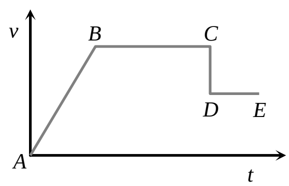
WORK, POWER & ENERGY

SOLUTIONS

LEVEL – 1

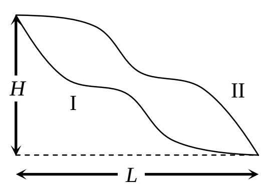
1. The work done on a body does not depend upon
(1) Force applied
(2) Displacement
(3) Initial velocity of the body
(4) Angle at which force is inclined to the displacement.
Work done is the product of force and displacement. Hence, work done depends on displacement, the force applied and on the angle between force and displacement. but it does not depend on the initial velocity of the object.

2. The adjoining diagram shows the velocity versus time plot for, a particle. The work done by the force on the particle is positive from



(1) *A* to *B* (2) *B* to *C* (3) *C* to *D* (4) *D* to *E*
From the increase in velocity takes place in AB region due to the application of force. There is increase in velocity in AB. So the Kinetic energy also increases in that portion due to the force. Thus, Work done is positive in portion AB.

3. A body is moved in vertical plane under gravity over route I and route II. Work done by gravity is



(1) Same for both routes (2) More on route I
(3) More on route II (4) Zero On both routes
Using work Energy theorem
Work done in lifting - work done against friction = change in total energy
$\Rightarrow W = mgh + \mu mgl$
which is a constant for both the routes

4. A body of mass m is displaced from point A(3, 1, 2) to point B(4, 3, 3) under the effect of a force $\vec{F} = (3\hat{i} + 2\hat{j} + 4\hat{k})$ N, calculate W.D. by the force
(1) 57 J (2) 11 J (3) 0 (4) 22 J

5. A body of mass M tied to a string is lowered at a constant acceleration of (g/4) through a vertical distance h. The work done by the string will be.............

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

Mass = M

acceleration = g

$\therefore Mg - T = Mg/4$

$\Rightarrow T = Mg/4 - Mg$

$= -\frac{3}{4}Mg$

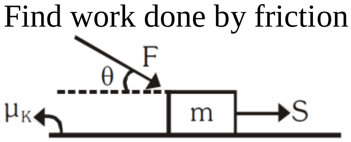
height = h.

work done, $W = F \cdot d \cos 180$

$= -F \cdot h$.

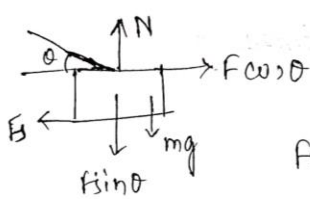
$= +\frac{3}{4}Mgh$

6. Find work done by friction for displacement 'S'?



(1) $\mu_K(mg + F\sin\theta).S$ (2) $-\mu_K(mg + F\sin\theta).S$

(3) $\mu_K(mg - F\sin\theta).S$ (4) $-\mu_K(mg - F\sin\theta).S$



Friction force,

$f_s = \mu_k N$

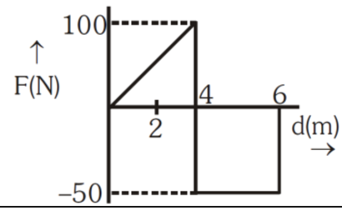
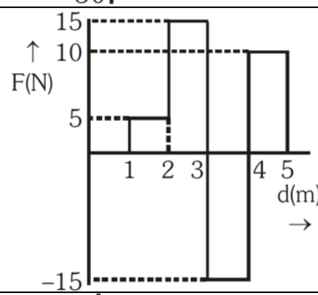
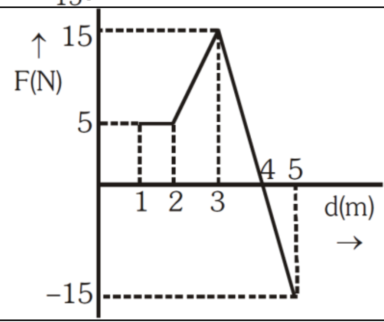
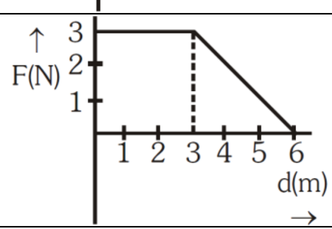
$= \mu_k(F\sin\theta + mg)$

Work done by the friction for displacement s

$= f_s \times s$

$= \mu_k(mg + F\sin\theta) \cdot s$

7. Calculate the work done for following F-d curves

(A)		(P)	100 J
(B)		(Q)	13.5 J
(C)		(R)	15 J
(D)		(S)	

(1) (A – P); (B – Q); (C – Q); (D – R)
(2) (A – P); (B – R); (C – R); (D – Q)
(3) (A – P); (B – P); (C – Q); (D – R)
(4) (A – P); (B – P); (C – R); (D – Q)

8. A force $F = Kx^2$ acts on a particle at an angle of 60° with the x-axis. the work done in displacing the particle from x_1 to x_2 will be.

(1) $\frac{kx^2}{2}$
(2) $\frac{k}{2}\left(x_2^2 - x_1^2\right)$
(3) $\frac{k}{6}\left(x_2^3 - x_1^3\right)$
(4) $\frac{k}{3}\left(x_2^3 - x_1^3\right)$

Given, $F = kx^2$, Angle $= 60^\circ$

We know that the work-done by the force is:

$$W = \int_{x_1}^{x_2} kx^2 dx = k[\frac{x^3}{3}]_{x_1}^{x_2} \cos 60^\circ$$

$$W = \frac{k}{6}[x_2^3 - x_1^3] \text{ Since } \cos\theta = \frac{1}{2}$$

9. A force acts $\vec{F} = (5\hat{i} + 4\hat{j})$ N on a body and produced a displacement $\vec{S} = (6\hat{i} - 5\hat{j} + 3\hat{k})$ m. The work done will be

(1) 30 J (2) 40 J (3) 10 J (4) 20 J

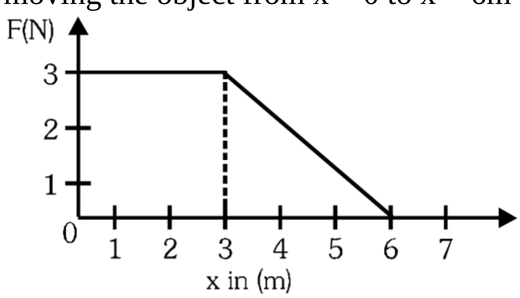
$$\overline{W} = \vec{F} \cdot \vec{S}$$

$$= (5\hat{i} + 4\hat{j}) \cdot (6\hat{i} - 5\hat{j} + 3\hat{k})$$

$$= 30 - 20 + 0$$

$$= 10J$$

10. A force F acting on an object varies with distance x as shown here. The work done by the force in moving the object from x = 0 to x = 6m is:-



(1) 18.0 J (2) 13.5 J (3) 4.5 J (4) 9.0 J

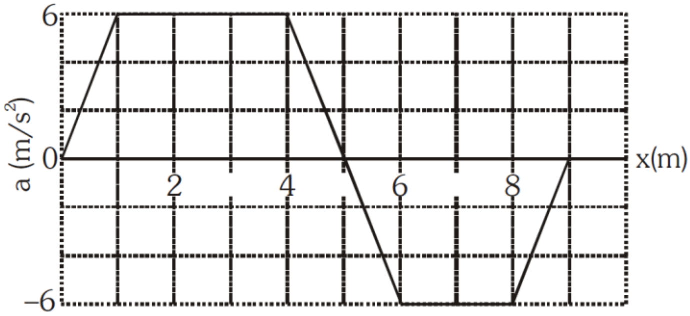
Work done in moving the object by distance $x = \int_0^x F\,.dx$

= Area under the given curve [from x = 0m to x = 6m]

$$= (3 \times 3) + (\frac{1}{2} \times 3 \times 3)$$

$$= 13.5J$$

11. Figure gives the acceleration of a 2.0 kg body as it moves from rest along x axis while a variable force acts on it from x = 0m to x = 9m. The work done by the force on the body when it reaches
(i) x = 4m and
(ii) x = 7m shall be as given below



(1) 21 J and 33 J respectively
(2) 21 J and 15 J respectively
(3) 42 J and 60 J respectively
(4) 42 J and 30 J respectively

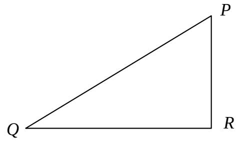
Work done is the area under force and displacement graph or work done is equal to product of mass and area under acceleration-displacement graph.

Conservative force

12. If the amount of work done by a force depends only on the initial and final, positions of the object and not on the path on which it has been moved, then such a force is called
(1) Gravitational (2) Dissipative (3) Conservative (4) Retarding

A conservative force is a force with the property that the total work done in moving a particle between two points is independent of the taken path. ... A conservative force depends only on the position of the object..

13. For the path *PQR* in a conservative force field, the amount of work done in carrying a body from *P* to *Q* and from *Q* to *R* are 5 *Joule* and 2 *Joule* respectively. The work done in carrying the body from *P* to *R* will be



(1) 7 *J* (2) 3 *J* (3) $\sqrt{21}$ *J* (4) Zero

Workdone in closed path is zero.

$$W_{PtoQ} + W_{QtoR} + W_{RtoP} = 0$$

$$2 + 5 + W_{RtoP} = 0W_{RtoP}$$

$$W_{RtoP} = -7$$

$$W_{PtoR} = -W_{RtoP} = -(-7) = 7J$$

14. The attractive force between the two particles is $F = -G\frac{m_1 m_2}{x^2}$. The work done in changing the distance between them from x to $x+d$ would be

(1) $\frac{Gm_1m_2}{x^2}d$ (2) $\frac{Gm_1m_2}{d}$ (3) $\frac{Gm_1m_2d}{x(x+d)}$ (4) $\frac{Gm_1m_2d}{(x+d)^2}$

15. When friction is present in an otherwise conservative mechanical system, the rate of change of mechanical energy is (where f is the frictional force and v is the speed of the system)

(1) fv (2) $-fv$ (3) fv^2 (4) $-fv^2$

Work Energy theorem & Law of conservation of energy

16. A neutron moving with a constant speed passes two points 3.6 m apart in 1.8×10^{-4} s. The kinetic energy of the neutron is

(1) 2.1×10^3 eV (2) 2.1 eV (3) 21 eV (4) 2.1×10^{-3} eV

17. A body m_1 is projected upwards with velocity v_1. Another body of same mass is projected at an angle of 45^0. Both reach the same height. What is the ratio of their kinetic energies at point of projection?

(1) 1 (2) 1/2 (3) 1/3 (4) ¼

Now for 1:-

$K.Ei_1 = \frac{1}{2}mv_1^2 \quad P.Ei_1 = 0$

$K.E_{f_1} = 0, \quad P.E_{f_1} = mgh \text{ (at B)}$

By energy conservation

$\frac{1}{2}mv_1^1 = mgh....(1)$

Now for 2:-

$K.Ei_2 = \frac{1}{2}mv_2^2 \quad P.Ei_2 = o$

$K.E_{f_2} = \frac{1}{2}m\left(\frac{v_2}{\sqrt{2}}\right) \quad P.E_{f_2}mgh \text{ (at B)}$

By energy conservation

$\frac{1}{2}mv_2^2 = \frac{1}{2}m\frac{v_2^2}{2} + mgh$

$\Rightarrow \frac{1}{2}mv_2^2 = 2\ mgh....(2)$

From (1) ÷ (2)

$\frac{K.Ei_1}{K.Ei_2} = \frac{\frac{1}{2}mv_1^2}{\frac{1}{2}mv_2^2} = \frac{mgh}{2\ mgh} = \frac{1}{2}(C)$

18. The kinetic energy of body is increased by 300% its momentum will be increased by

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

Kinetic energy $k = \frac{P^2}{2m}$

where, P is momentum and m is mass.

