KATTAR NEET 2026

Physics by Saleem Sir

Work, energy and power

Q1 A truck accelerates from speed v to 2v. Work done during this velocity change is:

(A) three times as the work done in accelerating it from rest to v

(B) same as the work done in accelerating it from rest to v

(C) four times as the work done in accelerating it from rest to v

(D) less than the work done in accelerating it from rest to v

Q2 A body of mass 10 kg moves with a constant speed v of $2ms^{-1}$ along a circular path of radius 8 m. The power produced by the body will be:

(A) $10\ Js^{-1}$ (B) $98\ Js^{-1}$

(C) $49\ Js^{-1}$ (D) zero

Q3 A rod of mass m and length l is lying on a horizontal table. Work done in making it stand on one end will be:

(A) mgl

(B) $\frac{mgl}{2}$

(C) $\frac{mgl}{4}$

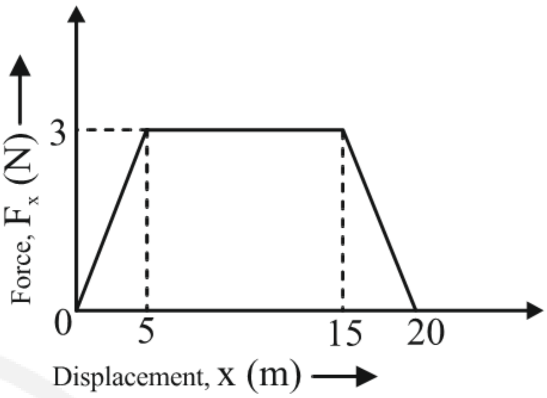
(D) $2\ mgl$

Q4 300 J of work is done in sliding a 2 kg block up an inclined plane of height 10 m. Taking $g = 10\ m/s^2$, work done against friction is:

(A) 200 J (B) 100 J

(C) Zero (D) 1000 J

Q5 A force F_x, acts on a particle such that its position x changes as shown in the figure.

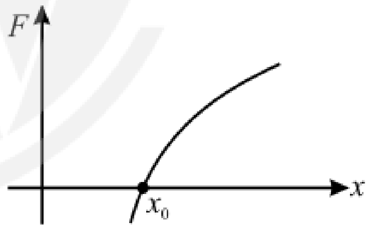


The work done by the particle as it moves from $x = 0$ to 20 m is:

(A) 37.5 J (B) 10 J

(C) 15 J (D) 45 J

Q6 Consider a particle moving along x-axis due to conservative force acting on it. If graph of conservative force F acting on it versus position x is as shown below, then



(A) particle is in stable equilibrium at $x = x_0$.

(B) particle is in neutral equilibrium at $x = x_0$.

(C) particle is in unstable equilibrium at $x = x_0$

(D) particle is not in equilibrium at $x = x_0$

Q7 Find the angle between force $\vec{F} = (3\hat{i} + 4\hat{j} + 7\hat{k})$ unit and displacement $\vec{S} = (2\hat{i} - 5\hat{k})$ unit.

(A) $\cos^{-1}\left(\frac{29}{37}\right)$ (B) $\cos^{-1}\left(-\frac{29}{37}\right)$

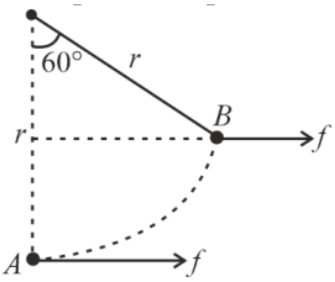
(C) $\cos^{-1}\left(\frac{1}{74}\right)$ (D) $\cos^{-1}\left(-\sqrt{\frac{29}{74}}\right)$

Q8

A particle of mass 100 g is thrown vertically upwards with a speed of 5 m/s. The work done by the force of gravity during the time the particle goes up is

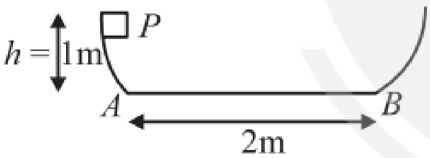
(A) –0.5 J (B) –1.25 J
(C) 1.25 J (D) 0.5 J

Q9 If a small ball of mass m is pulled along vertical circular arc with a constant horizontal force f as shown in figure then work done by this force in pulling it from point A to point B is:



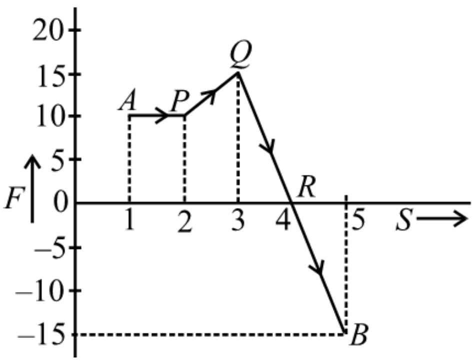
(A) 0.5 mgr (B) fr
(C) $\frac{\sqrt{3}}{2}fr$ (D) $\frac{1}{3}fr$

Q10 The curved portions are smooth and horizontal surface is rough, as shown If a block is released from P. At what distance from A, it will stop ? (if $\mu = 0.2$)



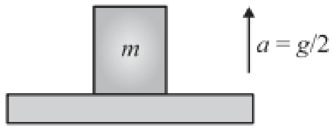
(A) 1 m (B) 2 m
(C) 3 m (D) 4 m

Q11 A body moves from point A to B under the action of a force varying in magnitude as shown in figure, then the work done is (force is expressed in newton and displacement in metre)



(A) 30 J (B) 22.5 J
(C) 25 J (D) 27 J

Q12 A block of mass m is kept on a platform which starts from rest with constant acceleration $g/2$ upward, as shown in figure. Work done by normal reaction on block in time t is:



(A) $\frac{-mg^2t^2}{8}$
(B) $\frac{mg^2t^2}{8}$
(C) zero
(D) $\frac{3mg^2t^2}{8}$

Q13 Given below are two statements:

Statement I: In an elastic collision $(e = 1)$ between two bodies; conservation of kinetic energy holds true, i.e., $(K_1 + K_2)_i = (K_1 + K_2)_f$

Statement II: In an elastic collision conservation of momentum of the system holds true i.e., $(p_1 + p_2)_i = (p_1 + p_2)_f$

In the light of the above statements, choose the most appropriate answer from the options given below:

(A) Statement I is correct but Statement II is incorrect.
(B) Statement I is incorrect but Statement II is correct.
(C) Both Statement I and Statement II are correct.
(D) Both Statement I and Statement II are incorrect.

Q14 A tangential force F acts along the rim of a ring of radius R and displaces the ring through an angle θ. The work done by the force is:

(A) $FR^2\theta$ (B) $\frac{FR}{\theta}$
(C) $\frac{FR\theta}{2}$ (D) $FR\theta$

Q15 At position A, kinetic energy of a particle is 60 J and potential energy is –20 J. At position B, kinetic energy is 100 J and potential energy is 40

J. Choose the **correct** statement, if the particle moves from *A* to *B*.
(A) Work done by conservative forces is 50 J.
(B) Work done by external forces is 40 J.
(C) Net work done by all the forces is 40 J.
(D) Net work done by all the forces is 100 J.

