PHYSICS

Q.1 A overhead tank of capacity 1000 liter has to be filled in $\frac{1}{2}$ hour using water pump. Tank is kept at a height 10 m above ground and water level is 10 m below ground. The opening of inlet pipe inside tank is 1.11 cm^2. Assuming the efficiency of motor to be 60%, the electric power used is (Neglect viscosity) -

(A) 118 W (B) 130 W

(C) 146 W (D) 198 W **[D]**

Sol. Volume rate of water filling tank :

$$Av = \frac{1000\times10^{-3}}{1800} \Rightarrow v = 5 \text{ m/s}$$

$\therefore$ work done by pump in filling the tank

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

[m = 1000 kg, h = 20 m, v = 5 m/s]

$= 2.125 \times 10^5$

$$\therefore P = \frac{2.125\times10^5}{1800} \text{ W}$$

$$\therefore \text{Electric power used} = \frac{10}{6}\times P = 198 \text{ W}$$

Q.2 A force $\vec{F} = 8\hat{i} - 6\hat{j} - 10\hat{k}$ Newton produces an acceleration of 1 m s^{-2} in a body. The mass of the body is -

(A) 10 kg (B) $10\sqrt{2}$ kg

(C) $10\sqrt{3}$ kg (D) 200 kg **[B]**

Sol. $m = \frac{|\vec{F}|}{a} = \frac{\sqrt{8^2+6^2+10^2}}{1}$

Q.3 The linear momentum of a particle varies with time t as :

$p = a + bt + ct^2$

Which of the following statements is correct ?

(A) Force varies with time in a quadratic manner

(B) Force is time-dependent

(C) The velocity of the particle is proportional to time

(D) The displacement of the particle is proportional to time. **[B]**

Sol. $P = a + bt + ct^2$

$$F = \frac{dP}{dt} = 0 + b + 2ct$$

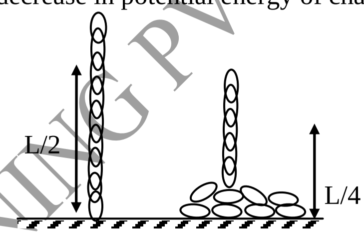
Q.4 A man places a chain (of mass 'm' and lenght 'ℓ') on a table slowly. Initally the lower end of the chain just touches the table. The man drops the chain when half of the chain is in vertical position. Then work done by the man in this process is :

(A) $-mg\frac{\ell}{2}$ (B) $-\frac{mg\ell}{4}$

(C) $-3\frac{mg\ell}{8}$ (D) $-\frac{mg\ell}{8}$

Sol. **[C]**

The work done by man is negative of magnitude of decrease in potential energy of chain.



$$\Delta U = mg\frac{L}{2} - \frac{m}{2}g\frac{L}{4} = 3\,mg\frac{L}{8}$$

$$\therefore W = -\frac{3mg\ell}{8}$$

Q.5 A body is displaced from (0, 0) to (1m, 1m) along the path x = y by a force $\vec{F} = (x^2\hat{j} + y\hat{i})$N. The work done by this force will be –

(A) $\frac{4}{3}$J (B) $\frac{5}{6}$J

(C) $\frac{3}{2}$J (D) $\frac{7}{5}$J

Sol. **[B]**

$$W = \int_{(0,0)}^{(1,1)} \vec{F}.\vec{d}x$$

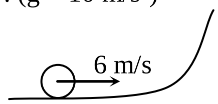
Here $\vec{d}s = dx\hat{i} + dy\hat{j} + dz\hat{k}$

$$\therefore W = \int_{(0,0)}^{(1,1)} (x^2dy + ydx)$$

$$= \int_{(0,0)}^{(1,1)} (x^2dy + x.dx) \quad \text{(as x = y)}$$

$$\therefore W = \left[\frac{y^3}{3} + \frac{x^2}{2}\right]_{(0,0)}^{(1,1)} = \frac{5}{6} \text{ J}$$

Q.6 A disc of radius 0.1 m rolls without sliding on a horizontal surface with a velocity of 6 m/s. It then ascends a smooth continuous track as shown in figure. The height upto which it will ascend is : (g = 10 m/s^2)



(A) 2.4 m (B) 0.9 m

(C) 2.7 m (D) 1.8 m

Sol. **[D]** Let m be the mass of the disc. Then translational kinetic energy of the disc is :

$$K_T = \frac{1}{2}mv^2 \qquad \text{... (1)}$$

When it ascends on a smooth track its rotational kinetic energy will remain same while translational kinetic energy will go on decreasing. At highest point.

