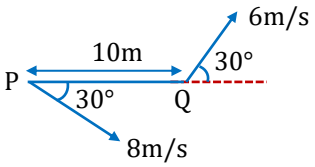
EXERCISE - O

SINGLE CORRECT TYPE QUESTIONS

Kinematics of Circular Motion

1. Two moving particles P and Q are $10m$ apart at a certain instant. The velocity of P is $8m/s$ making an angle of 30° with the line joining P and Q and Q is moving with $6m/s$ making an angle of 30° with PQ as shown in figure. Then angular velocity of P with respect to Q is



(A) Zero (B) 0.1 rad/s (C) 0.4 rad/s (D) 0.7 rad/s

PCR021

2. The second's hand of a watch has length 6 cm. Speed of end point and magnitude of difference of velocities at two perpendicular positions will be

(A) 2π and 0 mm/s (B) $2\sqrt{2}\,\pi$ and 4.44 mm/s

(C) $2\sqrt{2}\,\pi$ and 2π mm/s (D) 2π and $2\sqrt{2}\,\pi$ mm/s

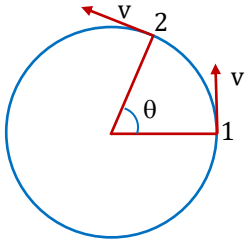
PCR022

3. The magnitude of displacement of a particle moving in a circle of radius a with constant angular speed ω varies with time t as :-

(A) $2a \sin \omega t$ (B) $2a \sin \frac{\omega t}{2}$ (C) $2a \cos \omega t$ (D) $2a \cos \frac{\omega t}{2}$

PCR023

4. Two particles describe the same circle of radius R in the same direction with the same speed V. then at the given instant relative angular velocity of 2 with respect to 1 will be :



(A) $\frac{2v \sin\frac{\theta}{2}}{R}$ (B) $\frac{v}{2R\sin\frac{\theta}{2}}$ (C) $\frac{v}{R}$ (D) $\frac{v\cos\frac{\theta}{2}}{R}$

PCR024

5. An insect trapped in a circular groove of some radius moves along the groove steadily and completes 10 revolutions in 100s. Choose the correct statement:-

(A) The angular velocity of the insect is 10 rad/s

(B) The angular velocity of the insect is $\frac{\pi}{5}$ rad/s

(C) The angular velocity of the insect is $\frac{2\pi}{5}$ rad/s

(D) The angular velocity of the insect can't be defined as radius is unknown.

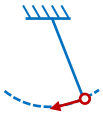
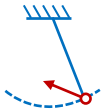
PCR029

6. At t = 0 a flywheel is rotating with angular velocity ω_0. It then undergoes uniform angular acceleration for a time t_1, at the end of which the angular velocity is ω_1. How many revolutions did the flywheel make during this time interval?

(A) $\frac{1}{2}(\omega_0 + \omega_1)\, t_1$ (B) $\frac{\omega_0 t_1}{2\pi}$ (C) $\frac{\omega_1 t_1}{2\pi}$ (D) $\frac{(\omega_0 + \omega_1)t_1}{4\pi}$

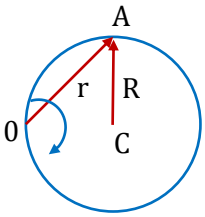
PCR030

7. Which vector in the figures best represents the acceleration of a pendulum mass at the intermediate point in its swing?

(A)  (B)  (C)  (D) 

PCR031

8. A particle A moves along a circle of radius R = 50 cm so that its radius vector r relative to the point O (figure) rotates with the constant angular velocity ω = 0.40 rad/s. Then modulus of the velocity of the particle, and the modulus of its total acceleration will be



(A) v = 0.4 m/s, a = 0.4 m/s^2 (B) v = 0.32 m/s, a = 0.32 m/s^2

(C) v = 0.32 m/s, a = 0.4 m/s^2 (D) v = 0.4 m/s, a = 0.32 m/s^2

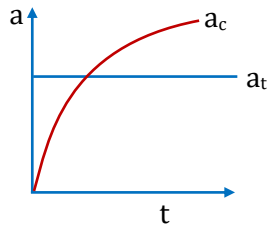
PCR036

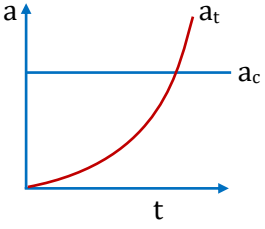
9. A particle is projected with initial velocity 50m/sec making an angle of 53° with horizontal. Find the radius of curvature of particle when velocity of particle is perpendicular to the direction of its initial velocity :

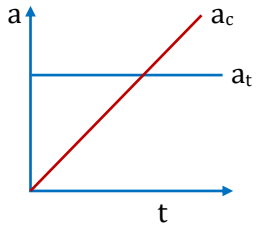
(A) 175.8 m (B) 200.3 m (C) 165.6 m (D) 170.8 m

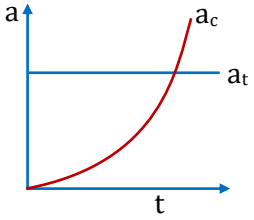
PCR040

10. A particle starts from rest and performing circular motion of constant radius with speed given by $v=\alpha\sqrt{x}$ where α is a constant and x is the distance covered. The correct graph of magnitude of its tangential acceleration (a_t) and centripetal acceleration (a_c) versus t will be:

(A)


(B)


(C)


(D)


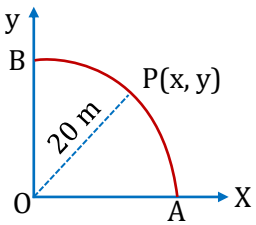
PCR041

11. A particle is moving in a circular path. The acceleration and momentum of the particle at a certain moment are $\vec{a}=\left(4\hat{i}+3\hat{j}\right)\ m/s^2$ and $\vec{p}=\left(8\hat{i}-6\hat{j}\right)\ kg\text{–}m/s$. The motion of the particle is

(A) uniform circular motion
(B) accelerated circular motion
(C) de–accelerated circular motion
(D) we can not say anything with $\vec{a}$ and $\vec{p}$ only

PCR069

12. A point P moves in counter clockwise direction on a circular path as shown in the figure. The movement of 'P' is such that it sweeps out a length $s = t^2 + 5$, where s is in metres and t is in seconds. The radius of the path is 20 m. The acceleration of 'P' when $t=5\sqrt{\frac{3}{10}}$ seconds is nearly :



(A) 2 m/s^2
(B) 1.5 m/s^2
(C) 2.5 m/s^2
(D) 3 m/s^2

PCR070

Dynamics of Circular Motion

13. A particle is acted upon by a force of constant magnitude which is always perpendicular to the velocity of the particle. The motion of the particle takes place in a plane, it follows that-

(A) Its velocity is constant
(B) Its acceleration is constant
(C) Its kinetic energy is constant
(D) It moves in a straight line

PCR042

14. A particle of mass m is tied to a light string and rotated with a speed v along a circular path of radius *r*. If *T* = tension in the string and *mg* = gravitational force on the particle then the actual forces acting on the particle are :

(A) *mg* and *T* only

(B) *mg*, *T* and an additional force of $\frac{mv^2}{r}$ directed inwards.

(C) *mg*, *T* and an additional force of $\frac{mv^2}{r}$ directed outwards.

(D) only a force $\frac{mv^2}{r}$ directed outwards.

PCR043

15. An unbanked circular highway curve on level ground makes a turn of 90°. The highway carries traffic at 108 *km-hr*$^{-1}$, and the centripetal force on a vehicle is not to exceed 1/10 of its weight. What is the minimum length of the curve?

(A) 1.4 *km* (B) 1 *km* (C) 0.6 *km* (D) 1.7 *km*

PCR060

16. A long horizontal rod has a bead which can slide along its length and is initially placed at a distance *L* from one end *A* of the rod. The rod is set in angular motion about *A* with a constant angular acceleration, α. If the coefficient of friction between the rod and bead is μ, and gravity is neglected, then the time after which the bead starts slipping is :–

(A) $\sqrt{\frac{\mu}{\alpha}}$ (B) $\frac{\mu}{\sqrt{\alpha}}$ (C) $\frac{1}{\sqrt{\mu\alpha}}$ (D) Infinitesimal

PCR072

17. A car is moving along a circular track with tangential acceleration of magnitude a_0. It just start to slip at speed v_0 then find radius of circle. (Coefficient of friction is μ)

(A) $\frac{v_0^2}{\sqrt{(\mu g)^2 + a_0^2}}$ (B) $\frac{v_0^2}{\sqrt{(\mu g)^2 - a_0^2}}$ (C) $\frac{v_0^2}{\sqrt{(\mu g)^2 - 2a_0^2}}$ (D) $\frac{v_0^2}{\sqrt{(\mu g)^2 + 2a_0^2}}$

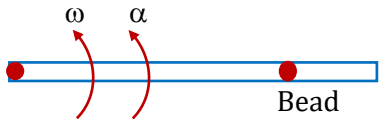
PCR074

18. A bead is constrained to move on rod in gravity free space as shown in figure. The rod is rotating with angular velocity ω and angular acceleration α about its end. If μ is coefficient of friction. Mark the correct option. (Rod rotates in the plane of paper)

(A) If $\mu = \frac{\omega^2}{\alpha}$ friction on bead is static in nature

(B) If $\mu > \frac{\omega^2}{\alpha}$ friction on bead is kinetic in nature

(C) If $\mu < \frac{\omega^2}{\alpha}$ friction is static



(D) If bead does not slide relative to rod. Friction will not exist between bead and rod.

PCR076

19. A horizontal turn table is initially at rest. It starts to rotate in horizontal plane with constant angular acceleration 3 rad/s^2. A block of mass 1 kg is placed 1 metre away from the axis of rotation on the turn table. A horizontal force $F = 5t$ N where t is in seconds, is acting on the block always towards the center of rotation. The block begins to slip at $t = 1s$. The coefficient of friction between block and turn table is

(A) 0.2 (B) 0.3 (C) 0.4 (D) 0.5

PCR077

Work

20. A cricket player throws a ball straight upward in the air. It rises and falls back to the hands of the player. During the catch, his hands are displaced downward a few inches as the ball slows down, then.

(A) During the catch while the ball is in hand and is moving downward, the work done by the player on the ball is positive.

(B) During the throw work done by gravity is positive.

(C) During the throw while ball is in hand and moving upward, work done by ball on hand is negative.

(D) During the catch while the ball is in hand and moving downward, work done by hand plus gravity on the ball is positive.

PWE060

21. A force of magnitude of 30 N acting along $\hat{i}+\hat{j}+\hat{k}$, displaces a particle from point (2, 4, 1) m to (3, 5, 2) m. The work done during this displacement is :-

(A) 90 J (B) 30 J (C) $30\sqrt{3}$ J (D) $30/\sqrt{3}$ J.

PWE061

22. A rope is used to lower vertically a block of mass M by a distance x with a constant downward acceleration $g/2$. The work done by the rope on the block is :

(A) Mgx (B) $\frac{1}{2} Mgx^2$ (C) $-\frac{1}{2} Mgx$ (D) Mgx^2

PWE062

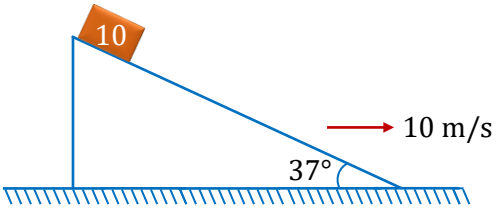
23. A block of mass 10 kg is released from the top of smooth wedge (whose inclination at $\theta = 37°$) which is moving with a constant velocity 10 m/s. The work done by the force applied by wedge on the block in 2 sec will be (in joules) :-

(A) 1600

(B) 960

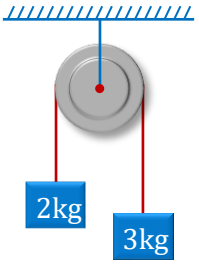
(C) Zero

(D) 720



PWE064

24. In the figure shown find work done by tension in string on 3 *kg* block in first two second, from beginning of motion. The system is set free at $t = 0$ ($g = 10\ m/s^2$) (Assume pulley and string is ideal)



(A) –96 Joule (B) –48 Joule (C) +24 Joule (D) 96 Joule

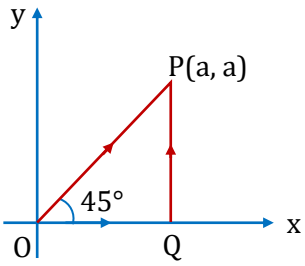
PWE070

25. Force acting on a particle is $\left(2\hat{i}+3\hat{j}\right)$ *N*. Work done by this force is zero, when a particle is moved on the line $3y + kx = 5$. Here value of *k* is

(A) 2 (B) 4 (C) 6 (D) 8

PWE071

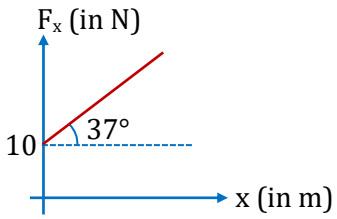
26. A particle is moved from (0, 0) to (*a*, *a*) under a force from $\vec{F}=\left(3\hat{i}+4\hat{j}\right)$ two paths. Path 1 is *OP* and path 2 is *OQP*. Let W_1 and W_2 be the work done by this force in these two paths. Then :

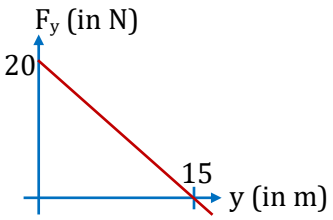


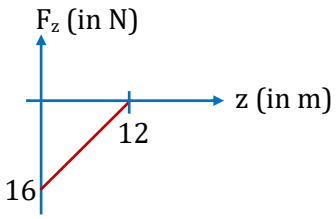
(A) $W_1 = W_2$ (B) $W_1 = 2W_2$ (C) $W_2 = 2W_1$ (D) $W_2 = 4W_1$

PWE072

27. The components of a force acting on a particle are varying according to the graphs shown. To reach at point *B* (8, 20, 0) from point *A*(0, 5, 12) the particle moves on paths parallel to *x*-axis then *y*-axis and then *z*-axis, then work done by this force is :-



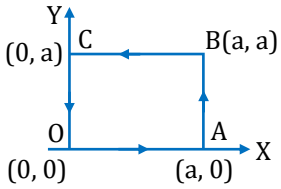




(A) 192 *J* (B) 58 *J* (C) 250 *J* (D) 125 *J*

PWE073

28. The work done by the force $\vec{F} = x^2\hat{i} + y^2\hat{j}$ around the path shown in the figure is

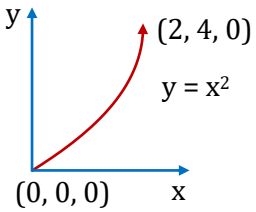


(A) $\frac{2}{3}a^3$ (B) zero

(C) a^3 (D) $\frac{4}{3}a^3$

PWE076

29. By applying a force $\vec{F} = (3xy - 5z)\hat{j} - 4\hat{k}$ a particle is moved along the path $y = x^2$ from point (0, 0, 0) to the point (2, 4, 0). The work done by the F on the particle is :-



(A) $\frac{280}{5}$ (B) $\frac{140}{5}$ (C) $\frac{232}{5}$ (D) $\frac{192}{5}$

PWE077

Kinetic Energy

30. A man who is running has half the kinetic energy of the boy of half his mass. The man speeds up by 1 m/s and then has the same kinetic energy as the boy. The original speed of the man was

(A) $\sqrt{2}\ m/s$ (B) $(\sqrt{2} - 1)\ m/s$ (C) 2 m/s (D) $(\sqrt{2} + 1)\ m/s$

PWE078

Work Energy Theorem

31. A body of mass 0.5 kg travels in a straight line with velocity $v = ax^{3/2}$ where $a = 5\ m^{-1/2}s^{-1}$. 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

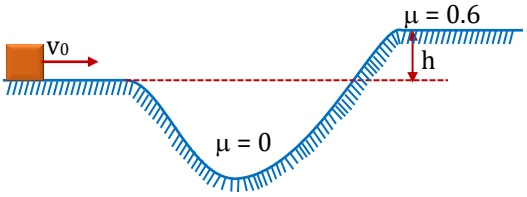
PWE080

32. In a shotput event an athlete throws the shotput of mass 10 kg with an initial speed of $1m/s$ at 45° from a height 1.5 m above ground. Assuming air resistance to be negligible and acceleration due to gravity to be 10 m/s^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) 155.0 J

PWE082

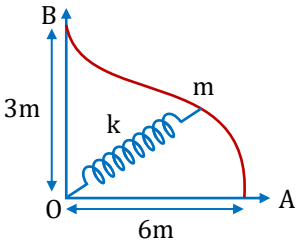
33. In the figure, a block slides along a track from one level to a higher level, by moving through an intermediate valley. The track is frictionless until the block reaches the higher level. There a frictional force stops the block in a distance d. The block's initial speed v_0 is 6 m/s, the height difference h is 1.1m and the coefficient of kinetic friction μ is 0.6. The value of d is



(A) 1.17 m (B) 1.71 m (C) 7.11 m (D) 11.7 m

PWE084

34. A small object with mass $m = 2\ kg$ is attached to the free end of an ideal spring with $k = 10\ Nm^{-1}$. The other end of the spring is connected to a fixed frictionless pivot located at the origin O as shown in the Figure. The relaxed length of the spring is 1 m. An unspecified force F carries the object at rest from point A to point B. At point B, the object has the speed $5\ ms^{-1}$. The work done by the force F is (Neglect gravity) :-

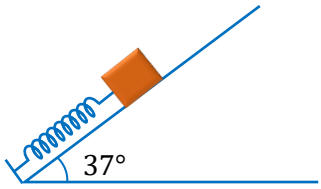


(A) 130 J (B) 80 J

(C) –105 J (D) –80 J

PWE088

35. In the arrangement shown a block of mass $2kg$ is pressed against a spring which is compressed by 10 cm and is applying a force of 80 N to the block. The spring is not attached to the block. The coefficient of friction is 0.5. When the block is released it moves up the plane by some distance and then comes back down. The kinetic energy of the block just before it starts compressing the spring again is



(A) 2 J (B) 1.6 J (C) 0.8 J (D) 0.4 J

PWE089

36. A block of mass $10kg$ is attached to a relaxed spring. Other end is attached to ceiling and block is released keeping the spring in vertical position. The spring is such that it has elongation of 10 cm under a force of 100 N. The maximum velocity of block in subsequent motion is :-

(A) 1 m/s (B) 1.5 m/s (C) 2.0 m/s (D) 2.5 m/s

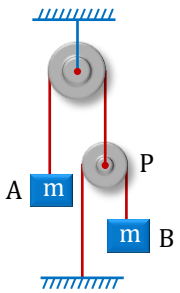
PWE090

37. A light spring of length 20 cm and force constant 2 N/cm is placed vertically on a table. A small block of mass 1 kg falls on it. The length h from the surface of the table at which the block will have the maximum velocity is :

(A) 20 cm (B) 15 cm (C) 10 cm (D) 5cm

PWE092

38. In the figure shown, the system is released from rest. Find the velocity of block A when block B has fallen a distance 'ℓ'. Assume all pulleys to be massless and frictionless.



