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Ables/504

WORK

Work is said to be done when a force applied on the body displaces the body through a certain distance in the direction of force.

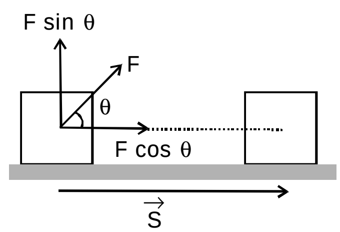
WORK DONE BY CONSTANT FORCE

Let a constant force $\vec{F}$ be applied on the body such that it makes an angle θ with the horizontal and body is displaced through a distance s

By resolving force $\vec{F}$ into two components :

(i) $F\cos\theta$ in the direction of displacement of the body.

(ii) $F\sin\theta$ in the perpendicular direction of displacement of the body.



Since body is being displaced in the direction of $F\cos\theta$, therefore work done by the force in displacing the body through a distance s is given by

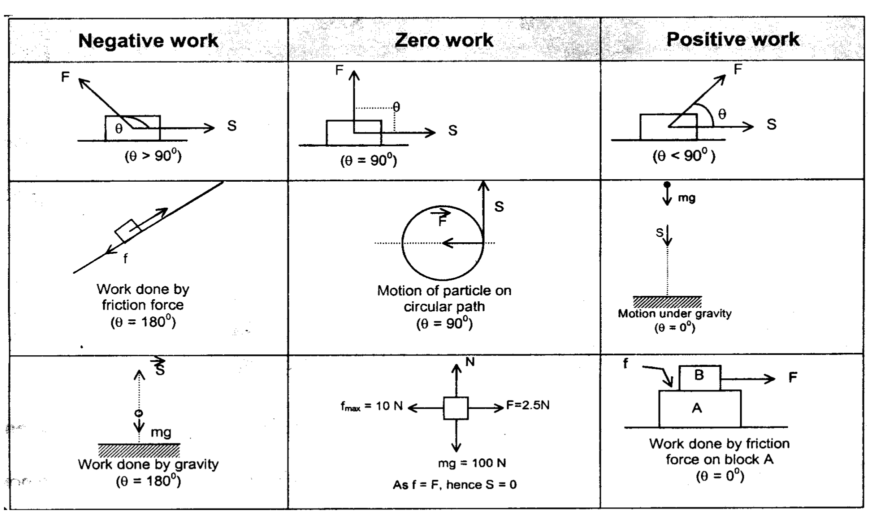
$$W = (F\cos\theta)\, s = Fs\cos\theta$$

or $$W = \vec{F}.\vec{s}$$

Thus work done by a force is equal to the scalar product (or dot product) of the force and the displacement of the body.

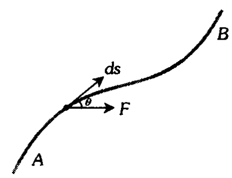
If a number of forces $\vec{F}_1$, $\vec{F}_2$, $\vec{F}_3$ .... $\vec{F}_n$ are acting on body and it shifts from position vector $\vec{r}_1$ to position vector $\vec{r}_2$ then $W = (\vec{F}_1 + \vec{F}_2 + \vec{F}_3 \,.......\, \vec{F}_n).(\vec{r}_2 - \vec{r}_1)$

The net work done on a body by several forces acting on it is obtained the algebraic sum of each work.



WORK DONE BY A VARIABLE FORCE

When the magnitude and direction of a force varies with position, the work done by such a force for an infinitesimal displacement is given by $dW = \vec{F}.d\vec{s}$



The total work done in going from A to B as shown in the figure is

$$W = \int_A^B \vec{F}.d\vec{s} = \int_A^B (F\cos\theta)\, ds$$

In terms of rectangular component

$$\vec{F} = F_x\hat{i} + F_y\hat{j} + F_z\hat{k}$$

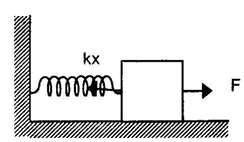
$$d\vec{s} = dx\hat{i} + dy\hat{j} + dz\hat{k}$$

$$\therefore \qquad W = \int_A^B (F_x\hat{i} + F_y\hat{j} + F_z\hat{k}).(dx\hat{i} + dy\hat{j} + dz\hat{k})$$

or $$W = \int_{x_A}^{x_B} F_x\, dx + \int_{y_A}^{y_B} F_y\, dy + \int_{z_A}^{z_B} F_z\, dz$$

Special cases :

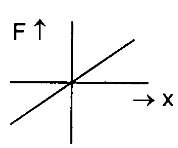
(i) Work done by spring force (–kx), spring force of a restoring force



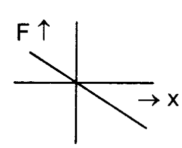
$$W = \int_A^B (-kx)\, dx = -\frac{1}{2}kx^2$$

$$W = \int_{x_i}^{x_f} (-kx)\, dx = -\frac{1}{2}k(x_f^2 - x_i^2)$$

External force connected with spring and block system (F = +kx)



Spring force (F = –kx)



(ii) If F is a function of time t i.e. $\vec{F} = \vec{F}(t)$ then

$$W = \int_0^t \vec{F}(t).\left(\frac{d\vec{s}}{dt}\right) dt = \int_0^t \vec{F}(t).\vec{v}\, dt$$

Conservative and Non-conservative Forces

If the work done by a force along a closed path is zero, the force is said to be conservative, otherwise, it is non-conservative. Also, in a conservative force field, the work done by the force depends only on the initial and final positions irrespective of the path followed.

Examples of conservative forces are gravitational force, elastic spring force, electrostatic force.

Examples of non-conservative forces are friction and viscous forces.

POWER

Power is defined as the time rate of doing work.

i.e. $P = \dfrac{dW}{dt}$

$dW = \vec{F}.d\vec{x}$

$P = \dfrac{dW}{dt} = \vec{F}.\dfrac{d\vec{x}}{dt}$

$P = \vec{F}.\vec{V}$

$P = FV\cos\theta$

When, $\theta = 0$

$P = FV$

If the force is variable, we calculate the average power as

$$P_{av} = \frac{\Delta W}{\Delta t} = \frac{\int_0^t P\,dt}{\int_0^t dt}.$$

Dimensional formula of power

$$[\text{Power}] = \frac{[\text{Work}]}{[\text{Time}]} = \frac{[ML^2T^{-2}]}{[T]} = ML^2T^{-3}$$

LINEAR MOMENTUM CONSERVATION

(a) If no external force acts on the system of constant mass, the total momentum of the system remain constant with time

$\because$ $\vec{F} = \dfrac{d\vec{P}}{dt}$

$\Rightarrow$ if $\vec{F} = 0$, then $d\vec{P} = 0$

$\Rightarrow$ $\vec{P} = \text{constant}$.

$\vec{P} = \vec{P}_1 + \vec{P}_2 + \vec{P}_3 + \vec{P}_4 + \ldots\ldots\ldots = \text{constant}$

$\vec{P} = m_1\vec{u}_1 + m_2\vec{u}_2 + \ldots\ldots\ldots = \text{constant}$

(b) $\because$ $\vec{F} = F_x\hat{i} + F_y\hat{j} + F_z\hat{k}$ and $\vec{P} = P_x\hat{i} + P_y\hat{j} + P_z\hat{k}$

$\Rightarrow$ $F_x\hat{i} + F_y\hat{j} + F_z\hat{k} = \dfrac{dP}{dt} = \dfrac{d}{dt}(P_x\hat{i} + P_y\hat{j} + P_z\hat{k})$

$\Rightarrow \quad F_x = \dfrac{dP_x}{dt}$ if $F_x = 0$ then, P_x = const. (F_y and F_z may or may not zero).

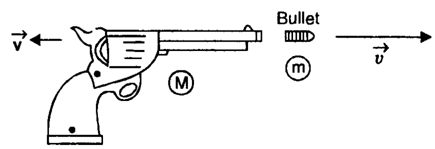
Similarly $\quad F_y = \dfrac{dP_y}{dt}$ if $F_y = 0$ then, P_y = const. (F_x and F_z may or may not be zero).

and $\quad F_z = \dfrac{dP_z}{dt}$ if $F_z = 0$ then, P_z = const. (F_x and F_y may or may not be zero).

(c) **Recoil of a Gun.** If the mass of bullet is m, mass of gun is M, forward velocity of bullet is $\vec{u}$ and velocity of gun is $\vec{v}$ then

$$M\vec{v} + m\vec{u} = 0 \text{ or } \vec{v} = -\frac{m\vec{u}}{M}$$

The negative sign shows that the velocity or recoil $\vec{v}$ is opposite to the velocity of the bullet.

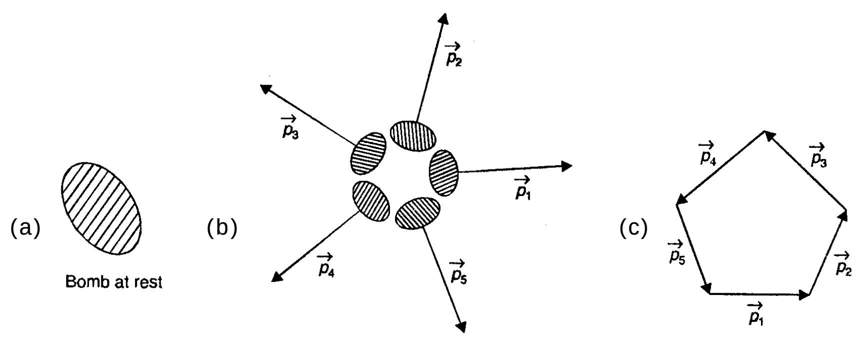


(d) **Explosion to a Bomb.**

Momentum after explosion = Momentum before explosion

$$\vec{P}_1 + \vec{P}_2 + \vec{P}_3 + \vec{P}_4 + \vec{P}_5 = \vec{0}$$

$$m_1\vec{u}_1 + m_2\vec{u}_2 + m_3\vec{u}_3 + m_4\vec{u}_4 + m_5\vec{u}_5 = 0$$



ENERGY

Energy of a body is defined as the capacity or ability to do work.

It is a scaler quantity.

The dimensional formula of energy is $[M^1L^2T^{-2}]$ it is same as that of work.

(i) 1 Calorie = 4.2 J

(ii) 1 Killowatt hour (KWh) = 3.6×10^6 J

(iii) 1 Electron volt (1 eV) = 1.6×10^{-19} J.