KT = mgh

or $\frac{1}{2}mv^2 = mgh$

or $h = \frac{v^2}{2g} = \frac{(6)^2}{2 \times 10} = 1.8$ m

Q. 7 Power applied to a particle varies with time as P = [3t^2 – 2t + 1] watts. Where t is time in seconds. Then the change in kinetic energy of particle between time t = 2s to t = 4s is –

(A) 46 J (B) 52 J

(C) 92 J (D) 104 J

Sol. **[A]**

$$\Delta K = \int_2^4 P dt = [t^3 - t^2 + t]_2^4 = 46J$$

Q.8 A block of mass 2 kg is kept at origin at t = 0 and is having velocity $4\sqrt{5}$ m/s in positive x-direction. The only force acting on it is a conservative and its potential energy is defind as

U = – x^3 + 6x^2 + 15 (SI units). Its velocity when its acceleration is minimum after t = 0 is-

(A) 8 m/s (B) 4 m/s

(C) $10\sqrt{24}$ m/s (D) 20 m/s

Sol. **[A]**

$F = -\frac{dU}{dx} \Rightarrow F = 3x^2 - 12x$

Now F = min. $\Rightarrow \frac{dF}{dx} = 0 \Rightarrow x = 2$ m

$U_i + K_i = U_f + K_f$

$$15 + \frac{1}{2} \times 2 \times 80 = [-(2)^3 + 6 \times (2)^2 + 15] + \frac{1}{2} \times 2 \times v^2$$

$v^2 = 64$

v = 8m/sec

Q.9 Power applied to a particle varies with time as P = (3t^2 – 2t + 1) watts, where t is time in seconds. Then the change in kinetic energy between time t = 2s to t = 4s is-

(A) 46 J (B) 52 J

(C) 92 J (D) 104 J

Sol. **[A]**

$P = 3t^2 - 2t + 1 \qquad \frac{dK}{dt} = P$

$$\Rightarrow \Delta K = \int_2^4 P dt = 46 \text{ J}$$

Q.10 A particle moves in a straight line with its retardation proportional to its displacement 'x'. Change in kinetic energy is proportional to –

(A) x^2 (B) e^x

(C) x (D) log$_e$ x **[A]**

Sol. $a \propto x$

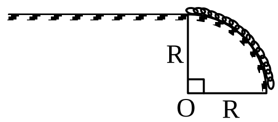
W_{net} = F. x

$\propto$ a.x

$\propto x^2$

$\therefore \Delta K \propto x^2$

Q.11 A chain of length $\ell < \frac{\pi R}{2}$ is placed on a smooth surface whose some part is horizontal and some part is quarter circular of radius r in the vertical plane as shown. Initially the whole part of chain lies in the circular part with one end at topmost point of circular surface. If the mass of chain is m, then work required to pull very slowly the whole chain on horizontal part is –



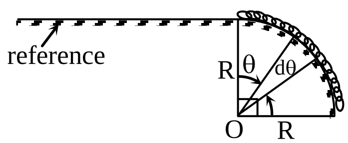
(A) $\frac{m}{\ell} gR^2 \left[\sin\left(\frac{\ell}{R}\right)\right]$

(B) $\frac{m}{\ell} gR^2 \left[\cos\left(\frac{\ell}{R}\right)\right]$

(C) $\frac{m}{\ell} gR^2 \left[\left(\frac{\ell}{R}\right) - \sin\left(\frac{\ell}{R}\right)\right]$

(D) $\frac{m}{\ell} gR^2 \left[\left(\frac{\ell}{R}\right) - \cos\left(\frac{\ell}{R}\right)\right]$ **[C]**

Sol.