Q16 A car of mass m starts from rest and accelerates so that the instantaneous power delivered to the car has a constant magnitude P_0. The instantaneous velocity of this car is proportional to: (where t is time)
(A) $t^2 P_0$
(B) $t^{1/2}$
(C) $t^{-1/2}$
(D) $\frac{1}{\sqrt{m}}$

Q17 A particle of mass M starting from rest undergoes uniform acceleration. If the speed acquired in time T is V, the power delivered to the particle is:

(A) $\frac{1}{2}\frac{MV^2}{T^2}$
(B) $2\frac{MV^2}{T^2}$
(C) $\frac{MV^2}{T^2}$
(D) $\frac{1}{2}\frac{MV^2}{T}$

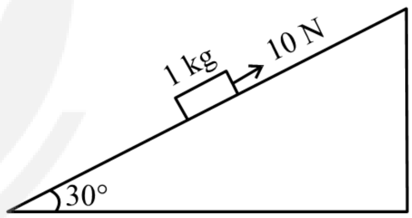
Q18 A car of mass m is driven with an acceleration a along a straight level road against a constant external resistive force R. When the velocity of the car is v, the rate at which engine of the car is doing work, will be
(A) Rv
(B) mav
(C) $(R+ma)v$
(D) $(ma-R)v$

Q19 Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R:
Assertion A: The potential energy of a system increases when work is done by conservative force.
Reason R: Kinetic energy can change into potential energy and vice-versa.
In the light of the above statements, choose the **correct** answer from the options given below:
(A) A is true but R is false.
(B) A is false but R is true.
(C) Both A and R are true and R is the correct explanation of A.
(D) Both A and R are true but R is NOT the correct explanation of A.

Q20 A body of mass 5 kg travels in straight line with velocity $v = kx^{3/2}$ where $k = 8m^{\frac{-1}{2}}s^{-1}$. Work done by the net force acting on the body during its displacement from x=1 m to x=4 m will be
(A) 10080 J
(B) 140 J
(C) 7840 J
(D) 12380 J

Q21 A positon-dependent force F = $(3x^2 - 2x + 7)$ N acts on a body of mass 7 kg and displaces it from $x = 0$ m to $x = 5$ m. The work done on the body is y joule. If both F and x are measured in SI units, the value of y is:
(A) 135
(B) 235
(C) 335
(D) 935

Q22 A block of mass 1 kg is pushed up a surface inclined to horizontal at an angle 30° by a force of 10 N parallel to the inclined surface as shown in the figure.



If the block is pushed up by 10 m along the incline, then the work against gravity is:
(Take g =10 ms^{-2})
(A) 10 J
(B) 50 J
(C) 100 J
(D) 150 J

Q23 Reyaansh roy and his sister Aarohi roy race up a hill. Reyaansh weighs twice as much as Aarohi and takes twice as long as Aarohi to reach the top. Hence compared to Aarohi
(A) Reyaansh did more work and delivered more power.
(B) Reyaansh did more work and delivered the same amount of power.
(C) Reyaansh did more work and delivered less power.

(D) Reyaansh did less work and Aarohi delivered less power.

Q24 A particle moves from point $P(1m, 2m, 3m)$ to $Q(3m, 2m, 4m)$ under the action of a constant force $F = (\hat{i} + 2\hat{j} + 3\hat{k})N$. Work done by the force is:

(A) 4 J (B) –4 J
(C) 5 J (D) –5 J

Q25 A body is dropped from a certain height. When it loses U amount of its energy it acquires a velocity 'v'. The mass of the body is:

(A) $\frac{2U}{v^2}$
(B) $\frac{2v}{U^2}$
(C) $\frac{2v}{U}$
(D) $\frac{U^2}{2v}$

Q26 A car of mass 1250 kg experience a resistance of 750 N when it moves at 30 ms^{-1}. If the engine can develop 30 kW at this speed, the maximum acceleration that the engine can produce is

(A) 0.8 ms^{-2}
(B) 0.2 ms^{-2}
(C) 0.4 ms^{-2}
(D) 0.5 ms^{-2}

Q27 A body of mass 5 kg is moving with a momentum of 10 kg-m/s. A force of 0.2 N acts on it in the direction of motion of the body for 10 seconds. The increase in its kinetic energy is

(A) 2.8 J (B) 3.2 J
(C) 3.8 J (D) 4.4 J

Q28 A force acts on a 2 kg object so that its position is given as a function of time as $x = (3t^2 + 5)$ m. What is the work done by this force in first 5 seconds?

(A) 850 J (B) 950 J
(C) 875 J (D) 900 J

Q29 A block of mass 10 kg moving in x-direction with a constant speed of 10 m/s, is subjected to a retarding force F = –0.1x J/m during its travel from x = 20 m to 30 m. Its final K.E. will be

(A) 475 J (B) 450 J
(C) 275 J (D) 250 J

Q30 **Statement I :** If the velocity of a body becomes 5 times, then K.E. becomes 125 times.
Statement II : Kinetic energy, K.E. $= \frac{1}{2}mv^2$

(A) Statement I and statement II both are correct.
(B) Statement I is correct and statement II is incorrect
(C) Statement I is incorrect and statement II is correct
(D) Both statements are incorrect

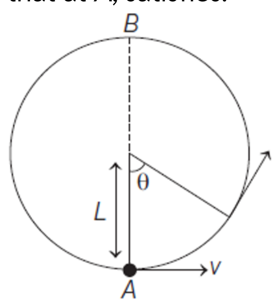
Q31 A force $\vec{F} = -k\left(y\hat{i} + x\hat{j}\right)$N (where, *k* is a positive constant) acts on a particle moving in the *x*–*y* plane. Starting from the origin, the particle is taken along the positive *X*-axis to the point (*a*, 0) and then parallel to the *Y*-axis to the point (*a*,*a*). The total work done in joule by the force *F* on the particle is:

(A) $-2ka^2$ (B) $2ka^2$
(C) $-ka^2$ (D) ka^2

Q32 An ideal spring with spring constant *k* is hung from the ceiling and a block of mass *M* is attached to its lower end. The mass is released with the spring initially unstretched. Then the maximum extension in the spring is:

(A) $\frac{4Mg}{k}$ (B) $\frac{2Mg}{k}$
(C) $\frac{Mg}{k}$ (D) $\frac{Mg}{2k}$

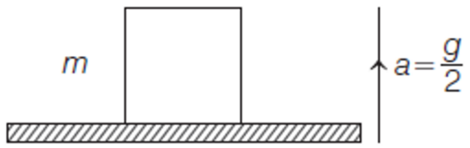
Q33 A bob of mass *M* is suspended by a massless string of length *L*. The horizontal velocity *v* at position *A* is just sufficient to make it reach the point *B*. The angle θ at which the speed of the bob is half of that at *A*, satisfies:



(A) $\theta = \frac{\pi}{4}$

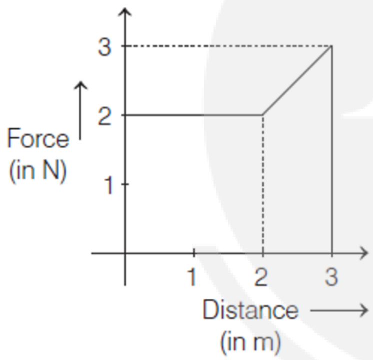
(B) $\frac{\pi}{4} < \theta < \frac{\pi}{2}$
(C) $\frac{\pi}{2} < \theta < \frac{3\pi}{4}$
(D) $\frac{3\pi}{4} < \theta < \pi$