$k_1 = k, k_2 = k + 300\ \%\ \text{of}\ k = 4k$

$\Rightarrow \frac{P_2}{P_1} = \sqrt{\frac{k_2}{k_1}} = \sqrt{\frac{4k}{k}} = 2$

$\Rightarrow P_2 = P_1 + 100\%\ \text{pf}\ P_1$

Hence, momentum will increase by 100%.

19. In the figure shown, the net work done by the tension on M till it touches the ground is –

(1) + Mgd (2) $\frac{-2Mm}{M+m}gd$ (3) $\frac{-Mm}{M+m}gd$ (4) zero

Tension is internal force on system

Explanation :-

When M touches the ground then both blocks moves by distance d.

Word done by tension on block m=Td

Word done by tension on block M=-Td

Work done by tension on pulley =0 as displacement of pulley is zero

Net work done by tension on system= Td-Td=0

20. Energy required to accelerate a car from 10 to 20 m/s compared with that required to accelerate from 0 to 10 m/s covering the same distance, is:

(1) twice (2) four times (3) three times (4) same

Energy required $E = \frac{1}{2}mv^2 - \frac{1}{2}mu^2 = \frac{1}{2}m(v^2 - u^2)$

where m is the mass of the car.

Case 1 :

Initial speed $u = 10\ m/s$

Final speed $v = 20\ m/s$

Energy required $E_1 = \frac{1}{2}m(20^2 - 10^2) = 150m$ Joules

Case 2 :

Initial speed $u = 0\ m/s$

Final speed $v = 10\ m/s$

Energy required $E_2 = \frac{1}{2}m(10^2 - 0) = 50m$ Joules

$\Rightarrow E_1 = 3E_2$

21. If a man increases his speed by 2 m/s his K.E. is doubled. The original speed of the man is:

(1) $(2+\sqrt{2})$ m/s (2) $(2+2\sqrt{2})$ m/s

(3) 4 m/s (4) $(1+2\sqrt{2})$ m/s

Let initially the man travells by speed u, then his KE will be:-

$$K_1 = \frac{1}{2}mu^2 \rightarrow (1)$$

As he in overces his speed by 2 m/s, (i.e., v = u + 2) his KE doubles.

Which mean,

$$2K_1 = \frac{1}{2}m(u+2)^2 \rightarrow (2)$$

Dividing (2) + (1):-

$$\frac{2K_1}{K_1} = \frac{\frac{1}{2}m(u+2)^2}{\frac{1}{2}m(u)^2} \Rightarrow 2u^2 = (u+2)^2$$

Expanding which given us a quadration equation:-

$$u^2 - 4x - 4 = 0$$

whose roots are given by quadratic formula:

$$u = \frac{-b \pm \sqrt{b^2-4ac}}{2a} = \frac{4 \pm \sqrt{4^2+4(4)}}{2}$$

$$\Rightarrow u = 2 \pm 2\sqrt{2}$$

we will not consider $u = 2 - 2\sqrt{2}$ as it in < 0. [speed in always positive]

Thus, we get:

$$K = 2 + 2\sqrt{2} \text{ m/s}$$

22. A man who is running has half the kinetic energy of a body of half his mass. The man speeds up by 1 ms^{-1} and then has same kinetic energy as the body. The original speed of the men was

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

23. There will be change in potential energy of the system, if work is done upon the system by

(1) Any conservative or non-conservative force (2) A non-conservative force

(3) A conservative force (4) None of the above

Since potential energy defined only for conservative force. It will increase for conservative force.

24. The kinetic energy of a body is numerically equal to thrice the momentum of the body. The velocity of the body is

(1) 2 units (2) 3 units (3) 6 units (4) 9 units

As we know

$KE=(m\times v^2)/2$

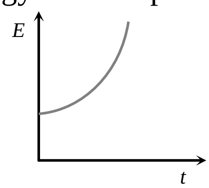
$P=m\times v$

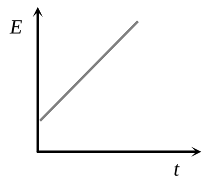
Now it is given that

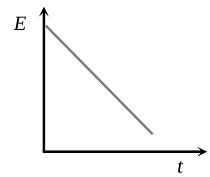
K.E=3P

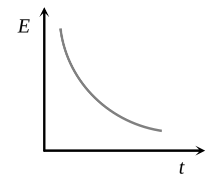
On solving, we get v=6 m/s

25. A particle is thrown horizontally from a height *h*. Taking *g* to be constant every where, kinetic energy *E* of the particle w. r. t. time *t* is correctly shown in

(1) 

(2) 

(3) 

(4) 

There will be some initial kinetic energy because there is some initial speed, yes we are dealing with speed, so graph will not start from origin and it will be always positive.

At any instant the velocity is given as $\vec{v} = \vec{u} + \vec{g}t$

K.E. at any instant will be $mv^2/2$ so it will be quadratic in time t

So its a parabola opening upward.

As the initial speed u is not zero so the parabola is shifted upward i.e on the K.E. Axis.

26. A man drags a box with uniform speed across a 10 m long rough floor. The coefficient of friction of the floor is 0.5. If the man pulls the box with a force of $(\sqrt{3})$ kN at an angle 30° with the horizontal, what is the work done in draging the box ?

(1) 30 kJ (2) 15 kJ (3) $10\sqrt{3}$ kJ (4) 5 kJ.

Work done =
F/c dotf
= F d cos 30°

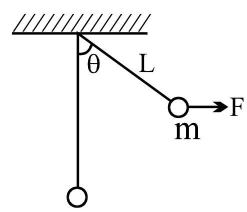
$$= \frac{mg}{\sqrt{5}+1/2} * 10 * \sqrt{3}/2$$

N = mg – F sin 30°
Uniform speed means $F_{net} = 0$
Mn = F = cos 30°
0.5(mg – F sin 30) = F cos 30
Mg – F/2 = $\sqrt{3}$F

$$F = \left(\sqrt{3}+1/2\right) = mg$$

N = mg – F sin 30
Uniform speed means $F_{net} = 0$
MN = F cos 30°
0.5 (mg – sin 30) = F cos 30

27. An object of mass m is tied to a string of length *l* and a variable horizontal force is applied on it, which initially, is zero and gradually increases until the string makes a maximum angle θ with the vertical. Workdone by the force F is



(1) mg*l*(1 – sin θ) (2) mg*l* (3) mg*l*(1 – cos θ) (4) mg*l*(1 + cos θ)

mass = m, length = l, force = f, angle = θ

By the work energy theorem, since the change in KE is zero, so the total work done by all forces must equal to zero.

Thus,

$W_f + W_g = 0$

Where W_f is the final work done, W_G is the initial work done.

$W_f = -W_g$

$W_f = -mgl(1-\cos\theta)$

Since $W_g = mgl(1 - co\theta)$

28. A ball falls under gravity from a height 10 m with an initial velocity v_0. It hits the ground, losses 50% of its energy in collision and it rises to the same height. What is the value of v_0 ?

(1) 14 m/s (2) 7 m/s (3) 28 m/s (4) 9.8 m/s.

Initial total energy at height h is, $= \frac{1}{2}mu^2 + mgh$

Energy of ball after collision,

=50% of total energy.

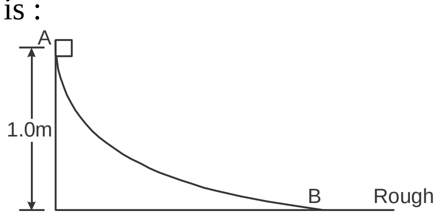
As ball rebounds to same height h, then

mgh= 50% of total energy.

$= \frac{1}{4}mu^2 + \frac{1}{2}mgh$

therefore, $u = sqrt(2gh) = 14m/s$

29. A block weighing 10 N travels down a smooth curved track AB joined to a rough horizontal surface. The rough surface has a friction coefficient of 0.20 with the block. If the block starts slipping on the track from a point 1.0 m above the horizontal surface, the distance it will move on the rough surface is :



(1) 5.0 m (2) 10.0 m (3) 15.0 m (4) 20.0 m

Let the velocity at point B be V .

By conservation of energy, $mgh = \frac{1}{2}mv^2 \Rightarrow v = \sqrt{2gh}.$

Now deceleration due to friction is $a = \mu g = 0.2g.$

So stopping distance, $s = \frac{v^2}{2a} = 2gh/0.4g = 5h = 5 \times 1 = 5m$

30. A chain of length l and mass m lies on the surface of a smooth sphere of radius $R(R > l)$ with one end tied on the top of the sphere. Then the gravitational potential energy of the chain with reference level at the center of sphere is given by

(1) $\frac{mR^2g}{l}\sin\left(\frac{l}{R}\right)$ (2) $\frac{mR^2g}{l}\cos\left(\frac{l}{R}\right)$ (3) $\frac{mR^2g}{l}\cot\left(\frac{R}{l}\right)$ (4) $\frac{mR^2g}{l}\tan\left(\frac{R}{l}\right)$

31. A simple pendulum of length 1m has a bob of 200 g. It is displaced through 60^o and then released. What will be its kinetic energy when it passes through the mean position

(1) 0.5 J (2) 1.0 J (3) 1.5 J (4) 2.0 J

Length of pendulum = 1 m , mass = 200 gm = 0.2 kg
It is displaced through an angle of 60° for vertical,
Height of pendulum at starting position = length $(1 - \cos 60°)$
$= 1 (1 - 0.5)$
$= 0.5$ m.

Potential energy = mgh = $0.2 \times 10 \times 0.5$ = 1 J
when it is released and it reaches mean position its potential energy at starting point is converted to kinetic energy.

So, K.E. of bob at mean position is **1 J**.

32. If v be the instantaneous velocity of the body dropped from the top of a tower, when it is located at height h, then which of the following remains constant

(1) $gh + v^2$ (2) $gh + \frac{v^2}{2}$ (3) $gh - \frac{v^2}{2}$ (4) $gh - v^2$

P.E + .K.E=constant
mass being constant
$gh+v^2/2$=constant

33. A man slides down a snow covered hill along a curved path and falls 20m below his initial position. The velocity in m/sec with which he finally strikes the ground is (g = 10 m/sec^2)

(1) 20 (2) 400 (3) 200 (4) 40

The equation of motion is

$$v^2 = u^2 + 2gh$$
$$v^2 = 0 + 2gh$$
$$v^2 = \sqrt{2gh}$$
$$v = \sqrt{2 \times 10 \times 20}$$
$$v = 20\frac{m}{s}$$

34. Mechanical Energy is conserved under

(1) Conservative system of forces (2) dissipative forces
(3) both (1) and (2) (4) none of these

If only internal forces are doing work (no work done by external forces), then there is no change in the total amount of mechanical energy then the total mechanical energy is said to be conserved.

35. A stone projected up with a velocity u reaches a maximum height h. When it is at a height of 3h/4 from the ground, the ratio of KE and PE at that point is : (consider PE = 0 at the point of projection)
(1) 1 : 1 (2) 1 : 2 (3) 1 : 3 (4) 3 : 1
We now that energy is always conserved
So, at a height 3h/4, it will have both kinetic and potential energy.
Potential energy is due to position, h = 3h/4 is:
So, PE = mgh

$\Rightarrow PE = \frac{3mgh}{4}$

Now, kinetic energy $= \frac{1}{2}mv^2$

Also, by third equation of motion, v2 = u2 +2gh
Here for kinetic energy h = h/4

$\Rightarrow v^2 = \frac{gh}{2}$

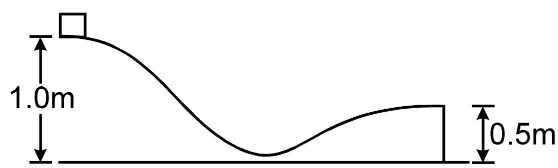
Substituting the value of v2 in the equation of kinetic energy,

We get, $KE = \frac{mgh}{4}$

$So, KE : PE = \frac{mgh}{4} \times \frac{4}{3mgh}$

$\Rightarrow KE : PE = 1 : 3$

36. Figure shows a particle sliding on a frictionless track which terminates in a straight horizontal section. If the particle starts slipping from the point A, how far away from the track will the particle hit the ground ?