(A) Kinetic Energy (B) Potential Energy

(A) Kinetic Energy : Kinetic energy of a body is the energy processed by the body by virtue of it's motion (Always positive)

$$E_k = \frac{1}{2}mv^2.$$

The kinetic energy of a group of particles or bodies is the sum of the kinetic energies of the individual particles. The total kinetic energy E_k of the system is given by

$$E_k = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2 + \ldots\ldots.. + \frac{1}{2}m_nv_n^2$$

Relation between linear momentum (p) and kinetic energy (E_k) :

$$E_k = \frac{p^2}{2m}$$

$$p = \sqrt{2mE_k}$$

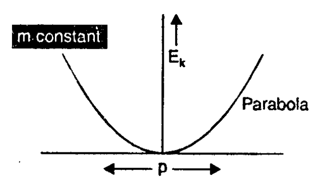
(i) When $p_1 = p_2$; $\sqrt{2mE_{k_1}} = \sqrt{2m_2E_{k_2}}$

or $\frac{E_{k_1}}{E_{k_2}} = \frac{m_2}{m_1}$

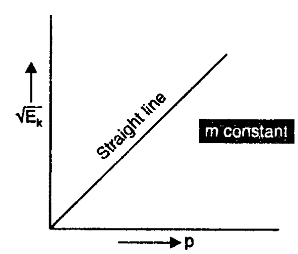
(ii) $E_{k_1} = E_{k_2}$

$$\frac{p_1^2}{2m_1} = \frac{p_2^2}{2m_2} \quad \text{or} \quad \frac{p_1}{p_2} = \sqrt{\frac{m_1}{m_2}}$$

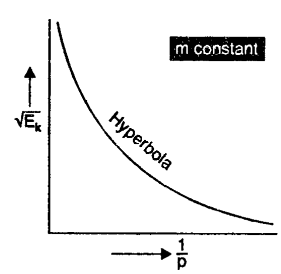
(iii) The graph between p and E_k is a parabola as shown in fig.



(iv) The graph between p and $\sqrt{E_k}$ is a straight line as shown in fig.



(v) The graph between $\sqrt{E_k}$ and $\frac{1}{p}$ is a rectangular hyperbola as shown in fig.



WORK ENERGY THEOREM

If W be the work done in increasing the velocity from $v_{(0)}$ to v, then

$$W = \int_{v_{(0)}}^{v} dW = \int_{v_{(0)}}^{v} mv\,dv$$

$$W = m\left[\frac{v^2}{2}\right]_{v_{(0)}}^{v} = \frac{1}{2}mv^2 - \frac{1}{2}mv_{(0)}^{\ 2}$$

So, the work done on a body by a resultant force is equal to the increase in the kinetic energy of body. This is called the work energy theorem.

LAW OF CONSERVATION OF MECHANICAL ENERGY :

The sum of the potential energy and the kinetic energy is called the total mechanical energy.

$v_f - v_i = -W$

$W = k_f - k_i$ (from work energy theorem)

then $v_f - v_i = -(k_f - k_i)$

$v_f + k_f = v_i + k_i$

The total mechanical energy of a system remains constant if only conservative forces are acting on a system of particle and the work done by all other force is zero. This is called the conservation of mechanical energy. The total mechanical energy is not constant if non-conservation forces such as friction is acting between parts of system. However, the work energy theorem, is still valid. Thus, we can apply

$W_e + W_{nc} + W_{ext} = k_f - k_i$

Here, $W_c = -(v_f - v_i)$

So, we get

$W_{nc} + W_{ext} = (k_f + v_f) - (k_i + v_i)$

$W_{nc} + W_{ext} = E_f - E_i$

Here, $E = k + v$ is total mechanical energy.

POTENTIAL ENERGY

The energy possessed by a body or system by virtue of its position or configuration is known as the potential energy.

(i) Potential energy is defined for a conservative force field only.

(ii) For non-conservative force it has no meaning.

(iii) The change in potential energy (dU) of system corresponding to a conservative internal force is given by

$$dU = -\vec{F}.d\vec{r} = -dw \qquad \left(F = -\frac{dU}{dr}\right)$$

or $$\int_i^f dU = -\int_{\vec{r}_i}^{\vec{r}_f} \vec{F}.d\vec{r}$$

or $$U_f - U_i = \int_{\vec{r}_i}^{\vec{r}_f} \vec{F}.d\vec{r}$$

it we take $r_i = \propto$ and $U_i = 0$ then we can write

$$U = -\int_{\infty}^{\vec{r}} F.dr = -W.$$

(iv) Potential energy of a body or system is the negative of work done by the conservative force in bringing it from infinity to the present position.

(a) Elastic potential energy : The work done by the spring force is $-\frac{1}{2}kx^2$ when the spring is position thus

$$U = -W = -\left(-\frac{1}{2}kx^2\right) = \frac{1}{2}kx^2. \text{ (K = spring constant).}$$

(b) Gravitational potential energy : The gravitational potential energy of two particles of masses m_1 and m_2 separated by a distance r is given by

$$U = -G\frac{m_1m_2}{r}$$

G = Universal constant = $6.67 \times 10^{-11}\ \frac{N-m^2}{kg^2}$

If body of mass m is raised to a height 'h' from the earth surface, the change in potential energy of the system.

$$\Delta U = \frac{mgh}{\left(1+\frac{h}{R}\right)} \qquad \text{(R = radius of earth)}$$

$\Delta U \approx mgh.$ If $h << R$.

(c) Electric Potential energy : The electric potential energy of two point charge q_1 and q_2 separated by a distance r in vacuum is given by

$$U = \frac{1}{4\pi\varepsilon_0}.\frac{q_1q_2}{r}$$

Here $\frac{1}{4\pi\varepsilon_0} = 9.0 \times 10^9\ \frac{N-m^2}{C^2}$ = constant.

COLLISION

1. Collision of particles

Collision is a kind of interaction between two or more bodies which come in contact with each other for a very short time interval.

(a) There are three distinct identifiable stages in a collision namely before, during and after.

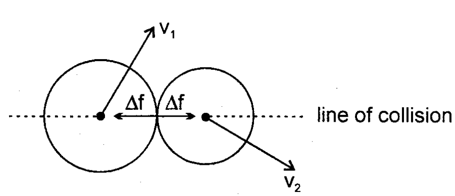
(b) In the before and after stage interaction forces are zero.

(c) Between these two stages, the interaction forces are very large and often the dominating forces governing the motion of bodies.

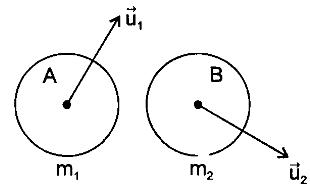
(d) The law of conservation of momentum is useful in relating the initial and final velocities.

2. Basic concept of collision

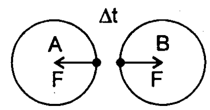
(a) **Line of collision :** When two particles collides with each other, they exert force on each other normal to contact surface. The line of action is known as line of collision.



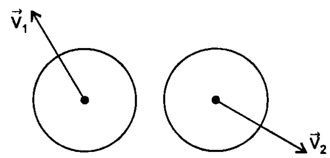
(b) Before collision



During collision



After collision



∴ change in momentum of B $\quad m_2\vec{v}_2 - m_2\vec{u}_2 = \vec{F}dt$ ....(1)

and change in momentum of A $\quad m_1\vec{v}_1 - m_1\vec{u}_1 = -\vec{F}dt$ ....(2)

From (1) and (2) $\quad m_1\vec{u}_1 + m_2\vec{u}_2 = m_1\vec{v}_1 + m_2\vec{v}_2$

(i) During collision momentum transfer take place from one body to another body due to interaction force $\vec{F}$.

(ii) This transfer takes place along the line of collision only.

(iii) Component of velocities of colliding particles perpendicular to line of collision remain unchanged during collision.

(iv) During collision if net impulsive force on system is zero. Then momentum of system remains conserve for velocities just before and after the collision.

3. Type of collision

Type of collision can be categorised on the following basis :

(a) on the basis of direction

(b) on the basis of conservation of K.E.

(a) on the basis of direction :

(i) Head of collision :- If two particles collides in head on manner then the collision is called head on collision i.e. velocities of both the particles are parallel or anti parallel of line of impact (collision).

(ii) Oblique collision :- If the relative velocity of approach is not on the line of impact i.e. velocities of both the particle are not parallel to the line of impact then the collision is called oblique collision.

(b) on the basis of conservation of K.E. :

(i) Elastic collision :- Those collisions, in which both momentum and kinetic energy of the system remain conserve are called elastic collisions.

For Example :

Collision between atomic and subatomic particles, between two glasses or preferably ivory balls may be taken as elastic collision.

(ii) Inelastic collision :- Those collision in which the momentum of the system is conserved but the kinetic energy is not conserved are called inelastic collision. Most of the collisions in every day life are inelastic collision. The kinetic energy lost in an inelastic collision appears in some other from of energy such as heat sound etc.

4. Newton's law of collision

$$\frac{\text{Relative velocity after collision}}{\text{Relative velocity before collision}} = -e \text{ where } e = \text{coefficient of restitution.}$$

Let u_1 and u_2 be the velocities of two bodies before collision and v_1 and v_2 that after the collision, along the line of impact or line of collision. [sec. 2(a)] then,

$$\frac{v_2 - v_1}{u_2 - u_1} = -e$$

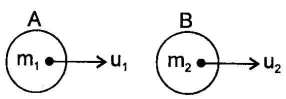
$e = 1$ for elastic collision

$e < 1$ for inelastic collision

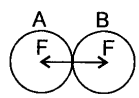
$e = 0$ for perfectly inelastic collision

Now we discuss the collisions as follows.

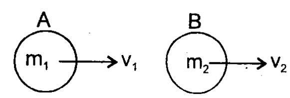
5. Direct elastic collision



Before collision (b.c.)



During collision (d.c.)



After collision (a.c.)

(a) In this collision, both momentum and kinetic energy remains conserved. Thus for such type of collision.

$$(P)_{b.c.} = (P)_{a.c.}$$

$\Rightarrow$ $$m_1\vec{u}_1 + m_2\vec{u}_2 = m_1\vec{v}_1 + m_2\vec{v}_2$$

and $$(K.E.)_{b.c.} = (K.E.)_{a.c.}$$

where, P stands for linear momentum and K.E. for kinetic energy.

$\Rightarrow$ $$\frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2$$

(b) Newton's law for direct elastic collision.

$$\vec{v}_2 - \vec{v}_1 = -(\vec{u}_2 - \vec{u}_1)$$

(c) Important formula and features for direct elastic collision.

(i) The velocity of first body after collision

$$v_1 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)u_1 + \left(\frac{2m_2}{m_1 + m_2}\right)u_2$$

(ii) The velocity of second body after collision

$$v_2 = \left(\frac{2m_1}{m_1 + m_2}\right)u_1 + \left(\frac{m_2 - m_1}{m_1 + m_2}\right)u_2$$

(iii) If the body with mass m_2 is initially at rest i.e. $u_2 = 0$

$$v_1 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)u_1 \text{ and } v_2 = \left(\frac{2m_1}{m_1 + m_2}\right)u_1$$

(iv) When a particle of mass m_1 moving with velocity u_1 collides with another particle with m_2 at rest and if.