Q34 A block of mass m is kept on a platform which starts from rest with constant acceleration $\frac{g}{2}$ upwards as shown in figure. Work done by normal reaction on block in time t is:



(A) $\frac{mg^2t^2}{8}$
(B) $\frac{3mg^2t^2}{8}$
(C) 0
(D) $-\frac{mg^2t^2}{8}$

Q35 A particle moves in one dimension from rest under the influence of a force that varies with the distance travelled by the particle as shown in the figure. The kinetic energy of the particle after it has travelled 3 m is:



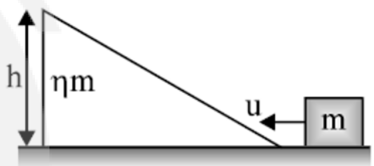
(A) 4 J
(B) 2.5 J
(C) 6.5 J
(D) 5 J

Q36 There are two identical massless springs A and B of spring constants K_A and K_B respectively and $K_A > K_B$. Then:
(A) If they are compressed to same distance, then work done on A > work done on B
(B) If they are compressed by same force work done on A < work done on B
(C) If they are compressed by same force work done on A > work done on B
(D) Both A and B are correct.

Q37 A body m_1 is projected upwards with velocity v_1, another body m_1 of same mass is projected at an angle of 45°. Both reach the same height. What is the ratio of their kinetic energies at the point of projection?
(A) 1
(B) $\frac{1}{2}$
(C) $\frac{1}{3}$
(D) $\frac{1}{4}$

Q38 The potential energy of a particle varies with position x according to the relation $U(x) = 2x^4 - 27x$ the point $x = \frac{3}{2}$ is point of:
(A) Unstable equilibrium
(B) Stable equilibrium
(C) Neutral equilibrium
(D) None of these

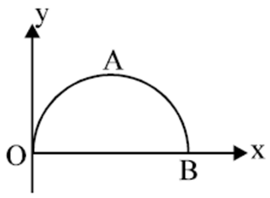
Q39 A block of mass m is pushed towards a movable wedge of ηm and height h, with a velocity u. All surfaces are smooth. The minimum value of u for which the block will reach the top of the wedge is :



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

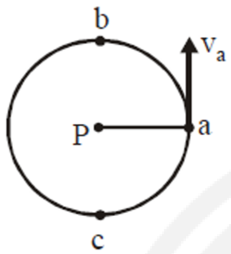
Q40 Power supplied to a particle of mass 2kg varies with time as $P = \frac{3t^2}{2}W$ where 't' is in second. If velocity of particle at time t = 0 is v = 0. The velocity of particle at time t = 2s will be:
(A) 1 m/s
(B) 4 m/s
(C) 2 m/s
(D) $2\sqrt{2}$ m/s

Q41 Given $\vec{F} = \left(xy^2\right)\hat{i} + \left(x^2y\right)\hat{j}$ newton. Find the work done by $\vec{F}$ when a particle is taken along the semicircular path OAB where the co-ordinates of B are (4, 0):



(A) $\frac{65}{3}$ J (B) $\frac{75}{2}$ J
(C) $\frac{73}{4}$ J (D) zero

Q42 If a particle is tied to a light inextensible string of length L fixed at P and particle is projected at a with velocity $v_a = \sqrt{4gL}$ as shown. The ratio of tension at c and b is:



(A) 5 : 1 (B) 7 : 1
(C) 6 : 1 (D) 1 : 4

Q43 Two masses of 1 g and 4 g are moving with equal kinetic energies. The ratio of the magnitudes of their momenta is:
(A) 4 : 1 (B) $\sqrt{2} : 1$
(C) 1 : 2 (D) 1 : 16

Q44 A body is moved along a straight line by a machine delivering constant power. The distance moved by the body in time t is proportional to:
(A) $t^{1/2}$ (B) $t^{3/4}$
(C) $t^{3/2}$ (D) t^2

Q45 A child on a swing is 1 m above the ground at the lowest point and 6 m above the ground at the highest point. The horizontal speed of the child at the lowest point of the swing is approximately:
(A) 8 m/s (B) 10 m/s
(C) 12 m/s (D) 14 m/s

Q46 Choose the **correct** statement(s) from the following.
I. No work is done if the displacement is perpendicular to the direction of the applied force.
II. If the angle between the force and displacement vectors is obtuse, then the work done is negative.
III. All the central forces are non-conservative.
(A) I only (B) I and II
(C) II and III (D) I, II and III

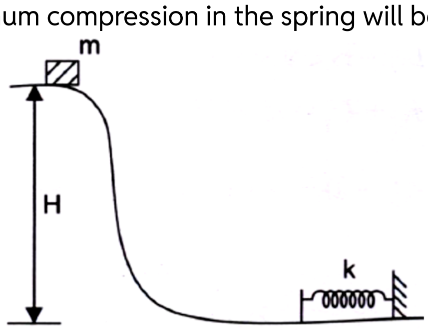
Q47 At time t = 0s particle starts moving along the x-axis. If its kinetic energy increases uniformly with time t, the net force acting on it must be proportional to:
(A) $\sqrt{t}$ (B) constant
(C) t (D) $\frac{1}{\sqrt{t}}$

Q48 A uniform cable of mass M and length L is placed on a horizontal surface such that its $\left(\frac{1}{n}\right)$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:
(A) $\frac{2MgL}{n^2}$ (B) $nMgL$
(C) $\frac{MgL}{n^2}$ (D) $\frac{MgL}{2n^2}$

Q49

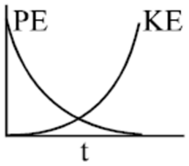
A body is projected vertically upwards with some velocity. At a point in its path the ratio of potential to kinetic energy is 25 : 144. Then the ratio of the velocity of projection to the velocity at that point is:
(A) 12 : 13 (B) 9 : 4
(C) 13 : 12 (D) 17 : 13

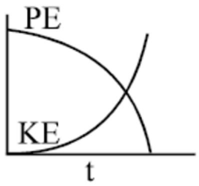
Q50 A spring of spring constant 'k' is fixed horizontally at the bottom of a hilly terrain as shown in the figure. A small block of mass m, initially at an altitude 'H' is gently pushed downwards. Assuming no friction anywhere, the maximum compression in the spring will be:

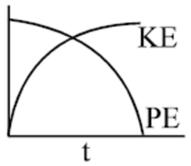


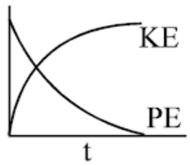
(A) $\sqrt{2gH}$ (B) mgH
(C) $\sqrt{\frac{mgH}{k}}$ (D) $\sqrt{\frac{2mgH}{k}}$

Q51 A particle falls from rest under gravity. Its potential energy with respect to the ground (PE) and its kinetic energy (KE) are plotted against time (t). Choose the **correct** graph.