(1) At a horizontal distance of 1 m from the end of the track.
(2) At a horizontal distance of 2 m from the end of the track.
(3) At a horizontal distance of 3 m from the end of the track.
(4) Insufficient information
Apply mechanical energy conservation,

$(mg \times 1) + 0 = mg(0.5) + \frac{1}{2}mV^2$

Where $(mg \times 1) = P.E_{initial}; 0 = K.E_{initial}; mg(0.5) = P.E_{final}$

$mg = \frac{mg}{\Sigma} + \frac{mV^2}{\Sigma}$

$\frac{mg}{\Sigma} = \frac{mV^2}{\Sigma}$

$V = \sqrt{g} m/s$

Range = R = V t
t = Time of flight.

$\because H = \frac{1}{2}gt^2$

$\therefore t = \sqrt{\frac{2H}{g}}$

$\therefore R = \sqrt{g}\sqrt{\frac{2H}{g}}$

$R = 1m$

37. A body is dropped from a certain height. When it lost an amount of Potential Energy. 'U', it acquires a velocity 'v'. The mass of the body is:

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

Potential Energy = Kinetic energy

$U = \frac{1}{2}mv^2$

$m = \frac{2U}{v^2}$

Mass is $\frac{2U}{v^2}$

38. Two bodies of mass 1kg and 4kg have equal K.E. then the ratio of their momentum is :-

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

We know the relation between kinetic Energy and momentum

$K = 1/2mv^2 \times \frac{m}{m} = \frac{p^2}{2m}$

$P = \sqrt{2km}$

So, $\frac{P_1}{P_2} = \sqrt{\frac{2km_1}{2km_2}} = \sqrt{\frac{1}{4}}$

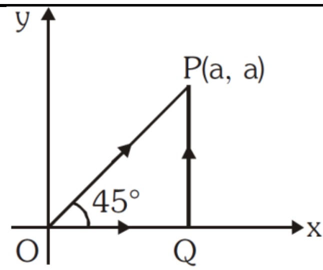
$\frac{P_1}{P_2} = \frac{1}{2}$

Ratio of momentum = 1 : 2

39. The relation between conservative force and potential energy U is given by:-

(1) $\vec{F} = \frac{dU}{dx}$ (2) $\vec{F} = \int Udx$ (3) $\vec{F} = -\frac{dU}{dx}$ (4) $F = \frac{dU}{dx}$

40. A particle is moved from (0, 0) to (a, a) under a force $\vec{F} = (3\hat{i} + 4\hat{j})$ from two paths. Path 1 is OP and path 2 is OQP. Let W1 and W2 be the work done by this in these two path. Then:



(1) $W_1 = W_2$ (2) $W_1 = 2W_2$ (3) $W_2 = 2W_1$ (4) $W2 = 4W_1$

Given that,

Position vector of point $P = a\hat{i} + a\hat{j} = \vec{s}$

Work done W_1 is

$W_1 = \vec{F}.\vec{s}$

$W_1 = (3\hat{i} + 4\hat{j}).(a\hat{i} + a\hat{j})$

$W_1 = 3a + 4a$

$W_1 = 7a$

Now, work done in two different paths

$OQ = a\hat{i}$

$QP = a\hat{j}$

Now, work done W_2 is

$W_2 = \vec{F}.\overrightarrow{OQ} + \vec{F}.\overrightarrow{QP}$

$W_2 = (3\hat{i} + 4\hat{j}).(a\hat{i}) + (3\hat{i} + 4\hat{j}).(a\hat{j})$

$W_2 = 3a + 4a$

$W_2 = 7a$

So, $W_1 = W_2$

Hence, the work done is equal for both paths

Spring block mass system

41. Two springs have their force constants K_1 and K_2. Both are stretched till their elastic energies are equal. If the stretching forces are F_1 and F_2 then $F_1 : F_2$ is equal to

(1) $K_1 : K_2$ (2) $K_2 : K_1$

(3) $\sqrt{K_1} : \sqrt{K_2}$ (4) K_1^2 / K_2^2

Let, for same potential energy, elongations of springs be$x_1$and x_2 and their respective force constants be $k_1$and k_2

then we have,

$$\frac{1}{2}k_1x_1^2 = \frac{1}{2}k_2x_2^2$$

$$\frac{x_1^2}{x_2^2} = \frac{k_2}{k_1} \text{.........(1)}$$

$$\frac{f_1}{f_2} = \frac{k_1x_1}{k_2x_2} = \frac{k_1}{k_2} \times \sqrt{\frac{k_2}{k_1}} = \sqrt{\frac{k_1}{k_2}}$$

42. A wound watch spring
(1) Has no energy stored in it
(2) Has mechanical kinetic energy stored in it
(3) Has mechanical potential energy stored in it
(4) Has electrical energy stored in it

43. A 2 kg block is dropped from a height of 0.4 m on a spring of force constant k = 1960 N/m. The maximum compression of the spring is
(1) 0.1 m (2) 0.2 m (3) 0.3 m (4) 0.4 m
By law of conservation of energy, we have loss in gravitational potential
Energy = gain in elastic potential energy

$$\Rightarrow mg\left(h+x=\frac{1}{2}\right)kx^2$$

$$2\times10\left(0.4+x\right)=\frac{1}{2}\times1960\times x^2$$

$$\Rightarrow 8+20x=980x^2$$

$$\Rightarrow 980x^2-20x-8=0$$

Solving, we get
x = 0.1m

44. A weight mg is suspended from a spring. If the elongation in the spring is x_0, the elastic energy stored in it is
(1) $\frac{1}{2}mgx_0$ (2) $2mgx_0$ (3) mgx_0 (4) $\frac{1}{4}mgx_0$

45. A block of mass m moving with speed v compresses a spring through distance x before its speed is halved. What is the value of spring constant ?
(1) $\frac{3mv^2}{4x^2}$ (2) $\frac{mv^2}{4x^2}$ (3) $\frac{mv^2}{2x^2}$ (4) $\frac{2mv^2}{x^2}$
From conservation of energy,
Loss in kinetic energy of block = Gain in potential energy of spring

$$\Rightarrow \frac{1}{2}mv^2-\frac{1}{2}m\left(\frac{v}{2}\right)^2=\frac{1}{2}kx^2$$

$$\Rightarrow \frac{3mv^2}{8}=\frac{1}{2}kx^2$$

$$\Rightarrow k=\frac{3mv^2}{4x^2}$$

46. Two springs A and B ($k_A = 2k_B$) are strettched by applying forces of equal magnitudes at the four ends. If the energy stored in A is E, that in B is
(1) E/2 (2) 2E (3) E (4) E/4
Force is same, thus 0.5 $k_a x_a = 0.5(k_a/2)(x_b)$
Thus $x_b = 2\,x_a$
Energy in A = U = 0.5 $k_A x^2$ = E
Energy in B = 0.5 $k_b x^2$ = 0.5 $(k_A/2)(2x)^2$ = 2E

Power

47. A body of mass m accelerates uniformly from rest to a velocity v_0 in time t_0. The instantaneous power delivered to the body at any time t is

(1) $\frac{mv_0t}{t_0}$ (2) $\frac{mv_0^2t}{t_0}$ (3) $\frac{mv_0t^2}{t_0}$ (4) $\frac{mv_0^2}{t_0^2}t$

48. An elevator's motor produces 3000 W power. The speed with which it can lift a 1000 kg load is

(1) $30.6ms^{-1}$ (2) $3.06\,ms^{-1}$ (3) $0.306ms^{-1}$ (4) $300.6ms^{-1}$

Power of the motor required to lift the mass m with velocity v

$$p = mgv$$

$$v = \frac{p}{mg}$$

$$= \frac{2000w}{1000\times 9.81}kg\frac{m}{sec^2}$$

$$= \frac{2000N\frac{m}{sec}}{9810kg\frac{m}{sec^2}}$$

$$v = 0.204\frac{m}{sec}$$

49. A man cycles up a hill rising 1 metre vertically for every 50 metre along the slope at the rate of 3.6 km/hour. If the weight of the man and cycle is 120 kg, the power of the man is

(1) 5.85 watt (2) 11.7 watt (3) 23.52 watt (4) 47.04 watt

F = mg sin θ

$$= 120\times 10\times\frac{1}{10}$$

$$P = f.v$$

$$= 120\times 10\times\frac{1}{50}\times 3.6\times\frac{5}{16}$$

$$= 120\times 10\times\frac{1}{50}\times\frac{36}{10}\times\frac{5}{16}$$

$$= 24watt$$

50. A particle moves with a velocity $\vec{v} = 10\hat{i} - 6\hat{j} + 12\hat{k}$ m/s under the influence of a constant force $\vec{F} = 10\hat{i} + 10\hat{j} + 20\hat{k}$ N. The instantaneous power applied to the particle is

(1) 100 J/s (2) 280 J/s (3) 350 J/s (4) 400 J/s

51. A car of mass 'm' is driven with 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 the engine of the car is doing work will be

(1) RV (2) maV (3) (R + ma)V (4) (ma – R)V

Total force require to oppose the resistive force and move with acceleration a is,

F = ma + R

Power is given by,

$\therefore P = (ma + R)V$

52. A man M1 of mass 80 kg runs up a staircase in 15 s. Another man M2 also of mass 80 kg runs up the stair case in 20 s. The ratio of the power developed by them (P1 / P2) will be:
(1) 1 (2) 4/3
(3) 16/9 (4) None of the above

$\text{Power} = \frac{\text{Work}}{\text{Time}}$

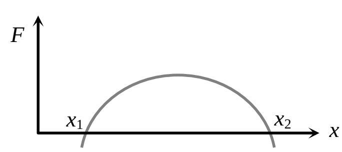
Since, work done is same in both the cases because both the man are of same mass and climb same height. Only difference is of Time-

$P1 = \frac{W}{15}$ and $P2 = \frac{W}{20}$

So, $\frac{P1}{P2} = \frac{\frac{W}{15}}{\frac{W}{20}} = \frac{\frac{1}{15}}{\frac{1}{20}} = \frac{20}{15} = \frac{4}{3}$

Equilibrium

53. The force acting on a body moving along *x*-axis varies with the position of the particle as shown in the figure. The body is in stable equilibrium at



(1) $x = x_1$ (2) $x = x_2$ (3) Both x_1 and x_2 (4) Neither x_1 nor x_2

Force, $F = -\frac{dU}{dx}$

At $x = x_1$, $x = x_2$, $\frac{dU}{dx} = 0$

For stable equilibrium, $\frac{dF}{dx} < 0$

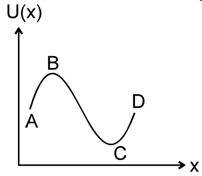
Here at $x = x_2$, $\frac{dF}{dx} < 0$

Here at $x = x_2$, $\frac{dF}{dx} < 0$

So the body is in stable equilibrium at $x = x_2$

54. If a particle under the action of a force *F* has potential energy *U* then in equilibrium
(1) Both F & U must be 0 (2) F may be non zero but U must be 0
(3) U may be non zero but F must be 0 (4) Both may be non zero

55. The potential energy of a particle varies with distance x as shown in the graph. The force acting on the particle is zero at



(1) C (2) B (3) B and C (4) A and D.