(A) $\sqrt{\frac{g\ell}{5}}$ (B) $\sqrt{g\ell}$ (C) $\sqrt{5g\ell}$ (D) None of these

PWE093

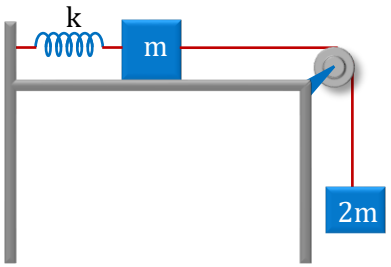
39. Two blocks, of masses M and $2M$, are connected to a light spring of spring constant K that has one end fixed, as shown in figure. The horizontal surface and the pulley are frictionless. The blocks are released from rest when the spring is non deformed. The string is light.

(I) Maximum extension in the spring is $\frac{4Mg}{K}$.

(II) Maximum kinetic energy of the system is $\frac{2M^2g^2}{K}$.

(III) Maximum extension in the spring is $\frac{2Mg}{K}$.

(IV) Maximum kinetic energy of the system is $\frac{4M^2g^2}{K}$.



Then which of the following option is correct?

(A) I and IV (B) I and II (C) III and IV (D) None of these

PWE099

Potential Energy

40. A radial force $\vec{F} = \frac{A}{r^2}\hat{r}$ acts on a particle. The work done by the force in displacing a particle from (1, 0) to (3, 4) is :

(A) $\frac{A}{5}$ (B) $\frac{A}{2}$ (C) $\frac{4A}{5}$ (D) $\frac{4A}{3}$

PWE097

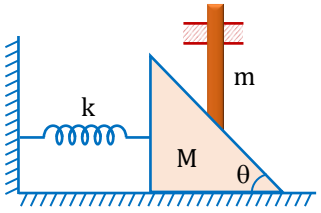
41. When a conservative force does positive work on a body

(A) the potential energy increases (B) the potential energy decreases

(C) total energy increases (D) total energy decreases

PWE102

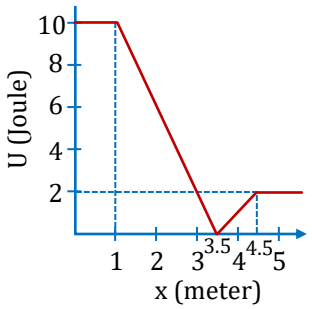
42. A wedge of mass M fitted with a spring of stiffness 'k' is kept on a smooth horizontal surface. A rod of mass m is kept on the wedge as shown in the figure. System is in equilibrium. Assuming that all surfaces are smooth, the potential energy stored in the spring is:



(A) $\frac{mg^2\tan^2\theta}{2k}$ (B) $\frac{m^2g\tan^2\theta}{2k}$ (C) $\frac{m^2g^2\tan^2\theta}{2k}$ (D) $\frac{m^2g^2\tan^2\theta}{k}$

PWE103

43. A body with mass 2 *kg* moves in one direction in the presence of a force which is described by the potential energy graph. If the body is released from rest at $x = 2m$, then its speed when it crosses $x = 5\ m$ is



(A) zero (B) 1 ms^{-1} (C) 2 ms^{-1} (D) 3 ms^{-1}

PWE105

44. The potential energy between two atoms in a molecule is given by

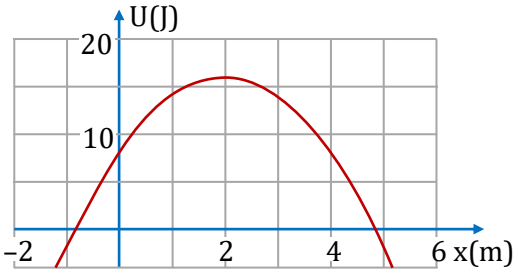
$U = ax^3 - bx^2$

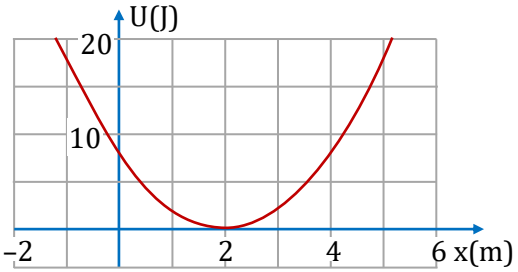
where a and b are positive constants and x is the distance between the atoms. The atom is in stable equilibrium when x is equal to :-

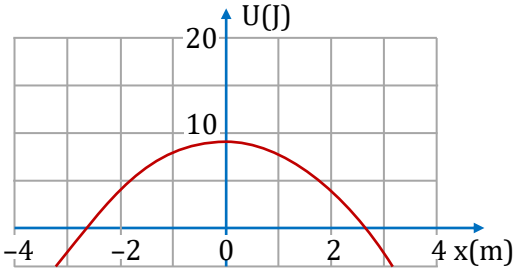
(A) 0 (B) $\frac{2b}{3a}$ (C) $\frac{3a}{2b}$ (D) $\frac{3b}{2a}$

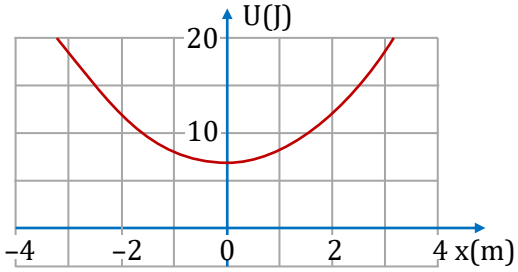
PWE106

45. A conservative force $\vec{F} = (4x - 8)\hat{i}N$ acts on a particle that moves on the x-axis. The potential energy associated with this force is assigned a value of 8J at $x = 0$. Which of the following best represents variation in potential energy with position coordinate x?

(A)


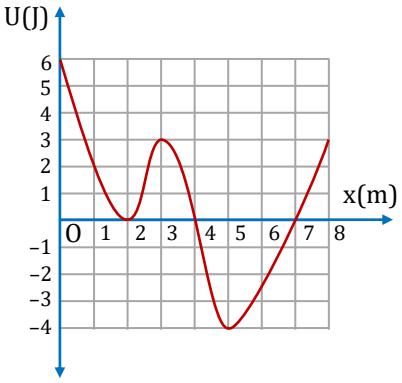
(B)


(C)


(D)


PWE107

46. Potential energy curve U of a particle as function of the position of a particle is shown. The particle has total mechanical energy E of 3.0 joules.



(A) It can never be present at $x = 0$ m.

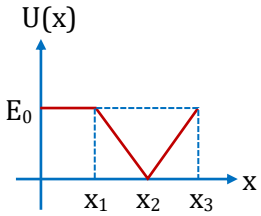
(B) It can never be present at $x = 5$ m

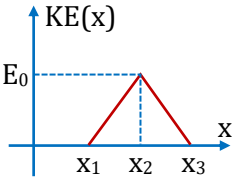
(C) At $x = 2$ its kinetic energy is 0 J

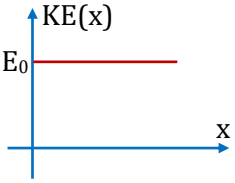
(D) At $x = 1$ its kinetic energy 3 J

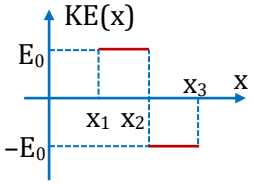
PWE108

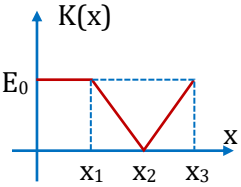
47. The potential energy $U(x)$ of a particle moving along x-axis is shown in figure. Which one of the following graphs represents the variation of kinetic energy of this particle if its total mechanical energy is E_0?



(A)


(B)


(C)


(D)


PWE109

Motion in Vertical Circle

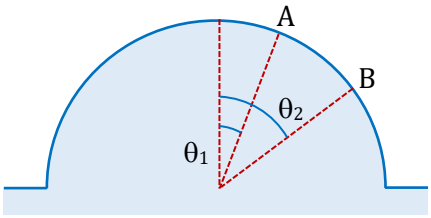
48. A stone is tied to a string of length 2 m is whirled in a vertical circle with the other end of the string at the centre. At a certain instant of time, the stone is at its lowest position and has a speed 10 m/s. The magnitude of the change in its velocity as it reaches a position where the string is horizontal is

(A) $\sqrt{60}$ (B) $\sqrt{40}$

(C) $\sqrt{80}$ (D) $\sqrt{160}$

PWE150

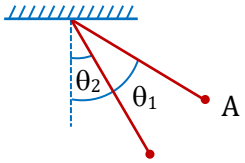
49. A small block slides down from rest at point *A* on the surface of a smooth circular cylinder, as shown. At point *B*, the block falls off (leaves) the cylinder. The equation relating the angles θ_1 and θ_2 is given by



(A) $\sin\theta_2 = \frac{2}{3}\sin\theta_1$ (B) $\sin\theta_2 = \frac{3}{2}\sin\theta_1$ (C) $\cos\theta_2 = \frac{2}{3}\cos\theta_1$ (D) $\cos\theta_2 = \frac{3}{2}\cos\theta_1$

PWE115

50. A particle of mass *m* is connected from a light inextensible string of length ℓ such that it behaves as a simple pendulum. Now string is pulled to point *A* making an angle θ_1 with the vertical and it is released from the point *A* then.



(A) Speed of the particle when string makes an angle θ_2 with vertical, is $\sqrt{2g\ell(cos\theta_2 - cos\theta_1)}$

(B) Speed of the particle when string makes an angle θ_2 with vertical, is $\sqrt{g\ell(cos\theta_2 - cos\theta_1)}$

(C) The tension in the string when string makes an angle θ_2 with vertical is $mg\,(4\cos\theta_2 - 2\cos\theta_1)$

(D) The tension in the string when string makes an angle θ_2 with vertical is $mg\,(\cos\theta_2 - \cos\theta_1)$

PWE117

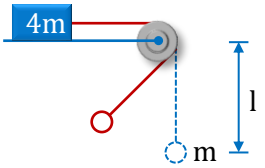
51. A stone of mass *m* at the end of a string of length *L* is whirled in a vertical circle at a constant speed. The tension in the string will be maximum when the stone is

(A) At the top of the circle (B) Half way down from the top

(C) Quarter way down from the top (D) At the bottom of the circle

PWE118

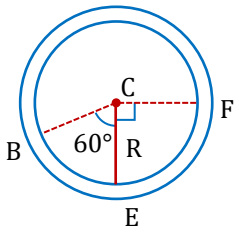
52. Two bodies of mass *m* and 4*m* are attached to a string as shown in the figure. The body of mass *m* hanging from string is executing oscillation with angular amplitude 60° while other body is at rest on a horizontal surface. The minimum coefficient of friction between the mass 4*m* and the horizontal surface is :



(A) 1/4 (B) 3/4 (C) 1/2 (D) 1/8

PWE119

53. As shown in figure *BEF* is a fixed vertical circular tube. A block of mass *m* starts moving in the tube at point *B* with velocity *V* towards *E*. It is just able to complete the vertical circle, then choose the **INCORRECT** option :-



(A) velocity at *B* must be $\sqrt{3Rg}$

(B) velocity at *F* must be $\sqrt{2Rg}$

(C) normal reaction at point *F* is $2mg$

(D) the normal reaction at point *E* is 6 *mg*

PWE120

Power

54. A body of mass *m* accelerates uniformly from rest to v_1 in time t_1. The instantaneous power delivered to the body as a function of time *t* is-

(A) $\frac{mv_1t}{t_1}$ (B) $\frac{mv_1^2t}{t_1^2}$ (C) $\frac{mv_1t^2}{t_1}$ (D) $\frac{mv_1^2t}{t_1}$

PWE122

55. Assume the aerodynamic drag force on a car is proportional to its speed. If the power output from the engine is doubled, then the maximum speed of the car.

(A) is unchanged

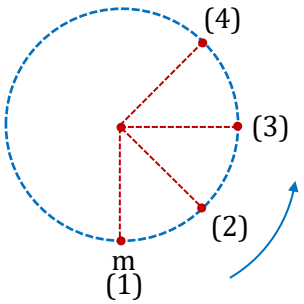
(B) increases by a factor of $\sqrt{2}$

(C) is also doubled

(D) increases by a factor of four

PWE123

56. A particle (bob) of mass 1 *kg* is performing vertical circular motion. Then :



(A) Power delivered by tension at point (4) is negative.

(B) Power delivered by tension at point (2) is positive.

(C) Power delivered by gravitational force at point (3) is zero

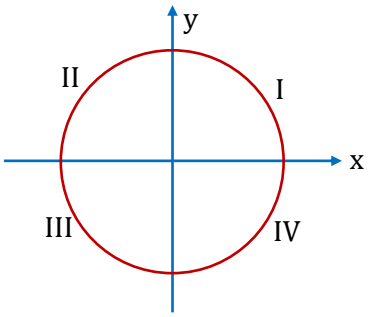
(D) Power delivered by gravitational force at point (4) is negative.

PWE128

MULTIPLE CORRECT TYPE QUESTIONS

Kinematics of Circular Motion

57. A particle is moving along a circular path as shown in figure below. The instantaneous velocity of the particle is $\vec{v}=(4m/s)\hat{i}-(3\text{ m/s})\hat{j}$. The particle may be moving through



(A) first quadrant (B) second quadrant (C) third quadrant (D) fourth quadrant

PCR027

58. The second-hand of a tower clock is 1.00 *m* long. Which of the following is/are **CORRECT** statement(s).

(A) Linear velocity of the tip of the hand is $\frac{10\pi}{3}cm/s$.

(B) Angular velocity of the hand is $\frac{\pi}{30}rad/s$.

(C) Average acceleration of the tip of the hand in 15 minutes is zero.

(D) Instantaneous acceleration of the tip of the hand is $\frac{\pi^2}{9}cm/s^2$.

PCR028

59. Let $\vec{v}\ (t)$ be the velocity of a particle at time *t*. Then :

(A) $|d\vec{v}(t)/dt|$ and $d|\vec{v}\ (t)|/dt$ are always equal

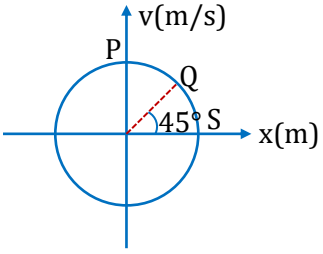
(B) $|d\vec{v}(t)/dt|$ and $d|\vec{v}\ (t)|/dt$ may be equal

(C) $d|\vec{v}(t)|/dt$ can be zero while $|d\vec{v}\ (t)/dt|$ is not zero

(D) $d|\vec{v}\ (t)|/dt\neq 0$ implies $|d\vec{v}\ \ (t)/dt|\neq 0$

PCR032

60. A particle is in motion on the *x*-axis. The variation of its velocity with position is as shown. The graph is circle and its equation is $x^2 + v^2 = 1$, where *x* is in *m* and *v* in *m/s*. The **CORRECT** statement(s) is/are :-



(A) When *x* is positive, acceleration is negative.

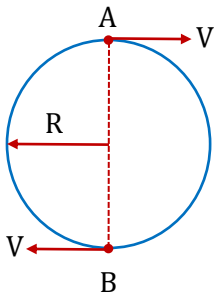
(B) When *x* is negative, acceleration is positive.