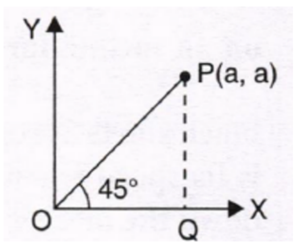
(A)


(B)


(C)


(D)


Q52 A particle is moved from (0, 0) to (a, a) under a force $\vec{F} = \left(3\hat{i} + 4\hat{j}\right)$ from two paths. Path 1 is OP and path 2 is OQP. Let w_1 and w_2 be the work done by this path force in these two paths. Then:



(A) $w_1 = w_2$ (B) $w_1 = 2w_2$
(C) $w_2 = 2w_1$ (D) $w_2 = 4w_1$

Q53 A body of mass m is moving with the velocity $+v\hat{i}$. After some time it is found that its momentum is changed by $+3mv\hat{i}$, then the final kinetic energy of the body is;

(A) $4mv^2$ (B) $2mv^2$
(C) $8mv^2$ (D) $16mv^2$

Q54 A force $\overline{F} = \left(2\hat{i} + 3\hat{j}\right)\text{N}$ displaces a body from its initial position $\vec{r}_1 = \left(2\hat{i} + 4\hat{j}\right)\text{m}$ to final position $\vec{r}_2 = \left(3\hat{i} + 7\hat{j}\right)\text{m}$. The work done by the force is;

(A) 4 J (B) 11 J
(C) 3 J (D) 1 J

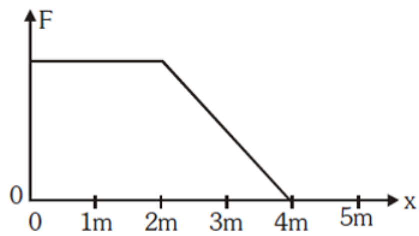
Q55 A variable force (F) is acting on a body which displaces the body from $x = 1$ m to $x = 2$ m. If $F = (3x^2)$ N, then the average force acting between $x = 1$ m to $x = 2$ m is;

(A) 8 N (B) 4 N
(C) 7 N (D) 10 N

Q56 A time dependent force $F = 6t$ acts on a particle of mass 1 kg. If the particle starts from rest, the work done by the force during the first 1 sec. will be :

(A) 9 J (B) 18 J
(C) 4.5 J (D) 22 J

Q57 A body of mass 2.0 kg, free to travel in the x-direction, is subjected to a force directed in the positive x-direction that varies with position as shown in the graph. The force does 9.0 J of work on the body as it moves from x = 0 to x = 5.0 meters. What is the value of F at x = 1.0 meters?



(A) 2 N (B) 3 N
(C) 6 N (D) 9 N

Q58 A train of mass 100 metric tons is ascending uniformly on an incline of 1 in 250, and the resistance due to friction, etc is equal to 6 kg per metric ton. If the engine be of 7.84×10^4 watts and be working at full power, find the speed at which the train is going.

(A) 2 m/s (B) 16 m/s
(C) 8 m/s (D) 10 m/s

Q59 Which of the following statements is/are **INCORRECT**?

(a) Mechanical energy is the sum of kinetic energy and potential energy.
(b) Potential energy is a relative quantity. It depends on the choice of reference point.
(c) Kinetic energy must be non negative.
(d) Potential energy must be positive.

(A) (b) only
(B) (a) and (b) only
(C) (d) only
(D) (c) and (d) only

Q60 A force *F* acting on a body depends on its displacement *x* as $F \propto x^n$. The power delivered by *F* will be independent of *x* if *n* is:

(A) $\frac{1}{3}$ (B) $-\frac{1}{3}$
(C) $\frac{1}{2}$ (D) $-\frac{1}{2}$

Answer Key

Q1	(A)
Q2	(D)
Q3	(B)
Q4	(B)
Q5	(D)
Q6	(C)
Q7	(D)
Q8	(B)
Q9	(C)
Q10	(A)
Q11	(B)
Q12	(D)
Q13	(C)
Q14	(D)
Q15	(C)
Q16	(B)
Q17	(D)
Q18	(C)
Q19	(D)
Q20	(A)
Q21	(A)
Q22	(B)
Q23	(B)
Q24	(C)
Q25	(A)
Q26	(B)
Q27	(D)
Q28	(D)
Q29	(A)
Q30	(C)
Q31	(C)
Q32	(B)
Q33	(D)
Q34	(B)
Q35	(C)
Q36	(D)
Q37	(B)
Q38	(B)
Q39	(C)
Q40	(C)
Q41	(D)
Q42	(B)
Q43	(C)
Q44	(C)
Q45	(B)
Q46	(B)
Q47	(D)
Q48	(D)
Q49	(C)
Q50	(D)
Q51	(A)
Q52	(A)
Q53	(C)
Q54	(B)
Q55	(C)
Q56	(C)
Q57	(B)
Q58	(C)
Q59	(C)
Q60	(B)

Hints & Solutions

Q1 Text Solution:

Work done (W) = ΔK.E = $\frac{1}{2}m\left(v_2{}^2 - v_1{}^2\right)$

Truck accelerated from v to $2v$

$$W = \frac{1}{2}m\left[(2v)^2 - (v)^2\right] = \frac{3}{2}mv^2 \quad \text{...(i)}$$

Truck accelerates from rest v_1 = 0 to v

$$W_1 = \frac{1}{2}m\left(v^2 - 0\right) = \frac{1}{2}mv^2 \quad \text{...(ii)}$$

From equation (i) and (ii), we get

W = 3W_1

Q2 Text Solution:

Power is defined as the rate of change of energy in system or the time rate of doing work.

$\Rightarrow \ P = \frac{dE}{dt} = \frac{dW}{dt}$

Here, P = $\overrightarrow{F} \cdot \overrightarrow{v}$

$as\ \overrightarrow{F}$ is perpendicular to $\overrightarrow{v}$

hence, P = 0

Q3 Text Solution:

(B)

Center of mass of the rod moves a height h= $\frac{l}{2}$.

Work done, $W = mgh = mgl/2$

Q4 Text Solution:

(B)

Net work done = work done against gravitation force + work done against frictional force.

$W = W_g + W_f$

$W = W_f + mgh$

300 = W_f + 2 × 10 × 10

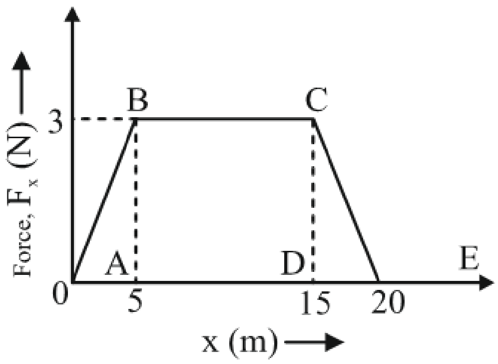
W_f = 300 - 200

W_f = 100J

Q5 Text Solution:

Work done by a variable force,

W_{net} = Area under the force and displacement curve



W = Area of DOBA + Area of ABCD + Area of DDCE

$$W = \frac{1}{2} \times 5 \times 3 + 10 \times 3 + \frac{1}{2} \times 5 \times 3$$

$= \frac{15}{2} + 30 + \frac{15}{2}$

$= \frac{15+60+15}{2} = \frac{90}{2}$

W = 45 J

Q6 Text Solution:

At $x = x_0, F = 0$ and $\frac{dF}{dx} > 0$

$\Rightarrow \frac{dU}{dx} = 0$

And $\Rightarrow \frac{d^2U}{dx^2} < 0$

Q7 Text Solution:

(D)

$\overrightarrow{F} \cdot \overrightarrow{S} = 6 - 35 = -29$ unit

$\left(\because \overrightarrow{F} \cdot \overrightarrow{S} = F_xS_x + F_yS_y + F_zS_z\right)$

Now, $\overrightarrow{F} \cdot \overrightarrow{F} = F^2 = F_x^2 + F_y^2 + F_z^2$

= 9 + 16 + 49

= 74 unit

$\overrightarrow{S} \cdot \overrightarrow{S} = S^2 = S_x^2 + S_y^2 + S_z^2$

= 4 +25

= 29 unit

$$\cos\theta = \frac{\overrightarrow{F} \cdot \overrightarrow{S}}{F\,S} = \frac{-29}{\sqrt{74}\ X\ \sqrt{29}} = -\sqrt{\frac{29}{74}}$$

$$\theta = \cos^{-1}\left(-\sqrt{\frac{29}{74}}\right)$$

Q8 Text Solution:

Given, Mass of the particle, m = 100g
Initial speed of the particle, u = 5 m/s
Final speed of the particle, v = 0
Work done by the force of gravity
= Loss in kinetic energy of the body.

$$=\frac{1}{2}m(v^2-u^2)=\frac{1}{2}\times\frac{100}{1000}(0^2-5^2)$$

= –1.25 J.

Q9 Text Solution:

$$W=f(r\sin 60^{\circ})=\frac{\sqrt{3}}{2}fr$$

Q10 Text Solution:

(1)

The distance travelled by the block on the rough surface can be calculated from energy conservation,

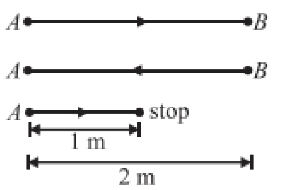
$$k_i+U_i=k_f+U_f+W_F$$

Where, W_F = work done by friction

$$\Rightarrow 0+mgh=0+0+\mu mgS$$

$$\Rightarrow S=\frac{h}{\mu}=\frac{1}{0.2}=5m$$

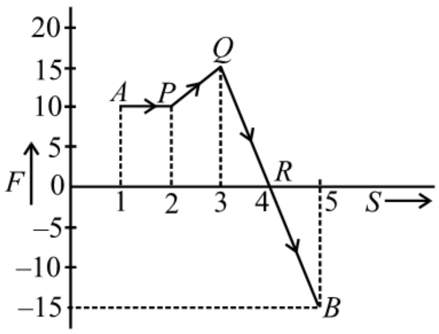
$$S=5m$$



The block stops at distance 1 m from A.

Q11 Text Solution:

Work done = Area under *F-s* curve



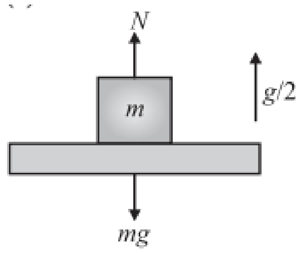
$$W_{AB}=W_{12}+W_{23}+W_{34}+W_{45}$$

= Area under *AP* + Area under *PQ* + Area under *QR* – Area above *RB*

$$=10\times 1+\tfrac{1}{2}(10+15)\times 1+\tfrac{1}{2}\times 1\times 15$$
$$-\tfrac{1}{2}\times 1\times 15$$

= 10 + 12.5 = 22.5 J

Q12 Text Solution:



From FBD,

Normal reaction force on the block is

$$\Rightarrow N=m(g+a)$$
$$=m\left(g+\tfrac{g}{2}\right)$$
$$=\tfrac{3g}{2}m$$
$$\Rightarrow N=\frac{3mg}{2}$$

Displacement of the block

$$S=ut+\frac{1}{2}\left(\frac{g}{2}\right)t^2$$
$$(u=0)$$
$$S=\frac{g}{4}t^2$$

Work done $=F_N\times S$

$$=\frac{3mg}{2}\times\frac{g}{4}t^2$$

Work done $=\dfrac{3mg^2t^2}{8}$

Q13 Text Solution:

1. In inelastic collision also conservation of momentum holds true.
2. If e = 1, the collision is perfectly elastic, with no kinetic energy dissipated and the objects rebounding from each other at the same relative speed with which they approached.
3. Elastic collisions are collisions that conserve both momentum and kinetic energy.
4. The total kinetic energy of the system before the collision equals the total kinetic energy of the system after the collision.

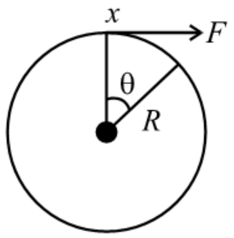
5. If the total kinetic energy is not conserved, the collision is classified as inelastic.

Q14 Text Solution:

Given, displacement = θ

Arc length = x

Then, $x = R\theta$



We know,

Work done = $F.x$

= $F(R\theta)$

Hence, work done by the force is $FR\theta$.

Q15 Text Solution:

Work done by conservative forces = $U_i - U_f$

= –20 – 40 = –60 J

Work done by external forces =

$E_f - E_i = 140 - 40 = 100$ J and net work done by all the forces = $K_f - K_i$

= 100 – 60 = 40 J

Q16 Text Solution:

$W = Pt = \frac{1}{2}mv^2$

$v^2 \propto t \Rightarrow v \propto t^{\frac{1}{2}}$

Q17 Text Solution:

$V = u + at \Rightarrow V = aT \Rightarrow a = \frac{V}{T}$

Work done

$(\mathrm{W}) = \Delta \mathrm{KE} = \frac{1}{2}MV^2 - 0 = \frac{1}{2}MV^2$

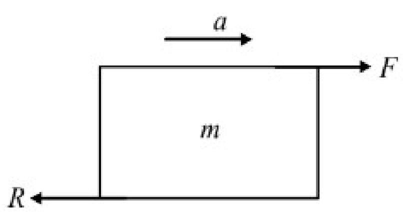
$\text{Power } \left(P\right) = \frac{W}{T} = \frac{1}{2}\frac{MV^2}{T}$

Q18 Text Solution:

From the free body diagram,

$F - R = ma$

$F = R + ma$



Rate of doing work $= P = Fv = (R + ma)v$

Q19 Text Solution:

(4)

Assertion:

- The potential energy of a system increases when work is done by a conservative force.
- This statement is true only if the work is done against the conservative force (e.g., lifting an object against gravity increases gravitational potential energy).
- However, if a conservative force (like gravity or a spring force) does work on the system, the potential energy decreases.

Reason:

- Kinetic energy can change into potential energy and vice-versa.
- This is always true in a conservative system, such as a pendulum or free-falling object.
- Thus, the reason is also true.
- The assertion talks about the potential energy increasing due to conservative forces, but the reason talks generally about kinetic and potential energy transformation.
- The reason is true, but it does not directly explain why potential energy increases due to conservative forces.
- Thus, both A and R are true but R is NOT the correct explanation of A.