$m_1 = m_2$	$m_1 >> m_2$	$m_1 << m_2$
$\Rightarrow$ $v_1 = 0$	$\Rightarrow$ $v_1 = u_1$	$\Rightarrow$ $v_1 = -u_1$
and $v_2 = u_1$	and $v_2 = 2u_1$	and $v_2 = \frac{2m_1}{m_2}u_1 \approx 0$

(v) When $m_1 = m_2 = m$ but $u_2 \neq 0$, then $v_1 = u_2$ and $v_2 = u_1$ i.e. the particle mutually exchange their velocities.

(vi) Exchange of energy is maximum when $m_1 = m_2$. This fact is utilised in atomic reactor in slowing down the neutrons. To slow down the neutrons, these are made to collide with nuclei of almost similar mass. For this hydrogen nuclei are most appropriate.

HEAD OF INELASTIC COLLISION

(a) In this case $(P)_{b.c.} = (P)_{a.c.}$

$\Rightarrow$ $m_1\vec{u}_1 + m_2\vec{u}_2 = m_1\vec{v}_1 + m_2\vec{v}_2$

and $(K.E.)_{b.c.} = (K.E.)_{a.c.}$

where, Q = heat energy, sound energy etc.

$$\Rightarrow \quad \frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 > \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2$$

(b) According to Newton's law, for inelastic collision we have

$$\vec{v}_1 - \vec{v}_2 = -e(\vec{u}_1 - \vec{u}_2)$$

(c) In inelastic collision, velocity of first body after collision

$$v_1 = \left(\frac{m_1 - em_2}{m_1 + m_2}\right)u_1 + \frac{m_2(1+e)}{m_1+m_2}u_2$$

and
$$v_2 = \frac{m_2(1+e)}{m_1+m_2}u_1 + \frac{m_2 - em_1}{m_1+m_2}u_2$$

(d) Loss of energy in inelastic collision

$$\Delta E_k = \frac{1}{2}\left(\frac{m_1m_2}{m_1+m_2}\right)(u_1 - u_2)^2(1 - e)^2$$

(e) Important Results :

(i) If e = 0 (perfect inelastic)

$$v_1 = v_2 = \frac{m_1u_1 + m_2u_2}{m_1+m_2}$$

$$\Delta E_k = \frac{1}{2}\left(\frac{m_1m_2}{m_1+m_2}\right)(u_1 - u_2)^2$$

(ii) If $m_1 >> m_2$

then $v_1 \approx u_1$

$v_2 \approx (1 + e)u_1 - eu_2$

where $m_1 >> m_2$ & $u_1 = 0$

$v_1 = 0$

and $v_2 = -eu_2$

where $m_1 >> m_2$ & $u_2 = 0$

$v_1 = u_1$

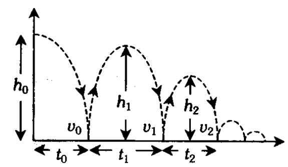
$v_2 = (1 + e)u_1$

IMPORTANT POINTS

1. Ball falling from a height h above a surface.

If the ball rebounds again and again then

$$e = \sqrt{\frac{h_1}{h}} = \sqrt{\frac{h_2}{h_1}} = \sqrt{\frac{h_3}{h_2}} = \dots\dots\dots = \sqrt{\frac{h_n}{h_{n-1}}}$$



$h_1 = e^2h,\ h_2 = e^4h,\ \dots\dots\dots\ h_n = e^{2n}h$

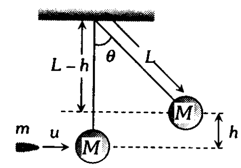
The total distance covered before stopping

$$= \left(\frac{1+e^2}{1-e^2}\right)h$$

The total time taken before stopping

$$= \left(\frac{1+e}{1-e}\right)\sqrt{\frac{2h}{g}}$$

2. If a bullet is fired towards a suspended object and after collision the object rises upto height h then from law of momentum conservation.



$$mv + 0 = (m + M)\sqrt{2gh}$$

because the velocity of the combined body

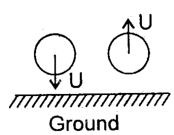
$$v' = \sqrt{2gh}$$

$\therefore$ speed of bullet $v = \dfrac{m+M}{m}\sqrt{2gh}$

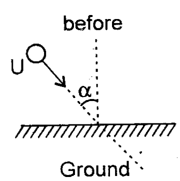
3. Collision of particle with ground

(a) Perfect elastic collision :

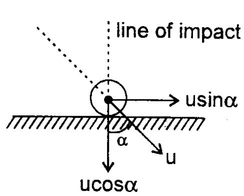
(i) If a particle falls vertically downwards and strikes with ground and if collision in perfectly elastic then magnitude of velocity of particle does not change only its direction reverses.



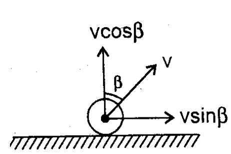
(ii) A particle of mass m moving with a speed U strikes a smooth horizontal surface at an angle α.



Before Collision



After Collision



Since no external impulse acts in the horizontal direction, therefore momentum of the ball is conserved in the horizontal direction. That is

$$mu \sin\alpha = mv \sin\beta$$

$\Rightarrow$ $$u \sin\alpha = u \sin\beta \quad ....(1)$$

Using the definition of coefficient of restitution.

$$\frac{v\cos\beta - 0}{(-u\cos\alpha - 0)} = -1 \quad ....(2)$$

[because collision is perfectly elastic]

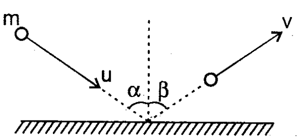
Solving (1) and (2), we get

$$\alpha = \beta \text{ and } v = u$$

(b) If collision is inelastic

(i) If a particle falls vertically downwards and strikes with ground and if the collision is inelastic of restitution and its direction reverses.

(ii) A particle of mass m moving with a speed u strikes a smooth horizontal surface at an angle α. The particle rebounds at an angle β with a speed v.



Since no external impulse acts in the horizontal direction, therefore momentum of the ball is conserved in the horizontal direction is

$$mu \sin\alpha = mv \sin\beta$$

$\Rightarrow$ $$u \sin\alpha = v \sin\beta \quad ......(1)$$

Using the newton's formula for collision

$$e(u \cos\alpha) = v \cos\beta \quad ......(2)$$

Dividing (2) by (1), we get

$$\cot\beta = e \cot\alpha$$

$\Rightarrow$ $$\tan\alpha = e \tan\beta$$

$\Rightarrow$ $$\tan\beta = \frac{\tan\alpha}{e}$$

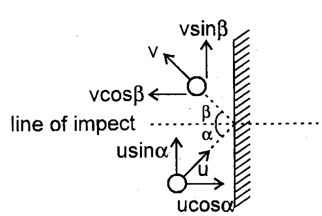
On squaring and adding, we get

$$v^2 = u^2(\sin^2\alpha + e^2\cos^2\alpha)$$

$\therefore$ $$v = u\sqrt{\sin^2\alpha + e^2\cos^2\alpha}$$

4. Collision of particle with wall

A particle of mass m moving with a speed u strikes a smooth horizontal surface at an angle α. The particle rebounds at an angle β with speed v.



Since no external impulse force acts in the vertical direction (due to negligible time of collision) therefore momentum on the ball is conserved in the vertical direction.

$$v \sin\beta = u \sin\alpha \quad ......(1)$$

and from the newton's law of collision

$$(v \cos\beta - 0) = -e(-u \cos\alpha - 0)$$

$\Rightarrow$ $$v \cos\beta = eu \cos\alpha \quad ......(2)$$

Dividing (2) by (1), we get

$$\tan\beta = \frac{\tan\alpha}{e}$$

$$\therefore \quad \beta = \tan^{-1}\left(\frac{\tan\alpha}{e}\right)$$

On squaring and adding, we get

$$v^2 = u^2(\sin^2\alpha + e^2\cos^2\alpha)$$

$$v = u\sqrt{\sin^2\alpha + e^2\cos^2\alpha}$$

Note : If collision is perfectly then e = 1

$\therefore$ $\tan\beta = \tan\alpha$ and $v = u\sqrt{\sin^2\alpha + e^2\cos^2\alpha}$

$\Rightarrow$ $\beta = \alpha$ $v = u$

i.e. incident angle and speed will be equal to reflecting angle and speed respectively.

EXERCISE #1

Q.1 **A Force F = $(3\hat{i}+4\hat{j}+5\hat{k})$N acts on a particle of mass 10 kg. If the work done during a displacement is 50 joule, find the displacement of the particle in x-axis if its displacement along y-axis and z-axis are 4m and 6m respectively.**

(A) $\frac{3}{4}\hat{i}+4\hat{j}+6\hat{k}$ (B) $\frac{4}{3}\hat{i}+4\hat{j}+6\hat{k}$

(C) $\frac{4}{3}\hat{i}+4\hat{j}-6\hat{k}$ (D) None of these

TOPIC SKILLS : **Based on work done by a constant force in vector form.**

Q.2 **A body moves a distance 10m along a straight line under the action of a force of 5N. If the work done is 25 joules, the angle which the force makes with the direction of motion of the body is**

(A) 0° (B) 30°

(C) 60° (D) 90°

TOPIC SKILLS : **Based on work done by constant force.**

Q.3 **A man pushes a wall and fails to displace it. He does**

(A) Negative work (B) Positive but not maximum work

(C) No work at all (D) Maximum work

TOPIC SKILLS : **Definition of work.**

Q.4 **A force $\vec{F}=(5\hat{i}+3\hat{j})$ newton is applied over a particle which displaces it from its origin to the point $\vec{r}=(2\hat{i}-1\hat{j})$ metres. The work done on the particle is**

(A) –7 joule (B) +13 joule

(C) +7 joule (D) +11 joule

TOPIC SKILLS : **Work done where constant force and displacement are in vector form.**

Q.5 **A force F = 0.5 x + 10 acts on a particle. Here F is in newton and x is in metre. Calculate the work done by the force during the displacement of the particle from x = 0 to x = 2 metre.**

(A) 21 J (B) 23 J

(C) 19 J (D) 20 J

TOPIC SKILLS : **Work done by a variable force.**

Q.6 **A body of mass 6 kg is under a force which causes displacement in it given by S = $\frac{t^2}{4}$ metres where t is time. The work done by the force in 2 seconds is**

(A) 12 J (B) 9 J

(C) 6 J (D) 3 J

TOPIC SKILLS : **Work done by a variable force.**

Q.7 **A uniform chain of length 2m is kept on a table such that a length of 60 cm hangs freely from the edge of the table. The total mass of the chain is 4 kg. What is the work done is pulling the entire chain on the table**