$$dU_i = -\left(\frac{m}{\ell} R d\theta\right) \times g \times R[1 - \cos\theta]$$

$$dU_i = -\frac{mgR^2}{\ell}[1 - \cos\theta]d\theta$$

$$\therefore \quad U_i = -\frac{mgR^2}{\ell}\left[\left(\frac{\ell}{R}\right) - \sin\left(\frac{\ell}{R}\right)\right]$$

and $U_f = 0$ $\therefore$ $W_{ext} = \Delta U$

Q.12 Water from a stream is falling on the blades of a turbine at the rate of 100 kg/sec. If the height of the stream is 100 m, then the power delivered to the turbine is -

(A) 100 kW (B) 100 W

(C) 10 kW (D) 1 kW **[A]**

Sol. $P = \frac{\text{Energy}}{\text{time}} = \frac{dm}{dt} gh = 100 \times 10 \times 100$

$= 100$ kW

[P = $\frac{\text{Åtkz}}{\text{le;}} = \frac{dm}{dt} gh = 100 \times 10 \times 100$

= 100 kW]

Q.13 A pump motor is used to deliver water at a certain rate from a given pipe. To obtain 'n' times water from the same pipe in the same time the amount by which the power of the motor should be increased –

(A) $n^{1/2}$ (B) n^2

(C) n^3 (D) n **[C]**

Sol. Volume delivered per sec. = Av

mass delivered per sec = Avd

momentum delivered per sec = Av^2d = force

power = force × velocity= Av^3d

i.e. power $\propto v^3$

Q.14 Power developed by a person on eating 100 g of ice per minute is –

(A) 130 W (B) 560 cal/sec

(C) 560 J/sec (D) none of these **[C]**

Sol. W = 100 × 80 × 4.2 J

$$P = \frac{dW}{dt} = \frac{100 \times 80 \times 4.2}{60} \text{ J/sec}$$

P = 560 J/sec

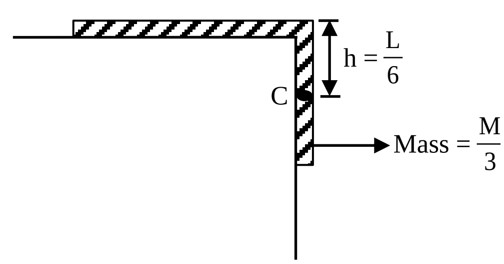
Q.15 A uniform chain of length L and mass M is lying on a smooth table and one-third of its length is hanging vertically down over the edge of the table. If g is acceleration due to gravity, the work required to pull the hanging part on to the table is –

(A) MgL (B) MgL/3

(C) MgL/9 (D) MgL/18 **[D]**

Sol. Mass of hanging portion is $\frac{M}{3}$ (one-third) and centre of mass c, is at a distance h = $\frac{L}{6}$ below the table top.

Therefore, the required work done is,



$$W = mgh = \left(\frac{M}{3}\right)(g)\left(\frac{L}{6}\right) = \frac{MgL}{18}$$

Q.16 A particle of mass **m** is moving in a circular path of constant radius **r** such that its centripetal acceleration $\mathbf{a_c}$ is varying with time t as $\mathbf{a_c} = k^2 rt^2$, where k is a constant. The power delivered to the particle by the force acting on it is –

(A) $2\pi\, mk^2 r^2$ (B) $mk^2 r^2 t$

(C) $\frac{(mK^4 r^2 t^5)}{3}$ (D) Zero **[B]**

Sol. $a_c = k^2 rt^2$

or $\frac{v^2}{r} = k^2 rt^2$

or v = krt

Therefore, tangential acceleration, $a_t = \frac{dv}{dt} = kr$

or Tangential force,

$F_t = ma_t = mkr$

Only tangential force does work.

Power = $F_t v$ = (mkr) (krt)

or Power = $mk^2 r^2 t$

Q.17 The ratio of work done by the internal forces of a car in order to change its speed from 0 to V, from V to 2V is (Assume that the car moves on a horizontal road) -

(A) 1 (B) 1/2

(C) 1/3 (D) 1/4

[C]

Sol. Work done in changing speed from 0 to V is -

$\Delta W_1 = \frac{1}{2} mV^2$

work done in changing the speed from V to 2V is

$\Delta W_2 = \frac{1}{2} m(2V)^2 - \frac{1}{2} mV^2 = \frac{1}{2}\, 3mV^2$

$\therefore \frac{\Delta W_1}{\Delta W_2} = \frac{1}{3}$

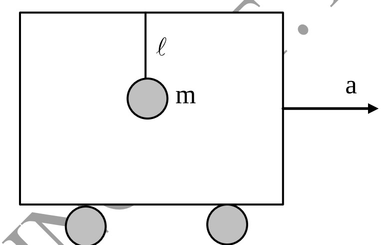
Q.18 A sping balance is adjusted at zero. Elastic collisions are brought about by dropping particles of one gram each on the pan of the balance. They recoil upwards without change is their velocities. If the height of fall of particles is 2 meter and the rate of particle dropping is 100 per seconds, then the reading of the balance is –

(A) 128 gm wt. (B) 1252 gm wt.