Q20 Text Solution:

(1)

Speed at $x = 1 \Rightarrow v = 8(1)^{\frac{3}{2}} = 8ms^{-1}$

Speed at $x = 4 \Rightarrow v = 8\left(4^{\frac{3}{2}}\right) = 64ms^{-1}$

Now, work done $= \Delta k$

$$= k_f - k_i$$
$$= \frac{1}{2}m\left(v_f^2 - v_i^2\right)$$
$$= \frac{1}{2} \times 5\left(64^2 - 8^2\right)$$

$\Delta K = 10080$ joule

Q21 Text Solution:

(A)

This is case of work done by a variable force,

$\therefore \quad W = \int_{x_1}^{x_2} F.\, dx$

$W = \int_0^5 \left(3x^2 - 2x + 7\right) dx$

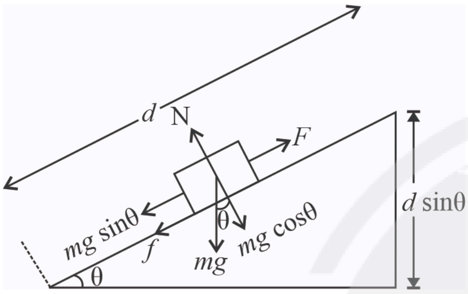
$= \left(x^3 - x^2 + 7x\right)_0^5$

$W = 5 \times 5 \times 5 - 5 \times 5 + 7 \times 5$

$\Rightarrow \quad W = 125 - 25 + 35 = 135\text{J}$

Q22 Text Solution:

The various forces acting on the block are as shown in the figure.



Given, m = 1 kg, $\theta = 30^\circ$, F = 10 N and d = 10 m

$\therefore$ Work done against gravity is

$W_g = mgd\ \sin\theta = (1\ \text{kg})$ × (10 ms^{-2}) × 10 m × sin 30° = 100 × $\frac{1}{2} = 50\text{J}$

Q23 Text Solution:

The work is done against gravity so it is equal to the change in potential energy. W = E_p = mgh

For a fixed height, work is proportional to weight lifted. Since Reyaansh weights twice as much as Aarohi he works twice as hard to get up the hill. Power is work done per unit time. For Reyaansh this is W/Δt. aarohi did half the work in half the time, (1/2 W)/ (1/2 Δt)= W/Δt which is the same power delivered by Reyaansh.

Q24 Text Solution:

Initial position vector, $\vec{r}_i = \hat{i} + 2\hat{j} + 3\hat{k}$

Final position vector, $\vec{r}_f = 3\hat{i} + 2\hat{j} + 4\hat{k}$

Displacement vector,

$$\vec{s} = \vec{r}_f - \vec{r}_i = (3\hat{i} + 2\hat{j} + 4\hat{k}) - (\hat{i} + 2\hat{j} + 3\hat{k}) = (2\hat{i} + \hat{k})$$

Work done,

$W = \vec{F} \cdot \vec{S} = (\hat{i} + 2\hat{j} + 3\hat{k}) \cdot (2\hat{i} + \hat{k})$

$= 2 + 3 = 5J$

Q25 Text Solution:

From energy conservation

$$0 + mgh = (mgh - U) + \frac{1}{2}mv^2$$

$mgh = mgh - U + \frac{1}{2}mv^2$

$U = \frac{1}{2}mv^2 \Rightarrow m = \frac{2U}{v^2}$

Q26 Text Solution:

Power = Force × velocity = (Resistive force + Accelerating force) × velocity

$\Rightarrow 30 \times 10^3 = \left(750 + \text{ma}\right) \times 30 \Rightarrow \text{ma} = 1000 - 750$

$\Rightarrow \text{a} = \frac{250}{1250} = 0.2\ \text{ms}^2$

Q27 Text Solution:

(4)

Change in momentum $= P_2 - P_1 = F \times t$

$\Rightarrow P_2 = P_1 + F \times t = 10 + 0.2 \times 10 = 12$ kg-m / s

Increase in kinetic energy $E = \frac{1}{2m}[P_2^2 - P_1^2]$

$= \frac{1}{2m}[(12)^2 - (10)^2] = \frac{1}{2 \times 5}[144 - 100] = \frac{44}{10} = 4.4\,\text{J}$.

Q28 Text Solution:

Position, $x = 3t^2 + 5$

$\therefore$ Velocity, $v = \frac{dx}{dt} \Rightarrow v = \frac{d(3t^2 + 5)}{dt}$

$\Rightarrow v = 6t + 0.$

At $t = 0$ $\qquad v = 0$

And, at $t = 5$ sec $\qquad v = 30$ m/s.

According to work-energy theorem, $W = \Delta KE$

or, $W = \frac{1}{2}mv^2 - 0 = \frac{1}{2}(2)(30)^2 = 900\text{J}$

Q29 Text Solution:

From work-energy theorem,

Work done $=$ change in kinetic energy

$$\Rightarrow W = k_f - k_i$$
$$\Rightarrow k_f = W + k_i$$
$$= \int_{x_1}^{x_2} F dx + \frac{1}{2} m v^2$$
$$= \int_{20}^{30} -0.1 x dx + \frac{1}{2} \times 10 \times (10)^2$$
$$= -0.1 \left[\frac{x^2}{2}\right]_{20}^{30} + 500$$
$$= -0.05 \left[(30)^2 - (20)^2\right] + 500$$
$$= -0.05[900 - 400] + 500$$
$$k_f = -0.05 \times 500 + 500$$
$$= -25 + 500$$
$$k_f = 475 J$$

Q30 Text Solution:

(3)

K.E.$= \frac{1}{2} m v^2$ if v becomes 5 times then K.E. becomes 25 times.

Q31 Text Solution:

$dW = F \cdot ds$, where $ds = dx\hat{i} + dy\hat{j}$
$+ dz\hat{k}$

and $F = -k\left(y\hat{i} + x\hat{j}\right)$

$\therefore$

$dW = -k(ydx + xdy) = -kd(xy)$

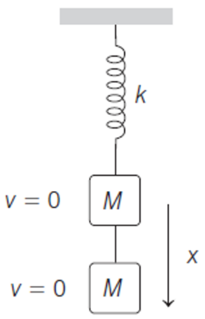
$\therefore W = \int_{0,0}^{a,a} dW = -k \int_{0,0}^{a,a} d\left(xy\right) =$

$-k\left[xy\right]_{0,0}^{a,a}$

$W = -ka^2$

Q32 Text Solution:

Let x be the maximum extension of the spring. From conservation of mechanical energy decrease in gravitational potential energy = increase in elastic potential energy



$\therefore \quad Mgx = \frac{1}{2} k x^2$

or $x = \frac{2Mg}{k}$

Q33 Text Solution:

As, $v = \sqrt{5gL}$ ....(i)

So, $\left(\frac{v}{2}\right)^2 = v^2 - 2gh$ ....(ii)

$h = L(1 - \cos\theta)$ ....(iii)

Solving Eqs. (i), (ii) and (iii), we get

$\cos\theta = -\frac{7}{8}$ or $\theta = \cos^{-1}\left(-\frac{7}{8}\right) = 151^\circ$

Q34 Text Solution:

Normal reaction force on the block is

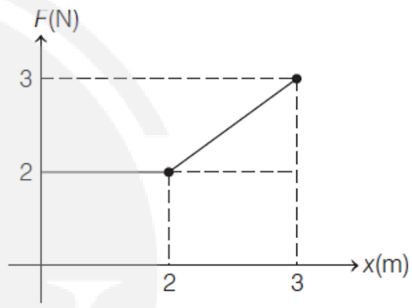
$N - mg = ma = \frac{mg}{2}$

$N = m\left(g + \frac{g}{2}\right) = \frac{3mg}{2}$

Now, in time 't' displacement of block,

$s = \frac{1}{2} a t^2 = \frac{1}{2}\left(\frac{g}{2}\right) t^2 = \frac{gt^2}{4}$

Q35 Text Solution:



Work done on the particle = Area under th ecurve ABC

$= 2 \times 2 + \frac{1}{2} \times 1 \times 1 + 2 \times 1 = 6.5\ \text{J}$

Now, from work-energy theorem,

$\Delta W = K_f - K_i$

$\Rightarrow K_f = \Delta W = 6.5\ \text{J}$ $\quad [\because K_i = 0]$

Q36 Text Solution:

(A) For the same compression x,

$W_A = \frac{1}{2} K_A x^2, W_B = \frac{1}{2} K_B x^2,$

$K_A > K_B \Rightarrow W_A > W_B$

(B) For the same applied force F, each spring compresses by $x = F/k$. Thus

$W = \frac{1}{2} k x^2 = \frac{1}{2} k \left(\frac{F}{k}\right)^2 = \frac{F^2}{2k}$

Hence

$W_A = \frac{F^2}{2K_A}, \ W_B = \frac{F^2}{2K_B},$

$K_A > K_B \Rightarrow W_A < W_B$

(A) and (B) are both true.

Q37 Text Solution:

H from vertical throw: $H = v_1^2 / (2g)$

From 45∘ throw:
$H=\left(v_2/\sqrt{2}\right)^2/(2g)=v_2^2/(4g)$
Equate: $v_2^2=2v_1^2$
KE ratio: $\frac{\frac{1}{2}mv_1^2}{\frac{1}{2}mv_2^2}=v_1^2/2v_1^2=\frac{1}{2}$

Q38 Text Solution:

$U(x)=2x^4-27x\Rightarrow\frac{dU}{dx}=8x^3-27$
Setting $\frac{dU}{dx}=0$ gives
$8x^3=27\Rightarrow x=\frac{3}{2}$
Next,
$\frac{d^2U}{dx^2}=24x^2,$
and $\mathrm{x}=\frac{3}{2}$
$\left.\frac{d^2U}{dx^2}\right|_{x=3/2}=24\left(\frac{3}{2}\right)^2=24\cdot\frac{9}{4}=54>0$
Since the second derivative is positive, $x=\frac{3}{2}$ is a **stable equilibrium.**

Q39 Text Solution:

Horizontal momentum (no external horizontal force):
$mu=\left(m+\eta m\right)V\Rightarrow V=\frac{u}{1+\eta}$
Energy conservation (initial KE → gain in PE + final KE):
$\frac{1}{2}mu^2=mgh+\frac{1}{2}(m+\eta m)V^2$
Substitute $V=\frac{u}{1+\eta}$:
$\frac{1}{2}mu^2=mgh+\frac{1}{2}m\frac{u^2}{1+\eta}$
$\Rightarrow u^2\left(1-\frac{1}{1+\eta}\right)=2gh$
$\Rightarrow u^2=2gh\frac{1+\eta}{\eta}$
$u=\sqrt{2gh\left(1+\frac{1}{\eta}\right)}$

Q40 Text Solution:

The velocity at $t=2$ s is 2 m/s.
Using the work-energy theorem,
$\frac{1}{2}mv^2=\int_0^2\frac{3t^2}{2}\,\mathrm{dt}$
$=\frac{3}{2}\cdot\frac{8}{3}=4$
so $v^2=4$ and $v=2$ m/s.

Q41 Text Solution:

Check if F is conservative:
$F_x=xy^2,\ F_y=x^2y$
Compute
$\frac{\partial F_x}{\partial y}=2xy,\frac{\partial F_y}{\partial x}=2xy$
Since $\frac{\partial F_x}{\partial y}=\frac{\partial F_y}{\partial x}$, F is a conservative vector field in the xy-plane.
Conclude path-independence:
Because F is conservative, the work depends only on those endpoints, not on the semicircle OAB.
Evaluate along the straight line $O\to B$ (where $y=0$):
$x:0\to4,\ y=0\Longrightarrow F_x=x(0)^2=0,\ F_y=x^2(0)=0.$
Hence along $y=0$, $F\cdot dr=0$.
Therefore, the net work $W(O\to B)$ is

Q42 Text Solution:

At a: $v_a^2=4gL$
At b (height + L):
$v_b^2=4gL-2gL=2gL$
$T_b+mg=m\frac{v_b^2}{L}=2mg\Rightarrow T_b=mg$
At c (height − L):
$v_c^2=4gL+2gL=6gL$
centripetal (upward) ⟹
$T_c-mg=m\frac{v_c^2}{L}=6mg\Rightarrow T_c=7mg$
Hence
$T_c:T_b=7mg:mg=7:1$

Q43 Text Solution:

$p=\sqrt{2\,\mathrm{Km}}\quad$ or $\quad p\propto\sqrt{m}$
$\frac{m_1}{m_2}=\frac{1}{4}\Rightarrow\qquad\therefore\ \frac{p_1}{p_2}=\frac{1}{2}$

Q44 Text Solution:

P = constant
∴ Work done in time t.
$W=Pt$
From work-energy theorem, net work done is change in kinetic energy. Therefore,
$\frac{1}{2}mv^2=Pt$
or $\quad v\propto t^{1/2}$
Integrating, we get $s\propto t^{3/2}$

Q45 Text Solution:

Highest point: height = 6 m
Lowest point: height = 1 m
Vertical drop $h=6-1=5$ m
By energy conservation:
$\frac{1}{2}mv^2=mgh\Rightarrow v=\sqrt{2gh}$

$= \sqrt{2 \times 9.8 \times 5} \approx \sqrt{98} \approx 10 \text{ m/s}$

Q46 Text Solution:

I. True: If $\vec{F} \perp \vec{d}$, then $W = Fd\cos 90° = 0$.

II. True: For obtuse angle θ, $\cos\theta < 0$ so $W = Fd\cos\theta$ is negative.

III. False: Many central forces (e.g. gravity, electrostatic) are conservative.

Therefore, only I and II are correct.

Answer: (2) I and II.

Q47 Text Solution:

Since $K \propto t$, write $K = \frac{1}{2}mv^2 = Ct$. Then

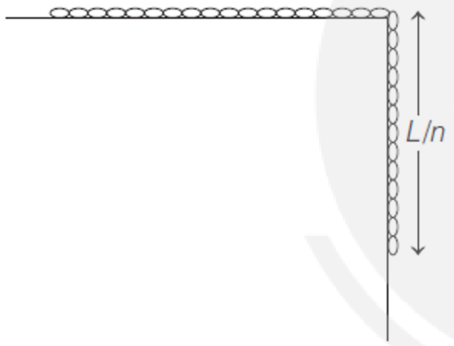
$v = \sqrt{\frac{2Ct}{m}} \propto \sqrt{t}, p = mv \propto \sqrt{t}$

Hence

$F = \frac{dp}{dt} \propto \frac{d}{dt}\left(\sqrt{t}\right)$

$= \frac{1}{2\sqrt{t}} \propto \frac{1}{\sqrt{t}}$

Q48 Text Solution:



Mass of the cable is M.