(A) 7.2 J (B) 3.6 J

(C) 120 J (D) 1200 J

TOPIC SKILLS : **Work done by a variable force.**

Q.8 **A particle moves along the x-axis from x = 0 to x = 5 m under the influence of a force F(in N) given by F = $3x^2 - 2x + 7$. Calculate the work done**

(A) 125 J (B) 130 J

(C) 132 J (D) 135 J

TOPIC SKILLS : **Work done by a variable force.**

Q.9 **A spring of spring constant 5×10^3 N/m is stretched initially by 5cm from the unstretched position. Then the work required to stretch it furth by another 5cm is**

(A) 6.25 N-m (B) 12.50 N-m
(C) 18.75 N-m (D) 25.00 N-m

TOPIC SKILLS **:** **Work done by a variable force.**

Q.10 **If the K.E. of a body is increased by 300%, its momentum will increase by**

(A) 100% (B) 150%
(C) $\sqrt{300}$ % (D) 175%

TOPIC SKILLS **:** **Relation between kinetic energy and momentum.**

Q.11 **Two bodies of different masses m_1 and m_2 have equal momenta. Their kinetic energies E_1 and E_2 are in the ratio**

(A) $\sqrt{m_1} : \sqrt{m_2}$ (B) $m_1 : m_2$
(C) $m_2 : m_1$ (D) $m_1^2 : m_2^2$

TOPIC SKILLS **:** **Relation between kinetic energy and momentum.**

Q.12 **A particle of mass m at rest is acted upon by a force F for a time t. Its kinetic energy after an interval t is**

(A) $\frac{F^2t^2}{m}$ (B) $\frac{F^2t^2}{2m}$
(C) $\frac{F^2t^2}{3m}$ (D) $\frac{Ft}{2m}$

TOPIC SKILLS **:** **Work energy theorem.**

Q.13 **A particle of mass 0.5 kg travels in a straight line with velocity $v = ax^{3/2}$ where $a = 5\ m^{-1/2}\ s^{-1}$. What is the work done by the net force during its displacement from x = 0 to x = 2 m ?**

(A) 55 J (B) 45 J
(C) 52 J (D) 50 J

TOPIC SKILLS **:** **Work energy theorem.**

Q.14 **A bullet of mass 20 g is fired from a rifle with a velocity of 800 ms^{-1}. After passing through a mud wall 100 cm thick, velocity drops to 100 ms^{-1}. What is the average resistance of the wall neglecting friction due to air ?**

(A) 6300 N (B) 6100 N
(C) 6200 N (D) 6000 N

TOPIC SKILLS **:** **Work energy theorem.**

Q.15 **A body of mass 5 kg initially at rest is moving by a horizontally force of 20 N on a frictionless table. Calculate the work done by the force in 10 second and prove that this equals the change in kinetic energy of the body.**

(A) 4000 J (B) 4200 J
(C) 3900 J (D) 4100 J

TOPIC SKILLS **:** **Work energy theorem.**

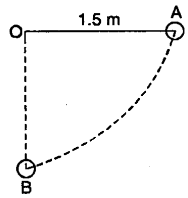
Q.16 **A block of mass 5 kg is taken at height 50 metre from earth surface then find potential energy of block**

(A) 2500 J (B) 2000 J
(C) 3000 J (D) 1800 J

TOPIC SKILLS **:** **Potential energy**

Q.17 **The bob of a pendulum is released from a horizontal position A as shown. [Fig]. If the length of the pendulum is 1.5 m, what is the speed with which the bob arrives at the lowermost point B, given that it dissipated 5% of its initial energy against air resistance ?**

TOPIC SKILLS : **Work energy theorem**



(A) 0.5285 ms^{-1} (B) 52.85 ms^{-1}
(C) 5.285 ms^{-1} (D) 5.625 ms^{-1}

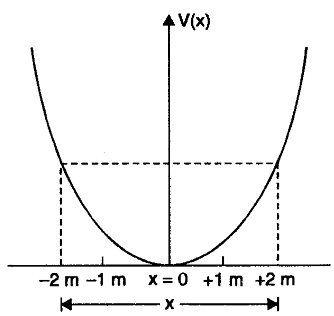
Q.18 **Two bodies of masses 3 kg and 5 kg are connected by a string which hangs over a frictionless pulley at the top of a frictionless inclined plane of slope 1 in 3, the first body hanging vertically and the second body resting on the plane. The system released from rest. Find the velocity when the first body has descended 6m. Given : g = 10 ms^{-2}.**

TOPIC SKILLS : **Work energy theorem.**

(A) 3.47 ms^{-1} (B) 44.7 ms^{-1}
(C) 0.447 ms^{-1} (D) 4.47 ms^{-1}

Q.19 **The potential energy function for a particle executing linear simple harmonic motion is given by $V(x) = \frac{1}{2}kx^2$, where k is the force constant of the oscillator. For k = 0.5 Nm^{-1}, the graph of V(x) versus x is shown in fig. Show that a particle of total energy 1J moving under this potential must 'turn back' when it reaches x = ±2m.**

TOPIC SKILLS : **Potential energy**



(A) ±1 (B) –2
(C) 2 (D) ±2

Q.20 **A spring with spring constant k when stretched through 1 cm, the potential energy is U. If it is stretched by 4 cm. The potential energy will be**

TOPIC SKILLS : **Potential energy**

(A) 4 U (B) 8 U
(C) 16 U (D) 2 U

Q.21 **The potential energy of a body is given by, $U = A - Bx^2$ (where x is the displacement). The magnitude of force acting on the particle is**

TOPIC SKILLS : **Potential energy**

(A) constant (B) proportional to x
(C) proportional to x^2 (D) inversely proportional to x

Q.22 **The potential energy between two atoms in a molecule is given by $U(x) = \frac{a}{x^{12}} - \frac{b}{x^6}$; where a and b are positive constants and x is the distance between the atoms. The atom is in stable equilibrium when**

(A) $x = \sqrt[6]{\frac{11a}{5b}}$ (B) $x = \sqrt[6]{\frac{a}{2b}}$

(C) $x = 0$ (D) $x = \sqrt[6]{\frac{2a}{b}}$

TOPIC SKILLS : **Potential energy and condition for translational equilibrium.**

Q.23 **A bullet of mass 10 g travelling horizontally with a velocity 300 m/s strikes a block of wood of mass 290 g which rests on a rough horizontal floor. After impact the block and the bullet move together and come to rest when the block has travelled a distance of 15m. The coefficient of friction between the block and the floor will be (duration of impact is very short)**

(A) 1/2 (B) 2/3

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

TOPIC SKILLS : **Work energy theorem.**

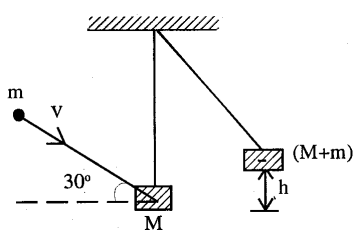
Q.24 **A bomb is thrown in a horizontal direction with a velocity of 50 ms^{-1}. It explodes into two parts of masses 6 kg and 3 kg. The heavier fragment continues to move in the horizontal direction with a velocity of 80 ms^{-1}. Calculate the velocity of the lighter fragment.**

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

(C) $12\ ms^{-1}$ (D) $-12\ ms^{-1}$

TOPIC SKILLS : **Conservation of linear momentum**

Q.25 **A bullet of mass 20 g hits at a block of 1.98 kg suspended from massless string of length 100 cm and sticks to it. The bullet flies down at an angle of 30° to the horizontal with a velocity of 200 m/s. Through what height the block will rise**



(A) 0.15 m (B) 0.30 m

(C) 0.45 m (D) 0.75 m

TOPIC SKILLS : **Work energy theorem and conservation of linear momentum.**

Q.26 **A bomb at rest explodes into three fragment of equal masses. Two fragments fly off at right angles to each other, with velocity of 9 ms^{-1} and 12 ms^{-1}. Calculate the speed of the third fragment.**

(A) $17\ ms^{-1}$ (B) $15\ ms^{-1}$

(C) $16\ ms^{-1}$ (D) $14\ ms^{-1}$

TOPIC SKILLS : **Conservation of linear momentum.**

Q.27 **A monkey of mass 20 kg rides on a 40 kg trolley moving with constant speed of 8 m/s along a horizontal track. If the monkey jumps vertically to grow the overhanging branch of a tree, the speed of the trolley after the monkey has jumped off is -**

(A) 8 m/s (B) 1 m/s

(C) 4 m/s (D) 12 m/s

TOPIC SKILLS : **Conservation of linear momentum.**

Q.28 **A bomb of mass m is thrown with velocity v. It explodes and breaks into two fragments. One fragment of mass m', immediately after the explosion, comes to rest. Determine the speed of the other fragment.**

(A) $\frac{mv}{m+m'}$ (B) $\frac{mv}{m-m'}$

(C) $\frac{mv}{2m+m'}$ (D) $\frac{mv}{m-2m'}$

TOPIC SKILLS **:** **Conservation of linear momentum.**

Q.29 **A one kilowatt motor pumps out water from a well 10 metre deep. Calculate the quantity of water pumped out per second.**

(A) 102.24 kg (B) 10.204 kg

(C) 1.0204 kg (D) 20.204 kg

TOPIC SKILLS **:** **Power**

Q.30 **An engine of 150 kW power is drawing a train of total mass 15×10^4 kg up an inclination of 1 in 50. The frictional resistance is 4 kg wt / 1000 kg. Calculate the maximum speed. $g = 10\ ms^{-2}$.**

(A) $4.17\ ms^{-1}$ (B) $41.7\ ms^{-1}$

(C) $0.417\ ms^{-1}$ (D) $417\ ms^{-1}$

TOPIC SKILLS **:** **Power**

Q.31 **A pump on the ground floor of a building can pump up water to fill a tank of volume $30\ m^3$ in 15 minute. If the tank is 40 m above the ground and the efficiency of the pump is 30%, how much electric power is consumed by the pump ?**

(A) 43.6 kW (B) 4.36 kW

(C) 42.4 kW (D) 436 kW

TOPIC SKILLS **:** **Power**

Q.32 **A cyclist climbing up an inclined road maintains a constant speed of $18\ km\ h^{-1}$. The total mass of the cycle plus the cyclist is 120 kg. If the angle of inclination is 15°, what is the minimum power expended by the cyclist ? Given : $g = 9.8\ ms^{-2}$.**

(A) 1.0×10^3 W (B) 1.22×10^3 W

(C) 1.3×10^3 W (D) 1.5×10^3 W

TOPIC SKILLS **:** **Power**

Q.33 **A ball falling vertically downwards collides with a heavy platform moving upwards. At this instant of collision velocity of ball was 5 m/s. Whereas velocity of platform was 10 m/s. Calculate the velocity of platform after collision.**

