Q1. A particle of mass m moves on a straight line with its velocity increasing with distance according to the equation $v = \alpha\sqrt{x}$, where α is a constant. The total work done by all the forces applied on the particle during its displacement from $x = 0$ to $x = \mathrm{d}$, will be : ***09 Apr 2024 (M)***

(1) $\frac{\mathrm{m}}{2\alpha^2\,\mathrm{d}}$ (2) $\frac{\mathrm{md}}{2\alpha^2}$

(3) $2\,\mathrm{m}\alpha^2\,\mathrm{d}$ (4) $\frac{m\alpha^2\,\mathrm{d}}{2}$

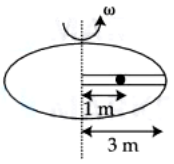
Q2. A force $\left(3x^2 + 2x - 5\right)\mathrm{N}$ displaces a body from $x = 2$ m to $x = 4$ m. Work done by this force is _____ J. ***09 Apr 2024 (E)***

Q3. A stationary particle breaks into two parts of masses m_A and m_B which move with velocities v_A and v_B respectively. The ratio of their kinetic energies $(K_B : K_A)$ is : ***08 Apr 2024 (M)***

(1) $v_B : v_A$ (2) $m_B : m_A$

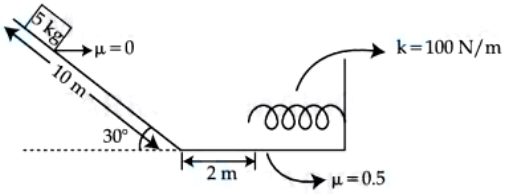
(3) $m_B v_B : m_A v_A$ (4) $1 : 1$

Q4. A circular table is rotating with an angular velocity of $\omega\mathrm{rad/s}$ about its axis (see figure). There is a smooth groove along a radial direction on the table. A steel ball is gently placed at a distance of 1 m on the groove. All the surfaces are smooth. If the radius of the table is 3 m, the radial velocity of the ball w.r.t. the table at the time ball leaves the table is $x\sqrt{2}\omega\mathrm{m/s}$, where the value of x is _____.



08 Apr 2024 (E)

Q5. A block is simply released from the top of an inclined plane as shown in the figure above. The maximum compression in the spring when the block hits the spring is:



08 Apr 2024 (E)

(1) $\sqrt{6}$ m (2) $\sqrt{5}$ m

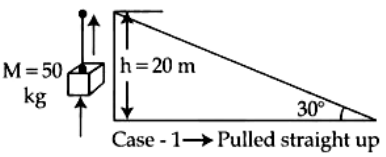
(3) 1 m (4) 2 m

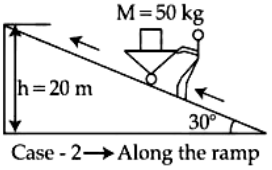
Q6. A bullet of mass 50 g is fired with a speed 100 m/s on a plywood and emerges with 40 m/s. The percentage loss of kinetic energy is : ***06 Apr 2024 (M)***

(1) 84% (2) 16%

(3) 32% (4) 44%

Q7. A body of mass 50 kg is lifted to a height of 20 m from the ground in the two different ways as shown in the figures. The ratio of work done against the gravity in both the respective cases, will be :





05 Apr 2024 (M)

(1) $1 : 2$ (2) $\sqrt{3} : 2$

(3) $2 : 1$ (4) $1 : 1$

Q8. A body is moving unidirectionally under the influence of a constant power source. Its displacement in time t is proportional to : ***05 Apr 2024 (E)***

(1) t (2) $t^{3/2}$

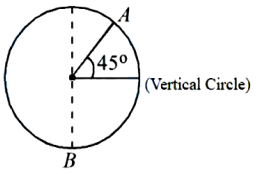
(3) t^2 (4) $t^{2/3}$

Q9. If a rubber ball falls from a height h and rebounds upto the height of $h/2$. The percentage loss of total energy of the initial system as well as velocity ball before it strikes the ground, respectively, are : ***04 Apr 2024 (M)***

(1) $50\%, \sqrt{2gh}$ (2) $50\%, \sqrt{gh}$

(3) $40\%, \sqrt{2gh}$ (4) $50\%, \sqrt{\frac{gh}{2}}$

Q10. A body of m kg slides from rest along the curve of vertical circle from point A to B in friction less path. The velocity of the body at B is _____ (given, $R = 14$ m, $g = 10$ m/s^2 and $\sqrt{2} = 1.4$)



04 Apr 2024 (E)

(1) 16.7 m/s (2) 19.8 m/s

(3) 10.6 m/s (4) 21.9 m/s

Q11. An artillery piece of mass M_1 fires a shell of mass M_2 horizontally. Instantaneously after the firing, the ratio of kinetic energy of the artillery and that of the shell is : ***31 Jan 2024 (M)***

(1) $\frac{M_1}{(M_1+M_2)}$ (2) $\frac{M_2}{M_1}$

(3) $\frac{M_2}{(M_1+M_2)}$ (4) $\frac{M_1}{M_2}$

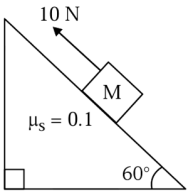
Q12. A solid circular disc of mass 50 kg rolls along a horizontal floor so that its center of mass has a speed of $0.4\ \text{m s}^{-1}$. The absolute value of work done on the disc to stop it is _____ J. ***31 Jan 2024 (M)***

Q13. A body of mass 2 kg begins to move under the action of a time dependent force given by $\vec{F} = \left(6t\,\hat{i} + 6t^2\,\hat{j}\right)$ N. The power developed by the force at the time t is given by: ***31 Jan 2024 (E)***