(C) At *Q*, acceleration has magnitude $\frac{1}{\sqrt{2}}$ m/s^2

(D) At *S*, acceleration is infinite.

PCR037

61. Two bodies A and B are moving with same constant speed v in clockwise direction in a horizontal circle of radius R and are initially diametrically opposite. The particle B now achieves a tangential acceleration $a\ m/s^2$. Then which option is/are correct ?



(A) they collide after time $\sqrt{\frac{\pi R}{a}}$

(B) they collide after time $\sqrt{\frac{2\pi R}{a}}$

(C) relative velocity just before collision is $\sqrt{\pi aR}$

(D) relative velocity just before collision is $\sqrt{2\pi aR}$

PCR038

62. An ant travels along a long rod with a constant velocity relative to the rod starting from the origin. The rod is kept initially along the positive x-axis. At $t = 0$, the rod also starts rotating with an angular velocity ω (anticlockwise) in x-y plane about origin. Then

(A) the position of the ant at any time t is $\vec{r} = ut\left[\cos\omega t\hat{i} + \sin\omega t\hat{j}\right]$

(B) the speed of the ant at any time t is $u\sqrt{1+\omega^2t^2}$

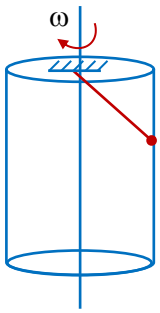
(C) the magnitude of the tangential acceleration of the ant at any time t is $\frac{\omega^2 tu}{\sqrt{1+\omega^2t^2}}$

(D) the speed of the ant at any time t is $\sqrt{1+2\omega^2t^2u}$

PCR081

Dynamics of Circular Motion

63. In the shown figure inside a fixed hollow cylinder with vertical axis a pendulum is rotating in a conical path with its axis same as that of the cylinder with uniform angular velocity. Radius of cylinder is 30 cm, length of string is 50 cm and mass of bob is 400 gm. The bob makes contact with the inner frictionless wall of the cylinder while moving :-



(A) The minimum value of angular velocity of the bob so that it does not leave contact is 5 rad/s

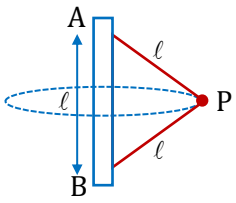
(B) Tension in the string is 5 N for all values of angular velocity

(C) For angular velocity of 10 rad/s the bob pushes the cylinder with a force of 9 N

(D) For angular velocity of 10 rad/s, tension in the string is 20N

PCR046

64. A particle P of mass m is attached to a vertical axis by two strings AP and BP of length l each. The separation $AB = l$. P rotates around the axis with an angular velocity ω. The tensions in the two strings are T_1 and T_2

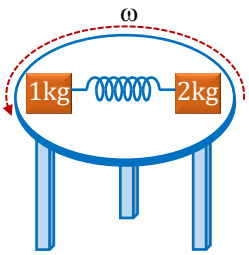


(A) $T_1 = T_2$ (B) $T_1 + T_2 = m\omega^2 l$

(C) $T_1 - T_2 = 2\,mg$ (D) BP will remain taut only if $\omega \geq \sqrt{\frac{2g}{\ell}}$

PCR047

65. On a circular turn table rotating about its center horizontally with uniform angular velocity ω rad/s placed two blocks of mass 1 kg and 2 kg, on a diameter symmetrically about center. Their separation is 1m and friction is sufficient to avoid slipping. The spring between them as shown is stretched and applied force of 5N. If f_1 and f_2 are values of friction on 1 kg and 2kg block respectively:-



(A) For $\omega = 2$ rad/s, $f_1 = 3N$ and $f_2 = 1N$

(B) For $\omega = 3$ rad/s, $f_1 = 0.5\ N$ and $f_2 = 4N$

(C) For $\omega = \sqrt{10}$ rad/s, $f_1 = 0$ and $f_2 = 5N$

(D) For $\omega = \sqrt{10}$ rad/s, $f_1 = 0$ and $f_2 = 0N$

PCR051

66. A heavy particle is tied to the end A of a string of length 1.6 m. Its other end O is fixed. It revolves as a conical pendulum with the string making 60° with the vertical. Then

(A) its period of revolution is $\frac{4\pi}{7}$ sec

(B) the tension in the string is double the weight of the particle

(C) the velocity of the particle = $2.8\sqrt{3}\ m/s$

(D) the centripetal acceleration of the particle is $9.8\sqrt{3}\ m/s^2$

PCR052

67. A car is moving with constant speed on a rough banked road.

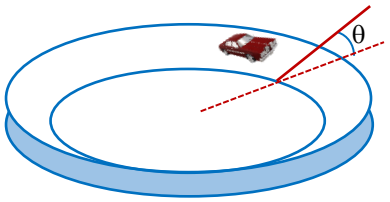
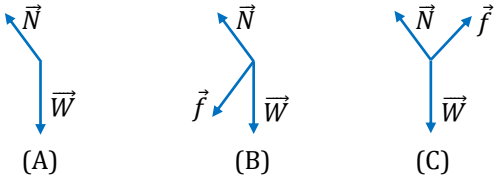


Figure shows the free body diagram of car in three situation A, B and C respectively:-



(A) Car in A has more speed than car in C

(B) Car in A has less speed than car in B

(C) FBD for car in A is not possible

(D) If $\mu > \tan\theta$ the FBD for car C is not possible

PCR063

Work

68. Which of the following statements is TRUE for a system comprising of two bodies in contact exerting frictional force on each other :

(A) total work done by static friction on whole system is always zero.

(B) work done by static friction on a body is always zero

(C) work done by kinetic friction on a body is always negative

(D) total work done by internal kinetic friction on whole system is always negative

PWE063

Work Energy Theorem

69. Select the correct alternatives :-

(A) Work energy theorem can be applied in non-inertial frame of reference also.

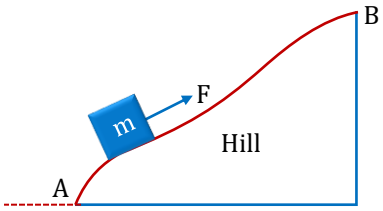
(B) Work done by any force can be positive, negative or zero depends on choice of reference frame.

(C) Kinetic friction force always acts opposite to direction of velocity.

(D) Work done by a force is independent of the choice of reference frame.

PWE079

70. A body of mass 'm' is moving slowly up the rough hill from point A to point B as shown in figure by a force which is acting tangential to surface at each point on the hill. Work done by this force is :



(A) Independent of shape of trajectory.

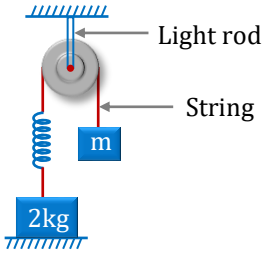
(B) Independent of horizontal component of displacement.

(C) Depends on coefficient of friction between the surfaces.

(D) Depends on the mass of the body.

PWE086

71. In figure, a block of mass m is released from rest when spring was in its natural length. The pulley also has mass m but it is frictionless. Suppose the value of m is such that finally it is just able to lift the block of mass $2kg$ up after being released. Mark the correct statement (s) :-



(A) Mass of m required to just lift $2kg$ block is $2kg$.

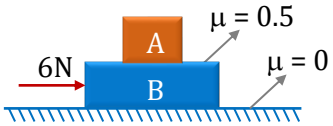
(B) The tension in the rod, when m has zero acceleration is $20N$.

(C) The normal force acting on 2 kg block when m has zero acceleration is $10N$.

(D) The tension in the string when displacement of m is maximum possible is $20N$.

PWE091

72. Block A of mass 1 kg is kept on block B of mass $2kg$ which is kept on smooth surface as shown in figure. At $t = 0$ both blocks are at rest and a force of $6N$ is applied on block B. Friction coefficient between A and B is 0.5. Which of the following is/are correct :-



(A) Acceleration of both the blocks is $2m/s^2$

(B) Work done by friction (in ground frame) on A is zero from $t = 0$ to $t = 2$ sec

(C) Friction force on A is $2N$

(D) Kinetic energy of A at $t = 2$ sec is $8J$

PWE094

Potential Energy

73. Which of the following is/are conservative force(s)?

(A) $\vec{F} = 2r^3\hat{r}$ (B) $\vec{F} = -\frac{5}{r}\hat{r}$ (C) $\vec{F} = \frac{3\left(x\hat{i} + y\hat{j}\right)}{(x^2 + y^2)^{3/2}}$ (D) $\vec{F} = \frac{3\left(yi + x\hat{j}\right)}{(x^2 + y^2)^{3/2}}$

PWE095

74. If one of the forces acting on a particle is conservative then :

(A) Work done by this force is zero when the particle moves exactly once around any closed path.

(B) Work done by this force equals the change in the kinetic energy of the particle.

(C) It obeys Newton's second law.

(D) Work done by this force depends on the end points of the motion, not on the path in between.

PWE096

75. A particle of mass 5 kg moving in the $X - Y$ plane has its potential energy given by $U = (-7x + 24y)$ J. The particle is initially at origin and has a velocity $\vec{u} = \left(14.4\hat{i} + 4.2\hat{j}\right)$ m/s.

(A) The particle has speed 25 m/s at $t = 4$ sec.

(B) The particle has an acceleration 25 m/s^2

(C) The acceleration of particle is normal to its initial velocity

(D) All above are correct

PWE104

Motion in Vertical Circle

76. A particle is given a velocity at the bottom most position in a smooth spherical shell of radius $2m$. It just complete a vertical circular motion. Then

(A) acceleration of particle when the velocity of the particle is in vertically upward direction is $g\sqrt{10}$

(B) acceleration of particle when the velocity of the particle is in vertically downward direction is $g\sqrt{10}$

(C) acceleration of the particle at the top most point of path is g

(D) acceleration of the particle at the bottom most point is $5g$

PWE113

Power

77. A particle of mass 2 *kg* is projected with an initial speed u = 10 *m*/sec at an angle θ = 30° with the horizontal:

(A) Total work done on the particle during the first half of the total time of flight of the particle is (–25) *J*.

(B) Total work done on the particle during the total time of flight of the particle is 0 *J*.

(C) Average power delivered to the particle during the first half of the flight is (–50) watt.

(D) The radius of curvature of the trajectory of the particle at the highest point of the projectile is 7.5*m*.

PWE124

78. A particle is moving from point (1, 2, 3) to (4, 6, 8) with initial speed $5\sqrt{2}$ *m/s* on a straight line. It experiences a force of $\left(3\hat{i}+4\hat{j}\right)N$ throughout its journey. Choose the **CORRECT** statement(s) :-

(A) Initial velocity vector of the particle is $\left(3\hat{i}+4\hat{j}+5\hat{k}\right)m/s$

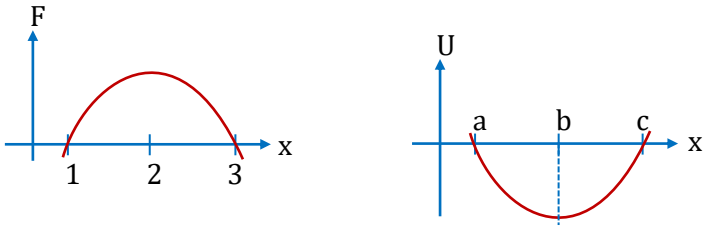
(B) Work done by the given force in the journey is 25*J* $\left(W=\vec{F}.\vec{S}\right)$

(C) Initial power delivered by the given force is 25 watt ($P=\vec{F}.\vec{V}$, P is power and V is velocity)

(D) If velocity of the particle doesn't change there must be some other force acting on the particle.

PWE129

79. A particle is subjected to a conservative force as seen in the graphs, which of the following are correct.



(A) Particle is in stable equilibrium at point 3 and *b*.

(B) Particle is in neutral equilibrium at point *b* and 2.

(C) No power is delivered by the force to the particle at 1, 3, and *b*.

(D) Particle has maximum kinetic energy at position *b*.

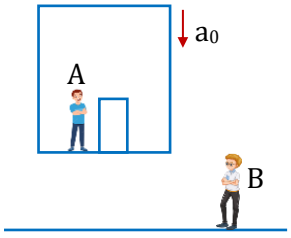
PWE131

PARAGRAPH TYPE QUESTIONS

Work

PARAGRAPH FOR QUESTION NO. 80 TO 83

A block of mass m is kept in an elevator which starts moving downward with an acceleration a_0 as shown in figure. The block is observed by two observers A and B for a time interval t_0.



80. The observer B finds that the work done by gravity is

(A) $\frac{1}{2}mg^2t_0^2$ (B) $-\frac{1}{2}mg^2t_0^2$ (C) $\frac{1}{2}mga_0t_0^2$ (D) $-\frac{1}{2}mga_0t_0^2$

PWE065

81. The observer B finds that work done by normal reaction N is :-

(A) zero (B) $-Na_0t_0^2$ (C) $\frac{Na_0t^2}{2}$ (D) None of these

PWE066

82. According to observer B, the net work done on the block is

(A) $-\frac{1}{2}ma_0t_0^2$ (B) $\frac{1}{2}ma_0^2t_0^2$ (C) $\frac{1}{2}mga_0t_0^2$ (D) $-\frac{1}{2}mga_0t_0^2$

PWE067

83. According to the observer A

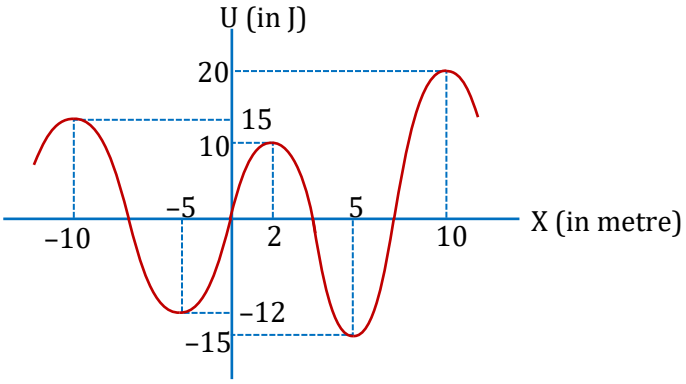
(A) the work done by gravity is zero (B) the work done by normal reaction is zero
(C) the work done by pseudo force is zero (D) all the above

PWE068

Potential Energy

PARAGRAPH FOR QUESTION NO. 84 TO 86

In the figure the variation of potential energy of a particle of mass $m = 2kg$ is represented w.r.t. its x-coordinate. The particle moves under the effect of this conservative force along the x-axis.



84. If the particle is released at the origin then :

(A) It will move towards positive x-axis.
(B) It will move towards negative x-axis.
(C) It will remain stationary at the origin.
(D) Its subsequent motion cannot be decided due to lack of information.

PWE110

85. If the particle is released at $x = 2 + \Delta$ where $\Delta \to 0$ (it is positive) then its maximum speed in subsequent motion will be-

(A) $\sqrt{22}\ m/s$ (B) $\sqrt{25}\ m/s$ (C) $\sqrt{24}\ m/s$ (D) $\sqrt{23}\ m/s$

PWE111

86. $x = -5\ m$ and $x = 10\ m$ positions of the particle are respectively of-

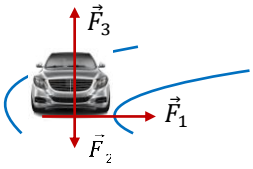
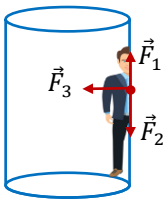
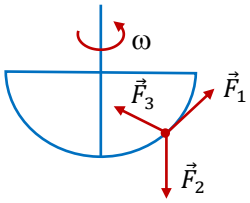
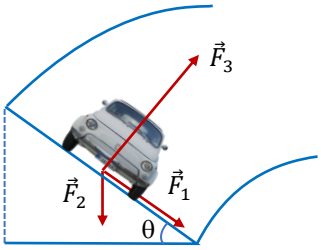
(A) Neutral and stable equilibrium (B) Neutral and unstable equilibrium
(C) Unstable and stable equilibrium (D) Stable and unstable equilibrium.

PWE112

MATRIX MATCH TYPE QUESTION

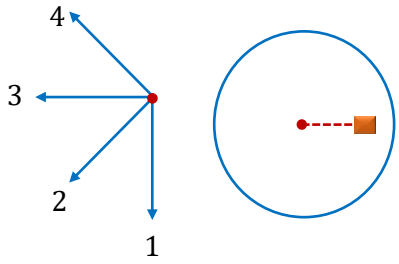
Dynamics of Circular Motion

87. Column-I shows certain situations and column-2 shows information about forces.

Column-I Situation	**Column-II**
(A)  Front view of a car rounding a curve with constant speed.	(P) $\vec{F}_1+\vec{F}_2+\vec{F}_3$ is centripetal force.
(B)  Passengers in a rotor not sliding relative to rotor wall cylindrical rotor is rotating with constant angular velocity about its symmetry axis.	(Q) $\vec{F}_1$ is static friction.
(C)  Particle kept on rough surface of a bowl, no relative motion of particle in bowl, bowl has constant angular velocity	(R) $\vec{F}_1$ can be in direction opposite to that shown in figure.
(D)  Car moving on a banked road with constant speed, no sideways skidding.	(S) $\vec{F}_1+\vec{F}_2=\vec{0}$
	(T) $\vec{F}_1+\vec{F}_2=\vec{0}$

PCR065

88. A block is placed on a horizontal table which can rotate about its axis. The block is placed at a certain distance from centre as shown in figure. Table rotates such that particle does not slide. Select possible direction of net acceleration of block at the instant shown in figure.