(A) 25 m/s (B) 15 m/s

(C) 20 m/s (D) None of these

TOPIC SKILLS **:** **Collision**

Q.34 **Two balls of masses 2 kg and 5 kg are moving toward's each other with 5 m/s & 10 m/s respectively. If collision is head on perfectly elastic. Calculate final velocities of the particles.**

(A) $\frac{10}{7}$ m/s (B) $-\frac{10}{7}$ m/s

(C) $\frac{7}{10}$ m/s (D) $-\frac{7}{10}$ m/s

TOPIC SKILLS **:** **perfectly elastic collision along a straight line**

Q.35 **A ball moving downward's with velocity 10 m/s collides with a platform which is also moving downwards with velocity 9 m/s. If e = 0.8, find the velocity after collision.**

(A) 34.2 m/s upwards (B) 34.2 m/s downwards

(C) 8.2 m/s downwards (D) 8.2 m/s upwards

TOPIC SKILLS **:** **Inelastic collision in one dimension.**

Q.36 **The masses of five balls at rest in a straight line from a geometrical progression whose ratio is 2 and their coefficient of restitution are each 2/3. If the first ball be started towards the second with velocity u, shown that the velocity communicated to the fifth is**

(A) $\frac{5}{9}u$ (B) $\left(\frac{5}{9}\right)^4 u$

(C) $\left(\frac{5}{9}\right)^3 u$ (D) None of these

TOPIC SKILLS **:** **Inelastic collision in one dimension.**

Q.37 **A block of mass m moving at speed v collides with another block of mass 2m at rest. The lighter block comes to rest after the collision. Find the coefficient of restitution.**

(A) 0.7 (B) 0.5

(C) 0.6 (D) 0.8

TOPIC SKILLS **:** **Inelastic collision in one dimension.**

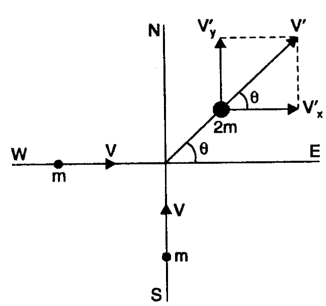
Q.38 **A particle of mass 'm' collides oblique with another particle of mass '2m' initially at rest. Both the particles have same diameter at the instant of collision velocity of Ist particle is making an angle of $\frac{p}{3}$ with line joining centres of the particles. If velocity of Ist particle before collision is 2 m/sec. Find its velocity after collision. The collision is perfect elastic.**

(A) $\frac{2\pi}{3} - \tan^{-1}(3\sqrt{3})$ (B) $\frac{2\pi}{3} + \tan^{-1}(3\sqrt{3})$

(C) $\frac{2\pi}{3} - \tan^{-1}\sqrt{3}$ (D) $\frac{2}{3} - \tan^{-1}(3\sqrt{3})$

TOPIC SKILLS **:** **Oblique elastic collision.**

Q.39 **A particle of mass m moving eastwards with a velocity V collides with another particle of the same mass moving northwards with the same seed V. The two particles coalesce on collision. After collision, the new particle moves in north-east direction. Calculate the velocity and direction of the new particle after collision.**



(A) $\frac{V}{\sqrt{2}}$, 45° (B) $\frac{V}{\sqrt{2}}$, 65°

(C) $\frac{V}{\sqrt{3}}$, 45° (D) $\frac{V}{\sqrt{3}}$, 65°

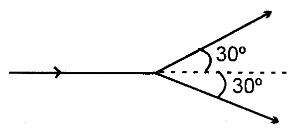
TOPIC SKILLS **:** **Collision in two dimensions**

Q.40 **Two similar balls P and Q having velocities of 0.5 m/s and –0.3 m/s respectively collide elastically. The velocities of P and Q after the collision will respectively be**

(A) –0.5 m/s and 0.3 m/s (B) 0.5 m/s and 0.3 m/s
(C) –0.3 m/s and 0.5 m/s (D) 0.3 m/s and 0.5 m/s

***TOPIC SKILLS* :**
Elastic collision along straight line for equal masses.

Q.41 **A ball with velocity 9 m/s collides with another similar stationary ball. After the collision the two balls move in directions makings an angle of 30° with the initial direction (Fig.) The ratio of the speeds of balls after the collision will be -**



(A) $\frac{v_1}{v_2} = 1$ (B) $\frac{v_1}{v_2} > 1$

(C) $\frac{v_1}{v_2} < 1$ (D) $\frac{v_1}{v_2} \neq 1$

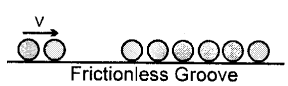
***TOPIC SKILLS* :**
Elastic collision in two dimension

Q.42 **A ball of mass 1 kg, moving with a velocity of 0.4 m/s, collides with another stationary ball. After the collision, the first ball moves with a velocity of 0.3 m/s in a direction making an angle of 90° with its initial direction. The momentum of second ball after collision will be - (in kg-m/s)**

(A) 0.1 (B) 0.3
(C) 0.5 (D) 0.7

***TOPIC SKILLS* :**
Elastic collision in two dimension

Q.43 **Six steel balls of identical size are lined upwelling a straight frictionless groove. Two similar balls moving with a speed V along the groove collide with this row on the extreme left hand then -**



(A) All the balls will start moving to the right with speed $\frac{1}{8}$ each

(B) All the six balls initially at rest will move on with speed $\frac{V}{6}$ each and two identical balls will come to rest

(C) Two balls from the extreme right end will move on with speed V each and the remaining balls will remain at rest

(D) One ball from the right end will move on with seed 2V, the remaining balls will be at rest.

***TOPIC SKILLS* :**
Elastic collision along straight line.

Q.44 **A 10 kg ball and a 20 kg ball approach each other with velocities 20 ms^{-1} and 10 ms^{-1} respectively. What are their velocities after collision if the collision is perfectly elastic ?**

(A) –20 ms^{-1}, 10 ms^{-1} (B) –10 ms^{-1}, 20 ms^{-1}
(C) –15 ms^{-1}, 16 ms^{-1} (D) –16 ms^{-1}, 20 ms^{-1}

***TOPIC SKILLS* :**
Elastic collision in straight line

Q.45 A ball is dropped on the ground from a height of 1 metre. What is the height to which the ball would rebound ? Given : coefficient of restitution = 0.6.

(A) 0.36 m (B) 0.42 m

(C) 0.38 m (D) 0.4 m

***TOPIC SKILLS* :**
Inelastic collision in one dimension

ANSWER-KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	B	C	C	C	A	D	B	D	C	A	C	B	D	A	A
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	A	C	D	D	C	B	D	C	A	A	B	A	B	B	A
Que.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	A	D	A	B	C	B	B	A	A	C	A	C	C	A	A

Notes

EXERCISE#2

Q.1 **A body of mass m is moving in a circle of radius r with a constant speed v. The force on the body is $\frac{mv^2}{r}$ and is directed towards the centre. What is the work done by this force in moving the body over half the circumference of the circle -**

(A) $\frac{mv^2}{\pi r^2}$

(B) Zero

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

(D) $\frac{\pi r^2}{mv^2}$

Q.2 **A force $\vec{F} = 5\hat{i} + 6\hat{j} - 4\hat{k}$ acting on a body, produces a displacement $\vec{s} = 6\hat{i} + 5\hat{k}$. Work done by the force is**

(A) 18 units
(B) 15 units
(C) 12 units
(D) 10 units

Q.3 **A force $\vec{F} = 6\hat{i} + 2\hat{j} - 3\hat{k}$ acts on a particle and produces a displacement of $\vec{s} = 2\hat{i} - 3\hat{j} + x\hat{k}$. If the work done is zero, the value of x is**

(A) –2

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

(C) 6
(D) 2

Q.4 **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**

(A) Cx_1^2

(B) $\frac{1}{2}Cx_1^2$

(C) Cx_1
(D) Zero

Q.5 **If a force F is applied on a body and it moves with a velocity v, the power will be**

(A) F × v

(B) $\frac{F}{v}$

(C) $\frac{F}{v^2}$

(D) F × v^2

Notes

Q.6 A body of mass m accelerates uniformly from rest to v_1 in time t_1. As a function of time t, the instantaneous power delivered to the body is

(A) $\frac{mv_1 t}{t_1}$

(B) $\frac{mv_1^2 t}{t_1}$

(C) $\frac{mv_1 t^2}{t_1}$

(D) $\frac{mv_1^2 t}{t_1^2}$

Q.7 The average power required to lift a 100 kg mass through a height of 50 metres in approximately 50 seconds would be

(A) 50 J/s
(B) 5000 J/s
(C) 100 J/s
(D) 980 J/s

Q.8 A force of $2\hat{i}+3\hat{j}+4\hat{k}$ N acts on a body for 4 second, produces a displacement of ($3\hat{i}+4\hat{j}+5\hat{k}$)m. The power used is

(A) 9.5 W
(B) 7.5 W
(C) 6.5 W
(D) 4.5 W

Q.9 A body of mass M at rest explodes into three pieces, two of which of mass M/4 each are thrown off in perpendicular directions with velocities of 3 m/s and 4 m/s respectively. The third piece will be thrown off with a velocity of

(A) 1.5 m/s
(B) 2.0 m/s
(C) 2.5 m/s
(D) 3.0 m/s

Q.10 If the momentum of a body is increased n times, its kinetic energy increases

(A) n times
(B) 2n times
(C) $\sqrt{n}$ times
(D) n^2 times

Q.11 The bob of a simple pendulum (mass m and length ℓ) dropped from a horizontal position strikes a block of the same mass elastically placed on a horizontal frictionless table. The K.E. of the block will be

Notes

(A) $2\,mg\ell$

(B) $\frac{mg\ell}{2}$

(C) $mg\ell$

(D) 0

Q.12 **A running man has half the kinetic energy of that of a body of half of his mass. The man speeds up by 1 m/s so as to have same K.E. as that of the body. The original speed of the man will be**

(A) $\sqrt{2}$ m/s

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

(C) $\frac{1}{(\sqrt{2}-1)}$ m/s

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

Q.13 **A particle of mass m moving with a velocity $\vec{V}$ makes a head on elastic collision with another particle of same mass initially at rest. The velocity of the first particle after the collision will be**

(A) $\vec{V}$

(B) $-\vec{V}$

(C) $-2\vec{V}$

(D) Zero

Q.14 **A ball of mass 10 kg is moving with a velocity of 10 m/s. It strikes another ball of mass 5 kg which is moving in the same direction with a velocity of 4 m/s. If the collision is elastic, their velocities after the collision will be, respectively**

(A) 6 m/s, 12 m/s

(B) 12 m/s, 6 m/s

(C) 12 m/s, 10 m/s

(D) 12 m/s, 25 m/s

Q.15 **A body of mass M_1 collides elastically with another mass M_2 at rest. There is maximum transfer of energy when**