(C) 625 gm wt. (D) 1.25 gm wt. **[A]**

Sol. W=2mvn,v= $\sqrt{2h}$

Q.19 A pendulum of mass m and length ℓ is suspended from the ceiling of a trolley which has a constant acceleration **a** in the horizontal direction as shown in figure. Work done by the tension is–



(A) $-mg\ell(1 - \cos\theta)$ (B) $ma\ell \sin\theta$

(C) $ma\ell \cos\theta$ (D) zero **[D]**

Q.20 The displacement x of a body of mass 1kg on horizontal smooth surface as a function of time t is given by $x = t^4/4$. The work done in the first one second is–

(A) $\frac{1}{4}$ J (B) $\frac{1}{2}$ J

(C) $\frac{3}{4}$ J (D) $\frac{5}{4}$ J **[B]**

Q.21 A body moves a distance of 10m along a straight line under the action of a force of 5N. If the work done is 25 J , the angle which the force makes with the direction of motion of the body is-

(A) 0° (B) 30°

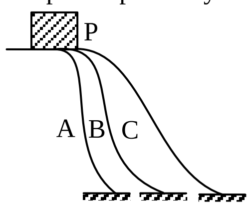
(C) 60° (D) 90° **[C]**

Q.22 A heavy box of 40 kg is pushed along 20 m by two coolies over a railway platform whose coefficient of friction with the box is 0.4. The work done by the two coolies (take g = 10 m/s^2 and assume that forces applied to be horizontal) is-

(A) + 3200 J (B) –3200 J

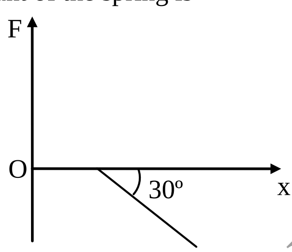
(C) + 1600 J (D) –1600 J **[A]**

Q.23 A greased block P may slide along any of the three frictionless slopes A, B, or C, to reach the ground. The work done on the block by the block's weight Mg, are W_A , W_B , and W_C for the three slopes respectively. Then-



(A) $W_A < W_B < W_C$
(B) $W_A > W_B > W_C$
(C) $W_A = W_B = W_C$
(D) None of the above **[C]**

Q.24 In a spring , it is found that the spring force F and the extension in the spring x are related as shown in figure. Then the value of the force constant of the spring is



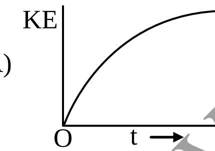
(A) $\sqrt{3}$ (B) $\sqrt{3}/2$
(C) $\frac{1}{\sqrt{3}}$ (D) $\frac{1}{2}$ **[C]**

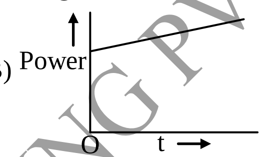
Q.25 If v, P and K denote the velocity, momentum and kinetic energy of a particle then–
(A) P = dK/dv
(B) P = dK/dt
(C) P = dv/dt
(D) P = (dK/dv) (dK/dt) **[B]**

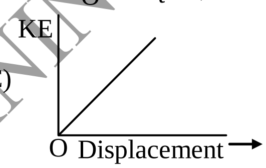
Q.26 A 5.0 kg block is thrust up a 30° incline with an initial speed v of 6.0 m/s. It is found to travel a distance d = 2.0 m up the plane as its speed gradually decreases to zero. then the loss in mechanical energy of the block due to friction in this process is
(A) 8 J (B) 41 J
(C) 49 J (D) 90 J **[B]**

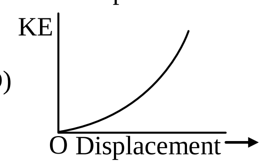
Q.27 If a man increases his speed by 2 m/sec, his K.E. is doubled. The original speed of the man is
(A) $(2+\sqrt{2})$ m/s (B) $(2 + 2\sqrt{2})$ m/s
(C) 4 m/s (D) $(1 + \sqrt{2})$ m/s **[C]**

Q.28 A block is resting over a smooth horizontal plane. A constant horizontal force starts acting on it at t =0 .Which of the following graphs is/are correct ?