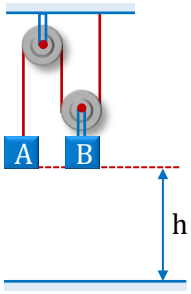


	Column-I		Column-II
(A)	When rotation is clockwise with constant ω	(P)	1
(B)	When rotation is clock wise with decreasing ω	(Q)	2
(C)	When rotation is clockwise with increasing ω	(R)	3
(D)	Just after clockwise rotation begins from rest	(S)	4

PCR068

Work Energy Theorem

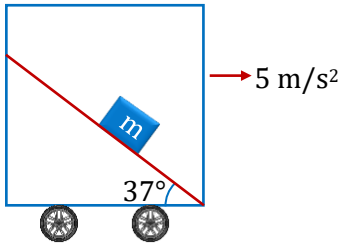
89. In the figure shown are two blocks *A* and *B* of same mass connected with pulley and string to each other. Initially both of them are at a height of $h = 0.5\ m$ from ground. After they are released they move in either direction and one of them strike the ground. For, the interval from releasing to when one of them strike, some physical quantities are in column I and their modulus values in SI units are in column II.



	Column-I		Column-II
(A)	Velocity of *A* immediately before any one of them strike ground.	(P)	1
(B)	Velocity of *B* immediately before any one of them strike ground.	(Q)	2
(C)	Ratio of work done by gravity on *A* to work done by gravity on *B*.	(R)	3
(D)	Acceleration of block *A* before any one of them strike ground.	(S)	4
		(T)	5

PWE087

90. In the given figure block of mass $m = 1/2\ kg$ is stationary with respect to car moving with constant acceleration $a = 5\ m/s^2$. (All surfaces are smooth)

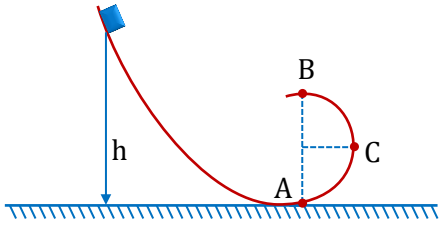


	Column-I		Column-II
(A)	Work done by the normal on the block in first 2 sec is	(P)	Zero
(B)	Work done by the force of gravity on the block in first 2 sec is	(Q)	25 joule
(C)	Network done from the ground frame at $t = 2$sec is	(R)	10 joule
(D)	Work done from the frame of car in first 2 sec is	(S)	5 joule
		(T)	15 joule

PWE098

Motion in Vertical Circle

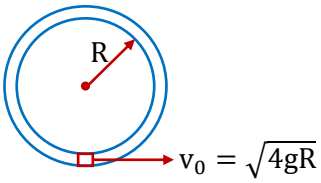
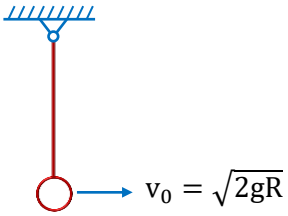
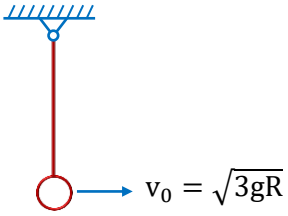
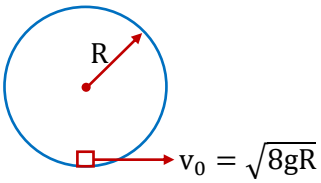
91. A block of mass m is released from top of a smooth track as shown in the figure. The end part of the track is a circle in vertical plane of radius R. N is normal reaction of the track at any point of the track. Match the entries of column I with entries of column–II.



	Column-I		Column-II
(A)	$h = \frac{5}{2} R$	(P)	Net force on the block at C is mg
(B)	$h = \frac{9}{2} R$	(Q)	$N_A - N_B = 6\ mg$
(C)	$h = R$	(R)	Block leaves contact before B
(D)	$h = 2R$	(S)	Block will keep contact with the track is region between A and B.
		(T)	$N_C > mg$

PWE116

92. Column-I shows constrained motion of a particle in vertical plane. The constraint force (tension and normal reaction) are collectively denoted by $\vec{F}$. Match the characteristic shown in column-II with that in column-I. Consider the motion by the time the particle returns to starting point or comes to permanently at rest.

Column-I	**Column-II**
(A) A particle is projected inside a smooth tube, it fits slightly loosely inside it. 	(P) Constraint force may be directed radially outward at an instant during subsequent motion.
(B) A bob constrained on a string. 	(Q) At a particular instant during motion is centripetal acceleration
(C) A bob constrained on a rod. 	(R) Tangential acceleration decreases speed of particle for entire motion.
(D) A small block is projected inside a spherical ball along the inner surface. 	(S) The particle completes circular path

PWE121

Power

93. A block of mass 1.0 *kg* is pulled up on a rough slope of inclination 37° with the horizontal. The coefficient of kinetic friction between the block and the slope is 0.25. The block moves with acceleration 2.0 m/s^2. After 5.0 *s* from the instant the block starts, which of the following statements is/are true. (Power of any force is given by $P = \vec{F} \cdot \vec{V}$)

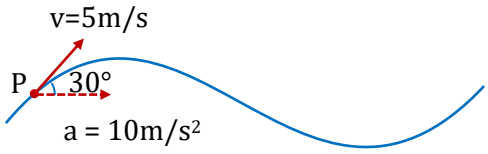
	Column-I		**Column-II**
(A)	Power delivered by the pulling force	(P)	20 *W*
(B)	Power delivered by the weight of the block	(Q)	–20 *W*
(C)	Magnitude of power delivered by the friction between the slope and the block	(R)	–60 *W*
(D)	Power delivered by the contact force between the slope and the block	(S)	100 *W*
		(T)	80 *W*

PWE130

MISCELLANEOUS QUESTION

PARAGRAPH FOR QUESTION NOS. 94 AND 95

A particle is moving on given curve path. At certain instant its velocity and acceleration shown in figure:



94. Rate of change of speed of particle at *P* is

(A) $5\sqrt{3}\,m/s^2$ (B) 10 m/s^2 (C) 5 m/s^2 (D) None of these

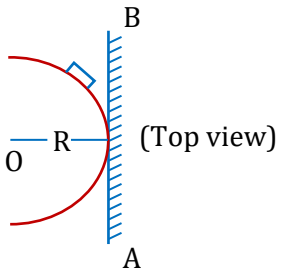
PCR105

95. Radius of curvature at point *P* is :

(A) $5\sqrt{3}\,m$ (B) 10 *m* (C) 5 *m* (D) None of these

PCR106

96. As shown in figure '*AB*' represents an infinite wall tangential to a horizontal semi circular track. 'O' is a point source of light on the ground at the centre of the circle. A block moves along the circular track with speed '*v*' starting from the point where the wall touches the circle. If the velocity and acceleration of shadow along the length of the wall is respectively '*V*' and '*a*' then;

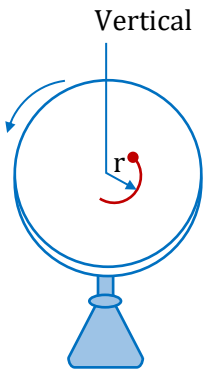


(A) $V = v\cos\dfrac{vt}{R}$ (B) $V = v\sec^2\left(\dfrac{vt}{R}\right)$

(C) $a = \dfrac{v^2}{R}\sec^2\left(\dfrac{vt}{R}\right)\tan\left(\dfrac{vt}{R}\right)$ (D) $a = \dfrac{2v^2}{R}\sec^2\left(\dfrac{vt}{R}\right)\tan\left(\dfrac{vt}{R}\right)$

PCR107

97. A small coin of mass $80g$ is placed on the horizontal surface of a rotating disc. The disc starts from rest and is given a constant angular acceleration $\alpha = 2 rad/s^2$. The coefficient of static friction between the coin and the disc is $\mu_s = 3/4$ and coefficient of kinetic friction is $\mu_k = 0.5$. The coin is placed at a distance $r = 1m$ from the centre of the disc. The magnitude of the resultant force on the coin exerted by the disc just before it starts slipping on the disc is:

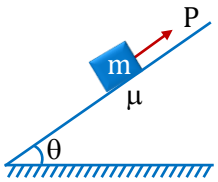


(A) 0.2 N (B) 0.3 N

(C) 0.4 N (D) 1 N

CR0156

98. A block of mass m is being pulled up the rough inclined by an agent delivering constant power P. The coefficient of friction between the block and the inclined is μ. The maximum speed of the block during the course of ascent is:

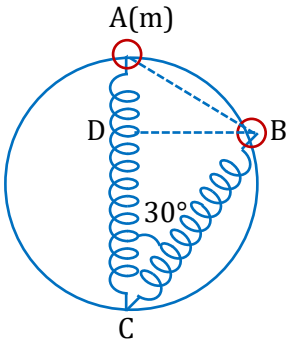


(A) $v = \dfrac{P}{mg\sin\theta + \mu mg\cos\theta}$ (B) $v = \dfrac{P}{mg\sin\theta - \mu mg\cos\theta}$

(C) $v = \dfrac{2P}{mg\sin\theta - \mu mg\cos\theta}$ (D) $v = \dfrac{3P}{mg\sin\theta - \mu mg\cos\theta}$

WE0188

99. A ring 'A' of mass 'm' is attached to a stretched spring of force constant K, which is fixed at C on a smooth vertical circular track of radius R. Points A and C are diametrically opposite. When the ring slips from rest on the track to point B, making an angle of 30° with AC. ($\angle ACB = 30°$) spring becomes unstretched. Find the velocity of the ring at B.



(A) $\left[\dfrac{KR^2}{2m}(2-\sqrt{3})^2 + gR\sqrt{3}\right]^{1/2}$ (B) $\left[\dfrac{KR^2}{m}(2-\sqrt{3})^2 + gR\right]^{1/2}$

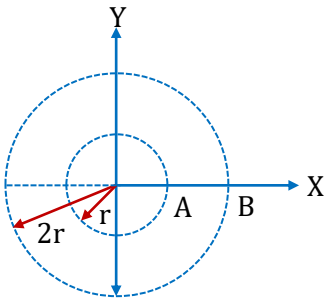
(C) $\left[\dfrac{2KR^2}{m}(2-\sqrt{3})^2 + gR\sqrt{3}\right]^{1/2}$ (D) $\left[\dfrac{KR^2}{2m}(\sqrt{2}-1)^2 + gR\right]^{1/2}$

WE0228

EXERCISE - S

Kinematics of Circular Motion

1. Two particles A and B are moving in a horizontal plane anticlockwise on two different concentric circles with different constant angular velocities 2ω and ω respectively. Find the relative velocity (in m/s) of B w.r.t. A after time $t = \pi/\omega$. They both start at the position as shown in figure.
(Take $\omega = 3$ rad/sec, $r = 2m$)



PCR025

2. A disk rotates about its central axis starting from rest and accelerates with constant angular acceleration. At one instant it is rotating at 12 rad/s and after 80 radian of more angular displacement, its angular speed becomes 28 rad/s. How much time (seconds) does the disk takes to complete the mentioned angular displacement of 80 radians.

PCR033

3. A particle is moving along a circular path of radius 5 m with a uniform speed 5 ms^{-1}. What is the magnitude of average acceleration during the interval in which particle completes half revolution?

PCR034

4. A particle is revolving in a circle of radius $1m$ with an angular speed of 12 rad/s. At $t = 0$, it was subjected to a constant angular acceleration α and its angular speed increased to $(480/\pi)$ rotation per minute (rpm) in 2 sec. Particle then continues to move with attained speed. Calculate:
(i) Angular acceleration of the particle.
(ii) Tangential velocity of the particle as a function of time.
(iii) Acceleration of the particle at $t = 0.5$ second and at $t = 3$ second
(iv) Angular displacement at $t = 3$ second.

PCR035

5. A particle is projected with a speed U at an angle θ with the horizontal what is the radius of curvature of the parabola traced out by the projectile at a point where the particle velocity makes an angle $\theta/2$ with the horizontal ?

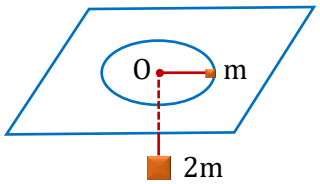
PCR039

6. A particle is travelling in a circular path of radius $4m$. At a certain instant the particle is moving at $20m/s$ and its acceleration is at an angle of 37° from the direction to the centre of the circle as seen from the particle:
(i) At what rate is the speed of the particle increasing?
(ii) What is the magnitude of the acceleration?

PCR071

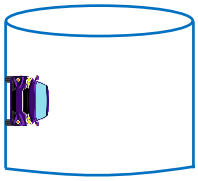
Dynamics of Circular Motion

7. A mass m rotating freely in a horizontal circle of radius 1 m on a frictionless smooth table supports a stationary mass $2m$, attached to the other end of the string passing through smooth hole O in table, hanging vertically. Find the angular velocity of rotation.



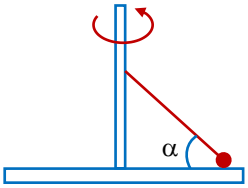
PCR044

8. You are shown a photo of a car driven on a vertical inside wall of a huge cylinder with a radius of 50 m. The coefficient of static friction between the car tires and the cylinder is m_s = 0.8. The minimum speed in (m/s), at which the car can be driven like that is $5x$. Find x.



PCR045

9. A circular platform rotates around a vertical axis with angular velocity ω = 10 rad/s. On the platform is a ball of mass 1 kg, attached to the long axis of the platform by a thin rod of length 10 cm (α = 30°). Find normal force exerted by the ball on the platform (in newton). Friction is absent.



PCR048

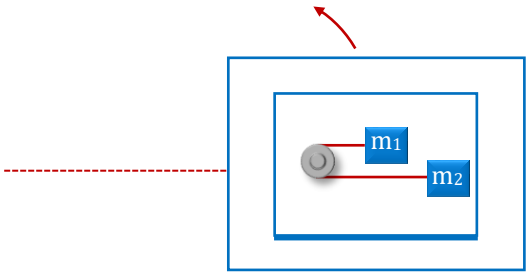
10. A stone of mass 0.25 kg tied to the end of a string is whirled round in a circle of radius 1.5 m with a speed of 40 rev/min in a horizontal plane. What is the tension in the string? What is the maximum speed with which the stone can be whirled around if the string can withstand a maximum tension of 200 N ?

PCR049

11. A ceiling fan has a diameter (of the circle through the outer edges of the three blades) of 120 cm and rpm 1500 at full speed. Consider a particle of mass 1g sticking at the outer end of a blade. What is the net force on it, when the fan runs at full speed ? Who exerts this force on the particle ? How much force does the particle exert on the blade in the plane of motion ?

PCR050

12. A table with smooth horizontal surface is placed in a cabin which moves in a circle of a large radius R (figure). A smooth pulley of small radius is fastened to the table. Two masses m and $2m$ placed on the table are connected through a string going over the pulley. Initially the masses are held by a person with the strings along the outward radius and then the system is released from rest (with respect to the cabin). Find the magnitude of the initial acceleration of the masses as seen from the cabin and the tension in the string.



PCR053

13. A cyclist speeding at 18 km/h on a level road takes a sharp circular turn of radius 3 m without reducing the speed. The co-efficient of static-friction between the tyres and the road is 0.1. Will the cyclist slip while taking the turn?

PCR054

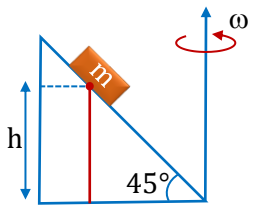
14. A cyclist moving with a speed of 4.9 m/s on a level road can take a sharp circular turn of radius 4 m, then find the minimum value of coefficient of friction between the cycle tyres and road. (g = 9.8 m/s^2)

PCR055

15. When the road is dry and coefficient of friction is μ, the maximum speed of a car in a circular path is 10 ms^{-1}. If the road becomes wet and coefficient of friction become $\frac{\mu}{2}$, what is the maximum speed permitted?

PCR056

16. A block of mass m is sitting on a rotating smooth wedge. The wedge rotates with constant angular velocity ω around the axis shown in figure. Calculate the value of w (in rad/s) such that the block stays at constant height h = 2.5 m.



PCR057

17. For traffic moving at 60 km/hr, if the radius of the curve is 0.1 km, what is the correct angle of banking of the road ? (g = 10 m/s^2)

PCR058

18. When an airplane is driven forward by its engines, the air flowing over its wings generates an upward force called lift. When this lift balances the weight of the plane, it can fly horizontally. A plane banks, that is, tilts its wings to the side, to turn, thus using the lift force another way. Note that it must then increase speed to generate more lift if it wants to stay at the same altitude while turning.

A jet airliner remains at constant altitude at a constant speed of v = 720 km/hr while banking at with respect to the horizon to turn in a circle. The radius (in km) of the circle in which the plane moves is given by R. Find the value of $\sqrt{R}$.

PCR059

19. A mosquito is sitting on an L.P. record of a gramophone disc rotating on a turn table at $33\frac{1}{3}$ revolution per minute. The distance of the mosquito from the center of the disc is 10 cm. Find minimum friction coefficient between the record and the mosquito.