$F = \frac{-dU}{dx}$

F = O where slope is O i.e. at maxima and minima

Hence, F = O at B & C

LEVEL - II

Work

1. The force on a particle varies as $F = \frac{9}{x^2}$. The work done in displacing the particle from $x = 1$ to $x = 3$ is

(1) 4 J (2) 3 J (3) 5 J (4) 6 J

$f = \frac{9}{x^2}$

$\int dw = \int F.dx$

$w = \int_{x=1}^{x=2} \frac{9}{x^2}.dx$

$= \left[\frac{-9}{x}\right]_1^3$

$= \left[\frac{-9}{3} - \left[\frac{-9}{1}\right]\right]$

$= [-3+9]$

$= 6J$

2. The velocity of a particle moving along a line varies with distance as $v = a\sqrt{x}$ where a is a constant. The work done by all forces when the particle moves from $x = 0$ to $x = l$ is (mass of the particle is m)

(1) 0 (2) ma^2l (3) $\frac{1}{2}ma^2l$ (4) $\frac{1}{3}mal$

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

(1) 70 J (2) 270 J (3) 35 J (4) 135 J

$W = \int F dx$

$= \int_0^5 7 - 2x + 3x^2 dx$

$= \left[7x - \frac{2x^2}{2} + \frac{3x^3}{3}\right]_0^5$

$= \left[7x - x^2 + x^3\right]_0^5$

$= \left[7\times5 - 5^2 + 5^3\right] - \left[0 - 0 + 0\right]$

$= \left[35 - 25 + 125\right] - 0$

$= 135 J$

4. Under the action of a force, a 3 kg body moves such that its position *x* as a function of time is given by $x = \frac{t^3}{3}$; where *x* is in meters and *t* in seconds. The work done by the force in the first two seconds is

(1) 24 J (2) 32 J (3) 81 J (4) 810 J

5. The displacement *x* of a particle of mass *m* kg moving in one dimension, under the action of a force, is related to the time *t* by the equation $t = \sqrt{x} + 3$ where *x* is in metres and *t* is in seconds. The work done by the force in the first six seconds in joules is

(1) 0 (2) 3 (3) 6 (4) 9

Given $t - 3 = \sqrt{x} \Rightarrow \sqrt{x} = t - 3 \Rightarrow x = (t-3)^2 = t^2 - 6t + 9$

Therefore, the velocity of the particle is

$v = \frac{dx}{dt} = 2t - 6$

and it will be zero when

$2t - 6 = 0 \Rightarrow t = 3s$

Hence, the velocity of the particle will be zero when t = 3 s. Putting t = 3 s. in (1), we get the required displacement of the particle as

$x = 3^2 - 6\times3 + 9 = 0$

$\Rightarrow x = 0$

Work Energy theorem & Law of conservation of energy

6. A string of mass 'm' end length '*l*' rests over a frictionless table with 1/4th of its length hanging from a side. The work done in bringing the hanging part back on the table is

(1) mgl/4 (2) mgl/32 (3) mgl/16 (4) none of these

Length of chain hanging from the table= $\frac{L}{4}$

Mass of chain (only the hanging part) = $\frac{m}{4}$

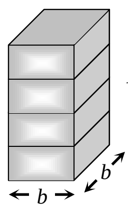
Gravitation force on hanging part of the chain = $\frac{mg}{4}$

Center of mass of the hanging part of the chain is at L/8 from end.(i.e, half of hanging lenght)

therefore, Work done = F .s

$= m(g/4) * (L/8) * \cos(180) = \frac{mgL}{32}$

7. N similar slabs of cubical shape of edge b are lying on ground. Density of material of slab is D. Work done to arrange them one over the other is



(1) $(N^2 - 1)b^3Dg$ (2) $(N-1)b^4Dg$ (3) $\frac{1}{2}(N^2 - N)b^4Dg$ (4) $(N^2 - N)b^4Dg$

Center of Gravity of first slab = $\frac{b}{2}$

Weight of each stab

$= \text{volume} \times \text{density} \times g$

$= b^3\rho g$

Center of Gravity of column of slabs

$= \frac{\text{Total height of N slabs}}{2}$

$= \frac{Nb}{2}$

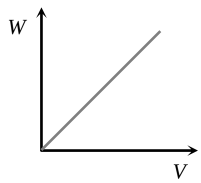
PE_{final} = Total weight of N slabs × height of center of mass

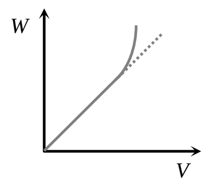
$= N \times b^3\rho g \times \frac{Nb}{2} = \frac{N^2b^4\rho g}{2}$

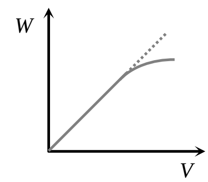
$PE_{initial} = Nb^3\rho g \times \frac{b}{2} = \frac{Nb^4\rho g}{2}$

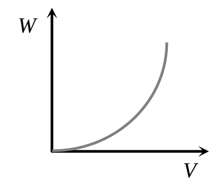
$\Delta PE = PE_{final} - PE_{initial} = \text{Work done} = \frac{N^2b^4\rho g}{2} - \frac{Nb^4\rho g}{2} = \frac{1}{2}(N^2 - N)b^4\rho g$

8. A particle, initially at rest on a frictionless horizontal surface, is acted upon by a horizontal force which is constant in size and direction. A graph is plotted of the work done on the particle *W*, against the speed of the particle, *v*. If there are no other horizontal forces acting on the particle the graph would look like

(1) 

(2) 

(3) 

(4) 

Work done = change in kinetic energy

$W = \frac{1}{2}mv^2 \therefore W \alpha v^2$ graph will be parabolic in nature

9. If the kinetic energy of a body is directly proportional to time *t*, the magnitude of the force acting on the body is
(1) Directly proportional to $\sqrt{t}$
(2) Inversely proportional to t
(3) Directly proportional to the speed of the body
(4) Inversely proportional to the speed of the body

10. A particle moves in a straight line with retardation proportional to its displacement. Its loss of kinetic energy for any displacement *x* is proportional to
(1) x (2) x^2 (3) $\ln x$ (4) e^x

Using the supplied data, derive a particle acceleration relationship. In this equation, substitute the value in the form of a change in velocity. Substitute the value of time change in this equation as well. Integrate this equation between the velocity and displacement limits to get the relationship between the change in kinetic energy of the particle and its displacement.

11. 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 the pipe is *V*, then the rate at which kinetic energy is being imparted to the liquid, is
(1) $\frac{1}{2}AdV^3$ (2) $\frac{1}{2}AdV^2$ (3) $\frac{1}{2}AdV$ (4) AdV^2

12. The distance covered by a body to come to rest when it is moving with a speed of $4\,ms^{-1}$ is *s* when a retarding force *F* is applied. If the *K.E.* is doubled, the distance covered by it to come to rest for the same retarding force *F* is
(1) 4 *s* (2) 6 *s* (3) 2 *s* (4) 8 *s*

13. A body is gently dropped on a conveyor belt moving at $3\,ms^{-1}$. If $\mu = 0.5$, how far will the body move relative to the belt before coming to rest relative to the belt ($g = 10\,ms^{-2}$)
(1) 0.3 *m* (2) 0.6 *m* (3) 0.9 *m* (4) 1.8 *m*

$4 = 3m/s$

$v = 0$ (rest)

$r = ?$

$a = \mu g = 0.5 \times 10 = 5m/s^2$

Using $v^2 = u^2 - 2as$

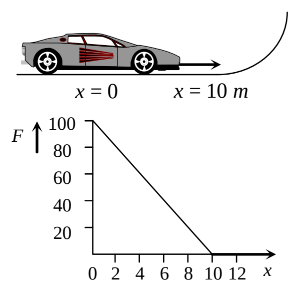
We get $s = \frac{u^2 - v^2}{2a} = \frac{9-0}{2 \times 5}$

$s = 0.9m.$

14. A toy car of mass 5 *kg* moves up a ramp under the influence of force *F* plotted against displacement *x*. The maximum height attained is given by

(1) $y_{max} = 20m$ (2) $y_{max} = 15m$

(3) $y_{max} = 11m$ (4) $y_{max} = 5m$



Work done = mgh

$\frac{1}{2} \times \text{base} \times \text{height} = mgh$

(area under the curve is work done)

$\frac{1}{2} \times 11 \times 100 = 5 \times 10 \times h$

or $h = 11m$

15. A mass *m* is thrown vertically upward into air with initial speed *u*. A constant force *F* due to air resistance acts on the mass during its travel. Taking into account the work done against air drag the maximum distance covered by the mass to reach the top is

(1) $\frac{u^2}{2g}$ (2) $\frac{u^2}{2g + (2F/m)}$ (3) $\frac{u^2}{2g + F/m}$ (4) $\frac{u^2}{g + F/m}$

Loss in K.E. = Gain in P.E. + Work done against air drag

i.e. $\frac{1}{2}mu^2 = mgh + Fh = h(mg + F)$

or $h = \frac{u^2}{2(g + F/m)}$

$= \frac{u^2}{2g + 2F/m}$

16. A hammer of mass M falls from a height h repeatedly to drive a pile of mass m into the ground. The hammer makes the pile penetrate in the ground & goes with it upto a distance d in single blow. Opposition force to penetration is given by

(1) $\frac{m^2gh}{M+md}$ (2) $\frac{Mgh}{d}+(M+m)g$ (3) $\frac{M^2gh}{M+md}$ (4) $\frac{mgh}{d}+(M+m)g$

Using law of conservation of total momentum, we get

$(M+m)v = M\sqrt{2gh}$

or $v = \frac{M\sqrt{2gh}}{M+m}$

Let opposition to penetration be F then

Total work done = change in K.E.

i.e. $F = \frac{1}{2}(M+m)\frac{(M^2 2gh)}{d(M+m)^2} + (M+m)g$

$= \frac{M^2gh}{(M+m)d} + (M+m)g$

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

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

Given,

acceleration $= \frac{g}{4}$

mass = m, distance = d

tension = T

So,

Work done by the tension is:

$t(-d) = -T\,d$

$mg - T = \frac{g}{4}m$

$T = mg - m\frac{g}{4}$

$= \frac{3mg}{4}$

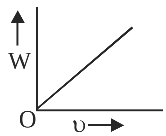
So, the work done is:

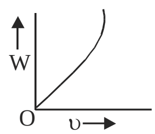
$= F s$

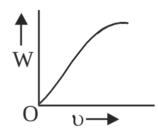
$= -\frac{3mgd}{4}$

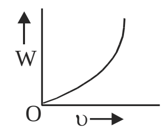
Thus, the work done by the string will be $= -\frac{3mgd}{4}$

18. A particle at rest on a frictionless table is acted on by a horizontal force which is constant in magnitude and direction. A graph is plotted of the work done on the particle W, against the speed of the particle v. If there are no frictional forces acting on the particle, the graph will look like

(1) 

(2) 

(3) 

(4) 

$W = F.d = F\frac{v^2}{2a} = F\frac{v^2}{\frac{2F}{m}} = \frac{m}{2}v^2$

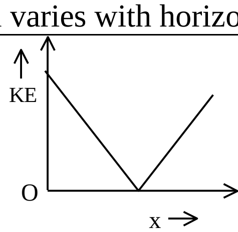
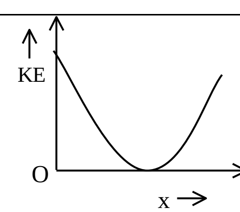
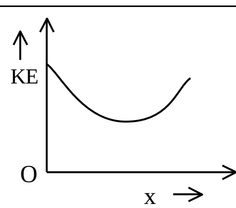
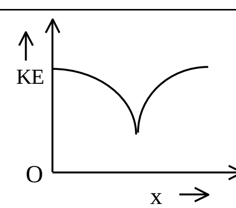
$W \propto v^2$

so, the graph will be a parabola.

Alternatively,

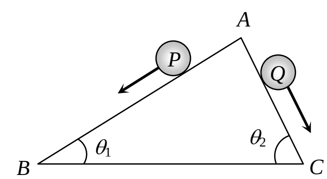
Work done on the particle changes the kinetic energy. $KE = \frac{1}{2}mv^2$ since F is constant.