(A)


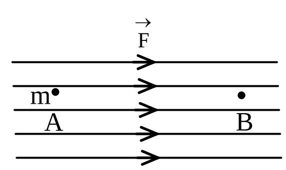
(B)


(C)


(D)


[B]

Q.29 In a region of space a constant force F newton acts on a particle of mass m, which is released from rest at point A. When the particle reaches B its -



(A) potential energy (PE) increases but kinetic energy (KE) decreases.
(B) PE decreases but KE increases.
(C) PE remains constant but KE increases.
(D) PE decreases but KE remains constant **[A]**

Q.30 The linear momentum of a body is increased by 50 % , then the increase in the kinetic energy will be
(A) 25% (B) 50 %
(C) 100 % (D) 125 % **[D]**

Q.31 A bus and a car, moving with the same speed are brought to rest by applying the same retarding force then

(A) bus will come to rest in a shorter distance

(B) car will come to rest in a shorter distance

(C) both will come to rest in the same distance

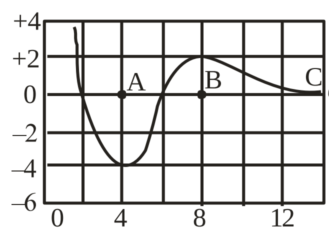
(D) none of the above **[B]**

Q.32 A long spring , when stretched by a distance x, has the potential energy U. On increasing the stretching to nx , the potential energy of the spring will be –

(A) U/n (B) nU

(C) n^2U (D) U/n^2 **[C]**

Q.33 For the potential energy function shown in fig. there will be an unstable equilibrium at position



(A) A

(B) B

(C) C

(D) none of the above **[B]**

Q.34 A body of mass 2 kg is thrown up vertically with a kinetic energy of 490 J. If g = 9.8 m/s^2, the height at which the kinetic energy becomes half its original value is-

(A) 10 m (B) 12.5 m

(C) 25 m (D) 50 m **[B]**

Q.35 The work done by the external forces on a system equals the change in the :-

(A) total energy (B) kinetic energy

(C) potential energy (D) none of these **[A]**

Q.36 Energy required to accelerate a car from 10 to 20 ms^{-1} compared with that required to accelerate from 0 to 10 ms^{-1} in the same interval of time covering the same distance, is.

(A) twice (B) four times

(C) three times (D) same **[C]**

Q.37 If a simple pendulum of length ℓ has the maximum angular displacement (θ) then the maximum KE of its bob of mass m is –

(A) (1/2) m (ℓ /g) (B) (1/2) m (g / ℓ)

(C) mgℓ (1 – cos θ) (D) (1/2) mgℓ sin θ

[C]

Q.38 Two springs A and B ($k_A = 2k_B$) are stretched by applying forces of equal magnitudes at the four ends. If the energy stored in A is E, then energy that in B is-

(A) E/ 2 (B) 2E (C) E (D) E/4

[B]

Q.39 A block of mass m = 1kg moving on horizontal surface with speed u = 2m/s enters a rough horizontal patch ranging from x = 0.10 m to x = 2.00m. If the retarding force f_r on the block in this range is inversely proportional to x over this range i.e.

$f_r = \frac{-k}{x}$ 0.10 < x < 2.00

= 0 for x < 0.10 and x > 2.00

If k = 0.5 J then the speed of this block as it crosses the patch is (use ℓn 20 = 3)

(A) 2.65 m/s (B) 1 m/s

(C) 1.5 m./s (D) 2 m/s **[B]**

Q.40 An engine pumps a liquid of density 'd' continuously through a pipe of area of cross section A. If the speed with which the liquid passes through a pipe is v. then the rate at which the kinetic energy is being imparted to the liquid is

(A) $Adv^3/2$ (B) (1/2) Adv

(C) $Adv^2/2$ (D) Adv^2 **[A]**

Q.41 A block of mass M is allowed to slide down a fixed smooth inclined plane of angle θ and length ℓ .What is the power developed by the force of gravity when the block reaches the bottom ?