(1) $\left(6t^4 + 9t^5\right)$ W (2) $\left(3t^3 + 6t^5\right)$ W

(3) $\left(9t^5 + 6t^3\right)$ W (4) $\left(9t^3 + 6t^5\right)$ W

Q14. A block of mass 1 kg is pushed up a surface inclined to horizontal at an angle of 60° by a force of 10 N parallel to the inclined surface as shown in figure. When the block is pushed up by 10 m along inclined surface, the work done against frictional force is : $\left[g = 10\ \text{m s}^{-2}\right]$

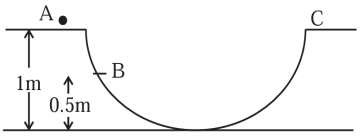


30 Jan 2024 (E)

(1) $5\sqrt{3}$ J (2) 5 J

(3) 5×10^3 J (4) 10 J

Q15. A particle is placed at the point A of a frictionless track ABC as shown in figure. It is gently pushed towards right. The speed of the particle when it reaches the point B is: (Take $g = 10\ \text{m s}^{-2}$).



30 Jan 2024 (M)

(1) $20\ \mathrm{m\ s^{-1}}$ (2) $\sqrt{10}\ \mathrm{m\ s^{-1}}$

(3) $2\sqrt{10}\ \mathrm{m\ s^{-1}}$ (4) $10\ \mathrm{m\ s^{-1}}$

Q16. A block of mass 100 kg slides over a distance of 10 m on a horizontal surface. If the co-efficient of friction between the surfaces is 0.4 , then the work done against friction (in J) is: ***29 Jan 2024 (M)***

(1) 4200 (2) 3900

(3) 4000 (4) 4500

Q17. The potential energy function (in J) of a particle in a region of space is given as $U=\left(2x^2+3y^3+2z\right)$. Here $x,\ y$ and z are in meter. The magnitude of x - component of force (in N) acting on the particle at point $P(1,\ 2,\ 3)$ m is: ***29 Jan 2024 (M)***

(1) 2 (2) 6

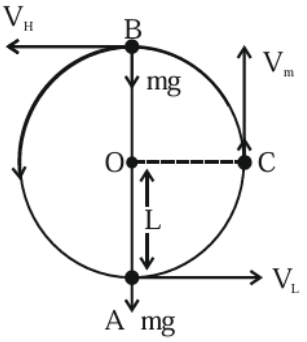
(3) 4 (4) 8

Q18. The bob of a pendulum was released from a horizontal position. The length of the pendulum is 10 m. If it dissipates 10% of its initial energy against air resistance, the speed with which the bob arrives at the lowest point is: [Use, $g=10\ \mathrm{m\ s^{-2}}$] ***29 Jan 2024 (E)***

(1) $6\sqrt{5}\ \mathrm{m\ s^{-1}}$ (2) $5\sqrt{6}\ \mathrm{m\ s^{-1}}$

(3) $5\sqrt{5}\ \mathrm{m\ s^{-1}}$ (4) $2\sqrt{5}\ \mathrm{m\ s^{-1}}$

Q19. A bob of mass m is suspended by a light string of length L. It is imparted a minimum horizontal velocity at the lowest point A such that it just completes half circle reaching the top most position B. The ratio of kinetic energies $\frac{(K.E.)_A}{(K.E.)_B}$ is :



29 Jan 2024 (E)

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

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

Q20. Two bodies of mass 4 g and 25 g are moving with equal kinetic energies. The ratio of magnitude of their linear momentum is : ***27 Jan 2024 (M)***

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

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

Q21. A ball suspended by a thread swings in a vertical plane so that its magnitude of acceleration in the extreme position and lowest position are equal. The angle (θ) of thread deflection in the extreme position will be : ***27 Jan 2024 (E)***

(1) $\tan^{-1}\left(\sqrt{2}\right)$ (2) $2\tan^{-1}\left(\frac{1}{2}\right)$

(3) $\tan^{-1}\left(\frac{1}{2}\right)$ (4) $2\tan^{-1}\left(\frac{1}{\sqrt{5}}\right)$

Q22. A block of mass 10 kg is moving along x-axis under the action of force $F = 5x$ N. The work done by the force in moving the block from $x = 2$ m to 4 m will be _____ J. ***15 Apr 2023 (M)***

Q23. A body is released from a height equal to the radius (R) of the earth. The velocity of the body when it strikes the surface of the earth will be: (Given g = acceleration due to gravity on the earth.) ***15 Apr 2023 (M)***

(1) $\sqrt{2gR}$ (2) $\sqrt{gR}$

(3) $\sqrt{4gR}$ (4) $\sqrt{\frac{gR}{2}}$

Q24. A car accelerates from rest of u m s^{-1}. The energy spent in this process is E J. The energy required to accelerate the car from u m s^{-1} to $2u$ m s^{-1} is nE J. The value of n is _____. ***13 Apr 2023 (E)***

Q25. The ratio of powers of two motors is $\frac{3\sqrt{x}}{\sqrt{x+1}}$, that are capable of raising 300 kg water in 5 minutes and 50 kg water in 2 minutes respectively from a well of 100 m deep. The value of x will be ***13 Apr 2023 (M)***

(1) 16 (2) 2

(3) 2.4 (4) 4

Q26. To maintain a speed of 80 km h^{-1} by a bus of mass 500 kg on a plane rough road for 4 km distance, the work done by the engine of the bus will be _____ kJ. [The coefficient of friction between tyre of bus and road is 0.04]