(A) $M_1 > M_2$

(B) $M_1 < M_2$

(C) $M_1 = M_2$

(D) Same for all value of M_1 and M_2

Q.16 **A body of mass M moves with velocity v and collides elastiscally with another body of mass m (M >> m) at rest then the velocity of body of mass m is**

(A) v

(B) 2v

(C) v/2

(D) Zero

Q.17 **A particle falls from a height h upon a fixed horizontal plane and**

rebounds. If e is the coefficient of restitution, the total distance travelled before rebounding has stopped is

Notes

(A) $h\left(\frac{1+e^2}{1-e^2}\right)$

(B) $h\left(\frac{1-e^2}{1+e^2}\right)$

(C) $\frac{h}{2}\left(\frac{1-e^2}{1+e^2}\right)$

(D) $\frac{h}{2}\left(\frac{1+e^2}{1-e^2}\right)$

Q.18 A body of mass m moving with a constant velocity v hits another body of the same mass moving with the same velocity v but in the opposite direction and sticks to it. The velocity of the compound body after collision is

(A) v

(B) 2v

(C) Zero

(D) $\frac{v}{2}$

Q.19 A bag (mass M) hangs by a long thread and a bullet (mass m) comes horizontally with velocity v and gets caught in the bag. Then for the combined (bag + bullet) system

(A) Momentum is $\frac{mvM}{M+m}$

(B) Kinetic energy is $\frac{mv^2}{2}$

(C) Momentum is $\frac{mv(M+m)}{M}$

(D) Kinetic energy is $\frac{m^2v^2}{2(M+m)}$

Q.20 A bullet of mass m moving with velocity v strikes a block of mass M at rest and gets embedded into it. The kinetic energy of the composite block will be

(A) $\frac{1}{2}mv^2 \times \frac{m}{(m+M)}$

(B) $\frac{1}{2}mv^2 \times \frac{M}{(m+M)}$

(C) $\frac{1}{2}mv^2 \times \frac{(M+m)}{M}$

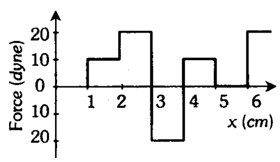
(D) $\frac{1}{2}Mv^2 \times \frac{m}{(m+M)}$

Notes

Q.21 **A body of mass 4 kg moving with velocity 12 m/s collides with another body of mass 6 kg at rest. If two bodies stick together after collision, then the loss of kinetic energy of system is**

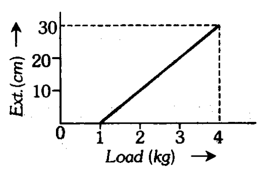
(A) Zero
(B) 288 J
(C) 172.8 J
(D) 144 J

Q.22 **The relationship between force and position is shown in the figure given (in one dimensional case). The work done by the force in displacing a body from x = 1 cm to x = 5 cm is**



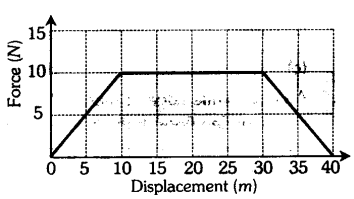
(A) 20 ergs
(B) 60 ergs
(C) 70 ergs
(D) 700 ergs

Q.23 **The pointer reading v/s load graph for a spring balance is as given in the figure. The spring constant is**



(A) 0.1 kg/cm
(B) 5 kg/cm
(C) 0.3 kg/cm
(D) 1 kg/cm

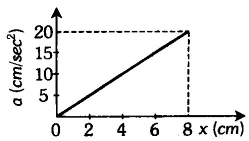
Q.24 **Adjacent figure shows the force-displacement graph of a moving body, the work done in displacing body from x = 0 to x = 35 m is equal to**



(A) 50 J
(B) 25 J
(C) 287.5 J
(D) 200 J

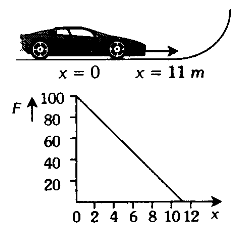
Notes

Q.25 A 10 kg mass moves along x-axis. Its acceleration as a function of its position is shown in the figure. What is the total work done on the mass by the force as the mass moves from x = 0 to x = 8 cm



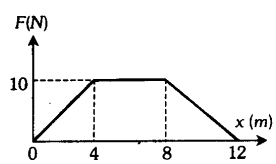
(A) 8×10^{-2} joules
(B) 16×10^{-2} joules
(C) 4×10^{-4} joules
(D) 1.6×10^{-3} joules

Q.26 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 in given by



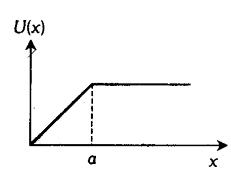
(A) $y_{max} = 20$ m
(B) $y_{max} = 15$ m
(C) $y_{max} = 11$ m
(D) $y_{max} = 5$ m

Q.27 A particle of mass 0.1 kg is subjected to a force which varies with distance as shown in fig. If it starts its journey from rest at x = 0, its velocity at x = 12 m is

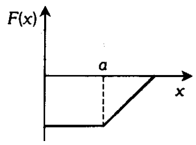


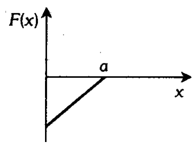
(A) 0 m/s
(B) $20\sqrt{2}$ m/s
(C) $20\sqrt{3}$ m/s
(D) 40 m/s

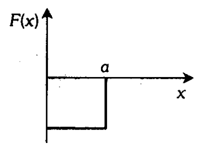
Q.28 The potential energy of a system is represented in the first figure. the force acting on the system will be represented by

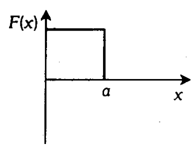


Notes

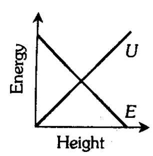
(A) 

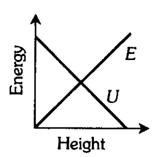
(B) 

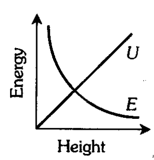
(C) 

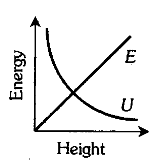
(D) 

Q.29 Which of the following graphs is correct between kinetic energy(E), potential energy(U) and height (h) from the ground of the particle

(A) 

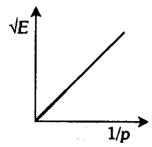
(B) 

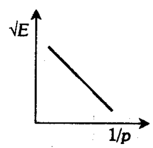
(C) 

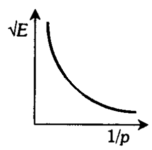
(D) 

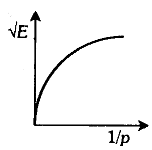
Notes

Q.30 The graph between $\sqrt{E}$ and $\frac{1}{p}$ is (E = kinetic energy and p = momentum)

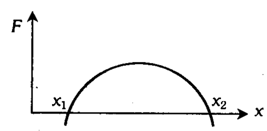
(A) 

(B) 

(C) 

(D) 

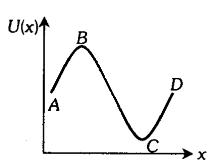
Q.31 The force acting on a body moving along x-axis varies with the position of the particle as shown in the figure.



The body is in stable equilibrium at

(A) $x = x_1$
(B) $x = x_2$
(C) both x_1 and x_2
(D) neither x_1 nor x_2

Q.32 The potential energy of a particle varies with distance x as shown in the graph.

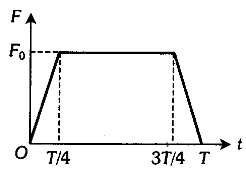


The force acting on the particle is zero at -

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

Notes

Q.33 **A particle of mass m moving with a velocity u makes an elastic one dimensional collision with a stationary particle of mass m establishing a contact with it for extremely small time T. Their force of contact increases from zero to F_0 linearly in time T/4, remains constant for a further time T/2 and decreases liner from F_0 to zero in further time T/4 as shown. The magnitude possessed by F_0 is**



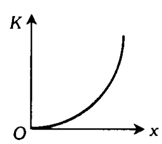
(A) $\frac{mu}{T}$

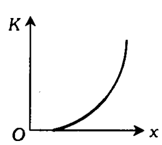
(B) $\frac{2mu}{T}$

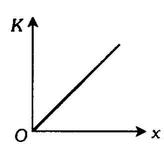
(C) $\frac{4mu}{3T}$

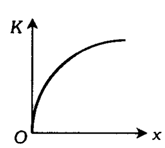
(D) $\frac{3mu}{4T}$

Q.34 **A body moves from rest with a constant acceleration. Which one of the following graphs represents the variation of its kinetic energy K with the displacement travelled x**

(A) 

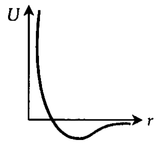
(B) 

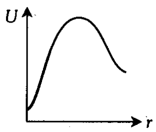
(C) 

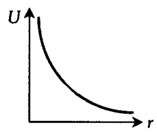
(D) 

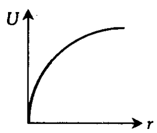
Q.35 **The diagrams represent the potential energy U of a function of the inter-atomic distance r. Which diagram corresponds to stable molecules found in nature.**

Notes

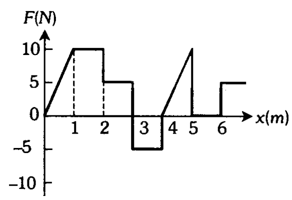
(A) 

(B) 

(C) 

(D) 

Q.36 The relationship between the force F and position x of a body is as shown in figure. The work done in displacing the body from x = 1m to x = 5m will be



(A) 30 J
(B) 15 J
(C) 25 J
(D) 20 J

Q.37 A body of mass m is dropped from a height of h metres. Simultaneously another body of mass 2m is thrown up vertically with such a velocity v that they collide at the height h/2 metres. If the collision is perfectly inelastic, the time in which they will fall to the ground from the moment of collision is

(A) $\frac{3mgh}{2}$

(B) $\sqrt{\frac{2h}{g}}$

(C) $\sqrt{\frac{3h}{2g}}$

(D) None of the above

Q.38 **A particle of mass m is moving in a circular path of constant radius r such that its centripetal acceleration a_c is varying with time t as $a_c = k^2 rt^2$, where k is a constant. The power delivered by the forces acting on it is**

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

(B) mk^2r^2t

(C) $\frac{(mk^4r^2t^6)}{3}$

(D) 0

Q.39 **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 the pipe is v, then the power of the engine is**

(A) $\frac{Adv^3}{2}$

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

(C) $\frac{Adv^2}{2}$

(D) Adv^2

Q.40 **A given object takes n times as much time to slide down a 45^0 rough incline as it takes to slide down a perfectly smooth 45^0 incline. The coefficient of kinetic friction between the object and the incline is given by**