So, mass of $\frac{1}{4}$th part of the cable, i.e. hanging part of the cable is = M/n ....(i)

Now, centre of mass of the hanging part will be its middle point. So, its distance from the top of the table will be $L/2n$.

$W = \Delta U$ of hanging part

$= \left(\frac{M}{n}\right)\left(g\right)\left(\frac{L}{2n}\right) = \frac{MgL}{2n^2}$

Q49 Text Solution:

Given $\frac{U}{K} = \frac{25}{144}$. Hence

$\frac{mgh}{\frac{1}{2}mv^2} = \frac{25}{144} \Rightarrow \frac{2gh}{v^2}$

$= \frac{25}{144} \Rightarrow v^2 = \frac{288}{25}gh$

$\frac{mgh}{\frac{1}{2}mv^2} = \frac{25}{144} \Rightarrow \frac{2gh}{v^2}$

$= \frac{25}{144} \Rightarrow v^2 = \frac{288}{25}gh$

By energy conservation (initial speed $u \to$ speed v at height h):

$u^2 = v^2 + 2gh$

$= \frac{288}{25}gh + 2gh$

$= \frac{288+50}{25}gh = \frac{338}{25}gh$

Thus

$\frac{u^2}{v^2} = \frac{\frac{338}{25}gh}{\frac{288}{25}gh} = \frac{338}{288}$

$= \frac{169}{144} \Rightarrow \frac{u}{v} = \frac{13}{12}$

Therefore, $u : v = 13:12$.

Q50 Text Solution:

Initial gravitational potential mgH converts entirely into spring energy $\frac{1}{2}kx^2$. Thus

$mgH = \frac{1}{2}kx^2 \Rightarrow x = \sqrt{\frac{2mgH}{k}}$

Answer: $\sqrt{\frac{2mgH}{k}}$ (Option D).

Q51 Text Solution:

PE and KE both vary as t^2 (since $v = gt \Longrightarrow$ KE $\propto t^2$, and $PE = mg(H - \frac{1}{2}gt^2) \propto -t^2$). Thus PE is a downward-opening parabola, KE an upward-opening parabola, crossing exactly once. That shape matches (A).

Q52 Text Solution:

Along OP:

$\vec{r} = \left(a, a\right) \Rightarrow W_1 = \vec{F} \cdot \Delta\vec{r}$

$= \left(3\hat{i} + 4\hat{j}\right) \cdot \left(a\hat{i} + a\hat{j}\right)$

$= 3a + 4a = 7a$

Along $OQ + QP$:

$O \to Q : \Delta\vec{r}_1 = \left(a, 0\right) \Rightarrow W_1$

$= \left(3\hat{i} + 4\hat{j}\right) \cdot \left(a\hat{i}\right) = 3a$

$Q \to P : \Delta\vec{r}_2 = \left(0, a\right) \Rightarrow W_2$

$= \left(3\hat{i} + 4\hat{j}\right) \cdot \left(a\hat{j}\right) = 4a$

Total $W_2 = 3a + 4a = 7a$

So $W_1 = W_2$

Q53 Text Solution:

$$\vec{P}_i = m\nu\hat{i}$$
$$\Delta\vec{P} = 3\ m\nu\ \hat{i}$$
$$\vec{P}_f = \vec{P}_i + \Delta\vec{P} = 4m\nu\ \hat{i}$$
$$m v_f = 4m\nu$$
$$\nu_f = 4v$$
$$\text{then } K_f = \tfrac{1}{2}m(4v)^2 = 8mv^2$$

Q54 Text Solution:

$$\Delta\vec{r} = \hat{i} + 3\hat{j}$$
$$W = \vec{F}\cdot\Delta\vec{r} = 11\ \mathrm{J}$$

Q55 Text Solution:

$$dW = \vec{F}\cdot d\vec{x}$$
$$W = \int_{x_1}^{x_2} F dx$$
$$W = \int_1^2 3x^2 dx$$
$$F_{\text{avg}} \times \left(2-1\right) = \left|x^3\right|_1^2$$
$$F_{\text{avg}} = \tfrac{8-1}{1} = 7\ \mathrm{N}$$

Q56 Text Solution:

$m = 1$ kg, $F = 6t$. So $a = F/m = 6t$.

Velocity:$v = \int_0^t 6t\ dt = 3t^2$.

Displacement rate: $dx/dt = v = 3t^2$.

Differential work:

$dW = Fdx = F(dx/dt)dt$

$= 6t\cdot(3t^2)\ dt = 18t^3\ dt.$

Total work over $0 \le t \le 1$:

$$W = \int_0^1 18t^3\ dt = 18\cdot\tfrac{1}{4} = 4.5\ \mathrm{J}$$

Q57 Text Solution:

From $x = 0$ to $x = 2$ m, F is constant (call it F_0). From $x = 2$ to $x = 4$, F falls linearly from F_0 to 0, so that triangular area is $\frac{1}{2}\times(2)\times F_0 = F_0$. Beyond $x = 4$, $F = 0$.

Thus the total work from 0 to 5 m is

$W =$ (area from 0 to 2) + (area from 2 to 4)

$= (2F_0) + (F_0) = 3F_0$.

Given $W = 9.0$ J, we get $3F_0 = 9 \implies F_0 = 3$ N.

Therefore, at $x = 1.0$ m (which lies in the 0 – 2m flat region),

$F = 3$ N.

Q58 Text Solution:

Down-slope weight component:

$$F_g = \left(100\times10^3\ \mathrm{kg}\right)\left(9.8\ \mathrm{m/s^2}\right)\times\tfrac{1}{250}$$
$$= 3920\ \mathrm{N}$$

Frictional resistance:

$$6\ \mathrm{kgf/ton}\times 100\ \mathrm{ton}\times 9.8 = 5880\ \mathrm{N}$$

Total opposing force = 3920 + 5880 = 9800 N.

With $P = 7.84\times10^4$ W at full power,

$$v = \tfrac{P}{F} = \tfrac{7.84\times10^4}{9800} = 8\ \mathrm{m/s}$$

Q59 Text Solution:

Statement (d) is incorrect because potential energy can be negative (it depends on the chosen zero). All other statements are correct.

Q60 Text Solution:

$F = kx^n$, so acceleration $a = F/m \propto x^n$.

Writing $a = v\,dv/dx$ gives $v\,dv/dx \propto x^n$, hence $\frac{1}{2}d\left(v^2\right)\propto x^n\ dx \Rightarrow v^2 \propto x^{n+1}$

and thus $v \propto x^{(n+1)/2}$.

Power $P = Fv \propto x^n\cdot x^{(n+1)/2}$

$= x^{(3n+1)/2}$.

For $P \propto x^0$, set $(3n + 1)/2 = 0$, yielding $n = -\frac{1}{3}$.