(A) $\sqrt{2m^2\ell(g\sin\theta)^3}$ (B) (2/3) m^3 ℓ g^2 sin θ

(C) $\sqrt{(2/3)m^2t^2gc\mathrm{os}\theta}$ (D) (1/3) $m^3 \ell g^2 \sin\theta$ **[A]**

Q.42 A body of mass m is projected at an angle θ to the horizontal with initial velocity u. The mean power developed by the gravity over the time of flight is–

(A) mgu sinθ (B) mgu cosθ
(C) mg(gt – u) (D) zero **[D]**

Q.43 An object of mass (m) is located on the horizontal plane at the origin O. The body acquires horizontal velocity V. The mean power developed by the frictional force during the whole time of motion is (μ = frictional coefficient)–

(A) μmgV (B) $\frac{1}{2}$ μmgV
(C) μ mg $\frac{V}{4}$ (D) $\frac{3}{2}$ μmgV **[B]**

Q.44 A 50 kg girl is swinging on a swing from rest. Then the power delivered when she was moving with a velocity of 2 m/s upwards in a direction making an angle 60º with the vertical is –

(A) 980 W (B) 490 W
(C) 490W (D) 245 W **[B]**

Q.45 From a water fall, water is pouring down at the rate of 100 kg per second on the blades of turbine. If the height of the fall is 100 m, the power delivered to the turbine is approximately equal to –

(A) 100 kW (B) 10 kW
(C) 1 kW (D) 100 W **[A]**

Q.46 A bus of mass 1000 kg has an engine which produces a constant power of 50 kW. If the resistance to motion, assumed constant, is 1000 N. The maximum speed at which the bus can travel on level road and the acceleration when it is travelling at 25 m/s , will respectively be -

(A) 50 m/s , 1.0 m/s^2 (B) 1.0 m/s , 50 m/s^2
(C) 5.0 m/s, 10 m/s^2 (D) 10 m/s , 5 m/s^2 **[A]**

Q.47 It is found that the force required to row a boat in a river is proportional to the speed of the boat. When the speed of the boat is kept v km / hr, the power expended by the boat engine is 24 horse power. What shall be the power required, if one wishes to row the boat at a speed 2v km/hr –

(A) 48 hp (B) 96 hp
(C) 144 hp (D) 192 hp **[B]**

Q.48 Power applied to a particle varies with time as P = $[3t^2 - 2t + 1]$ watts. Where t is time in seconds. Then the change in kinetic energy of particle between time t = 2s to t = 4s is –

(A) 46 J (B) 52 J
(C) 92 J (D) 104 J **[A]**

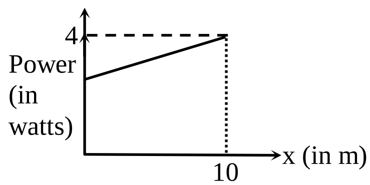
Q.49 A 60 cm diameter hand wheel is rotated by exerting a force of 30 newton at the outer rim. If the wheel is turned through 1/2 revolution, then the work done is -

(A) zero (B) 18.0 joule
(C) 28.3 joule (D) 56.5 joule **[C]**

Q.50 A small block of mass m is kept on a rough inclined surface of inclination θ fixed in an elevator. The elevator goes up with a uniform velocity v and the block does not slide on the wedge. The work done by the force of friction on the block in time t will be –

(A) zero (B) mgvt $\cos^2\theta$
(C) mgvt $\sin^2\theta$ (D) mgvt sin 2θ **[C]**

Q.1 A particle of mass $\frac{10}{7}$ Kg is moving in the positive direction of x. Its initial position x = 0 & initial velocity is 1 m/s. The velocity at x = 10 is -



Sol. Area under P – x graph = $\int$Pdx

$$= \int\left(\frac{mdN}{dt}\right)vdx$$

$$= \int_1^v mv^2dv \quad = \left[\frac{mv^3}{3}\right]_1^V$$

$$= \frac{10}{7\times3}(v^3 - 1) \qquad \ldots(1)$$

from graph, area = $\frac{1}{2}$ × (2 + 4) × 10 = 30 …(2)

from (1) & (2)

