 20 kg are connected by a massless string. A force of 200N acts on 20 kg mass. At the instant when the 10 kg mass has an acceleration 12 m/s^2 the energy stored (in Joule) in the spring (k= 2400 N/m) will be?

SECTION – II

1. A Force (mv^2/r) is acting on a body of a mass m moving with a speed v in a circle of radius r what is the work done by the force in moving the body over half the circumference of the circle?

a) $mv^2/r \times \pi r$ b)zero c)mv^2/r^2 d)$\pi r^2/mv^2$

2. A body constrained to move in y- direction is subjected to a force given by $F=(-2\hat{i}+15\hat{j}-6\hat{k})$ N. what is the work done by this force in moving the body through a distance of 10 m along y- axis?

a) 190J b) 160J c) 150J d) 20J

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

a) work done by friction b) acceleration of the block c) kinetic energy of the block at time t d) total work done on the block

4.A particle moves along the x-axis from x=0 to x=5m under the influence of a force given by $F= 7- 2x+3x^2$. Work done in the process is

a) 70 b) 270 c) 35 d) 135

5. A body of mass 2 kg is projected vertically upwards with a speed f 3m/s. The maximum gravitational potential energy of the body is

a) 18J b)4.5J c) 9J d)2.25J

6. A ball of mass 50g is thrown upwards. It rises to a maximum height of 100 m. At what height its K.E. will be reduced to 70%.

a) 30m b) 40m c) 60m d) 70m

7.A long spring is stretched by 2 cm. Its potential energy is U. If the spring is stretched by 10 cm, its potential energy would be

a)U/25 b) U/5 c) 5U d) 25U

8. the K.E., acquired by a mass m in travelling a certain distance d, starting from rest, under the action of a constant force is directly proportional to

a) m b) $\sqrt{m}$ c) $1/\sqrt{m}$ d) none of the above

9. Out of a pair of identical spring of spring constant 240 N/m, one is compressed by 10 cm and the other is stretched by 10 cm. the difference in potential energy stored in the two spring is

a) zero b) 4J c) 12J d) 1.2J

10. In which case does the potential energy decreases?

a) on compressing the spring b) on stretching a spring c) on moving a body against gravitational pull d) none of these

11. A body of mass 5kg is moving with a momentum of 10 kg m/s.A force of 0.2 N acts on it in the direction of motion of the body for 10 sec. The increase in its kinetic energy is

a) 2.8 J b) 3.2J c) 3.8J d) 4.4J

12. Force F applied on a body moves it through a distance S along F. Energy spent is

a) F×S b) F/S c) FS^2 d)F/S^2

13. The potential energy of a particle is determined by the expression $U= \alpha (x^2+y^2)$, where α is a positive constant. The particle begins to move from a point with the coordinates (3,3)(m), only under the action of potential field force. Then its kinetic energy T at the instant when the particle is at a point with the coordinates (1,1)(m) is

a) 8α b)24α c)16 α d) zero

14. A particle of mass m attached to an inextensible light string is moving in a Vertical circle of radius r. The critical velocity at the highest point is v_0 to complete the vertical circle. The tension in the string when it becomes horiozontal is

a) $3mv^2_0/ r$ b) $9mv^2_0/r$ c) 3mg d) both (a) and(c) correct

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