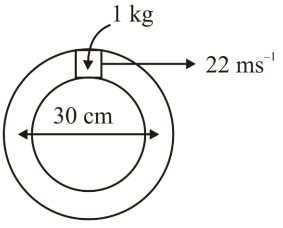
12 Apr 2023 (M)

Q27. A force $\vec{F} = (2 + 3x)\hat{i}$ acts on a particle in the x direction where F is in Newton and x is in meter. The work done by this force during a displacement from $x = 0$ to $x = 4$ m is _____ J. ***11 Apr 2023 (M)***

Q28. If the maximum load carried by an elevator is 1400 kg (600 kg-Passengers + 800 kg-elevator), which is moving up with a uniform speed of 3 m s^{-1} and the frictional force acting on it is 2000 N, then the maximum power used by the motor is _____kW. $(g = 10$ m s$^{-2})$

10 Apr 2023 (E)

Q29. A closed circular tube of average radius 15 cm, whose inner walls are rough, is kept in vertical plane. A block of mass 1 kg just fit inside the tube. The speed of block is 22 m s^{-1}, when it is introduced at the top of tube. After completing five oscillations, the block stops at the bottom region of tube. The work done by the tube on the block is _____ J. (Given $g = 10$ m s^{-2}).



10 Apr 2023 (M)

Q30. A body of mass 5 kg is moving with a momentum of 10 kg m s^{-1}. Now a force of 2 N acts on the body in the direction of its motion for 5 s. The increase in the Kinetic energy of the body is _____ J. ***08 Apr 2023 (E)***

Q31. A body is dropped on ground from a height h_1 and after hitting the ground, it rebounds to a height h_2. If the ratio of velocities of the body just before and after hitting ground is 4, then percentage loss in kinetic energy of the body is $\frac{x}{4}$. The value of x is _____.

06 Apr 2023 (E)

Q32. A small particle of mass m moves in such a way that its potential energy $U = \frac{1}{2}m\omega^2 r^2$ where ω is constant and r is the distance of the particle from origin. Assuming Bohr's quantization of momentum and circular orbit, the radius of n^{th} orbit will be proportional to

06 Apr 2023 (E)

(1) $\sqrt{n}$ (2) $\frac{1}{n}$

(3) n^2 (4) n

Q33. A small particle moves to position $5\hat{i} - 2\hat{j} + \hat{k}$ from its initial position $2\hat{i} + 3\hat{j} - 4\hat{k}$ under the action of force $5\hat{i} + 2\hat{j} + 7\hat{k}$ N. The value of work done will be _____ J. ***01 Feb 2023 (M)***

Q34. A force $F = \left(5 + 3y^2\right)$ acts on a particle in the y-direction, where F is newton and y is in meter. The work done by the force during a displacement from $y = 2$ m to $y = 5$ m is _____ J. ***01 Feb 2023 (E)***

Q35. A block is fastened to a horizontal spring. The block is pulled to a distance $x = 10$ cm from its equilibrium position (at $x = 0$) on a frictionless surface from rest. The energy of the block at $x = 5$ cm is 0.25 J. The spring constant of the spring is _____ $\mathrm{N\ m^{-1}}$. ***01 Feb 2023 (E)***

Q36. A lift of mass $M = 500$ kg is descending with speed of $2\ \mathrm{m\ s^{-1}}$. Its supporting cable begins to slip thus allowing it to fall with a constant acceleration of $2\ \mathrm{m\ s^{-2}}$. The kinetic energy of the lift at the end of fall through to a distance of 6 m will be _____ kJ. ***31 Jan 2023 (M)***

Q37. A body of mass 2 kg is initially at rest. It starts moving unidirectionally under the influence of a source of constant power P. Its displacement in 4 s is $\frac{1}{3}\alpha^2\sqrt{P}$ m. The value of α will be _____. ***30 Jan 2023 (E)***

Q38. 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 is zero

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

Choose the correct answer from the options given below:

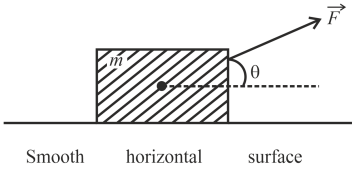
29 Jan 2023 (E)

(1) B and E only (2) A and C only

(3) B, D and E only (4) B and D only

Q39. A 0.4 kg mass takes 8 s to reach ground when dropped from a certain height P above surface of earth. The loss of potential energy in the last second of fall is _____ J. [Take $g = 10\ \mathrm{m\ s^{-2}}$] ***29 Jan 2023 (M)***

Q40. An object of mass m initially at rest on a smooth horizontal plane starts moving under the action of force $F = 2$ N. In the process of its linear motion, the angle θ (as shown in figure) between the direction of force and horizontal varies as $\theta = kx$, where k is a constant and x is the distance covered by the object from its initial position. The expression of kinetic energy of the object will be $\mathrm{E} = \frac{n}{k}\sin\ \theta$. The value of n is _____.



25 Jan 2023 (M)

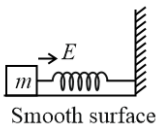
Q41. A spherical body of mass 2 kg starting from rest acquires a kinetic energy of 10000 J at the end of 5^{th} second. The force acted on the body is _____ N.

24 Jan 2023 (M)

Q42. 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 $t = 2$ s, will be _____W.

24 Jan 2023 (E)

Q43. A block of mass 'm' (as shown in figure) moving with kinetic energy E compresses a spring through a distance 25 cm when, its speed is halved. The value of spring constant of used spring will be nE N m^{-1} for $n =$_____.