19. A ball is thrown up with a certain velocity at angle θ to the horizontal. The kinetic energy KE of the ball varies with horizontal displacement x as:

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

As x increases, kinetic energy initially decreases till the highest point of projectile, because vertical component of velocity is decreasing (horizontal velocity remains same). At maximum height, kinetic energy is minimum but not zero, because of some horizontal velocity. Thus after that KE again increases with distance as magnitude of y-component of velocity increases on falling down.This is depicted in C

20. Two inclined frictionless tracks of different inclinations ($\theta_1 < \theta_2$) meet at A from where two blocks *P* and *Q* of different masses are allowed to slide down from rest at the same time, one on each track as shown in fig.



(1) Both blocks will reach the bottom at the same time
(2) Block *P* will reach the bottom earlier than block *Q*
(3) Both blocks reach the bottom with the same speed
(4) Block *Q* will each the bottom with a higher speed that block *P*

21. In comparison to the temperature of water at the foot of fall, the temperature of the water at the top of the fall is
(1) Same (2) Slightly less (3) Slightly greater (4) Uncertain

Spring block mass system

22. A force $F = Kx^2$ acts on a particle at an angle of 60^o with the *x*-axis. The work done in displacing the particle from x_1 to x_2 will be
(1) $\frac{kx^2}{2}$ (2) $\frac{k}{2}(x_2^2 - x_1^2)$ (3) $\frac{k}{6}(x_2^3 - x_1^3)$ (4) $\frac{k}{3}(x_2^3 - x_1^3)$

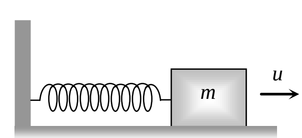
Given, $F = kx^2$, Angle $= 60°$

We know that the work-done by the force is:

$$W = \int_{x_1}^{x_2} kx^2 dx = k[\frac{x^3}{3}]_{x_1}^{x_2} \cos 60°$$

$$W = \frac{k}{6}[x_2^3 - x_1^3] \text{ Since } \cos\theta = \frac{1}{2}$$

23. A block of mass *m* has initial velocity *u* having direction towards +*x* axis. The block stops after covering distance *S* causing similar extension in the spring of constant *K* holding it. If μ is the kinetic friction between the block and the surface on which it was moving, the distance *S* is given by



(1) $\frac{1}{K}\mu^2 m^2 g^2$ (2) $\frac{\sqrt{(\mu mg)^2 - mu^2k} + \mu mg}{k}$

(3) $\frac{1}{K}(\mu^2 m^2 g^2 + mKu^2 + \mu mg)^{\frac{1}{2}}$ (4) $\frac{\sqrt{(\mu mg)^2 + mu^2k} - \mu mg}{k}$

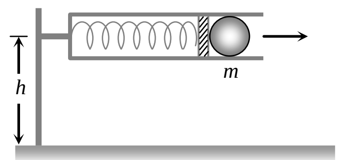
By the work-energy theorem $\frac{1}{2}mu^2 = \mu mgS + \frac{1}{2}kS^2$

i.e $S^2 + \frac{2\mu mgS}{k} - \frac{mu^2}{k} = 0$

$\Rightarrow \dfrac{\frac{-2\mu mg}{k} + \sqrt{\frac{4\mu^2m^2g^2}{k^2} + \frac{4mu^2}{k}}}{2}$

$= \dfrac{-\mu mg + \sqrt{\mu^2m^2g^2 + mu^2k}}{k}$

24. A compressed spring of spring constant k releases a ball of mass m. If the height of spring is h and the spring is compressed through a distance x, the horizontal distance covered by ball to reach ground is



(1) $x\sqrt{\frac{kh}{mg}}$ (2) $\frac{xkh}{mg}$

(3) $x\sqrt{\frac{2kh}{mg}}$ (4) $\frac{mg}{x\sqrt{kh}}$

Spring energy = kinetic energy

i.e. $\frac{1}{2}kx^2 = \frac{1}{2}mv^2$ or $v = x\sqrt{\frac{k}{m}}$

Time taken by ball to reach ground, t

$= \sqrt{\frac{2h}{g}}$ (from $S = ut + \frac{1}{2}at^2$)

$\therefore$ Horizontal distance covered = vt

$= x\sqrt{\frac{k}{m}}\sqrt{\frac{2h}{g}} = x\sqrt{\frac{2kh}{mg}}$

25. A light elastic string of natural length l is extended by an amount Fl/λ when subjected to a tension F. A small body of mass m is attached to a point O on a smooth horizontal table by, means of this elastic string. The body moves in a horizontal orbit of constant radius $(5l/4)$ and centre O with a tangential velocity. Find the value of v and calculate the ratio of kinetic energy to the elastic stored energy

(1) $\left(\frac{5\lambda l}{16m}\right)^{1/2}$, 5 : 1 (2) $\left(\frac{16m}{5\lambda l}\right)^{1/2}$, 5 : 1 (3) $\left(\frac{16\lambda l}{5m}\right)^{1/2}$, 1 : 5 (4) $\left(\frac{16m}{5\lambda l}\right)^{1/2}$, 1 : 5

26. An elastic string of unstretched length L and force constant k is stretched by a small length x. It is further stretched by a small length y. The work done in the second stretching is

(1) $\frac{1}{2}ky^2$ (2) $\frac{1}{2}k(x^2 + y^2)$ (3) $\frac{1}{2}k(x + y)^2$ (4) $\frac{1}{2}ky(2x + y)$

27. A force $\vec{F} = -k(y\hat{i} + x\hat{j})$, where k is a positive constant, acts on a particle moving in the xy plane. Starting from the origin, the particle is taken along the positive x-axis to the point (a, 0), and the parallel to the y-axis to the point (a, a). The total work done by the force on the particle is

(1) $-2ka^2$ (2) $2ka^2$ (3) $-ka^2$ (4) ka^2

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

We know that

$W = \int \vec{F}.\vec{ds} = \int_{(0,0)}^{(a,a)} -k(y\hat{i} + x\hat{j}).(dx\hat{i} + dy\hat{j}) = \int_{(0,0)}^{(a,a)} -k(ydx + xdy)$ $W = -\int_{(0,0)}^{(a,a)} k\, d(xy) = -ka^2$

Power & Equilibrium

28. A car seller claims that his 1000 *kg* car can accelerate from rest to a speed of 24 ms^{-1} in just 8.0*s*. The engine of the car, on an average, should be of

(1) 60 *hp* (2) 48 *hp* (3) 80 *hp* (4) 24 *hp*

29. An engine of mass one metric ton is ascending on a inclined plane, at an angle $\tan^{-1}\left(\frac{1}{2}\right)$ with horizontal, with a speed of 36 *km/hour*. If the coefficient of friction of the surface is $1/\sqrt{3}$ then the power (in watts of engine is)

(1) 94400 (2) 9440 (3) 944 (4) 94.4

30. The aerodynamic drag on an airplane is given by $D = bv^2$. The power output of an airplane cruising at constant speed *v* in level flight is proportional to

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

31. A vehicle of mass *M* is accelerated on a horizontal frictionless road under a force changing its velocity from *u* to *v* in distance *S*. A constant power *P* is given by the engine of the vehicle, then *v* =

(1) $\left(u^3 + \frac{2PS}{M}\right)^{1/3}$ (2) $\left(\frac{PS}{M} + u^3\right)^{1/2}$ (3) $\left(\frac{PS}{M} + u^2\right)^{1/3}$ (4) $\left(\frac{3PS}{M} + u^3\right)^{1/3}$

Using $P = Fv = M\left(\frac{dv}{dt}\right)v$

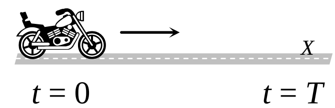
i.e. $v^2 dv = \frac{P}{M} v dt = \frac{P}{M} dS$

Integrating $\int_u^v v^2 dv = \frac{P}{M}\int_0^S dS$

$v^3 - u^3 = \frac{3PS}{M}$

or $v = \left(\frac{3PS}{M} + u^3\right)^{1/3}$

32. A motorcycle of mass m resting on a frictionless road moves under the influence of a constant force F. The work done by this force in moving the motorcycle is given by $F^2t^2/2m$, where t it the time interval. Ratio of instantaneous power to average power of the motorcycle in $t = T$ second is



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

acceleration (a) = F/m

distance covered (s)= $1/2at^2$

$= 1/2(F/m)t^2$

velocity after time t (v)= at = Ft/m

average power (Pav) = work/time

$= F^2t/2m$

instantaneous power = Fv

$= F^2t/m$

The ratio of instantaneous power to average power is 2:1

33. The potential energy of a particle is given by $U = a/r^2 - b/r$ where a and b are positive constants and r is the distance from the centre of the field. The stable equilibrium position of the particle corresponds to the distance r_0 given by

(1) $r_0 = \frac{a}{2b}$ (2) $r_0 = -\frac{a}{b}$ (3) $r_0 = \frac{2a}{b}$ (4) $r_0 = \frac{a}{b}$

$$U = \frac{a}{r^2} - \frac{b}{r}$$

$$F = \frac{dU}{dr} = -\frac{2a}{r^3} + \frac{b}{r^2}$$

For equilibrium

$$F = 0 \Rightarrow -\frac{2a}{r^3} + \frac{b}{r^2} = 0$$

$$-\frac{2a}{r^3} + \frac{b}{r^2} \Rightarrow r = \frac{2a}{b}$$

ASSERTION & REASON

Read the assertion and reason carefully to mark the correct option out of the options given below:

(1) If both assertion and reason are true and the reason is the correct explanation of the assertion.
(2) If both assertion and reason are true but reason is not the correct explanation of the assertion.
(3) If assertion is true but reason is false.
(4) If the assertion and reason both are false.
(e) If assertion is false but reason is true.

1. Assertion : A person working on a horizontal road with a load on his head does no work on the load.
Reason : No work is said to be done, if directions of force and displacement of load are perpendicular to each other.

2. Assertion : The work done during a round trip is always zero.
Reason : No force is required to move a body in its round trip.

3. Assertion : Work done by friction on a body sliding down an inclined plane is positive.
Reason : Work done is greater than zero, if angle between force and displacement is acute or both are in same direction.

4. Assertion : When a gas is allowed to expand, work done by gas is positive.
Reason : Force due to gaseous pressure and displacement (of piston) are in the same direction.

5. Assertion : A light body and heavy body have same momentum. Then they also have same kinetic energy.
Reason : Kinetic energy does not depend on mass of the body.

6. Assertion : The instantaneous power of an agent is measured as the dot product of instantaneous velocity and the force acting on it at that instant.
Reason : The unit of instantaneous power is watt.

7. Assertion : The change in kinetic energy of a particle is equal to the work done on it by the net force.
Reason : Change in kinetic energy of particle is equal to the work done only in case of a system of one particle.

8. Assertion : A spring has potential energy, both when it is compressed or stretched.
Reason : In either compressing or stretching, work is done on the spring against the restoring force.

9. Assertion : Planets move around the sun in elliptical orbits. The gravitational force on the Planet due to sun is not normal to the Planet's velocity but the work done by the gravitational force over every complete orbit of the Planet is zero.
Reason : Gravitational force is a non conservative force.

10. Assertion : The rate of change of total momentum of a many particle system is proportional to the sum of the internal forces of the system.
Reason : Internal forces can change the kinetic energy but not the momentum of the system.

11. Assertion : Water at the foot of the water fall is always at different temperature from that at the top.
Reason : Some of the potential energy of water at the top is converted into heat energy during falling.

12. Assertion : The power of a pump which raises 100 *kg* of water in 10*sec* to a height of 100 *m* is 10 *KW*.

Reason : The practical unit of power is horse power.

13. Assertion : According to law of conservation of mechanical energy change in potential energy is equal and opposite to the change in kinetic energy.

Reason : Mechanical energy is not a conserved quantity.

14. Assertion : When the force retards the motion of a body, the work done is zero.

Reason : Work done depends on angle between force and displacement.