Take g = 10 m/s^2.

PCR061

20. A motorcyclist wants to drive on the vertical surface of wooden 'well' of radius 5 m, in horizontal plane with speed of $5\sqrt{5}$ m/s. Find the minimum value of coefficient of friction between the tyres and the wall of the well . (take $g = 10\ m/s^2$)

PCR062

21. A train has to negotiate a curve of radius 400 m. By how much height should the outer rail be raised with respect to inner rail for a speed of 48 km/hr ? The distance between the rails is 1 m :

PCR064

22. A turn of radius 20 m is banked for the vehicles going at a speed of 36 km/h. If the coefficient of static friction between the road and the tyre is 0.4, what are the possible speeds of a vehicle so that it neither slips down nor skids up?

Between $\sqrt{\frac{50}{3}\times\frac{18}{5}}$ = 14.7 km/h and 54 km/hr

PCR066

23. A circular racetrack of radius 300 m is banked at an angle of 15°. If the coefficient of friction between the wheels of a race car and the road is 0.2.

(a) What is the optimum speed of the race car to avoid wear and tear on its tires?

(b) What is the maximum permissible speed to avoid slipping?

PCR067

24. A block of mass m = 20 kg is kept at a distance R = 1m from central axis of rotation of a round turn table (A table whose surface can rotate about central axis). Table starts from rest and rotates with constant angular acceleration, α = 3 rad/sec^2. The friction coefficient between block and table is μ = 0.5. At time $t = \frac{x}{3}$ sec from starting of motion (i.e. t = 0 sec) the block is just about to slip. Find the value of x.

PCR073

25. A car goes on a horizontal circular road of radius R, the speed increasing at constant rate $\frac{dv}{dt} = a$. The friction coefficient between the road and the tyre is μ. Find the speed at which the car will skid.

PCR075

26. A motorcycle has to move with a constant speed on an overbridge which is in the form of a circular are of radius R and has a total length L. Suppose the motorcycle starts from the highest point.

(a) What can its maximum velocity be for which the contact with the road is not broken at the highest point ?

(b) If the motorcycle goes at speed $1/\sqrt{2}$ times the maximum found in part (a), where will it lose the contact with the road?

(c) What maximum uniform speed can it maintain on the bridge if it does not lose contact anywhere on the bridge?

PCR078

27. A block of mass m is kept on a horizontal ruler. The friction coefficient between the ruler and the block is μ. The ruler is fixed at one end and the block is at a distance L from the fixed end. The ruler is rotated about the fixed end in the horizontal plane through the fixed end. (a) What can the maximum angular speed be for which the block does not slip? (b) If the angular speed of the ruler is uniformly increased from zero at an angular acceleration α, at what angular speed will the block slip?

PCR079

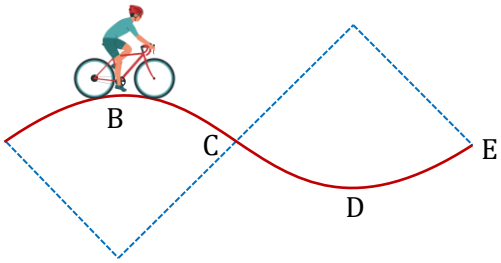
28. A track consists of two circular parts ABC and CDE of equal radius 100 m and joined smoothly as shown in figure. Each part subtends a rights angle at its centre. A cycle weighing 100 kg together with the rider travels at a constant speed of 18 km/h on the track.

(a) Find the normal contact force by the road on the cycle when it is at B and at D.

(b) Find the force of friction exerted by the track on the tyres when the cycle is at B, C, and D.

(c) Find the normal force between the cycle crosses C.

(d) What should be the minimum friction coefficient between the road and the tyre, which will ensure that the cyclist can move with constant speed? (Take $g = 10\ m/s^2$)



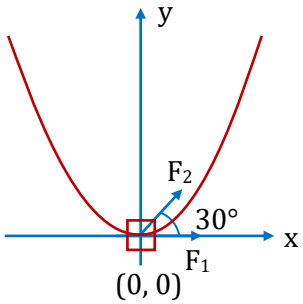
PCR080

29. A table with smooth horizontal surface is turning at an angular speed ω about its axis. A groove is made on the surface along a radius and a particle is gently placed inside the groove at a distance a from the centre. Find the speed of the particle as its distance from the centre becomes L.

PCR082

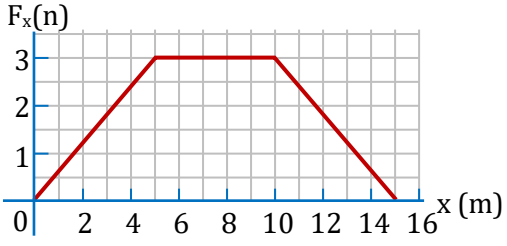
Work

30. A sleeve of mass 2 kg at origin can move on wire of parabolic shape $x^2 = 4y$. Two forces $F_1 = 6N$ and $F_2 = 8N$ are applied on the sleeve. F_1 is constant and is in x-direction. F_2 is constant in direction and magnitude. Body is displaced from origin to $x = 4$, then net work done by F_1 and F_2 is



PWE069

31. A particle is subject to a force F_x that varies with position as in figure. Find the work done by the force on the body as it moves (a) from $x = 0$ to $x = 5.00\ m$, (b) from $x = 5.00\ m$ to $x = 10.0\ m$, and (c) from $x = 10.0\ m$ to $x = 15.0\ m$. (d) What is the total work done by the force over the distance $x = 0$ to $x = 15.0\ m$?



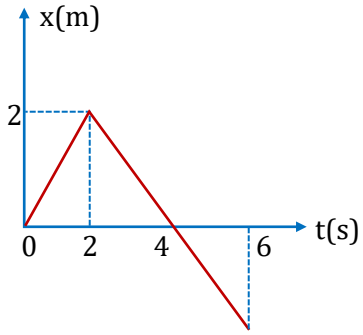
PWE074

32. A spring, which is initially in its unstretched condition, is first stretched by a length x and then again by a further length x. The work done in the first case is W_1 and in the second case is W_2. Find $\frac{W_2}{W_1}$.

PWE075

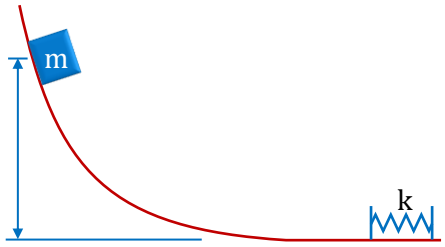
Work Energy Theorem

33. Position-time graph of a particle of mass 2 kg is shown in figure. Total work done on the particle from $t = 0$ to $t = 4s$ is



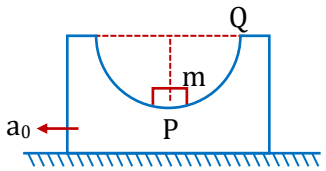
PWE081

34. A mass m slides from rest at height h down a smooth curved surface which becomes horizontal at zero height (see figure). A spring is fixed horizontally on the level part of the surface. The spring constant is k N/m. When the mass encounters the spring it compresses it by an amount $x = h/10$. If $m = 1$ kg, $h = 5m$ then find k /100.



PWE083

35. A small block of mass m is lying at rest at point P of a wedge having a smooth semi-circular track of radius R. The minimum value of horizontal acceleration a_0 (in m/s^2) of wedge so that mass can just reach the point Q, is



PWE085

Potential Energy

36. A uniform chain of mass m and length l overhangs a table with its two third part on the table. Find the work to be done by a person to put the hanging part back on the table.

PWE100

37. A uniform chain of length L and mass M overhangs a horizontal table with its two third part on the table. The friction coefficient between the table and the chain is μ. Find the work done by the friction during the period the chain slips off the table.

PWE101

Power

38. A 4 kg particle moves along the X-axis. It's position x varies with time according to $x(t) = t + 2t^3$, where x is in m and t is in seconds. Compute:

(i) The kinetic energy at time t.

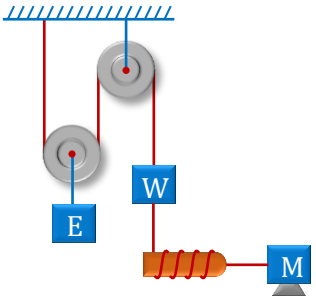
(ii) The force acting on the particle at time t.

(iii) The power delivered to the particle at time t.

(iv) The work done on the particle from $t = 0$ to $t = 2$ seconds.

PWE125

39. The elevator E has a mass of 3000 kg when fully loaded and is connected as shown to a counterweight W of mass 1000 kg. Determine the power in kilowatts delivered by the motor:



(a) when the elevator is moving down at a constant speed of 3 m/s,

(b) when it has an upward velocity of 3 m/s and a deceleration of 0.5 m/s^2.

PWE126

40. Power applied to a particle varies with time as $P = (3t^2 - 2t + 1)$ watt, where t is in second. Find the change in its kinetic energy between time $t = 2$ s and $t = 4$ s.

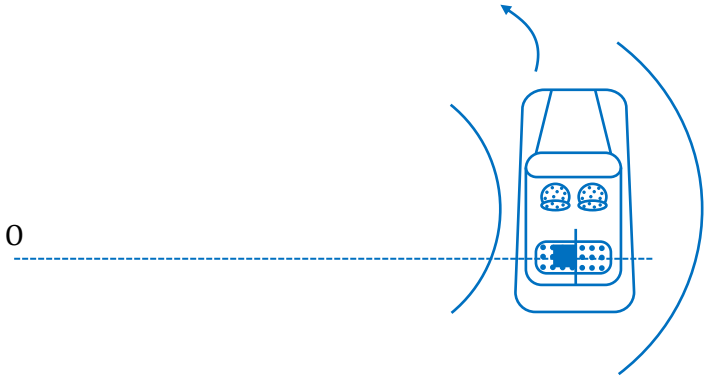
PWE127

MISCELLANEOUS QUESTION

41. A block of mass m moves on a horizontal circle against the wall of a cylindrical room of radius R. The floor of the room on which the block moves is smooth but the friction coefficient between the wall and the block is μ. The block is given and initial speed v_0. As a function of the speed v write (a) the normal force by the wall on the block, (b) the frictional force by the wall and (c) the tangential acceleration of the block. (d) Integrate the tangential acceleration $\left(\frac{dv}{dt} = v\frac{dv}{ds}\right)$ to obtain the speed of the block after one revolution.

PCR108

42. A car moving at a speed of 36 km/hr is taking a turn on a circular road of radius 50m. A small wooden plate is kept on the seat with its plane perpendicular to the radius of the circular road in figure. A small block of mass 100g is kept on the seat which rests against the plate. The friction coefficient between the block and the plate is $\mu = 0.58$. (a) Find the normal contact force exerted by the plate on the block. (b) The plate is slowly turned so that the angle between the normal to the plate and the radius of the road slowly increases. Find the angle at which the block will just start sliding on the plate.



PCR109

43. A uniform rod of mass m length L is sliding along its length on a horizontal table whose top is partly smooth & rest rough with friction coefficient μ. If the rod after moving through smooth part, enters the rough with velocity v_0.

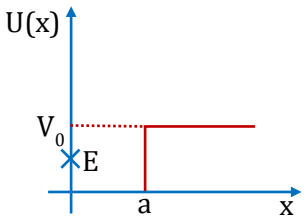
(i) What will be the magnitude of the friction force when its x length ($< L$) lies in the rough part during sliding.

(ii) Determine the minimum velocity v_0 with which it must enter so that it lies completely in rough region before coming to rest.

(iii) If the velocity is double the minimum velocity as calculated in part (a) then what distance does its front end A would have travelled in rough region before rod comes to rest.

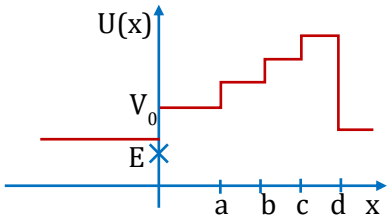
PWE151

44. The given graph is a potential energy function in one dimension. The total energy of particle is indicated by cross on the ordinate axis. The graph of figure-1 is given as an example. From the figure-1, it can be interpreted that for the given total energy indicated by cross on the ordinate axis the particle cannot be found in the Region : $x > a$. Now, for the following potential functions in one dimensions, specify the regions, in which the particle cannot be found for the energy marked as E on graphs. Give your answer in the blocks shown.

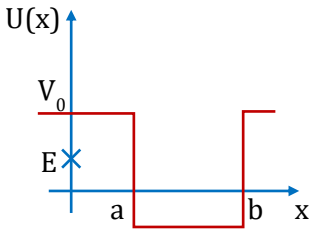


(Figure -1)

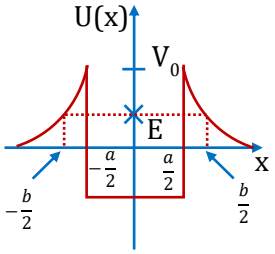
(Graph-1)



(Graph-2)

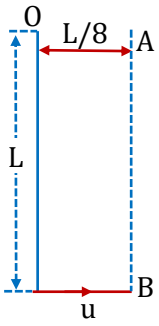


(Graph-3)



PWE152

45. A particle is suspended vertically from a point *O* by an inextensible massless string of length *L*. A vertical line *AB* is at a distance $\frac{L}{8}$ from *O* as shown in figure. The object is given a horizontal velocity *u*. At some point, its motion ceases to be circular and eventually the object passes through the line *AB*. At the instant of crossing *AB*, its velocity is horizontal. Find *u*.



PWE153

EXERCISE - JEE (Main) PYQ

1. A 60 *HP* electric motor lifts an elevator having a maximum total load capacity of 2000 *kg*. If the frictional force on the elevator is 4000 *N*, the speed of the elevator at full load is close to:
(1 *HP* = 746 *W*, g = 10 ms^{-2}) **[JEE (Main) 2020]**
(1) 1.7 ms^{-1} (2) 2.0 ms^{-1} (3) 1.9 ms^{-1} (4) 1.5 ms^{-1}

PWE023

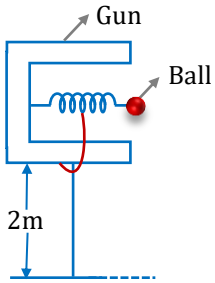
2. A small bob tied at one end of a thin string of length 1*m* is describing a vertical circle so that the maximum and minimum tension in the string are in the ratio 5 : 1. The velocity of the bob at the highest position is ____ m/s. (Take g = 10 m/s^2) **[JEE (Main) 2021]**

PWE024

3. A ball of mass 4 *kg*, moving with a velocity of 10 ms^{-1}, collides with a spring of length 8 *m* and force constant 100 Nm^{-1}. The length of the compressed spring is *x m*. The value of *x*, to the nearest integer, is____. **[JEE (Main) 2021]**

PWE025

4. In a spring gun having spring constant 100 N/m a small ball '*B*' of mass 100 *g* is put in its barrel (as shown in figure) by compressing the spring through 0.05 *m*. There should be a box placed at a distance '*d*' on the ground so that the ball falls in it. If the ball leaves the gun horizontally at a height of 2 *m* above the ground. The value of d is ___ *m*. (g = 10 m/s^2) **[JEE (Main) 2021]**



PWE026

5. If the Kinetic energy of a moving body becomes four times its initial Kinetic energy, then the percentage change in its momentum will be : **[JEE (Main) 2021]**
(1) 100% (2) 200% (3) 300% (4) 400%

PWE027

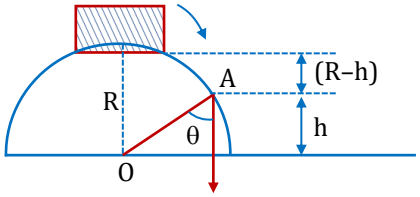
6. A porter lifts a heavy suitcase of mass 80 *kg* and at the destination lowers it down by a distance of 80 *cm* with a constant velocity. Calculate the work done by the porter in lowering the suitcase.
(Take g = 9.8 ms^{-2}) **[JEE (Main) 2021]**
(1) –62720.0 *J* (2) –627.2 *J* (3) +627.2 *J* (4) 784.0 *J*

PWE028

7. A boy is rolling a 0.5 *kg* ball on the frictionless floor with the speed of 20 ms^{-1}. The ball gets deflected by an obstacle on the way. After deflection it moves with 5% of its initial kinetic energy. What is the speed of the ball now ? **[JEE (Main) 2021]**
(1) 19.0 ms^{-1} (2) 4.47 ms^{-1} (3) 14.41 ms^{-1} (4) 1.00 ms^{-1}

PWE029

8. A small block slides down from the top of hemisphere of radius $R = 3\ m$ as shown in the figure. The height 'h' at which the block will lose contact with the surface of the sphere is ___m.
(Assume there is no friction between the block and the hemisphere) **[JEE (Main) 2021]**



PWE030

9. A uniform chain of length 3 meter and mass 3 kg overhangs a smooth table with 2 meter lying on the table. If k is the kinetic energy of the chain in joule as it completely slips off the table, then the value of k is _____ (Take $g = 10\ m/s^2$) **[JEE (Main) 2021]**

PWE031

10. Two persons A and B perform same amount of work in moving a body through a certain distance d with application of forces acting at angle 45° and 60° with the direction of displacement respectively. The ratio of force applied by person A to the force applied by person B is $\frac{1}{\sqrt{x}}$. The value of x is ..... **[JEE (Main) 2021]**

PWE032

11. A body of mass 'm' dropped from a height 'h' reaches the ground with a speed of $0.8\sqrt{gh}$. The value of work done by the air-friction is : **[JEE (Main) 2021]**

(1) $-0.68\ mgh$ (2) mgh (3) $1.64\ mgh$ (4) $0.64\ mgh$

PWE033

12. **Statement I :** A cyclist is moving on an unbanked road with a speed of 7 kmh^{-1} and takes a sharp circular turn along a path of radius of $2m$ without reducing the speed. The static friction coefficient is 0.2. The cyclist will not slip and pass the curve ($g = 9.8\ m/s^2$)
Statement II : If the road is banked at an angle of 45°, cyclist can cross the curve of $2m$ radius with the speed of 18.5 kmh^{-1} without slipping.
In the light of the above statements, choose the correct answer from the options given below. **[JEE (Main) 2021]**

(1) Statement I is incorrect and statement II is correct
(2) Statement I is correct and statement II is incorrect
(3) Both statement I and statement II are false
(4) Both statement I and statement II are true

PCR009

13. The angular speed of truck wheel is increased from 900 rpm to 2460 rpm in 26 seconds. The number of revolutions by the truck engine during this time is _____.
(Assuming the acceleration to be uniform). **[JEE (Main) 2021]**

PCR010

14. The normal reaction 'N' for a vehicle of 800 kg mass, negotiating a turn on a 30° banked road at maximum possible speed without skidding is _____ $\times 10^3\ kg\ m/s^2$. **[JEE (Main) 2021]**
[cos 30° = 0.87, $\mu_s = 0.2$]

(1) 10.2 (2) 7.2 (3) 12.4 (4) 6.96

PCR011

15. A particle of mass m is suspended from a ceiling through a string of length L. The particle moves in a horizontal circle of radius r such that $r = \frac{L}{\sqrt{2}}$. The speed of particle will be: **[JEE (Main) 2021]**

(1) $\sqrt{rg}$ (2) $\sqrt{2rg}$ (3) $2\sqrt{rg}$ (4) $\sqrt{\frac{rg}{2}}$

PCR012

16. A huge circular arc of length 4.4 ly subtends an angle '4s' at the centre of the circle. How long it would take for a body to complete 4 revolution if its speed is 8 AU per second ?