28 Jul 2022 (M)

Q44. A bullet of mass 200 g having initial kinetic energy 90 J is shot inside a long swimming pool as shown in the figure. If it's kinetic energy reduces to 40 J within 1 s, the minimum length of the pool, the bullet has to travel so that it completely comes to rest is

28 Jul 2022 (E)

(1) 45m (2) 90m

(3) 125m (4) 25m

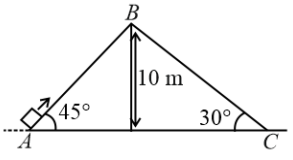
Q45. Sand is being dropped from a stationary dropper at a rate of 0.5 kg s^{-1} on a conveyor belt moving with a velocity of 5 m s^{-1}. The power needed to keep belt moving with the same velocity will be ***27 Jul 2022 (M)***

(1) 1.25 W (2) 2.5 W

(3) 6.25 W (4) 12.5 W

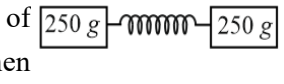
Q46. Two inclined planes are placed as shown in figure.

A block is projected from the Point A of inclined plane AB along its surface with a velocity just sufficient to carry it to the top Point B at a height 10 m. After reaching the Point B the block slides down on inclined plane BC. Time it takes to reach to the point C from point A is $t\left(\sqrt{2}+1\right)$s. The value of t is _____ (use $g = 10$ m s^{-2})



27 Jul 2022 (E)

Q47. As per the given figure, two blocks each of mass 250 g are connected to a spring of spring constant 2 N m^{-1}. If both are given velocity v in opposite directions, then



26 Jul 2022 (M)

(1) $\frac{v}{2\sqrt{2}}$ (2) $\frac{v}{2}$

(3) $\frac{v}{4}$ (4) $\frac{v}{\sqrt{2}}$

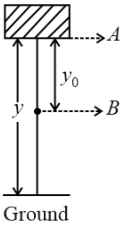
Q48. A body of mass 0.5 kg travels on straight line path with velocity $v = \left(3x^2 + 4\right)$ m s^{-1}. The net work done by the force during its displacement from $x = 0$ to $x = 2$ m is ***25 Jul 2022 (M)***

(1) 64 J (2) 60 J
(3) 120 J (4) 128 J

Q49. A bag of sand of mass 9.8 kg is suspended by a rope. A bullet of 200 g travelling with speed $10\ \text{ms}^{-1}$ gets embedded in it, then loss of kinetic energy will be ***25 Jul 2022 (E)***

(1) 4.9 J (2) 9.8 J
(3) 14.7 (4) 19.6 J

Q50. In the given figure, the block of mass m is dropped from the point 'A'. The expression for kinetic energy of block when it reaches point 'B' is



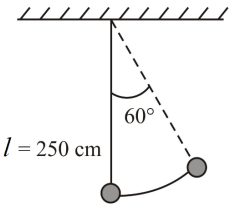
29 Jun 2022 (E)

(1) mgy_0 (2) $\frac{1}{2}mgy_0^2$
(3) $\frac{1}{2}mgy^2$ (4) $mg(y-y_0)$

Q51. A particle of mass 500 g is moving in a straight line with velocity $v = \text{b}x^{\frac{5}{2}}$. The work done by the net force during its displacement from $x = 0$ to $x = 4$ m is (Take $\text{b} = 0.25\ \text{m}^{\frac{-3}{2}}\text{s}^{-1}$). ***29 Jun 2022 (M)***

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

Q52. A pendulum is suspended by a string of length 250 cm. The mass of the bob of the pendulum is 200 g. The bob is pulled aside until the string is at 60° with vertical as shown in the figure. After releasing the bob, the maximum velocity attained by the bob will be _____ m s^{-1}. (if $g = 10\ \text{m s}^{-2}$)



28 Jun 2022 (M)

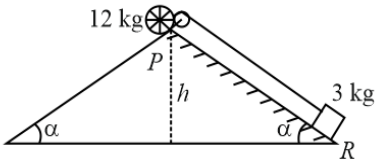
Q53. Water falls from a 40 m high dam at the rate of 9×10^4 kg per hour. Fifty percentage of gravitational potential energy can be converted into electrical energy. Using this hydro electric energy number of 100 W lamps, that can be lit, is _____ (Take $g = 10\ \text{ms}^{-2}$) ***28 Jun 2022 (E)***

(1) 25 (2) 50
(3) 100 (4) 18

Q54. A particle of mass m is moving in a circular path of constant radius r such that its centripetal acceleration a_c is varying with time t as $a_c = k^2rt^2$, where k is a constant. The power delivered to the particle by the force acting on it is - ***28 Jun 2022 (M)***

(1) Zero (2) $2mk^2r^2t$
(3) mk^2r^2t (4) $2mk^2rt$

Q55. A rolling wheel of 12 kg is on an inclined plane at position P and connected to a mass of 3 kg through a string of fixed length and pulley as shown in figure. Consider PR as friction free surface. The velocity of centre of mass of the wheel when it reaches at the bottom Q of the inclined plane PQ will be $\frac{1}{2}\sqrt{xgh}$ m s^{-1}. The value of x (rounded off to the nearest integer) is _____.



27 Jun 2022 (E)

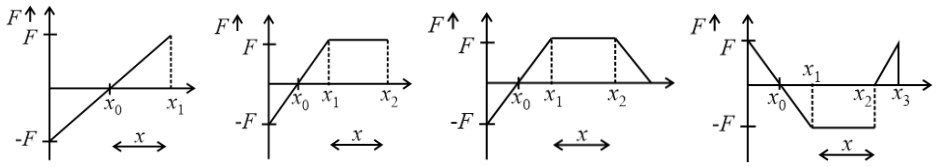
Q56. A stone tide to a string of length L is whirled in a vertical circle with the other end of the string at the centre. At a certain instant of time, the stone is at its lowest position and has a speed u. The magnitude of change in its velocity, as it reaches a position where the string is horizontal, is $\sqrt{x(u^2-gL)}$. The value of x is

27 Jun 2022 (E)

(1) 2 (2) 3

(3) 4 (4) 1

Q57. Arrange the four graphs in descending order of total work done; where W_1, W_2, W_3 and W_4 are the work done corresponding to figure a, b, c and d respectively.