15. Assertion : In an elastic collision of two bodies, the momentum and energy of each body is conserved.

Reason : If two bodies stick to each other, after colliding, the collision is said to be perfectly elastic.

16. Assertion : A body cannot have energy without having momentum but it can have momentum without having energy.

Reason : Momentum and energy have same dimensions.

17. Assertion : Power developed in circular motion is always zero.

Reason : Work done by any force in case of circular motion is zero.

18. Assertion : A kinetic energy of a body is quadrupled, when its velocity is doubled.

Reason : Kinetic energy is proportional to square of velocity.

19. Assertion : A quick collision between two bodies is more violent than slow collision, even when initial and final velocities are identical.

Reason : The rate of change of momentum determine that force is small or large.

20. Assertion : Work done by or against gravitational force in moving a body from one point to another is independent of the actual path followed between the two points.

Reason : Gravitational forces are conservative forces.

21. Assertion : Graph between potential energy of a spring versus the extension or compression of the spring is a straight line.

Reason : Potential energy of a stretched or compressed spring, proportional to square of extension or compression.

22. Assertion : In case of bullet fired from gun, the ratio of kinetic energy of gun and bullet is equal to ratio of mass of bullet and gun.

Reason : In firing, momentum is conserved.

23. Assertion : Power of machine gun is determined by both, the number of bullet fired per second and kinetic energy of bullets.

Reason : Power of any machine is defined as work done (by it) per unit time.

24. Assertion : A work done in moving a body over a closed loop is zero for every force in nature.

Reason : Work done does not depend on nature of force.

25. Assertion : Mountain roads rarely go straight up the slope.

Reason : Slope of mountains are large therefore more chances of vehicle to slip from roads.

26. Assertion : Soft steel can be made red hot by continued hammering on it, but hard steel cannot.

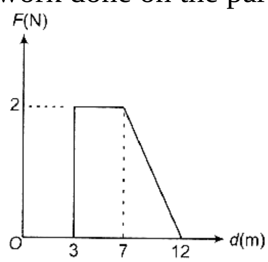
Reason : Energy transfer in case of soft iron is larger than in hard steel.

PREVIOUS YEAR'S QUESTIONS

Work Done by Constant Force & Variable Force

1. A uniform force of $(3i + j)$ newton acts on a particle of mass 2kg. Hence the particle is displaced from position $(2\hat{i} + \hat{k})$ meter to position $(4\hat{i} + 3\hat{j} - \hat{k})$ meter. The work done by the force on the particle is : **[NEET – 2013]**
(1) 15 J (2) 9J (3) 6 J (4) 13 J

2. Force F on a particle moving in a straight line varies with distance d as shown in the figure. The work done on the particle during its displacement of 12 m is **[CBSE AIPMT 2011]**



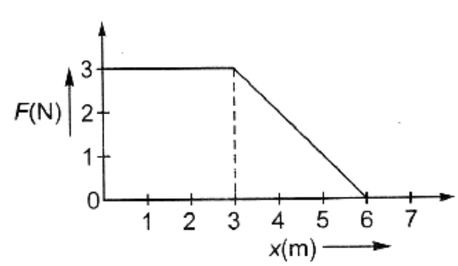
(1) 21 J (2) 26 J (3) 13 J (4) 18 J

3. A person of mass 60 kg is inside a lift of mass 940 kg and presses the button on control panel. The lift starts moving upwards with an acceleration 1.0 ms^{-2}. If g = 10 ms^{-2}, the tension in the supporting cable is **[CBSE AIPMT 2011]**
(1) 9680 N (2) 11000N (3) 1200 N (4) 8600 N

4. A gardener pushes a lawn roller through a distance 20 m. If he applies a force of 20 kg–wt in a direction inclined at 60° to the ground, the work done by him is **[J&K CET 2011]**
(1) 1960 J (2) 196 J (3) 1.96 J (4) 196 kJ

5. A plate of mass m, length b and breadth a is initially lying on a horizontal floor with length parallel to the floor and breadth perpendicular to the floor. The work done to exect it on its breadth is **[BVP 2010]**
(1) $mg\left[\frac{b}{2}\right]$ (2) $mg\left[a+\frac{b}{2}\right]$ (3) $mg\left[\frac{b-a}{2}\right]$ (4) $mg\left[\frac{b+a}{2}\right]$

6. A force F acting on an object varies with distance x as shown here. The force is in Newton and x is in metre. The work done by the force in moving the object from x = 0 m to x = 6m is **[CBSE AIPMT 2010]**
(1) 4.5 J (2) 13.5 J
(3) 9J (4) 18 J



7. A quarter horse power motor runs at a speed of 600 rpm. Assuming 40% efficiency, the work done by the motor in one rotation will be **[Manipal 2009]**
(1) 7.46 J (2) 7400 J (3) 7.46 erg (4) 74.6 J

8. A particle of mass 100 g is thrown vertically upwards with a speed of 5 ms^{-1}. The work done by the force of gravity during the time, the particle goes up is **[UP CPMT 2008]**
(1) –0.5 J (2) –1.25 J (3) 1.25 J (4) 0.5 J

9. How much work must be done by a force on 50 kg body in order to accelerate it from rest to 20 ms^{-1} in 10 s? **[AMU 2008]**
(1) 10^3 J (2) 10^4J (3) 2×10^3J (4) 4×10^4J

10. When the bob of a simple pendulum swings, the work done by tension in the string is **[BHU 2008]**
(1) > 0 (2) < 0 (3) zero (4) maximum

11. A body of mass 10 kg initially at rest acquires velocity 10 ms^{-1}. What is the work done? **[DUMET 2008]**
(1) –500 J (2) 500 J (3) 50 J (4) –50 J

12. A block of mass m = 2 kg is pulled by a force F = 40 N upwards through a height h = 2 m. Find the work done on the block by the applied force F and its weight mg. (g = 10 ms^{-2}) **[EAMCET 2008]**
(1) 80 J, -45 J (2) 40 J, 35 J (3) zero, 0.25 J (4) 80 J,-40 J

13. A spring of spring constant 5×10^3 N/m is stretched initially by 5 cm from the unstretched position. Then the work required to stretch it further by another 5 cm is **[MP PMT 2008]**
(1) 12.50 N-m (2) 18.75 N-m (3) 25.00N-m (4) 6.25 N-m

14. 300 J of work is done in sliding a 2 kg block up an inclined plane of height 10 m. Taking g = 10ms^{-2}, work done against friction is **[RPMT 2008]**
(1) 200 J (2) 100 J (3) zero (4) 1000 J

15. A body of mass 3 kg is under a constant force which causes a displacement s in metre in it, given by the relation $s = \frac{1}{3}t^2$, where t is in second. Work done by the force in 2s is **[Haryana PMT 2008]**
(1) $\frac{5}{19}J$ (2) $\frac{3}{8}J$ (3) $\frac{8}{3}J$ (4) $\frac{19}{5}J$

16. When a spring is stretched by a distance x, it exerts a force, given by
$F = (-5x - 16x^3)N$
The work done, when the spring is stretched from 0.1 m to 0.2 m is **[BCECE 2008]**
(1) 8.7×10^{-2} J (2) 12.2×10^{-2} J (3) 8.7×10^{-1} J (4) 12.2×10^{-1} J

17. $4m^3$ of water is to be pumped to a height of 20 m and forced into a reservoir at a pressure of 2×10^5 Nm^{-2}. The work done by the motor is (external pressure = 10^5 Nm^{-2}) **[JCECE 2008]**
(1) 8×10^5J (2) 16×10^5 J (3) 12×10^5J (4) 32×10^5 J

18. A vertical spring with force constant k is fixed on a table. A ball of mass m at a height h above the free upper end of the spring falls vertically on the spring, so that the spring is compressed by a distance d. The net work done in the process is **[CBSE AIPMT 2007]**

(1) $mg(h+d)+\frac{1}{2}kd^2$ (2) $mg(h+d)-\frac{1}{2}kd^2$

(3) $mg(h-d)-\frac{1}{2}kd^2$ (4) $mg(h-d)+\frac{1}{2}kd^2$

19. A body constrained to move in the y-direction is subjected to a force F = 2i + 15j + 6k N. The work done by this force in moving the body through a distance of 10 m along y-axis is **[Kerala CEE 2007]**

(1) 100 J (2) 150 J (3) 120 J (4) 200 J
(5) 50 J

20. A man pushes against a wall but fails to move it. He does **[Kerala CEE 2007]**

(1) negative work (2) positive but not maximum work
(3) maximum positive work (4) no work at all
(5) maximum negative work

21. A body moves a distance of 10 m along a straight line under an action of 5 N force. If work done is 25 J, then angle between the force and direction of motion of the body will be **[BCECE 2007]**

(1) 75° (2) 60° (3) 45° (4) 30º

22. A particle accelerating uniformly has velocity v at time t_1. What is work done in time t? **[DUMET 2006]**

(1) $\frac{1}{2}\left(\frac{mv^2}{t_1^2}\right)t^2$ (2) $\frac{1}{2}\left(\frac{mv^2}{t_1}\right)t^2$ (3) $\left(\frac{mv^2}{t_1^2}\right)t^2$ (4) $\left(\frac{2mv^2}{t_1^2}\right)t^2$

23. The work done by a force F = $(-6x^3)$i N, in displacing a particle from x = 4 m to x = –2 m is **[Kerala CEE 2006]**

(1) 360 J (2) 240 J (3) –240 J (4) –360 J
(e) 408 J

24. Due to a force of $(6\hat{i}+2\hat{j})N$ the displacement of a body is $(3\hat{i}-\hat{j})m$, then the work done is **[Orissa JEE 2005]**

(1) 16 J (2) 12 J (3) 8 J (4) Zero

25. A ball is released from the top of a tower. The ratio of work done by force of gravity in first, second and third second of the motion of the ball is **[Kerala PET 2005]**

(1) 1 : 2 : 3 (2) 1 : 4 : 9 (3) 1 : 3 : 5 (4) 1 : 5 : 3

26. A particle moves under the effect of a force $F = Cx$ from $x = 0$ to $x = x_1$. The work done in the process is **[CPMT 1982; DCE 2002;Orissa JEE 2005]**

(1) Cx_1^2 (2) $\frac{1}{2}Cx_1^2$ (3) Cx_1 (4) Zero

27. Which one of the following is not a conservative force **[Kerala PMT 2005]**
(1) Gravitational force
(2) Electrostatic force between two charges
(3) Magnetic force between two magnetic dipoles
(4) Frictional force

28. A body of 2 kg mass is moving under a force, relation between time and displacement is $x = \frac{t^3}{3}$ where x in meter and t in time work done in first two seconds is: **[AFMC 2012]**
(1) 1.6 J (2) 16 J (3) 160 J (4) 1600 J

29. A uniform chain of L length and M mass, two third part of chain is on a frictionless table and one third part is vertically suspended, work done to pull the hole chain on table, is : **[AFMC 2012]**
(1) $\frac{MgL}{18}$ (2) $\frac{MgL}{9}$ (3) $\frac{MgL}{6}$ (4) $\frac{MgL}{3}$

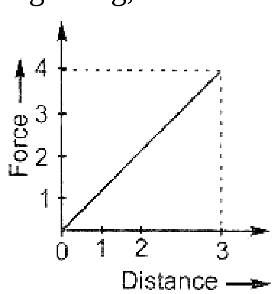
ENERGY

1. The potential energy of a system increase if work is done **[CBSE AIPMT 2011]**
(1) by the system against a conservative force (2) by the system against a non-conservative force
(3) upon the system by a conservative force (4) upon the system by a non-conservative force

2. Two bodies of masses 4 kg and 5 kg are moving with equal momentum. Then the ratio of their respective kinetic energies is **[Kerala KCEE 2011]**
(1) 4 : 5 (2) 2 : 1 (3) 1 : 3 (4) 5 : 4
(5) 1 : 2