Given : 1 $ly = 9.46 \times 10^{15}\ m$

$1\ AU = 1.5 \times 10^{11}\ m$ **[JEE (Main) 2021]**

(1) $4.1 \times 10^{8}\ s$ (2) 4.5×10^{10} s (3) $3.5 \times 10^{6}\ s$ (4) 7.2×10^{8} s

PCR013

17. A boy ties a stone of mass 100 g to the end of a 2 m long string and whirls it around in a horizontal plane. The string can withstand the maximum tension of 80 N. If the maximum speed with which the stone can revolve is $\frac{K}{\pi} rev./\min$. The value of K is :

(Assume the string is massless and unstretchable) **[JEE (Main) 2022]**

(1) 400 (2) 300 (3) 600 (4) 800

PCR014

18. Potential energy as a function of r is given by $U = \frac{A}{r^{10}} - \frac{B}{r^{5}}$, where r is the interatomic distance, A and B are positive constants. The equilibrium distance between the two atoms will be : **[JEE (Main) 2022]**

(1) $\left(\frac{A}{B}\right)^{\frac{1}{5}}$ (2) $\left(\frac{B}{A}\right)^{\frac{1}{5}}$ (3) $\left(\frac{2A}{B}\right)^{\frac{1}{5}}$ (4) $\left(\frac{B}{2A}\right)^{\frac{1}{5}}$

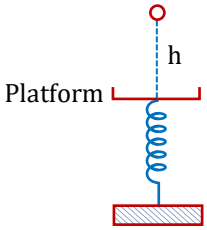
PWE034

19. A particle experiences a variable force $\vec{F} = (4x\hat{\imath} + 3y^2\hat{\jmath})$ in a horizontal x-y plane. Assume distance in meters and force in newton. If the particle moves from point (1, 2) to point (2, 3) in the x-y plane, the Kinetic Energy changes by **[JEE (Main) 2022]**

(1) 50.0 J (2) 12.5 J (3) 25.0 J (4) 0 J

PWE035

20. A ball of mass 100 g is dropped from a height h = 10 cm on a platform fixed at the top of vertical spring (as shown in figure). The ball stays on the platform and the platform is depressed by a distance $\frac{h}{2}$. The spring constant is _____ Nm^{-1}. (Use g = 10 ms^{-2}) **[JEE (Main) 2022]**



PWE036

21. A body of mass 200g is tied to a spring of spring constant 12.5 N/m, while the other end of spring is fixed at point O. If the body moves about O in a circular path on a smooth horizontal surface with constant angular speed 5 rad/s, then the ratio of extension in the spring to its natural length will be:

[JEE (Main) 2023]

PCR083

(1) 1 : 2 (2) 1 : 1 (3) 2 : 3 (4) 2 : 5

22. A car is moving on a circular path of radius 600 m such that the magnitudes of the tangential acceleration and centripetal acceleration are equal. The time taken by the car to complete first quarter of revolution, if it is moving with an initial speed of 54 km/hr is $t(1 - e^{-\pi/2})$s. The value of t is _____.

[JEE (Main) 2023]

PCR084

23. A body of mass 1 kg begins to move under the action of a time dependent force $\vec{F} = \left(t\hat{i} + 3t^2\hat{j}\right)N$. where $\hat{i}$ and $\hat{j}$ are the unit vectors along x and y axis. The power developed by above force, at the time t = 2s. will be _____W.

[JEE (Main) 2023]

PWE132

24. Identify the correct statements from the following:

(A) Work done by a man in lifting a bucket out of a well by means of a rope tied to the bucket is negative.

(B) Work done by gravitational force in lifting a bucket out of a well by a rope tied to the bucket is negative.

(C) Work done by friction on a body sliding down an inclined plane is positive.

(D) Work done by an applied force on a body moving on a rough horizontal plane with uniform velocity in zero.

(E) Work done by the air resistance on an oscillating pendulum in negative.

Choose the correct answer from the options given below:

(1) B and E only (2) A and C only (3) B, D and E only (4) B and D only

[JEE (Main) 2023]

PWE133

EXERCISE - JEE (Advanced) PYQ

1. The work done on a particle of mass m by a force, $K\left[\frac{x}{(x^2+y^2)^{3/2}}\hat{\imath}+\frac{y}{(x^2+y^2)^{3/2}}\hat{\jmath}\right]$ (K being a constant of appropriate dimensions), when the particle is taken from the point $(a, 0)$ to the point $(0, a)$ along a circular path of radius a about the origin in the x-y plane is :-

[JEE (Advanced) 2013]

(A) $\frac{2K\pi}{a}$ (B) $\frac{K\pi}{a}$ (C) $\frac{K\pi}{2a}$ (D) 0

PWE051

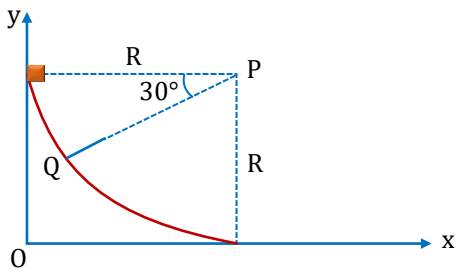
2. A particle of mass 0.2 kg is moving in one dimension under a force that delivers a constant power $0.5W$ to the particle. If the initial speed (in ms^{-1}) of the particle is zero, the speed (in ms^{-1}) after 5 s is. **[JEE (Advanced) 2013]**

PWE052

PARAGRAPH FOR QUESTIONS 3 AND 4

A small block of mass 1 kg is released from rest at the top of a rough track. 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 below, is 150 J.

(Take the acceleration due to gravity, $g = 10\ m\ s^{-2}$) **[JEE (Advanced) 2013]**



3. 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

PWE053

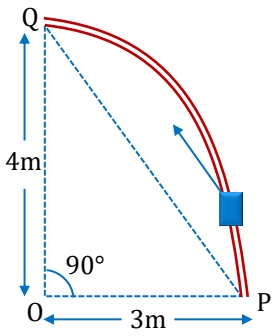
4. The speed of the block when it reaches the point Q is

(A) 5 ms^{-1} (B) 10 ms^{-1} (C) $10\sqrt{3}\ ms^{-1}$ (D) 20 ms^{-1}

PWE054

5. Consider an elliptically shaped rail PQ in the vertical plane with $OP = 3\ m$ and $OQ = 4m$. A block of mass $1\ kg$ is pulled along the rail from P to Q with a force of $18\ N$, which is always parallel to line PQ (see the figure given). Assuming no frictional losses, the kinetic energy of the block when it reaches Q is $(n \times 10)$ Joules. The value of n is (Take acceleration due to gravity = $10\ ms^{-2}$)

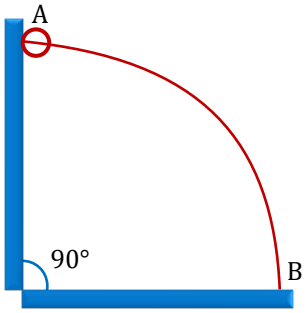
[JEE (Advanced) 2014]



PWE055

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

[JEE (Advanced) 2014]



(A) Always radially outwards

(B) Always radially inwards

(C) Radially outwards initially and radially inwards later.

(D) Radially inwards initially and radially outwards later.

PWE056

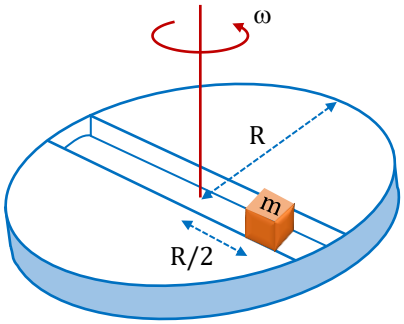
PARAGRAPH FOR QUESTION NO. 7 AND 8

A frame of reference that is accelerated with respect to an inertial frame of reference is called a non-inertial frame of reference. A coordinate system fixed on a circular disc rotating about a fixed axis with a constant angular velocity ω is an example of a non-inertial frame of reference. The relationship between the force $\vec{F}_{rot}$ experienced by a particle of mass m moving on the rotating disc and the force $\vec{F}_{in}$ experienced by the particle in an inertial frame of reference is

$$\vec{F}_{rot} = \vec{F}_{in} + 2m(\vec{v}_{rot} \times \vec{\omega}) + m(\vec{\omega} \times \vec{r}) \times \vec{\omega},$$

where $\vec{v}_{rot}$ is the velocity of the particle in the rotating frame of reference and o$\vec{r}$ is the position vector of the particle with respect to the centre of the disc.

Now consider a smooth slot along a diameter of a disc of radius R rotating counter-clockwise with a constant angular speed ω about its vertical axis through its center. We assign a coordinate system with the origin at the centre of the disc, the x-axis along the slot, the y-axis perpendicular to the slot and the z-axis along the rotation axis $(\vec{\omega} = \omega\hat{k})$. A small block of mass m is gently placed in the slot at $\vec{r} = (r/2)\hat{\imath}$ at $t = 0$ and is constrained to move only along the slot. **[JEE (Advanced) 2016]**



7. The distance r of the block at time t is :

(A) $\frac{R}{4}\left(e^{2\omega t} + e^{-2\omega t}\right)$ (B) $\frac{R}{2}\cos 2\,\omega t$ (C) $\frac{R}{2}\cos\omega\, t$ (D) $\frac{R}{4}\left(e^{\omega t} + e^{-\omega t}\right)$

PCR019

8. The net reaction of the disc on the block is :

(A) $-m\omega^2 R\cos\omega\, t\hat{\jmath} - mg\hat{k}$ (B) $m\omega^2 R\sin\omega\, t\hat{\jmath} - mg\hat{k}$

(C) $\frac{1}{2}m\omega^2\, R\left(e^{\omega t} - e^{-\omega t}\right)\hat{\jmath} + mg\hat{k}$ (D) $\frac{1}{2}m\omega^2\, R\left(e^{2\omega t} - e^{-2\omega t}\right)\hat{\jmath} + mg\hat{k}$

PCR020

9. 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. Its kinetic energy K changes with time as $dK/dt = \gamma t$, where γ is a positive constant of appropriate dimensions. Which of the following statements is (are) true? **[JEE (Advanced) 2018]**

(A) The force applied on the particle is constant

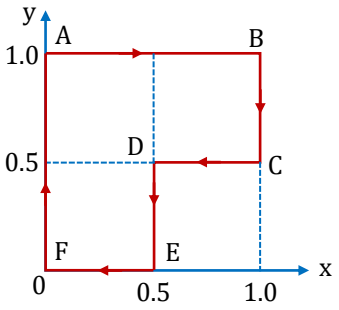
(B) The speed of the particle is proportional to time

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

(D) The force is conservative

PWE057

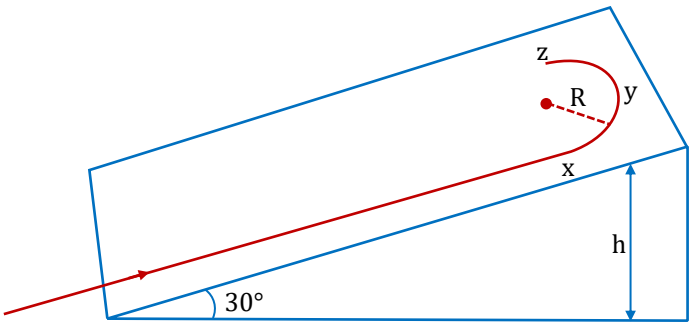
10. A particle is moved along a path AB-BC-CD-DE-EF-FA, as shown in figure, in presence of a force $\vec{F} = (\alpha y\hat{\imath} + 2\alpha x\hat{\jmath})N$, where x and y are in meter and $\alpha = -1\ N/m^{-1}$. The work done on the particle by this force $\vec{F}$ will be ___ Joule. **[JEE (Advanced) 2019]**



PWE058

11. A student skates up a ramp that makes an angle 30° with the horizontal. He/she starts (as shown in the figure) at the bottom of the ramp with speed v_0 and wants to turn around over a semicircular path *xyz* of radius *R* during which he/she reaches a maximum height *h* (at point *y*) from the ground as shown in the figure. Assume that the energy loss is negligible and the force required for this turn at the highest point is provided by his/her weight only. Then (*g* is the acceleration due to gravity)

[JEE (Advanced) 2020]



(A) $v_0^2 - 2gh = \frac{1}{2}gR$

(B) $v_0^2 - 2gh = \frac{\sqrt{3}}{2}gR$

(C) the centripetal force required at points *x* and *z* is zero

(D) the centripetal force required is maximum at points *x* and *z*

PWE059

JEE (Main) Practice Paper

This paper is for yourself practice and assessment the discussion of this paper is optional though you can see PDF solutions or video solutions or solutions in hardcopy whichever is provided.

SECTION–A

- This section contains **TWENTY** questions.
- Each question has **FOUR** options (1), (2), (3) and (4). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories:

Full Marks : +4, if only the bubble corresponding to the correct option is darkened.
Zero Marks : 0, if none of the bubbles is darkened.
Negative Marks : –1 in all other cases.

---

1. Two particles move on a circular path (one just inside and the other just outside) with angular velocities ω and 5ω starting from the same point. Then which of the following is incorrect?

(1) they cross each other at regular intervals of time $\frac{2\pi}{4\omega}$ when their angular velocities are oppositely directed.

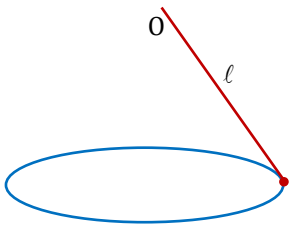
(2) they cross each other at points on the path subtending an angle of 60° at the centre if their angular velocities are oppositely directed.

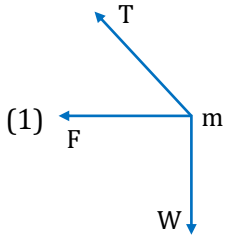
(3) they cross at intervals of time $\frac{\pi}{3\omega}$ if their angular velocities are oppositely directed.

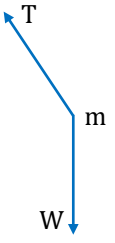
(4) they cross each other at points on the path subtending 90° at the centre if their angular velocities are in the same sense.

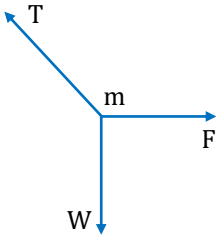
PCR001

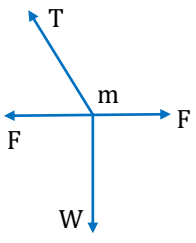
2. A point mass *m* is suspended from a light thread of length ℓ, fixed at *O*, is whirled in a horizontal circle at constant speed as shown. From your point of view, stationary with respect to the mass, the forces on the mass are :



(1) 

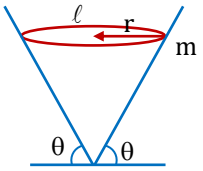
(2) 

(3) 

(4) 

PCR002

3. A ball of mass 'm' is rotating in a circle of radius 'r' with speed v inside a smooth cone as shown in figure. Let N be the normal reaction on the ball by the cone, then choose the correct option.