26 Jun 2022 (E)

(1) $W_3 > W_2 > W_1 > W_4$ (2) $W_3 > W_2 > W_4 > W_1$

(3) $W_2 > W_3 > W_4 > W_1$ (4) $W_2 > W_3 > W_1 > W_4$

Q58. A 0.5 kg block moving at a speed of 12 ms^{-1} compresses a spring through a distance 30 cm when its speed is halved. The spring constant of the spring will be _____ Nm^{-1} ***25 Jun 2022 (M)***

Q59. For a particle in uniform circular motion, the acceleration $\vec{a}$ at any point $P(R,\theta)$ on the circular path of radius R is (when θ is measured from the positive x-axis and v is uniform speed): ***25 Jun 2022 (E)***

(1) $-\frac{v^2}{R}\sin\theta\hat{\mathrm{i}}+\frac{v^2}{R}\cos\theta\hat{\mathrm{j}}$ (2) $-\frac{v^2}{R}\cos\theta\hat{\mathrm{i}}+\frac{v^2}{R}\sin\theta\hat{\mathrm{j}}$

(3) $-\frac{v^2}{R}\cos\theta\hat{\mathrm{i}}-\frac{v^2}{R}\sin\theta\hat{\mathrm{j}}$ (4) $-\frac{v^2}{R}\hat{\mathrm{i}}+\frac{v^2}{R}\hat{\mathrm{j}}$

Q60. A stone of mass m, tied to a string is being whirled in a vertical circle with a uniform speed. The tension in the string is ***24 Jun 2022 (E)***

(1) the same throughout the motion.

(2) minimum when the rope is in the horizontal position.

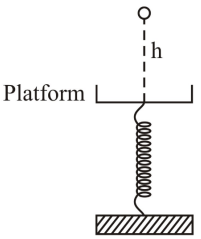
(3) minimum at the highest position of the circular path.

(4) minimum at the lowest position of the circular path.

Q61. A particle experiences a variable force $\vec{\mathrm{F}}=\left(4x\hat{i}+3y^2\hat{j}\right)$ in a horizontal $x-y$ plane. Assume distance in meters and force is newton. If the particle moves from point $(1,2)$ to point $(2,3)$ in the $x-y$ plane, then Kinetic Energy changes by : ***24 Jun 2022 (M)***

(1) 25 J (2) 50 J
(3) 12.5 J (4) 0 J

Q62. A ball of mass 100 g is dropped from a height $h = 10$ cm on a platform fixed at the top of a 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 _____ N m^{-1} (Use $g = 10\ \text{m s}^{-2}$)



24 Jun 2022 (M)

Q63. 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 : ***24 Jun 2022 (E)***

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

Q64. 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: ***01 Sep 2021 (E)***

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

Q65. An engine is attached to a wagon through a shock absorber of length 1.5 m. The system with a total mass of 40,000 kg is moving with a speed of 72 km h^{-1} when the brakes are applied to bring it to rest. In the process of the system being brought to rest, the spring of the shock absorber gets compressed by 1.0 m. If 90% of energy of the wagon is lost due to friction, the spring constant is _____ $\times 10^5\ \text{N m}^{-1}$. ***01 Sep 2021 (E)***

Q66. A block moving horizontally on a smooth surface with a speed of 40 m s^{-1} splits into two equal parts. If one of the parts moves at 60 m s^{-1} in the same direction, then the fractional change in the kinetic energy will be $x : 4$ where $x =$ _____. ***31 Aug 2021 (M)***

Q67. A block moving horizontally on a smooth surface with a speed of 40 m s^{-1} splits into two parts with masses in the ratio of 1 : 2. If the smaller part moves at 60 m s^{-1} in the same direction, then the fractional change in kinetic energy is : ***31 Aug 2021 (E)***

(1) $\frac{1}{3}$ (2) $\frac{2}{3}$
(3) $\frac{1}{4}$ (4) $\frac{1}{8}$

Q68. 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 angles 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 _____.

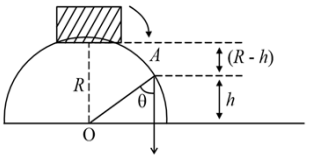
27 Aug 2021 (M)

Q69. The height of victoria's falls is 63 m. What is the difference in the temperature of water at the top and at the bottom of the fall? [Given 1 cal = 4.2 J and specific heat of water = 1 cal $\text{g}^{-1}\ ^\circ\text{C}^{-1}$] ***27 Aug 2021 (E)***

(1) 14.76 °C (2) 1.476 °C
(3) 0.147 °C (4) 0.014 °C

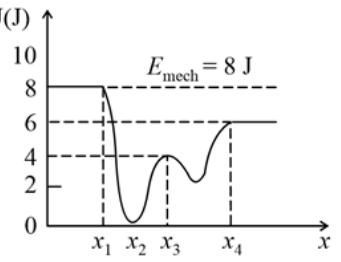
Q70. A uniform chain of length 3 m and mass 3 kg overhangs a smooth table with 2 m laying on the table. If K is the kinetic energy of the chain in J as it completely slips off the table, then the value of K is _____
$\left(\text{Take g} = 10\ \text{m s}^{-2}\right)$ ***26 Aug 2021 (M)***