3. A body of mass 5 kg is thrown vertically up with a kinetic energy of 490 J. The height at which the kinetic energy of the body becomes half of the original value is **[KCET 2011]**
(acceleration due to gravity = 9.8 ms~^{2})
(1) 5 m (2) 2.5 m (3) 10 m (4) 12.5 m

4. A 10 kg mass moves 3.0 m against a retarding force shown in the figure. If the force is zero at the beginning, how much kinetic energy is changed? **[CMC 2010]**



(1) 6 J (2) –6 J (3) 12 J (4) –12 J

5. A bullet of mass m moving with velocity v strikes a suspended wooden block of mass M. If the bock rises to a height h, the initial velocity of the block will be **[Haryana PMT 2010]**

(1) $\sqrt{2gh}$ (2) $\frac{M+m}{m}\sqrt{gh}$ (3) $\frac{m}{M+m}2gh$ (4) $\frac{M+m}{M}\sqrt{2gh}$

6. A body is projected horizontally with a velocity of u ms^{-1} at an angle β with the horizontal. The kinetic energy at the highest point is $\frac{3}{4}th$ of the kinetic energy. The value of β is **[WB JEE 2010]**

(1) 30° (2) 45° (3) 60° (4) 120°

7. An open water tight railway wagon of mass 5×10^3 kg coasts at an initial velocity of 1.2 m/s without friction on a railway track. Rain falls vertically downwards into the wagon. What change occurs in kinetic energy of the wagon, when it has collected 10^3 kg of water? **[AFMC 2010]**

(1) 900 J (2) 300 J (3) 600 J (4) 1200 J

8. A particle of mass m at rest is acted upon by a force *P* for a time *t*. Its kinetic energy after an interval t is **[Manipal 2009]**

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

9. If the linear momentum of a body is increased by 50%, then the kinetic energy of that body increases by **[KCET 2009]**

(1) 100% (2) 125% (3) 225% (4) 25%

10. A body is thrown vertically up with certain initial velocity. The potential and kinetic energies of the body are equal at a point P in its path. If the same body is thrown with double the velocity upwards, the ratio of potential and kinetic energies of the body when it crosses the same point, is **[Punjab PMET 2008]**

(1) 1:1 (2) 1 : 4 (3) 1 : 7 (4) 1 : 8

11. A body of mass 2 kg is thrown up vertically with kinetic energy of 490 J. If g = 9.8 ms^{-2}, the height at which the kinetic energy of the body becomes half of the original value, is **[Punjab PMET 2008]**

(1) 50 m (2) 25 m (3) 12.5 m (4) 19.6 m

12. A rod of length L and mass m is kept vertically on the ground. Its potential energy is **[DUMET 2008]**

(1) *mgL* (2) $mg\frac{L}{2}$ (3) $mg\frac{L}{3}$ (4) $mg\frac{L}{4}$

13. A particle moves in a straight line with retardation proportional to its displacement. Its loss of kinetic energy for any displacement *x* is proportional to **[JCECE 2008]**

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

14. A child is swinging a swing. Minimum and maximum heights of swing from earth's surface are 0.75 m and 2 m respectively. The maximum velocity of this swing is **[AFMC 2007]**

(1) 5 ms^{-1} (2) 10 ms^{-1} (3) 15 ms^{-1} (4) 20 ms^{-1}

15. Two bodies A and B having masses in the ratio of 3 : 1 possess the same kinetic energy. The ratio of linear momentum of B to A is **[UP CPMT 2007]**
(1) 1:3 (2) 3 : 1 (3) $1:\sqrt{3}$ (4) $\sqrt{3}:1$

16. An open knife edge of mass m is dropped from a height h on a wooden floor. If the blade penetrates s into the wood, the average resistance offered by the wood to the blade is **[AMU 2007]**
(1) Mg (2) $Mg\left(1+\frac{h}{s}\right)$ (3) $Mg\left(1-\frac{h}{s}\right)$ (4) $Mg\left(1+\frac{h}{s}\right)^2$

17. A bread gives a boy of mass 40 kg an energy of 21 kJ. If the efficiency is 28%, then the height that can be climbed by him using this energy, is **[BHU 2007]**
(1) 22.5 m (2) 15m (3) 10 m (4) 5 m

18. A ball of mass 2 kg and another of mass 4 kg are dropped together from a 60 ft tall building. After a fall of 30 ft each towards earth, their respective kinetic energies will be in the ratio of **[Manipal 2007]**
(1) $\sqrt{2}:1$ (2) 1 : 4 (3) 1 : 2 (4) $1:\sqrt{2}$

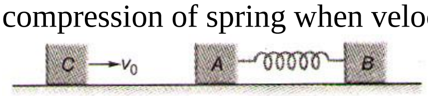
19. A stone is tied to a string of length I and is whirled in a vertical circle with the other end of the string at the centre. At a certain instant of time, the stone is at its lowest position and has a speed u. The magnitude of the change in velocity when string becomes horizontal (g being acceleration due to gravity) is **[Manipal 2007]**
(1) $\sqrt{2\left(u^2-gl\right)}$ (2) $\sqrt{u^2-gl}$ (3) $u-\sqrt{u^2-2gl}$ (4) $\sqrt{2gl}$

20. A particle of mass m_1 is moving with a velocity v_1 and another particle of mass m_2 is moving with a velocity v_2. Both of them have the same momentum but their different kinetic energies are E_1 and E_2 respectively. If $m_1 > m_2$, then **[MP PMT 2007]**
(1) $E_1 < E_2$ (2) $\frac{E_1}{E_2}=\frac{m_1}{m_2}$ (3) $E_1 > E_2$ (4) $E_1 = E_2$

21. Two springs of spring constant 1500 Nm^{-1} and 3000 Nm^{-1} respectively are stretched with the same force. They will have potential energy in ratio **[BCECE 2007]**
(1) 1 : 2 (2) 2 : 1 (3) 1 : 4 (4) 4 : 1

22. If we throw a body upwards with velocity of 4 ms^{-1}, at what height does its kinetic energy reduce to half of the initial value? (Take g = 10 ms^{-2}) **[AFMC 2006]**
(1) 4 m (2) 2 m (3) 1 m (4) 0.4 m

23. A block C of mass m is moving with velocity v_0 and collides elastically with block A of mass m and connected to another block B of mass 2m through spring of spring constant k. What is k, if x_0 is compression of spring when velocity of A and B is same? **[DUMET 2006]**



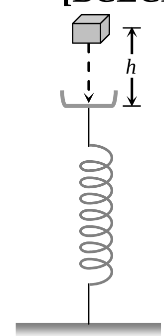
(1) $\frac{mv_0^2}{x_0^2}$ (2) $\frac{mv_0^2}{2x_0^2}$

(3) $\frac{3}{2}\frac{mv_0^2}{x_0^2}$ (4) $\frac{2}{3}\frac{mv_0^2}{x_0^2}$

24. A steel ball of mass 5 g is thrown downwards with velocity 10 ms^{-1} from height 19.5 m. It penetrates sand by 50 cm. The change in mechanical energy will be (Take g = 10 ms^{-2}) **[DUMET 2006]**

(1) 1J (2) 1.25 J (3) 1.51 J (4) 1.75 J

25. A block of mass *m* initially at rest is dropped from a height *h* on to a spring of force constant *k*. the maximum compression in the spring is *x* then **[BCECE 2005]**



(1) $mgh = \frac{1}{2}kx^2$

(2) $mg(h+x) = \frac{1}{2}kx^2$

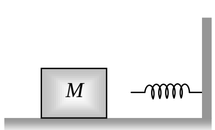
(3) $mgh = \frac{1}{2}k(x+h)^2$

(4) $mg(h+x) = \frac{1}{2}k(x+h)^2$

26. A spherical ball of mass 20 *kg* is stationary at the top of a hill of height 100 *m*. It slides down a smooth surface to the ground, then climbs up another hill of height 30 *m* and finally slides down to a horizontal base at a height of 20 *m* above the ground. The final velocity attained by the ball is **[AIEEE 2005]**

(1) 10 *m/s* (2) $10\sqrt{30}$ *m/s* (3) 40 *m/s* (4) 20 *m/s*

27. The block of mass *M* moving on the frictionless horizontal surface collides with the spring of spring constant *K* and compresses it by length *L*. The maximum momentum of the block after collision is **[AIEEE 2005]**



(1) Zero (2) $\frac{ML^2}{K}$ (3) $\sqrt{MK}\,L$ (4) $\frac{KL^2}{2M}$

POWER

1. A box is moved along a straight line by a machine delivering constant power. The distance moved by the body in time t is proportional to **[WB JEE 2011]**

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

2. A cyclist rides up a hill at a constant velocity. Determine the power developed by the cyclist if the length of the connecting rod of the pedal is r = 25 cm, the time of revolution of the rod is t = 2 s and the mean force exerted by his foot on the pedal is F = 15 kg. **[AFMC 2010]**

(1) 115.6 W (2) 215.6 W (3) 15.6 W (4) 11.56 W

3. A body of mass 10 kg moves with a velocity v of 2 m/s along a circular path of radius 8 m. The power produced by the body will be **[Manipal 2010]**

(1) 10 Js^{-1} (2) 98 Js^{-1} (3) 49 Js^{-1} (4) zero

4. A car of mass 1000 kg accelerates uniformly from rest to a velocity of 54 km/h in 5 s. The average power of the engine during this period in watt is (neglect friction). **[VMMC 2010]**
(1) 2000 W (2) 22500 W (3) 5000 W (4) 2250 W

5. Water falls from a height of 60 m at the rate of 15 kgs^{-1} to operate a turbine. The losses due to frictional forces are 10% of energy. How much power is generated by the turbine? (Take g = 10 ms^{-2})
[CBSE AIPMT 2008]
(1) 8.1 kW (2) 10.2 kW (3) 12.3 kW (4) 7.9 kW

6. A motor is used to deliver water at a certain rate through a given horizontal pipe. To deliver *n*-times the water through the same pipe in the same time the power of the motor must be increased as follows **[AFMC 2008]**
(1) n-times (2) n^2 –times (3) n^3-times (4) n^4-times

7. A machine is delivering constant power to drive a body along a straight line. What is the relation between the distance travelled by the body against time? **[AMU 2008]**
(1) $s^2 \propto t^3$ (2) $s^2 \propto t^{-3}$ (3) $s^3 \propto t^2$ (4) $s \propto t^3$

8. A particle of mass m is moving in a circular path of constant radius r such that centripetal acceleration a_c varying with time is $a_c = k^2rt^2$, where A: is a constant. What is the power delivered to the particle by the force acting on it? **[BHU 2008]**
(1) $lmkr^2t$ (2) mkr^2t^2 (3) mk^2r^2t (4) mk^2rt^2

9. A motor of power 60 W draws current 5 A from a source of 15 V. What is loss of power?
[DUMET 2008]
(1) 30 W (2) 25 W (3) 20 W (4) 15 W

10. An engine pumps up 100 kg of water through a height of 10 m in 5 s. Given that the efficiency of engine is 60%. If g = 10 ms^{-2}, the power of the engine is **[BCECE 2008]**
(1) 3.3 kW (2) 0.33 kW (3) 0.033 kW (4) 33 kW

11. A body is initially at rest. It undergoes one-dimensional motion with constant acceleration. The power delivered to it at time t is proportional to **[BHU 2006]**
(1) $t^{1/2}$ (2) t (3) $t^{3/2}$ (4) t^2

12. An engineer claims to have made an engine delivering 10 kW power with fuel consumption of l gs^{-1}. The calorific value of fuel is 2 kcal g^{-1}. This claim is **[MHT CET 2006]**
(1) valid (2) invalid
(3) dependent on engine design (4) dependent on load

13. A particle moves with a velocity (5i -3j + 6k) ms^{-1} under the influence of a constant force F = (10i + 10 j + 20k) N. The instantaneous power applied to the particle is **[Haryana PMT 2006]**
(1) 200 Js^{-1} (2) 40 Js^{-1} (3) 140 Js^{-1} (4) 170 Js^{-1}