$\frac{10}{7\times3}(v^3 - 1) = 30$

⇒ v = 4m/s

Q.2 A man is throwing bricks of mass 2 kg onto a floor of height 2m. Bricks reaches to floor with speed $2\sqrt{10}$ m/s. Man throws 10 bricks in a minute. If power of man is W watt then $\frac{3}{10}$W is equal to –

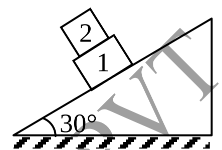
Sol. **[4]**

Work done by man on bricks = n (mgh + $\frac{1}{2}$ mv²)

$$\therefore P = \frac{10\left(2\times10\times2+\frac{1}{2}\times2\times(2\sqrt{10})^2\right)}{60} = \frac{40}{3}\ W$$

Q.3 An over head tank of capacity 10 k litre is kept at the top of building 15 m high. Water falls in tank with speed $5\sqrt{2}$ m/s. Water level is at a depth

5 m below ground. The tank is to be filled in 1/2 hr. If efficiency of pump is 67.5% electric power used in hecto watt is -



Sol. **[2]**

Work done by motor

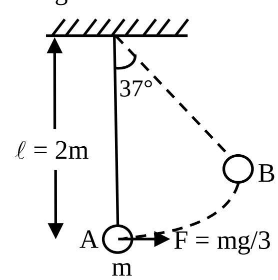
= mgh + $\frac{1}{2}$ mv² = 225 × 10000 Joule

Power of motor = $\frac{225\times10000}{1800}$ W

∴ Electric power used

$= \frac{225\times10000}{1800} \times \frac{100}{67.5} \approx 200$ W

Q.4 A pendulum of mass m = 2kg is pulled from position 'A' by applying a constant horizontal force F = mg/3. Velocity (in m/s) at point 'B' shown in figure -



Sol. **[0]**

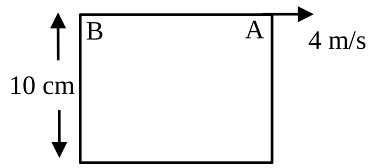
$W_{net} = \Delta K$

⇒ (F sin θ. ℓ – mgℓ (1 – cosθ) = $\frac{1}{2}$ mv²

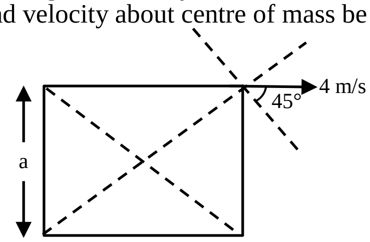
where θ = 37º , F = $\frac{mg}{3}$

$$\Rightarrow v = \left\{\frac{2\ell}{5m}(3F - mg)\right\}^{\frac{1}{2}} = 0$$

Q.5 A cube of mass 3kg is kept on a frictionless horizontal surface. The block is given an impulse so that point 'A' acquires velocity 4 m/s in the direction shown. If speed of point B is $4\sqrt{2}$ m/s, K.E. of block (in Joule) minus 10 Joule is -



Sol. **[6]**
Let angular velocity about centre of mass be 'ω' and velocity about centre of mass be V_{cm}.



$\omega = \dfrac{V_A \cos 45°}{(a/\sqrt{2})}$ = 40 rad/sec (a = 10 cm)

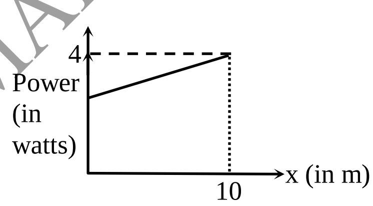
$V = V_A \sin 45° = 2\sqrt{2}$ m/s

$\therefore$ K.E. = $\frac{1}{2}MV_{cm}^2 + \frac{1}{2}I\omega^2 = 16$ J

Q.6 A ball of mass 1 kg is dropped from height 10 m. If hits the ground with speed 8 m/s, magnitude of work done by air friction is (in Joule) minus 60 joule is -

Sol. **[8]**

Q.7 A particle of mass $\frac{10}{7}$ Kg is moving in the positive direction of x. Its initial position x = 0 & initial velocity is 1 m/s. The velocity at x = 10 is -