Q71. 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)



27 Jul 2021 (E)

Q72. Given below is the plot of a potential energy function U(x) for a system, in which a particle is in one dimensional motion, while a conservative force F(x) acts on it. Suppose that $\text{E}_{\text{mech}} = 8$ J, the incorrect statement for this system is :



[where K.E. = kinetic energy]

27 Jul 2021 (E)

(1) at $\text{x} > \text{x}_4$, K. E. is constant throughout the region.
(2) at $\text{x} < \text{x}_1$, K. E. is smallest and the particle is moving at the slowest speed.
(3) at $\text{x} = \text{x}_2$, K. E. is greatest and the particle is moving at the fastest speed.
(4) at $\text{x} = \text{x}_3$, K. E. $= 4$ J

Q73. An automobile of mass m accelerates starting from the origin and initially at rest, while the engine supplies constant power P. The position is given as a function of time by: ***27 Jul 2021 (E)***

(1) $\left(\frac{9P}{8\,m}\right)^{\frac{1}{2}} t^{\frac{3}{2}}$ (2) $\left(\frac{8P}{9\,m}\right)^{\frac{1}{2}} t^{\frac{2}{3}}$
(3) $\left(\frac{9m}{8P}\right)^{\frac{1}{2}} t^{\frac{3}{2}}$ (4) $\left(\frac{8P}{9\,m}\right)^{\frac{1}{2}} t^{\frac{3}{2}}$

Q74. A force of $F = \left(5y + 20\right)\hat{\text{j}}$ N acts on a particle. The work done by this force when the particle is moved from $y = 0$ m to $y = 10$ m is _____J. ***25 Jul 2021 (E)***

Q75. 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 $g = 9.8\ \text{ms}^{-2}$)
22 Jul 2021 (M)

(1) -62720.0 J (2) -627.2 J
(3) $+627.2$ J (4) 784.0 J

Q76. If the kinetic energy of a moving body becomes four times its initial kinetic energy, then the percentage change in its momentum will be: ***20 Jul 2021 (E)***

(1) 100% (2) 200%
(3) 300% (4) 400%

Q77. A ball of mass 4 kg, moving with a velocity of 10 m s^{-1}, collides with a spring of length 8 m and force constant 100 N m^{-1}. The length of the compressed spring is x m. The value of x, to the nearest integer, is ___

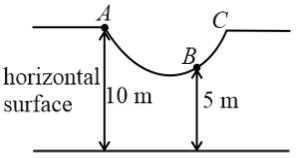
. ***18 Mar 2021 (E)***

Q78. A constant power delivering machine has towed a box, which was initially at rest, along a horizontal straight line. The distance moved by the box in time t is proportional to :- ***18 Mar 2021 (M)***

(1) $t^{\frac{2}{3}}$ (2) $t^{\frac{3}{2}}$

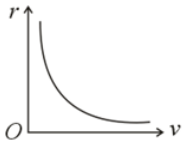
(3) t (4) $t^{\frac{1}{2}}$

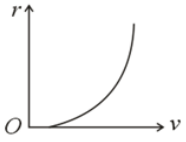
Q79. As shown in the figure, a particle of mass 10 kg is placed at a point A. When the particle is slightly displaced to its right, it starts moving and reaches the point B. The speed of the particle at B is x m s^{-1}. (Take $g = 10$ m s^{-2}) The value of x to the nearest integer is

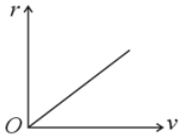


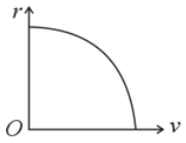
18 Mar 2021 (M)

Q80. A particle of mass m moves in a circular orbit under the central potential field, $U(r) = \frac{-C}{r}$, where C is a positive constant. The correct radius - velocity graph of the particle's motion is : ***18 Mar 2021 (E)***

(1) 

(2) 

(3) 

(4) 

Q81. A boy is rolling a 0.5 kg ball on the frictionless floor with the speed of 20 m s^{-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? ***17 Mar 2021 (M)***

(1) 19.0 m s^{-1} (2) 4.4 m s^{-1}

(3) 14.41 m s^{-1} (4) 1.00 m s^{-1}

Q82. Two particles having masses 4 g and 16 g respectively are moving with equal kinetic energies. The ratio of the magnitudes of their linear momentum is $n : 2$. The value of n will be ___. ***25 Feb 2021 (E)***

Q83. The potential energy (U) of a diatomic molecule is a function dependent on r (interatomic distance) as $U = \frac{\alpha}{r^{10}} - \frac{\beta}{r^5} - 3$ where, α and β are positive constants. The equilibrium distance between two atoms will be $\left(\frac{2\alpha}{\beta}\right)^{\frac{a}{b}}$, where $a =$_____ . ***25 Feb 2021 (M)***

Q84. 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 is in the ratio $5 : 1$. The velocity of the bob at the highest position is _____ m s^{-1}. (Take $g = 10$ m s^{-2}) ***25 Feb 2021 (M)***

Q85. Two solids A and B of mass 1 kg and 2 kg respectively are moving with equal linear momentum. The ratio of their kinetic energies $(K.E.)_A : (K.E.)_B$ will be $\frac{A}{1}$, so the value of A will be _____. ***24 Feb 2021 (E)***

Q86. If the potential energy between two molecules is given by $U = \frac{A}{r^6} + \frac{B}{r^{12}}$, then at equilibrium, separation between molecules, and the potential energy are: ***06 Sep 2020 (M)***