14. A body of mass 2 kg is projected at 20 ms^{-1} at an angle 60° above the horizontal. Power due to the gravitational force at its highest point is **[J&K CET 2006]**
(1) 200 W (2) $100\sqrt{3}W$ (3) 50 W (4) zero

15. If the heart pushes 1 cc of blood in one second under pressure 20000 N/m^2 the power of heart is **[J&K CET 2005]**
(1) 0.02 *W* (2) 400 *W* (3) 5×10^{-10} *W* (4) 0.2 *W*

16. A man does a given amount of work in 10 sec. Another man does the same amount of work in 20 sec. The ratio of the output power of first man to the second man is **[J&K CET 2005]**
(1) 1 (2) 1/2 (3) 2/1 (4) None of these

17. A car of mass m start 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: **[AIPMT 2012]**
(1) $t^{-1/2}$ (2) *t* (3) t^2 (4) $t^{1/2}$

18. A block of mass 10 kg, moving in x direction with a constant speed of 10 ms^{-1}, is subjected to a retarding force F = 0.1 x J/m during its travel from x = 20 m to 30m. Its final KE will be **[AIPMT 2015]**
(1) 450 J (2) 275 J (3) 250 J (4) 475J

19. A ball is thrown vertically downwards from a height of 20 m with an initial velocity υ_0. It collides with the ground, loses 50 percent of its energy in collision and rebounds to the same height. The initial velocity υ_0 is: (Take g = 10 ms^{-2}) **[RE AIPMT 2015]**
(1) 10 ms^{-1} (2) 14 ms^{-1} (3) 20 ms^{-1} (4) 28 ms^{-1}

20. The heart of a man pumps 5 litres of blood through the arteries per minute at a pressure of 150 mm of mercury. If the density of mercury be 13.6×10^3 kg /m^3 and g = 10 m/s^2 then the power of heart in watt is: **[RE AIPMT 2015]**
(1) 1.50 (2) 1.70 (3) 2.35 (4) 3.0

21. A particle of mass 10 g moves along a circle of radius 64 cm with a constant tangential acceleration. What is the magnitude of this acceleration if the kinetic energy of the particle becomes equal to 8×10^{-4} J by the end of the second revolution after the beginning of the motion? **[NEET-I 2016]**
(1) 0.02 m/s^2 (2) 0.01 m/s^2 (3) 0.015 m/s^2 (4) 0.018 m/s^2

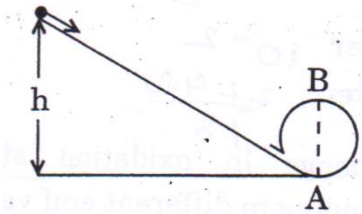
22. A body of mass 1 kg begins to move under the action of a time dependent force $\vec{F} = (2t\hat{i} + 3t^2\hat{j})N$, where $\hat{i}$ and $\hat{j}$ are unit vectors along x and y axis. What power will be developed by the force at the time t? **[NEET-I 2016]**
(1) $(2t^3 + 3t^5)$W (2) $(2t^2+3t^3)$W (3) $(2t^2+4t^4)$ W (4) $(2t^3+3t^4)$W

Questions Asked in 2017 to 2023

1. Consider a drop of rain water having mass 1 g falling from a height of 1 km. It hits the ground with a speed of 50 m/s. Take 'g' constant with a value $10\,m/s^2$. The work done by the (i) gravitational force and the (ii) resistive force of air is: **[NEET- 2017]**

(1) (i) -10 J (ii) -8.25 J
(2) (i) 1.25 J (ii) -8.25 J
(3) (i) 100 J (ii) 8.75 J
(4) (i) 10 J (ii) -8.75 J

2. A body initially at rest and sliding along a frictionless track from a height h (as shown in the figure) just completes a vertical circle of diameter AB = D. The height h is equal to **[NEET- 2018]**



(1) $\frac{7}{5}D$
(2) $\frac{5}{4}D$
(3) D
(4) $\frac{3}{2}D$

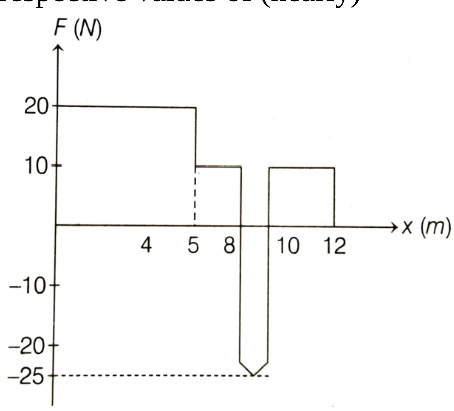
3. Three objects, A : (a solid sphere), B : (a thin circular disk) and C : (a circular ring), each have the same mass M and radius R. They all spin with the same angular speed ω about their own symmetry axes. The amounts of work (W) required to bring them to rest, would satisfy the relation

(1) $W_B > W_A > W_C$
(2) $W_A > W_C > W_B$
(3) $W_A > W_B > W_C$
(4) $W_C > W_B > W_A$

4. A force F =20+10y acts on a particle in y-direction, where F is in newton and y in meter. Work done by this force to move the particle from y =0to y =1m is **[NEET (National) 2019]**

(1) 5J
(2) 25J
(3) 2 0J
(4) 30 J

5. An object of mass 500 g, initially at rest acted upon by a variable force whose X component varies with X in the manner shown. The velocities of the object a point X = 8 m and X=12 m, would be the respective values of (nearly) **[NEET (Odisha) 2019]**



(1) 18 m/s and 24.4 m/s
(2) 23 m/s and 24.4 m/s
(3) 23 m/s and 20.6 m/s
(4) 18 m/s and 20.6 m/s

6. A mass m is attached to a thin wire and whirled in a vertical circle. The wire is most likely to break when: **[NEET (National) 2019]**

(1) the wire is horizontal
(2) the mass is at the lowest point
(3) inclined at an angle of 60° from vertical
(4) the mass is at the highest point

7. The energy required to break one bond in DNA is 10-20 J. This value in eV) is nearly **[NEET (Sep.) 2020]**

(1) 0.6 (2) 0.06 (3) 0.006 (4) 6

8. A point mass m is moved in a vertical circle of radius r with the help of a string. The velocity of the mass is /7gr at the lowest point. The tension in the string at the lowest point is **[NEET (Oct.) 2020]**

(1) 6 mg (2) 7 mg (3) 8 mg (4) 1mg

9. A particle is released from height S from the surface of the Earth. At a certain height its kinetic energy is three times its potential energy. The height from the surface of earth and the speed of the particle at that instant are respectively **[NEET 2021]**

(1) $\frac{S}{4}, \frac{3gS}{2}$ (2) $\frac{S}{4}, \frac{\sqrt{3gS}}{2}$ (3) $\frac{S}{2}, \frac{\sqrt{3gS}}{2}$ (4) $\frac{S}{4}, \sqrt{\frac{3gS}{2}}$

10. Water falls from a height of 60 m at the rate of 15 kg/s to operate a turbine. The losses due to frictional force are 10% of the input energy. How much power is generated by the turbine? (g=10 m/s) **[NEET 2021]**

(1) 10.2 kW (2) 8.1 kW (3) 12.3 kW (4) 7.0 kW

11. An electric lift with a maximum load of 2000 kg (lift+ passengers) is moving up with a constant speed of $1.5\,ms^{-1}$. The fractional force opposing the motion is 3000 N. The minimum power delivered by the motor to the lift in watts is: $(g = 10\,ms^{-2})$ **[NEET 2022]**

(1) 20000 (2) 34500 (3) 23500 (4) 23000

12. The potential energy of a long spring when stretched by 2 cm is U. If the spring is stretched by 8 cm, potential energy stored in it will be: **[NEET 2023]**

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

13. A bullet from a gun is fired on a rectangular wooden block with velocity u. when bullet travels 24 cm through the block along its length horizontally, velocity of bullet becomes $\frac{u}{3}$. Then it further penetrates into the block in the same direction before coming to rest exactly at the other end of the block. The total length of the block is: **[NEET 2023]**

(1) 24 cm (2) 28 cm (3) 30 cm (4) 27 cm

ANSWER KEY

LEVEL-I

1.	(3)	2.	(1)	3.	(1)	4.	(2)	5.	(3)
6.	(2)	7.	(2)	8.	(3)	9.	(3)	10.	(2)
11.	(4)	12.	(3)	13.	(1)	14.	(3)	15.	(2)
16.	(2)	17.	(2)	18.	(1)	19.	(2)	20.	(3)
21.	(2)	22.	(4)	23.	(3)	24.	(3)	25.	(1)
26.	(2)	27.	(3)	28.	(1)	29.	(1)	30.	(1)
31.	(2)	32.	(2)	33.	(1)	34.	(1)	35.	(3)
36.	(1)	37.	(1)	38.	(2)	39.	(3)	40.	(1)
41.	(3)	42.	(3)	43.	(1)	44.	(1)	45.	(1)
46.	(2)	47.	(4)	48.	(3)	49.	(3)	50.	(2)
51.	(3)	52.	(2)	53.	(2)	54.	(3)	55.	(3)

LEVEL – II

1.	(4)	2.	(3)	3.	(4)	4.	(2)	5.	(1)
6.	(2)	7.	(3)	8.	(4)	9.	(4)	10.	(2)
11.	(1)	12.	(3)	13.	(3)	14.	(3)	15.	(2)
16.	(2)	17.	(2)	18.	(4)	19.	(3)	20.	(3)
21.	(2)	22.	(3)	23.	(4)	24.	(3)	25.	(1)
26.	(4)	27.	(3)	28.	(2)	29.	(1)	30.	(3)
31.	(4)	32.	(2)	33.	(3)				

Assertion & Reason

1.	(1)	2.	(4)	3.	(5)	4.	(1)	5.	(4)
6.	(2)	7.	(3)	8.	(1)	9.	(3)	10.	(5)
11.	(1)	12.	(2)	13.	(3)	14.	(5)	15.	(4)
16.	(4)	17.	(4)	18.	(1)	19.	(1)	20.	(1)
21.	(5)	22.	(1)	23.	(1)	24.	(4)	25.	(1)
26.	(1)								

Previous Year's Questions

Work Done by Constant Force & Variable Force

1.	(2)	2.	(3)	3.	(2)	4.	(1)	5.	(3)
6.	(2)	7.	(1)	8.	(2)	9.	(2)	10.	(3)
11.	(2)	12.	(4)	13.	(2)	14.	(2)	15.	(3)
16.	(1)	17.	(3)	18.	(2)	19.	(2)	20.	(4)
21.	(2)	22.	(1)	23.	(1)	24.	(1)	25.	(3)
26.	(2)	27.	(4)	28.	(4)	29.	(1)		

Energy

1.	(1)	2.	(4)	3.	(1)	4.	(2)	5.	(1)
6.	(1)	7.	(3)	8.	(2)	9.	(2)	10.	(3)
11.	(3)	12.	(2)	13.	(1)	14.	(1)	15.	(3)

16. (2)	**17.** (2)	**18.** (3)	**19.** (1)	**20.** (1)
21. (2)	**22.** (4)	**23.** (4)	**24.** (2)	**25.** (2)
26. (3)	**27.** (3)			

Power

1. (3)	**2.** (1)	**3.** (4)	**4.** (2)	**5.** (1)
6. (3)	**7.** (1)	**8.** (3)	**9.** (4)	**10.** (1)
11. (2)	**12.** (2)	**13.** (3)	**14.** (4)	**15.** (1)
16. (3)	**17.** (4)	**18.** (4)	**19.** (3)	**20.** (2)
21. (2)	**22.** (1)			

Questions Asked in 2017 to 2023

1. (4)	**2.** (2)	**3.** (4)	**4.** (2)	**5.** (3)
6. (2)	**7.** (2)	**8.** (3)	**9.** (4)	**10.** (2)
11. (2)	**12.** (3)	**13.** (4)		