(1) $N = mg\cos\theta$ (2) $g\sin\theta = \frac{v^2}{r^2}\cos\theta$ (3) $N\sin\theta - \frac{mv^2}{r} = 0$ (4) None of these

PCR003

4. An aircraft executes a horizontal loop at a speed of 720 km/h with its wings banked at 15°. What is the radius of the loop (in Km)?

(1) 12 Km (2) 15 Km (3) 20 Km (4) 21 Km

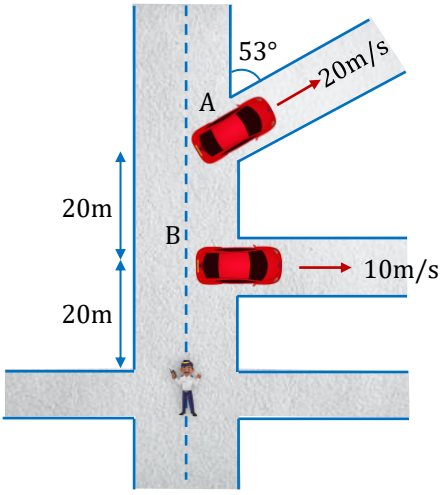
PCR004

5. A stone is launched upward at 45° with speed v_0. A bee follows the trajectory of the stone at a constant speed equal to the initial speed of the stone. Find the radius of curvature at the top point of the trajectory.

(1) $\frac{v_0}{g}$ (2) $\frac{v_0^2}{g}$ (3) $\frac{v_0}{2g^2}$ (4) $\frac{V_0^2}{2g}$

PCR005

6. A traffic policeman standing at the intersection sees 2 cars A and B turning at angles 53° and 90° respectively (as shown in the figure). Their velocities are $V_A = 20\ m/s$, $V_B = 10\ m/s$. Then, which car appears to be moving faster to the traffic policeman :-



(1) A (2) B
(3) Both equally fast (4) Insufficient info

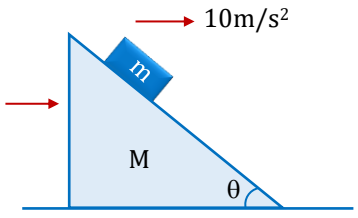
PCR006

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

(1) 16 J (2) 8 J (3) 32 J (4) 24 J

PWE001

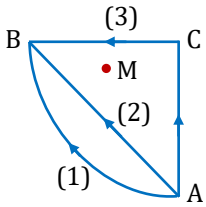
8. In the figure shown all the surfaces are frictionless, and mass of the block, $m = 1\ kg$. The block and wedge are held initially at rest. Now wedge is given a horizontal acceleration of 10 m/s^2 by applying a force on the wedge, so that the block does not slip on the wedge. Then work done by the normal force in ground frame on the block in $\sqrt{3}$ seconds is :



(1) 30 J (2) 60 J (3) 150 J (4) 100 $\sqrt{3}J$

PWE002

9. In a region of only gravitational field of mass 'M' a particle is shifted from A to B via three different paths in the figure. The work done in different paths are W_1, W_2, W_3 respectively then



(1) $W_1 = W_2 = W_3$ (2) $W_1 = W_2 > W_3$ (3) $W_1 > W_2 > W_3$ (4) $W_1 < W_2 < W_3$

PWE003

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

(1) 250 π^2 joule (2) 100π^2 joule (3) 5π^2 joule (4) 0 joule

PWE004

11. A particle moves on a rough horizontal ground with some initial velocity say v_0. If 3/4 of its kinetic energy is lost in friction in time t_0 then coefficient of friction between the particle and the ground is :-

(1) $\frac{v_0}{2gt_0}$ (2) $\frac{v_0}{4gt_0}$ (3) $\frac{3v_0}{4gt_0}$ (4) $\frac{v_0}{gt_0}$

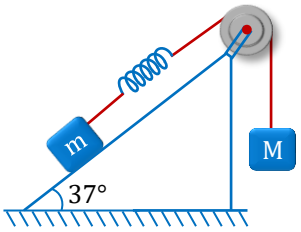
PWE005

12. A block of mass m is hung vertically from an elastic thread of force constant mg/a. Initially the thread was at its natural length and the block is allowed to fall freely. The kinetic energy of the block when it passes through the equilibrium position will be :

(1) mga (2) $mga/2$ (3) zero (4) $2mga$

PWE006

13. A block of mass m is attached with a massless spring of force constant k. The block is placed over a rough inclined surface for which the coefficient of friction is $\mu = \frac{3}{4}$. The minimum value of M required to move the block up the plane is :
(Neglect mass of string and pulley and friction in pulley)



(1) $\frac{3}{5}m$ (2) $\frac{4}{5}m$

(3) 2 m (4) $\frac{3}{2}m$

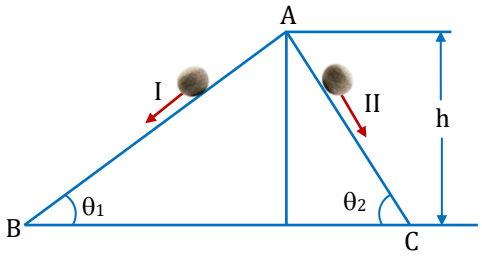
PWE007

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

(1) x^2 (2) e^x (3) x (4) $\log_e x$

PWE008

15. 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?



(1) Both the stones reach the bottom at the same time but not with the same speed.

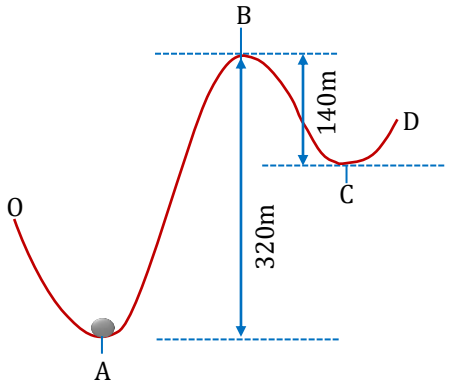
(2) Both the stones reach the bottom with the same speed and stone I reaches the bottom earlier than stone II.

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

(4) Both the stones reach the bottom at different times and with different speeds.

PWE009

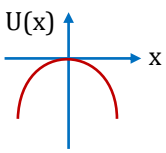
16. Track *OABCD* (as shown is figure) is smooth and fixed in vertical plane. What minimum speed has to be given to a particle lying at point *A*, so that it can reach point *C*?

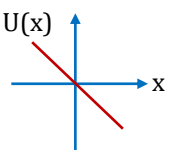


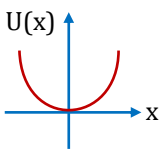
(1) 60 m/s (2) 100 m/s (3) 70 m/s (4) 80 m/s

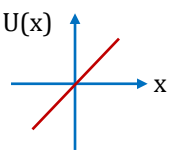
PWE010

17. 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)

(1) 

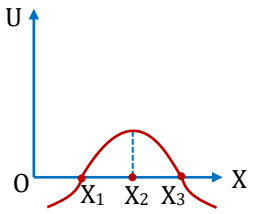
(2) 

(3) 

(4) 

PWE011

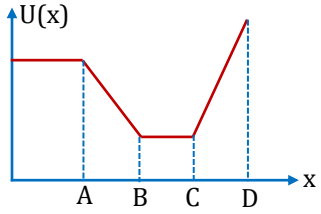
18. In the figure shown the potential energy (U) of a particle is plotted against its position 'x' from origin. Then which of the following statement is correct. A particle at :



(1) x_1 is in stable equilibrium
(2) x_2 is in stable equilibrium
(3) x_3 is in stable equilibrium
(4) None of these

PWE012

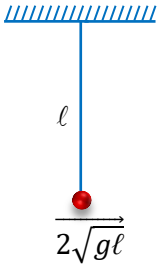
19. As a particle moves along the x–axis it is acted upon by a conservative force. The potential energy is shown below as a function of the coordinate x of the particle. Rank the labelled regions according to the magnitude of the force, least to greatest.



(1) AB, BC, CD (2) AB, CD, BC (3) BC, CD, AB (4) BC, AB, CD

PWE013

20. One end of a string of length $\ell = \frac{14}{9} m$ is fixed and a mass of 1 kg is tied to the other end. The ball is given a velocity $2\sqrt{g\ell}$ at the bottom most point as shown in figure. The string is cut when the ball becomes horizontal. Find the distance (in m) travelled till it stop for the 1st time (Take $\pi = \frac{22}{7}$).



(1) 1 (2) 3 (3) 4 (4) 6

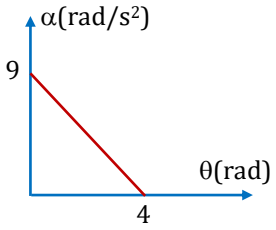
PWE014

SECTION–B

- This section will have **TEN questions**. Candidate can choose to attempt any 5 questions out of these 10 questions. In case if candidate attempts more than 5 questions, first 5 attempted questions will be considered for marking.
- The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value (Answer should be rounded off to the nearest integer).
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+4, if only correct answer is given.
Zero Marks	:	0, if no answer is given.
Negative Marks	:	–1 for incorrect answer.

1. A particle starts moving in a non-uniform circular motion, has angular acceleration as shown in figure. The angular velocity at the end of 4 radian is given by ω rad/s then find the value of ω.



PCR007

2. A stone is thrown horizontally with the velocity 15 m/s. If the ratio of normal acceleration to the tangential acceleration stone in 1 second after it begins to move is x, then value of $2x$ will be

PCR008

3. A body constrained to move along the z-axis of a coordinate system is subject to a constant force F given by

$$F = -\hat{\imath} + 2\hat{\jmath} + 3\hat{k}N$$

where $\hat{\imath}, \hat{\jmath}, \hat{k}$ are unit vectors along the x, y and z-axis of the system respectively. What is the work done (in J) by this force in moving the body a distance of 4 m along the z-axis ?

PWE015

4. A point mass of 0.5 kg is moving along x-axis as $x = t^2 + 2t$, where x is in meters and t is in seconds. Find the work done (in J) by all the forces acting on the body during the time interval $[0, 2s]$.

PWE016

5. A block is released from rest from top of a rough curved track as shown in figure. It comes to rest at some point on the horizontal part. If its mass is 200 gm, calculate negative of work by friction in joules.

PWE017

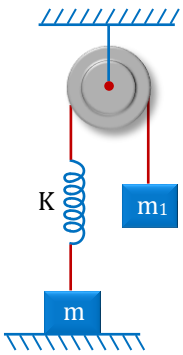
6. The potential energy (in joules) function of a particle in a region of space is given as :

$$U = (2x^2 + 3y^3 + 2z)$$

Here x, y and z are in metres. Find the magnitude of x component of force (in newton) acting on the particle at point P $(1m, 2m, 3m)$.

PWE018

7. Initially spring is relaxed when m_1 is released from rest. Calculate for what minimum value of m_1 the block of mass m will just leave the contact with surface ? Give answer in terms of $\frac{m}{m_1}$.



PWE019

8. The potential energy of a 2 kg particle moving along the x axis is given by

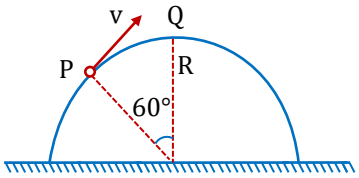
$U(x) = (4.0J/m^2)x^2 + (1.0J/m^4)x^4$

When the particle is at $x = 1.0m$, find the magnitude (in m/s^2) of its acceleration.

[Only conservative forces are acting]

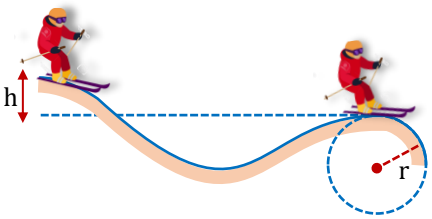
PWE020

9. A particle is given a certain velocity v at point P as shown on a hemispherical smooth surface. Find the value of v (in m/s), such that when particle reaches Q, the normal reaction of surface becomes equal to particle's weight. [$R = 1.6\ m$, $g = 10\ m/s^2$]



PWE021

10. A skier starts from rest at the top of a hill. The skier coasts down the hill and up a second hill, as the drawing illustrates. The crest of the second hill is circular, with a radius of $r = 36\ m$. Neglect friction and air resistance. What must be the height h (in m) of the first hill so that the skier just loses contact with the snow at the crest of the second hill?



PWE022

JEE (Advanced) Practice Paper

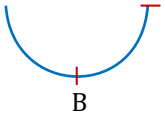
This paper is for yourself practice and assessment the discussion of this paper is optional though you can see PDF solutions or video solutions or solutions in hardcopy whichever is provided.

SECTION–I

- This section contains **TWO** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories:

Full Marks : +3 if only the bubble corresponding to the correct option is darkened.
Zero Marks : 0 if none of the bubbles is darkened.
Negative Marks : –1 in all other cases.

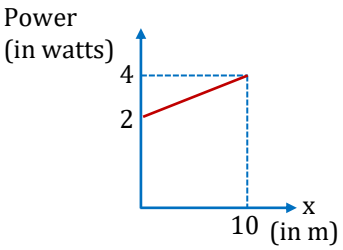
1. A small ball can move in a vertical plane along a semi–circle of radius r without friction. At what speed is the ball to launch from point A so that its acceleration is $3g$ at point B ?



(A) $(3gr)^{1/2}$ (B) $(2gr)^{1/2}$ (C) $(gr)^{1/2}$ (D) $2(gr)^{1/2}$

PWE037

2. A particle 'A' of mass $\frac{10}{7}$ kg is moving in the positive x–direction. Its initial position is $x = 0$ and initial velocity is 1 m/s. The velocity at $x = 10m$ is (Use the graph given)



(A) 4 m/s (B) 2 m/s

(C) $3\sqrt{2}$ m/s (D) $\frac{100}{3}$ m/s

PWE038

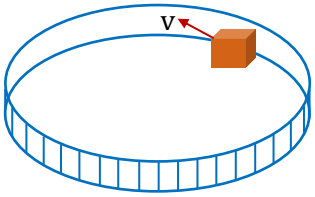
SECTION-II

- This section contains **FIVE** questions.
- Each question has **FOUR** options for correct answer(s). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct option(s).
- For each question, choose the correct option(s) to answer the question.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 if only (all) the correct option(s) is (are) chosen.
Partial Marks : +3 if all the four options are correct but ONLY three options are chosen.
Partial Marks : +2 if three or more options are correct but ONLY two options are chosen, both of which are correct options.
Partial Marks : +1 if two or more options are correct but ONLY one option is chosen and it is a correct option.
Zero Marks : 0 if none of the options is chosen (i.e. the question is unanswered).
Negative Marks : –2 in all other cases.

For Example : If first, third and fourth are the **ONLY** three correct options for a question with second option being an incorrect option; selecting only all the three correct options will result in +4 marks. Selecting only two of the three correct options (e.g. the first and fourth options), without selecting any incorrect option (second option in this case), will result in +2 marks. Selecting only one of the three correct options (either first or third or fourth option), without selecting any incorrect option (second option in this case), will result in +1 marks. Selecting any incorrect option(s) (second option in this case), with or without selection of any correct option(s) will result in –2 marks.

3. A block of mass m moves with speed v against a smooth, fixed vertical circular groove of radius r kept on smooth horizontal surface. Find net force on the block.



(A) mg

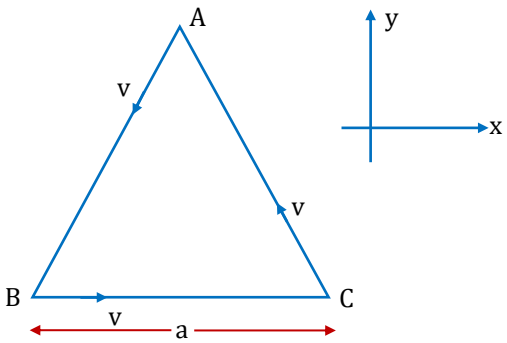
(B) $\frac{mv^2}{r}$

(C) $\sqrt{(mg)^2+\left(\frac{mV^2}{r}\right)^2}$

(D) $\sqrt{(mg)+\left(\frac{mV^2}{r}\right)}$

PCR015

4. Three particles A, B, C are located at the corners of an equilateral triangle as shown in figure. Each of the particle is moving with velocity v. Then at the instant shown, the relative angular velocity of



(A) A wrt B is $\frac{v\cos 30°}{a}$ in $z-$ direction

(B) B wrt C is $\frac{v\cos 30°}{a}$ in z–direction

(C) A wrt C is $\frac{v\cos 30°}{a}$ in $z-$ direction

(D) B wrt A is $\frac{v\cos 30°}{a}$ in z–direction

PCR016

5. A particle of mass m is at rest in a train moving with constant velocity with respect to ground. Now the particle is accelerated by a constant force F_0 acting along the direction of motion of train for time t_0. A girl in the train and a boy on the ground measure the work done by this force. Which of the following are **INCORRECT**?