(1) $\left(\frac{\mathrm{B}}{2\mathrm{A}}\right)^{1/6}, -\frac{\mathrm{A}^2}{2\mathrm{B}}$ (2) $\left(\frac{\mathrm{B}}{\mathrm{A}}\right)^{1/6}, 0$

(3) $\left(\frac{2B}{A}\right)^{1/6}, \frac{A^2}{4B}$ (4) $\left(\frac{\mathrm{B}}{2\mathrm{A}}\right)^{\frac{1}{6}}, \frac{\mathrm{A}^2}{2\mathrm{B}}$

Q87. A body of mass 2 kg is driven by an engine delivering a constant power of $1\ \mathrm{J\ s^{-1}}$. the body starts from rest and moves in a straight line. After 9 s, the body has moved a distance (in m)…. ***05 Sep 2020 (E)***

Q88. A person pushes a box on a rough horizontal plateform surface. He applies a force of 200 N over a distance of 15 m. Thereafter, he gets progressively tired and his applied force reduces linearly with distance to 100 N. The total distance through which the box has been moved is 30 m. What is the work done by the person during the total movement of the box? ***04 Sep 2020 (E)***

(1) 3280 J (2) 2780 J

(3) 5690 J (4) 5250 J

Q89. A particle of charge q and mass m is subjected to an electric field $E = E_0\left(1-ax^2\right)$ in the $x-$direction, where a and E_0 are constants. Initially the particle was at rest at $x = 0$. Other than the initial position the kinetic energy of the particle becomes zero when the distance of the particle from the origin is : ***04 Sep 2020 (E)***

(1) a (2) $\sqrt{\frac{2}{\mathrm{a}}}$

(3) $\sqrt{\frac{3}{\mathrm{a}}}$ (4) $\sqrt{\frac{1}{\mathrm{a}}}$

Q90. A cricket ball of mass 0.15 kg is thrown vertically up by a bowling machine so that it rises to a maximum height of 20 m after leaving the machine. If the part pushing the ball applies a constant force F on the ball applies a constant force F on the ball and moves horizontally a distance of 0.2 m while launching the ball, the value of $F(\text{in } N)$ is $\left(g = 10\ \mathrm{m\ s^{-2}}\right)$ ***03 Sep 2020 (M)***

Q91. Hydrogen ion and singly ionized helium atom are accelerated, from rest, through the same potential difference. The ratio of final speeds of hydrogen and helium ions is close to: ***03 Sep 2020 (E)***

(1) 1 : 2 (2) 10 : 7

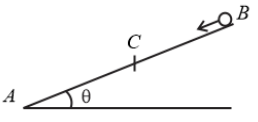
(3) 2 : 1 (4) 5 : 7

Q92. In a reactor, 2 kg of $_{92}\mathrm{U}^{235}$ fuel is fully used up in 30 days. The energy released fission is 200 MeV. Given that the Avogadro number, $\mathrm{N} = 6.023 \times 10^{26}$ per kilo mole and $1\ \mathrm{eV} = 1.6 \times 10^{-19}$ J. The power output of the reactor is close to: ***02 Sep 2020 (M)***

(1) 35 MW (2) 60 MW

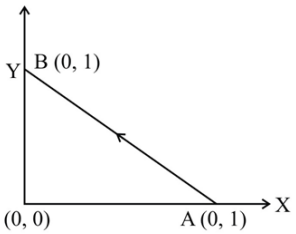
(3) 125 MW (4) 54 MW

Q93. A small block starts slipping down from a point B on an inclined plane AB, which is making an angle θ with the horizontal section BC is smooth and the remaining section CA is rough with a coefficient of friction μ. It is found that the block comes to rest as it reaches the bottom (point A) of the inclined plane. If $BC = 2AC$, the coefficient of friction is given by $\mu = \mathrm{k}\ \tan\theta$. The value of k is .....



02 Sep 2020 (M)

Q94. Consider a force $\vec{F} = -x\hat{i} + y\hat{j}$. The work done by this force in moving a particle from point $A(1,0)$ to $B(0,1)$ along the line segment is: (all quantities are in SI units)

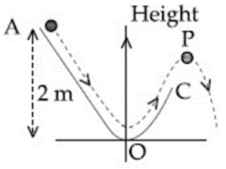


09 Jan 2020 (M)

(1) 2 (2) $\frac{1}{2}$

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

Q95. A particle $(\mathrm{m} = 1\mathrm{kg})$ slides down a frictionless track (AOC) starting from rest at a point A (height $2\mathrm{m}$). After reaching $C,$ the particle continues to move freely in air as a projectile. When it reaching its highest point P (height $1\mathrm{m}$), the kinetic energy of the particle (in J) is: (Figure drawn is schematic and not to scale; take $g = 10\mathrm{ms}^{-2}$) _____.