Sol. **[4]**

Area under P – x graph = $\int P dx$

$= \int \left(\frac{mdN}{dt}\right) v dx$

$= \int_1^v mv^2 dv = \left[\frac{mv^3}{3}\right]_1^V$

$= \frac{10}{7\times 3}(v^3 - 1)$ …(1)

from graph, area = $\frac{1}{2} \times (2+4) \times 10 = 30$ …(2)

from (1) & (2)

$\frac{10}{7\times 3}(v^3 - 1) = 30$

$\Rightarrow$ v = 4m/s

Q. 8 A block of mass m = 1kg moving on horizontal surface with speed u = 2m/s enters a rough horizontal patch ranging from x = 0.10 m to x = 2.00m. If the retarding force f_r on the block in this range is inversely proportional to x over this range i.e.

$f_r = \frac{-k}{x}$ 0.10 < x < 2.00

= 0 for x < 0.10 and x > 2.00

If k = 0.5 J then the speed of this block as it crosses the patch is (use ℓn 20 = 3) in m/s is –

Sol. **[0001]** $W = \int f_r dx = -k \log_e \frac{2}{0.1} = -1.5$ J

$\therefore$ W = ΔK

$\frac{1}{2} \times 1 \times v^2 - \frac{1}{2} \times 1 \times 4 = -1.5$

Q.9 A particle moves in a straight line with its retardation proportional to its displacement 'x'. Change in kinetic energy is proportional to n^{th} power of x, where n is -

Sol. **[2]**

$a \propto x$

$W_{net} = F.x$

$\propto a.x$

$\propto x^2$

$\therefore \Delta K \propto x^2$

Q.10 A particle of mass 10^{-2} kg is moving along the positive x-axis under the influence of a force $F(x) = -K/(2x^2)$ where $K = 10^{-2}\ Nm^2$. At time t = 0 it is at x = 1.0 m and its velocity is v = 0. Find its velocity when it reaches x = 0.50 m.

Sol.[1] $F = \frac{-k}{2x^2} \Rightarrow F = -\frac{10^{-2}}{2x^2}$

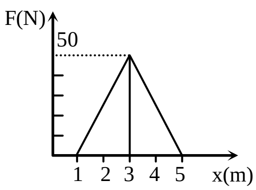
$$a = \frac{F}{m} = \frac{10^{-2}}{(10^{-2})2x^2} \Rightarrow a = \frac{-1}{2x^2} = v\frac{dv}{dx}$$

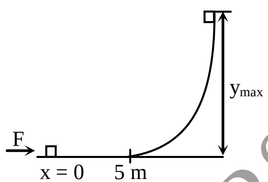
$$-\int_1^{0.5}\frac{dx}{2x^2} = \int_0^v vdv \Rightarrow -\frac{1}{2}\int_1^{0.5}x^{-2}dx = \frac{v^2}{2}$$

$$\Rightarrow \frac{-1}{2}\left[\frac{-1}{x}\right]_1^{0.5} = \frac{v^2}{2} \Rightarrow \frac{1}{2}\left[\frac{1}{0.5}-1\right] = \frac{v^2}{2}$$

$\Rightarrow$ v = 1 m/s

Q.11 A force shown in the F – x graph is applied to a 5 kg cart, which then coast up a ramp as shown. Calculate the maximum height , y_{max}, at which cart can reach? ($g = 10\ m/s^2$)





Sol.[2] As per graph, the velocity at point,

x = 5 is $v = \sqrt{40}$ m/s

Energy conservation, $\frac{1}{2} \times m \times 40 = m \times 10 \times h$

h = 2m

Q.12 A man is drawing water from a well with a bucket which leaks uniformly. The bucket when full weights 20 kg and when it arrives the top only half the water remains. The depth of the water is 20 m. What is the work done?

Sol. 3000

Q.13 A person is painting his house walls. He stands on a ladder with a bucket containing paint in one hand and a brush in other. Suddenly the bucket slips from his hand and falls down on the floor. If the bucket with the paint had a mass of 6.0 kg and was at a height of 2.0 m at the time it slipped, how much gravitational potential energy is lost together with the paint?

Sol. 0118