(A) Both will measure the same work

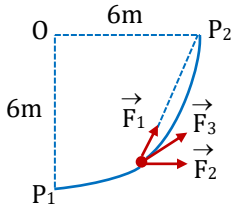
(B) Boy will measure higher value than the girl

(C) Girl will measure higher value than the boy

(D) Data are insufficient for the measurement of work done by the force F_0

PWE039

6. A smooth track in the form of a quarter circle of radius 6 m lies in the vertical plane. A particle moves from P_1 to P_2 under the action of forces $\vec{F}_1, \vec{F}_2$ and $\vec{F}_3$. Force $\vec{F}_1$ is always toward P_2 and is always 20N in magnitude. $\vec{F}_2$ force always acts horizontally and is always 30 N in magnitude. Force $\vec{F}_3$ always acts tangentially to the track and is of magnitude 15 N. Select the correct alternative(s)



(A) work done by $\vec{F}_1$ is 120 J

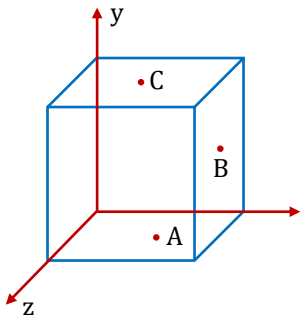
(B) work done by $\vec{F}_2$ is 180 J

(C) work done by $\vec{F}_3$ is 45 π

(D) $\vec{F}_1$ is conservative in nature

PWE040

7. A particle is shifted from A to B and then from B to C where A, B and C are the midpoints of the corresponding faces of a cube of side $2m$. If a force $\vec{F} = (3\hat{\imath} + 4\hat{\jmath} - 5\hat{k})N$ is continuously acting on the particle, then select correct alternative :-



(A) work done from A to B is $7\,J$ (B) work done from B to C is $1\,J$

(C) work done A to C is $8\,J$ (D) $\vec{F}$ is a conservative force

PWE041

SECTION-III

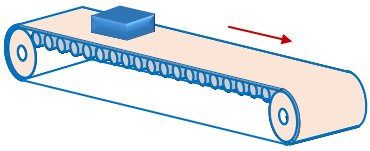
- This section contains **TWO** paragraphs.
- Based on each paragraph, there are **TWO/THREE** questions.
- Each question has **FOUR** options (A), (B), (C) and (D) **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories :

Full Marks : +3 if only the bubble corresponding to the correct answer is darkened.

Zero Marks : 0 in all other cases.

PARAGRAPH FOR QUESTION 8 AND 9

An object of mass M is gently placed on a horizontal conveyor belt, which is moving with uniform velocity v_o as shown in the figure. The coefficient of static friction is μ_s, the coefficient of kinetic friction is μ_k, and the acceleration of gravity is g. Initially the object slips for a while but finally moves without slipping together with the belt.



8. How far the conveyor belt moves while the object is slipping?

(A) $\frac{v_o^2}{\mu_k g}$ (B) $\frac{v_o^2}{2\mu_k g}$ (C) $\frac{v_o^2}{\mu_s g}$ (D) $\frac{v_o^2}{2\mu_s g}$

PWE042

9. Work done on the object by friction force relative to the reference frame moving with the conveyer belt is

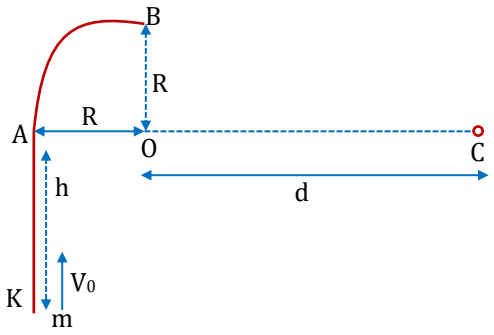
(A) $\frac{1}{2}Mv_o^2$ (B) $-\frac{1}{2}Mv_o^2$ (C) Mv_o^2 (D) zero

PWE043

PARAGRAPH FOR QUESTION NO. 10 TO 12

A point like object of mass m starts from point K as shown in the figure. It slides inside along the full length of the smooth track of radius R, and then moves freely and travels to point C.

[The track is kept in vertical plane]



10. Determine the vertical initial velocity of the point like object.

(A) $v_0 = \sqrt{2g(h+R) + \frac{d^2 g}{R}}$

(B) $v_0 = \sqrt{2g(h-R) + \frac{d^2 g}{2R}}$

(C) $v_0 = \sqrt{2g(h+R) + \frac{d^2 g}{2R}}$

(D) $v_0 = \sqrt{2g(h+R) + \frac{dg}{2R}}$

PWE044

11. What is the minimum possible distance $OC = d$, necessary for the object to slide along the entire length of the track ?

(A) $d_{min} = R\sqrt{2}$

(B) $d_{min} = \sqrt{3}\,R$

(C) $d_{min} = \frac{R}{\sqrt{2}}$

(D) $d_{min} = \frac{R}{\sqrt{3}}$

PWE045

12. Find the normal force exerted by the track at point A.

(A) $F_A = mg\left(\frac{d^2}{2R^2} - 2\right)$

(B) $F_A = mg\left(\frac{d^2}{2R^2} + 2\right)$

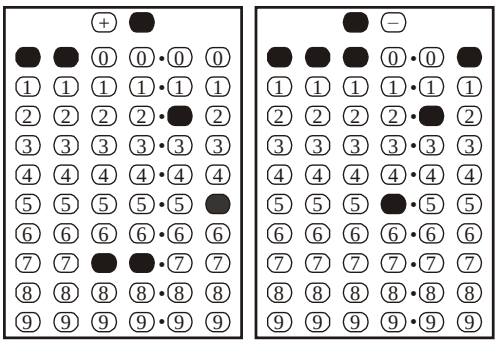
(C) $F_A = mg\left(\frac{3d^2}{R^2} + 2\right)$

(D) $F_A = mg\left(\frac{d}{3R^2} + 2\right)$

PWE046

SECTION-IV

- This section contains **FIVE** questions.
- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. 6.25, 7.00, –0.33, –.30, 30.27, –127.30, if answer is 11.36777..... then both 11.36 and 11.37 will be correct) by darken the corresponding bubbles in the ORS.
  For Example : If answer is –77.25, 5.2 then fill the bubbles as follows:



- Answer to each question will be evaluated according to the following marking scheme:
  Full Marks : +3 if ONLY the correct numerical value is entered as answer.
  Zero Marks : 0 in all other cases.

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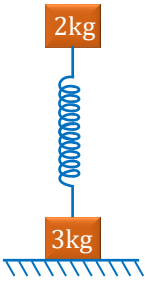
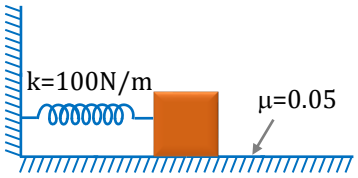
13. The ends of spring are attached to blocks of mass 3 kg and 2 kg. The 3 kg block rests on a horizontal surface and the 2 kg block which is vertically above it is in equilibrium producing a compression of 1 cm of the spring. The 2 kg mass must be compressed further by at least _____(in mm), so that when it is released, the 3 kg block may be lifted off the ground.



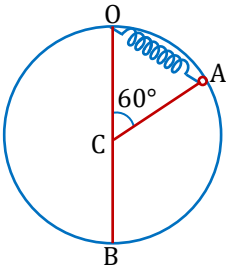
PWE047

14. A block of mass 1 kg is attached to a spring with a force constant 100 N/m and rests on a rough horizontal ground as shown in the figure. Initial displacement of block from natural length is 50 cm. The total distance (in m) covered by the block if coefficient of friction between block and ground is 0.05. [g =10 m/s^2]



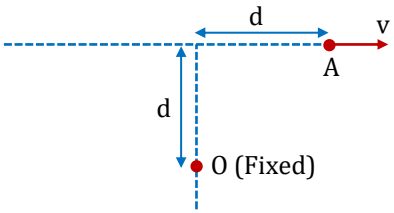
PWE048

15. A particle of mass 5 kg is free to slide on a smooth ring of radius r = 20 cm fixed in a vertical plane. The particle is attached to one end of a spring whose other end is fixed to the top point O of the ring. Initially the particle is at rest at a point A of the ring such that OCA = 60°, C being the centre of the ring. The natural length of the spring is also equal to r = 20 cm. After the particle is released and slides down the ring the contact force between the particle and the ring becomes zero when it reaches the lowest position B. Determine the force (in N/m) constant of the spring.



PWE049

16. Find angular velocity of *A* with respect to *O* at the instant shown in the figure. If answer is in terms of $\frac{xv}{2d}$, find the value of 'x'.



PCR017

17. A toy car of mass 10 kg is moving with constant speed on a circular track of radius $10\sqrt{3}$ *m* bank at angle 30°. Coefficient of friction between wheels of the car and track is. When the car moves on this track with maximum safe constant speed, the normal reaction (in *N*) between the car and the track is *N*. Find numerical value of $N\sqrt{3}$.

PCR110

SECTION–V

- This section contains **ONE** question.
- Each question contains two columns, **Column-I** and **Column-II.**
- **Column-I** has **four** entries (A), (B), (C) and (D).
- **Column-II** has **four** entries (P), (Q), (R) and (S)
- Match the entries in **Column-I** with the entries in **column-II.**
- One or more entries in **Column-I** may match with one or more entries in **Column-II.**
- The ORS contains a 4 × 4 matrix whose layout will be similar to the one shown below:

(A) (P) (Q) (R) (S)
(B) (P) (Q) (R) (S)
(C) (P) (Q) (R) (S)
(D) (P) (Q) (R) (S)

- For each entry in **column-I,** darken the bubbles of all the matching entries. For example, if entry (A) in **Column-I** matches with entries (Q), (R) and (S), then darken these three bubbles in the ORS. Similarly, for entries (B), (C) and (D).
- For each question, marks will be awarded in one of the following categories :

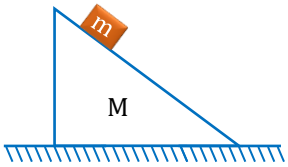
For each entry in **Column-I**

Full Marks : +2 if only the bubble(s) corresponding to all the correct match(es) is (are) darkened.

Zero Marks : 0 if none of the bubbles is darkened.

Negative Marks : –1 in all other cases.

18. A block of mass m lies on wedge of mass M. The wedge in turn lies on smooth horizontal surface. Friction is absent everywhere. The wedge block system is released from rest. All situation given in column–I are to be estimated in duration the block undergoes a vertical displacement 'h' starting from rest (assume the block to be still on the wedge, g is acceleration due to gravity).



	Column I		**Column II**
(A)	Work done by normal reaction acting on the block is	(P)	Positive
(B)	Work done by normal reaction (exerted by block) acting on wedge is	(Q)	Negative
(C)	The sum of work done by normal reaction on block and work done by normal reaction (exerted by block) on wedge is	(R)	Zero
(D)	Net work done by all forces on block is	(S)	Less than mgh in magnitude

PWE050

ANSWER KEY

EXERCISE - O

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	D	D	B	C	B	D	B	D	A	D
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	B	C	C	A	A	A	B	A	D	C
Que.	21	22	23	24	25	26	27	28	29	30
Ans.	C	C	B	A	A	A	C	B	D	D
Que.	31	32	33	34	35	36	37	38	39	40
Ans.	B	D	A	D	D	A	B	A	B	C
Que.	41	42	43	44	45	46	47	48	49	50
Ans.	B	C	C	B	A	A	A	D	C	A
Que.	51	52	53	54	55	56	57	58	59	60
Ans.	D	C	D	B	B	D	AC	ABCD	BCD	ABC
Que.	61	62	63	64	65	66	67	68	69	70
Ans.	BD	ABC	ABC	BCD	ABC	ABCD	AB	AD	AB	ACD
Que.	71	72	73	74	75	76	77	78	79	80
Ans.	BCD	ACD	ABC	ACD	AC	ABCD	ABDC	ABCD	ACD	C
Que.	81	82	83	84	85	86	87			
Ans.	D	B	D	B	B	D	(A-P,Q), (B-P,Q,S), (C-P,Q,R), (D-P,Q,R)			
Que.	88						89			
Ans.	(A-R), (B-S) (C-Q), (D-P)						(A-Q), (B-P), (C-Q), (D-S)			
Que.	90						91			
Ans.	(A-Q), (B-P), (C-Q), (D-P)						(A-Q,S,T), (B-Q,S,T), (C-P), (D-R,T)			
Que.	92						93			
Ans.	(A-P,Q,R), (B-Q), (C-P,Q), (D-Q,S)						(A-S), (B-R), (C-P), (D-Q)			
Que.	94	95	96	97	98	99				
Ans.	A	C	BD	D	A	B				

EXERCISE - S

1. 24 **2.** 4 **3.** $\frac{10}{\pi} ms^{-2}$

4. (i) 2 rad/s^2 (ii) $12 + 2t$ for $t \leq 2s$, 16 for $t \geq 2s$
(iii) $a = 169.01\ m/s^2$ (iv) 44 rad

5. $\frac{u^2\cos^2\theta}{g\cos^3\left(\theta/2\right)}$ **6.** (i) $75 m/s^2$, (ii) $125 m/s^2$ **7.** $\sqrt{2g}$ rad/s

8. 5 **9.** 5 **10.** $T = 6.6\ N$, $v_{max} = 35\ ms^{-1}$

11. $\frac{15\pi^2}{10} = 14.8N$, This force is exerted by blade of fan and equal force is exerted by particle on blade in same magnitude but opposite in direction.

12. $\frac{4m\omega^2R}{3}$ **13.** Yes, $a_c = 8$, $\mu g = 1$ **14.** $\frac{49}{80}$

15. $5\sqrt{2}\,ms^{-1}$ **16.** 2.0 **17.** $\theta = tan^{-1}\left(\frac{5}{18}\right)$

18. 4 **19.** $\frac{\pi^2}{81}$ **20.** $\frac{2}{5}$

21. $\frac{2}{45}m$ **22.** $\sqrt{\frac{50}{3}}\times\frac{18}{5} = 14.7\ km/h$ **23.** (a) 28 *m/s* (b) 38.19 *m/s*

24. 2 **25.** $V = \left[\left(\mu^2g^2 - a^2\right)R^2\right]^{\frac{1}{4}}$

26. (a) $v = \sqrt{Rg}$, (b) $\frac{\pi R}{3}$, (c) $V = \sqrt{gR\cos\left(\frac{L}{2R}\right)}$

27. (A) $\omega_{max} = \sqrt{\frac{\mu g}{L}}$, (B) $\omega = \left(\left(\frac{\mu g}{L}\right)^2 - \alpha^2\right)^{\frac{1}{4}}$

28. (a) 975 *N*, 1025 *N* (b) 707 *N* (c) 683 *N* (d) $\mu = 1.037$

29. $v = \omega\sqrt{L^2 - a^2}$ **30.** 67.7 *J*

31. (a) 7.5 *J*; (b) 15 *J*; (c) 7.5 *J*; (d) 30 *J* **32.** 3 **33.** 0

34. 4 **35.** 10 **36.** $\frac{mgl}{18}$

37. $-\frac{2}{9}\mu MgL$ **38.** (i) $2 + 24t^2 + 72t^4\,J$, (ii) $48\,t\,N$, (iii) $48t + 288t^3\,W$, (iv) 1248 *J*

39. (a) –30 k*W*, (b) 19.5 K*w* **40.** 46 *J*

41. (a) $\frac{mv^2}{R}$; (b) $\frac{\mu mv^2}{R}$; (c) $-\frac{\mu v^2}{R}$; (d) $v_0e^{-2\pi\mu}$ **42.** (a) 0.2 *N*; (b) 30°

43. (i) $f = \frac{\mu m}{L}xg$; (ii) $\sqrt{\mu gL}$; (iii) $\frac{5L}{2}$

44. Graph-1 : For all *x*, Graph-2 : $x < a$ & $x > b$, Graph-3 : $-\frac{b}{2} < x < -\frac{a}{2}$ & $\frac{a}{2} < x < \frac{b}{2}$

45. $u = \sqrt{gL\left(2 + \frac{3\sqrt{3}}{2}\right)}$

EXERCISE - JEE (Main) PYQ

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	3	5	6	1	1	2	2	2	40	2
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	1	4	728	1	1	2	3	3	3	120
Que.	21	22	23	24						
Ans.	3	40	100	1						

EXERCISE - JEE (Advanced) PYQ

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	D	5	A	B	5	D	D	C	ABD	0.75
Que.	11									
Ans.	AD									

JEE (Main) Practice Paper

Section-A	Q.	1	2	3	4	5	6	7	8	9	10
	A.	1	3	3	2	4	2	2	3	1	1
	Q.	11	12	13	14	15	16	17	18	19	20
	A.	1	2	1	1	3	4	1	4	4	3
Section-B	Q.	1	2	3	4	5	6	7	8	9	10
	A.	6	3	12	8	4	4	2	6	4	18

JEE (Advanced) Practice Paper

Section-I	Q.	1	2			
	A.	C	A			
Section-II	Q.	3	4	5	6	7
	A.	C	ABCD	AC	BCD	ABCD
Section-III	Q.	8	9	10	11	12
	A.	A	B	C	A	B
Section-IV	Q.	13	14	15	16	17
	A.	25	25	500	1	300
Section-V	Q.	18				
	A.	(A-Q,S), (B-P,S), (C-R,S), (D-P,S)				

Important Notes

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