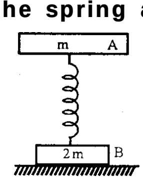
(A) $\left(1-\frac{1}{n^2}\right)$

(B) $1 - \frac{1}{n^2}$

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

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

Q.41 **Two blocks A and B are attached to the ends of a spring. B rests on a horizontal surface and A produces a compression 'x' of the spring. How much more A should be pressed down so that when it is released it will go up extending the spring and lift B ?**



(A) 2x

(B) 3x

(C) 4x

(D) x/2

Notes

Notes

Q.42 **A stone tied to a string of length *L* is whirled in a vertical circle with the other end of the string at the centre. At a certain instant of time, the stone is at its lowest position, and has a speed *u*. The magnitude of the change in its velocity as it reaches a position where the string is horizontal is :**

(A) $\sqrt{u^2 - 2gL}$

(B) $\sqrt{2gL}$

(C) $\sqrt{u^2 - gL}$

(D) $\sqrt{2(u^2 - gL)}$

Q.43 **A particle of mass m moves on the x-axis under the influence of a force of attraction towards the origin O given by $\vec{F} = -\left(\frac{k}{x^3}\right)\hat{i}$ If the particle starts from rest at x = a, the speed it will attain to reach the origin will be**

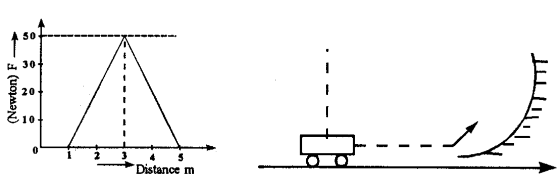
(A) $\sqrt{\frac{k}{m}}\left(\frac{a^2 - x^2}{x^2 a^2}\right)^{-\frac{1}{2}}$

(B) $\sqrt{\frac{k}{m}}\left(\frac{a^2 - x^2}{x^2 a^2}\right)^{\frac{1}{2}}$

(C) $\sqrt{\frac{k}{m}}\left(\frac{a^2 + x^2}{x^2 a^2}\right)^{\frac{1}{2}}$

(D) $\sqrt{\frac{k}{m}}\left(\frac{x^2 - a^2}{x^2 a^2}\right)^{\frac{1}{2}}$

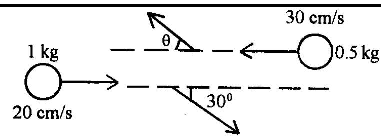
Q.44 **The force applied on a horizontally moving cart of weight 5 kg is shown by the graph (a). The maximum height reached by cart (g = 10 m/s²)**



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

Q.45 **Two balls collide and bounce of each other as shown in the figure. The 1 kg ball has a speed of 10 cm/s after collision. The velocity of the 0.5 kg ball will be**

Notes



(A) 36 cm/s
(B) 24 cm/s
(C) 12 cm/s
(D) 18 cm/s

Q.46 **A ball bearing strikes a steel plate at an angle a with the vertical. If the coefficient of restitution is e, the angle at which the rebound will take place is**

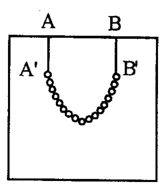
(A) α

(B) $\tan^{-1}\left(\frac{\tan\alpha}{e}\right)$

(C) e $\tan\alpha$

(D) $\frac{e}{\tan\alpha}$

Q.47 **A uniform chain A'B' of length 2*l* having mass l per unit length is hanging from ceiling of an elevator by two light. Inextensible threads AA' and BB' of equal length as shown in fig. Distance AB is very small. At a certain instant. elevator starts ascending with constant acceleration a. Two seconds after the beginning of motion. Thread BB' is burnt. Assuming that instant to be t = 0_1 tension in thread AA' at time t**



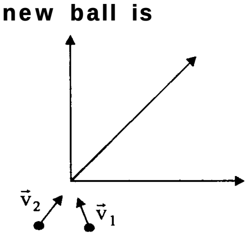
(A) $\lambda \ell (g + a) t$

(B) $\lambda\ell (g + a) + \lambda\frac{3}{4}(g + a)^2 t$

(C) $\lambda\ell (g - a) + \lambda\frac{3}{4}(g + a)^2$

(D) N. O. T.

Q.48 **Two putty balls A and B of mass 2 and 3 kg respectively collide plastically at O with velocities $\vec{V}_1 = 12\hat{i} + 5\hat{j} + 3\hat{k}$ and $\vec{V}_2 = 6\hat{i} + 6\hat{j}$ m/s. The velocity of the new ball is**



Notes

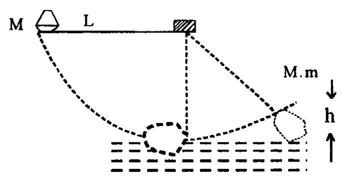
(A) $\frac{1}{5}\left(28\hat{i}+42\hat{j}+6\hat{k}\right)$

(B) $\frac{1}{5}\left(42\hat{i}+28\hat{j}+6\hat{k}\right)$

(C) $\frac{1}{5}\left(6\hat{i}+28\hat{j}-42\hat{k}\right)$

(D) $5\left(42\hat{i}-6\hat{j}+28\hat{k}\right)$

Q.49 **A small bucket of mass M kg is attached to a long inextensible cord of length L m as shown in the figure. The bucket is released from rest when the cord is in a horizontal position. At its lowest position, the bucket scoops up m kg of water and swings up to a height h. The height metres is**



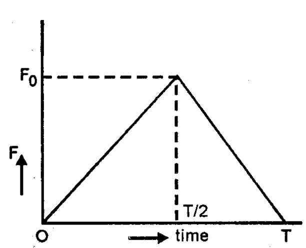
(A) $\left(\frac{M}{M+m}\right)^2 L$

(B) $\left(\frac{M}{M+m}\right) L$

(C) $\left(\frac{M+m}{M}\right)^2 L$

(D) $\left(\frac{M+m}{M}\right) L$

Q.50 **A particle of mass m moving with velocity u makes an elastic one dimensional collision with a stationary particle of mass m. They are in contact for a very brief time T. The force of interaction increases from zero to F_0 linearly in time $\frac{T}{2}$ and decreases linearly to zero in further time $\frac{T}{2}$. The magnitude of F_0 is**



Notes

(A) $\frac{mu}{T}$

(B) $\frac{2mu}{T}$

(C) $\frac{mu}{2T}$

(D) None of these

Q.51 An engine pump is used to pump a liquid of density r continuously through a pipe of cross-sectional area A. If the speed of flow of the liquid in the pipe is v, then the rate at which kinetic energy is being imparted to the liquid is

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

(B) $\frac{1}{2}A\rho v^2$

(C) $\frac{1}{2}A\rho v$

(D) $A\rho v$

Q.52 A smooth sphere of mass M moving with velocity u directly collides elastically with another sphere of mass m at rest. After collision their final velocities are V and v respectively. The value of v is

(A) $\frac{2uM}{m}$

(B) $\frac{2um}{M}$

(C) $\frac{2u}{1+\frac{m}{M}}$

(D) $\frac{2u}{1+\frac{M}{m}}$

Q.53 A ball of mass m falls vertically to the ground from a height h_1 and rebound to a height h_2. The change in momentum of the ball on striking the ground is

(A) $mg(h_1 - h_2)$

(B) $mg(\sqrt{2gh_1} + \sqrt{2gh_2})$

(C) $m\sqrt{2g(h_1+h_2)}$

(D) $m\sqrt{2g}(h_1 + h_2)$

Q.54 A space craft of mass M is moving with velocity V and suddenly explodes into two pieces. A part of it of mass m becomes at rest, then the velocity of other part will be

Notes

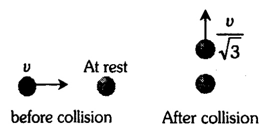
(A) $\frac{MV}{M-m}$

(B) $\frac{MV}{M+m}$

(C) $\frac{mV}{M-m}$

(D) $\frac{(M+m)V}{m}$

Q.55 A mass 'm' moves with velocity 'v' and collides in elastically with another identical mass. After collision the 1st mass moves with velocity $\frac{v}{\sqrt{3}}$ in a direction perpendicular to the initial direction of motion. Find the speed of the 2nd mass after collision



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

(B) $\frac{v}{\sqrt{3}}$

(C) v

(D) $\sqrt{3}$ v

Q.56 A body is dropped from a certain height. When it lost an amount of P.E. 'U', it acquires a velocity 'v'. The mass of the body is :

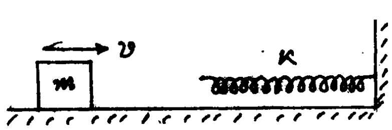
(A) $\frac{2U}{v^2}$

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

(C) $\frac{2v}{U}$

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

Q.57 A block of mass m moves towards a light spring of stiffness k on a smooth horizontal plane. If it compresses the spring through a distance x_0, the magnitude of total change in momentum of the block returns to the initial position is :



Notes

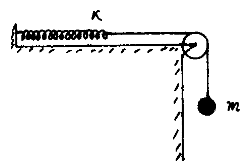
(A) $2\sqrt{km}\,x_0$

(B) 0

(C) $\sqrt{km}\,x_0$

(D) None of these

Q.58 In the given figure the light spring is of force constant k and is on a smooth horizontal surface. Initially the spring is relaxed. The work done by an external agent to lower the hanging body of mass M slowly, till it remains in equilibrium, is :



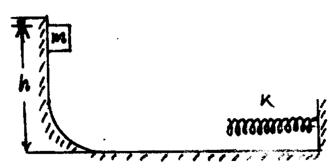
(A) $\frac{m^2g^2}{-2k}$

(B) $\frac{m^2g^2}{2k}$

(C) $\frac{3m^2g^2}{2k}$

(D) $-\frac{3m^2g^2}{2k}$

Q.59 A small mass m is sliding down on a smooth curved incline from a height h and finally moves through a horizontal smooth surface. A light spring of force constant k is fixed with a vertical rigid stand on the horizontal surface, as shown in the figure. The maximum compression in the spring if the mass m is released from rest from the height h and hits the spring on the horizontal surface is :



(A) $\frac{2mgh}{k}$

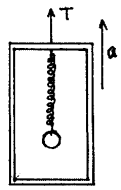
(B) $\frac{mgh}{k}$

(C) $\frac{mgh}{2k}$

(D) None of these

Notes

Q.60 **A small metallic sphere is suspended by a light spring of force constant k from the ceiling of a cage. The ratio of mass of the cage to the sphere in 'n'. The cage is accelerated uniformly by a tension T. The potential energy stored in the spring is :**