07 Jan 2020 (M)

Q96. A 60HP electric motor lifts an elevator having a maximum total load capacity of $2000\ \mathrm{kg}$. If the frictional force on the elevator is 4000 N, the speed of the elevator at full load is close to :

$\left(1\ \mathrm{HP} = 746\ \mathrm{W},\ g = 10\ \mathrm{m\ s^{-2}}\right)$

(1) $1.7\ \mathrm{m\ s^{-1}}$ (2) $1.9\ \mathrm{m\ s^{-1}}$

(3) $1.5\ \mathrm{m\ s^{-1}}$ (4) $2.0\ \mathrm{m\ s^{-1}}$

Q97. A uniform cable of mass M and length L is placed on a horizontal surface such that its $\left(\frac{1}{n}\right)^{\mathrm{th}}$ part is hanging below the edge of the surface. To lift the hanging part of the cable upto the surface, the work done should be:

09 Apr 2019 (M)

(1) $\frac{MgL}{2n^2}$ (2) $\frac{MgL}{n^2}$

(3) $nMgL$ (4) $\frac{2MgL}{n^2}$

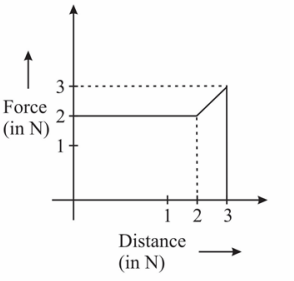
Q98. A wedge of mass $M = 4m$ lies on a frictionless plane. A particle of mass m approaches the wedge with speed v. There is no friction between the particle and the plane or between the particle and the wedge. The maximum height climbed by the particle on the wedge is given by:

09 Apr 2019 (E)

(1) $\frac{v^2}{g}$ (2) $\frac{v^2}{2g}$

(3) $\frac{2v^2}{5g}$ (4) $\frac{2v^2}{7g}$

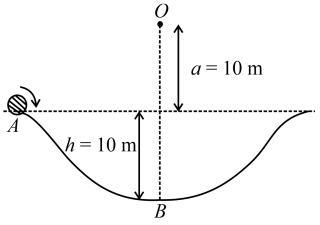
Q99. A particle moves in one dimension from rest under the influence of a force that varies with the distance traveled by the particle as shown in the figure. The kinetic energy of the particle after it has traveled $3\ \mathrm{m}$ is:



08 Apr 2019 (M)

(1) 4 J (2) 2.5 J (3) 6.5 J (4) 5 J

Q100. A particle of mass 20 g is released with an initial velocity $5\ \text{m s}^{-1}$ along the curve from the point A, as shown in the figure. The point A is at height h from point B. The particle slides along the frictionless surface. When the particle reaches point B, its angular momentum about O will be: (Take $g = 10\ \text{m s}^{-2}$)



12 Jan 2019 (E)

(1) $3\ \text{kg m}^2\ \text{s}^{-1}$ (2) $2\ \text{kg m}^2\ \text{s}^{-1}$
(3) $6\ \text{kg m}^2\ \text{s}^{-1}$ (4) $8\ \text{kg m}^2\ \text{s}^{-1}$

Q101. A particle which is experiencing a force, given by $\vec{F} = 3\hat{i} - 12\hat{j}$, undergoes a displacement of $\vec{d} = 4\hat{i}$. If the particle had a kinetic energy of 3 J at the beginning of the displacement, what is its kinetic energy at the end of the displacement?

10 Jan 2019 (E)

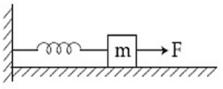
(1) 9 J. (2) 15 J.
(3) 12 J. (4) 10 J.

Q102. A force acts on a 2 kg object so that its position is given as a function of time as $x = 3t^2 + 5$. What is the work done by this force in first 5 seconds?

09 Jan 2019 (E)

(1) 875 J (2) 850 J
(3) 950 J (4) 900 J

Q103. A block of mass m, lying on a smooth horizontal surface, is attached to a spring (of negligible mass) of spring constant k. The other end of the spring is fixed, as shown in the figure. The block is initially at rest in its equilibrium position. If now the block is pulled with a constant force F, the maximum speed of the block is:



09 Jan 2019 (M)

(1) $\frac{F}{\sqrt{mk}}$ (2) $\frac{2F}{\sqrt{mk}}$
(3) $\frac{\pi F}{\sqrt{mk}}$ (4) $\frac{F}{\pi\sqrt{mk}}$

ANSWER KEYS

1. (4)	**2.** (58)	**3.** (1)	**4.** (2)	**5.** (4)	**6.** (1)	**7.** (4)	**8.** (2)
9. (1)	**10.** (4)	**11.** (2)	**12.** (6)	**13.** (4)	**14.** (2)	**15.** (2)	**16.** (3)
17. (3)	**18.** (1)	**19.** (2)	**20.** (3)	**21.** (2)	**22.** (30)	**23.** (2)	**24.** (3)
25. (1)	**26.** (784)	**27.** (32)	**28.** (48)	**29.** (245)	**30.** (30)	**31.** (375)	**32.** (1)
33. (40)	**34.** (132)	**35.** (67)	**36.** (7)	**37.** (4)	**38.** (1)	**39.** (300)	**40.** (2)
41. (40)	**42.** (100)	**43.** (24)	**44.** (1)	**45.** (4)	**46.** (2)	**47.** (2)	**48.** (2)
49. (2)	**50.** (1)	**51.** (4)	**52.** (5)	**53.** (2)	**54.** (3)	**55.** (3)	**56.** (1)
57. (1)	**58.** (600)	**59.** (3)	**60.** (3)	**61.** (1)	**62.** (120)	**63.** (3)	**64.** (1)
65. (16)	**66.** (1)	**67.** (4)	**68.** (2)	**69.** (3)	**70.** (40)	**71.** (2)	**72.** (2)
73. (4)	**74.** (450)	**75.** (2)	**76.** (1)	**77.** (6)	**78.** (2)	**79.** (10)	**80.** (1)
81. (2)	**82.** (1)	**83.** (1)	**84.** (5)	**85.** (2)	**86.** (3)	**87.** (18)	**88.** (4)
89. (3)	**90.** (150)	**91.** (3)	**92.** (2)	**93.** (3)	**94.** (3)	**95.** (10)	**96.** (2)
97. (1)	**98.** (3)	**99.** (3)	**100.** (3)	**101.** (2)	**102.** (4)	**103.** (1)	