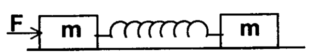
(A) $\frac{T^2}{2k}$

(B) $\frac{T^2}{(n+1)gk}$

(C) $\frac{T^2}{2(n+1)^2k}$

(D) $\frac{T^2}{2(n+1)^2k}$

Q.61 **Two identical blocks each of mass m being interconnected by a light spring of stiffness k is pushed by a force F as shown in the figure. The maximum potential energy stored in the spring is equal to :**



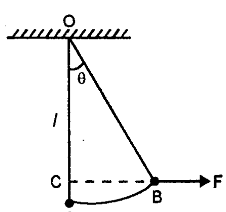
(A) $\frac{F^2}{2k}$

(B) $\frac{F^2}{4k}$

(C) $\frac{F^2}{8k}$

(D) None of these

Q.62 **An object of mass m is tied to a string of length ℓ and a variable horizontal force is applied on it, which starts at zero and gradually increases (it is pulled extremely slowly so that equilibrium exists at all times) until the string makes an angle q with the vertical. Work done by the force F is**



(A) $mg\ell(1 - \sin\theta)$

(B) $mg\ell$

(C) $mg\ell(1 - \cos\theta)$

(D) $mg\ell(1 - \tan\theta)$

Notes

Q.63 **A particle moves on a rough horizontal ground with some initial velocity v_0. If $\frac{3}{4}$th of its K.E. is lost in friction in time t_0, the coefficient of friction between the particle and the ground is**

(A) $\frac{v_0}{2gt_0}$

(B) $\frac{v_0}{4gt_0}$

(C) $\frac{3v_0}{4gt_0}$

(D) $\frac{v_0}{gt_0}$

Q.64 **Two blocks A and B of mass m and 2m are connected by a massless spring of force constant k. They are placed on a smooth horizontal plane. Spring is stretched by an amount x and then released. The relative velocity of the block when the spring comes to its natural length is**

(A) $\sqrt{\frac{3k}{2m}}\,x$

(B) $\sqrt{\frac{2k}{3m}}\,x$

(C) $\sqrt{\frac{2kx}{m}}$

(D) $\sqrt{\frac{3km}{2x}}$

Q.65 **A force F acting on a body depends on its displacement S as F µ $S^{-1/3}$. The power delivered by F will depend on displacement as**

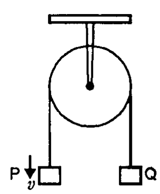
(A) $S^{2/3}$

(B) $S^{1/2}$

(C) S^{0}

(D) $S^{-5/3}$

Q.66 **P and Q are two identical masses at rest suspended by an inextensible string passing over a smooth frictionless pulley. Mass P is given a downward push with a speed v as shown in Fig. It collides with the floor and rebounds. What happens immediately after collision ?**



(A) P and Q both move upwards with equal speeds

(B) P and Q both move upwards with different speeds

(C) P moves upwards and Q moves downwards with equal speeds

(D) Both P and Q are all rest.

Notes

Q.67 **A pendulum consists of a wooden bob of mass (m) and length (ℓ). A bullet of mass (m_1) is fired towards the pendulum with a speed v_1. The bullet emerges out of the bob with a speed $\frac{v_1}{3}$, and the bob just completes the vertical circle. The value of v_1 is**

(A) $\left(\frac{m}{m_1}\right)\sqrt{5g\ell}$

(B) $\frac{m}{m_1}\sqrt{\frac{g}{\ell}}$

(C) $\frac{2}{3}\left(\frac{m_1}{m}\right)\sqrt{5g\ell}$

(D) $\frac{3}{2}\left(\frac{m}{m_1}\right)\sqrt{5g\ell}$

Q.68 **A ball falls vertically on to a floor, with momentum p, and then bounces repeatedly, the coefficient of restitution is e. The total momentum imparted by the ball to the floor is**

(A) $p(1 + e)$

(B) $\frac{p}{1-e}$

(C) $p\left(\frac{1+e}{1-e}\right)$

(D) $p\left(1-\frac{1}{e}\right)$

ANSWERKEY

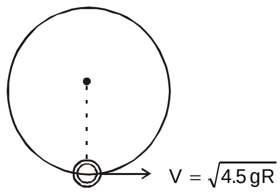
Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	B	D	D	B	A	D	D	A	C	D	C	C	D	A	C
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	B	A	C	D	A	C	A	A	C	A	C	D	C	A	C
Que.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	B	C	C	C	A	B	D	B	A	A	B	D	B	B	C
Que.	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	B	C	B	B	D	A	C	B	A	A	A	A	A	A	D
Que.	61	62	63	64	65	66	67	68							
Ans.	A	C	A	A	C	C	D	C							

EXCERSICE #3

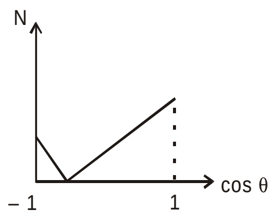
Notes

MORE THAN ONE OPTIONS CORRECT

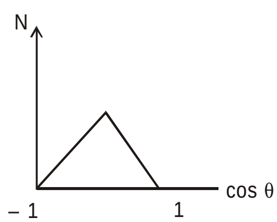
Q.1 **Figure shows a fixed vertical smooth wire frame through which a bead can slide without friction. At lowest point, the bead is given a velocity $V = \sqrt{4.5\ gR}$ where R is radius of the frame. The magnitude of contact force between the bead and wire frame varies with cos q as**



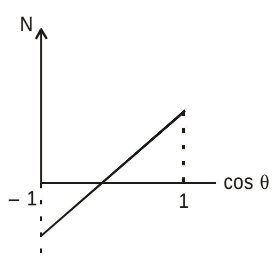
(A)



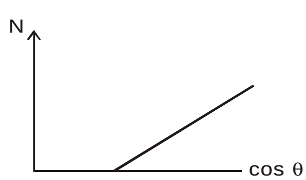
(B)



(C)

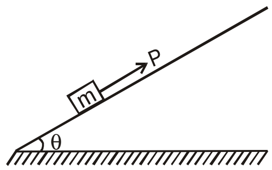


(D)



Notes

Q.2 A block of mass 'm' is being pulled up the rough incline by an agent delivering constant power P. The coefficient of friction between the block and the incline is m. The maximum speed of the block during the course of ascent is-



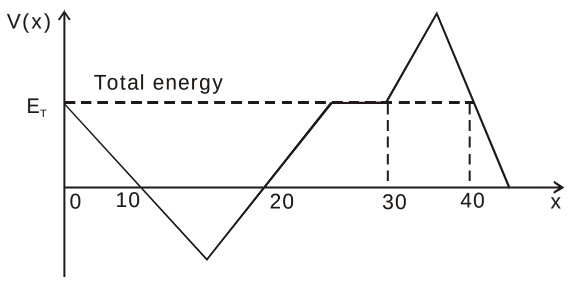
(A) v = $\dfrac{p}{mg\sin\theta - \mu mg\cos\theta}$

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

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

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

Q.3 Potential energy v/s x curve is shown in figure. The total energy of the particle is indicated by the dotted line. In which region, particle cannot be found-



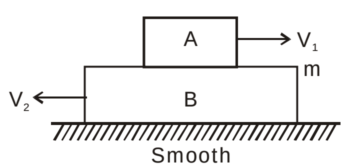
(A) $x \in (0, 10)$

(B) $x \in (10, 20)$

(C) $x \in (20, 30)$

(D) $x \in (30, 40)$

Q.4 Two block A and B are sliding on each other. At certain instant, velocity of A is V_1 and velocity of block B is V_2. If friction coefficient between block A and B is m, the power lost in friction at that moment will be-



(A) $(\mu m_A g)(v_1 + v_2)$

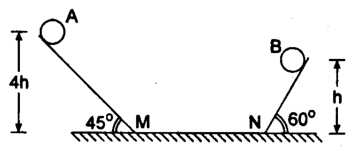
(B) $(\mu m_A g)(v_1 - v_2)$

(C) $(\mu m_B g)(v_2 + v_1)$

(D) $(\mu m_A g)(v_2 - v_1)$

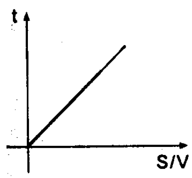
Notes

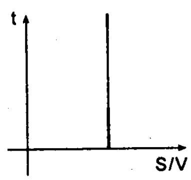
Q.5 **Two identical balls A and b are released from the positions shown in figure. They collide elastically on horizontal portion MN. All surfaces are smooth. The ratio of heights attained by A and B after collision will be.**

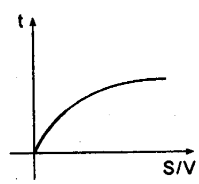


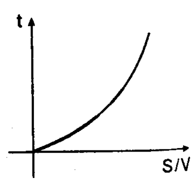
(A) 1 : 4
(B) 2 : 1
(C) 4 : 13
(D) 2 : 5

Q.6 **A body is moved from rest along a straight line by a machine delivering constant power. The ratio of displacement and velocity (S/V) varies with time t as.**

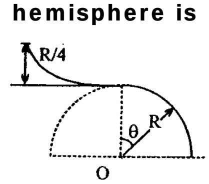
(A) 

(B) 

(C) 

(D) 

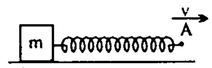
Q.7 **A skier plans to ski a smooth fixed hemisphere of radius R. He starts from rest from a curved smooth surface of height (R/4). The angle θ at which he leaves the hemisphere is**



(A) $\cos^{-1}(2/3)$
(B) $\cos^{-1}(5/\sqrt{3})$
(C) $\cos^{-1}(5/6)$
(D) $\cos^{-1}(5/2\sqrt{3})$

Notes

Q.8 **A block of mass 'm' is attached to a spring in natural length of spring constant 'k'. The other end A of the spring is moved with a constant velocity v away from the block. Find the maximum extension in the spring.**



(A) $\frac{1}{4}\sqrt{\frac{mv^2}{k}}$

(B) $\sqrt{\frac{mv^2}{k}}$

(C) $\frac{1}{2}\sqrt{\frac{mv^2}{k}}$

(D) $2\sqrt{\frac{mv^2}{k}}$

Q.9 **In the above question, find the amplitude of oscillation of the block in the reference frame of point A of the spring :**

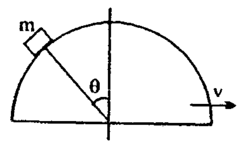
(A) $\frac{1}{4}\sqrt{\frac{mv^2}{k}}$

(B) $\frac{1}{2}\sqrt{\frac{mv^2}{k}}$

(C) $\sqrt{\frac{mv^2}{k}}$

(D) $2\sqrt{\frac{mv^2}{k}}$

Q.10 **A hemisphere of mass 3m and radius R is free to slide with its base on a smooth horizontal table. A particle of mass m is placed on the top of the hemisphere. If particle is displaced with a negligible velocity, then find the angular velocity of the particle relative to the centre of the hemisphere at an angular displacement** q, **when velocity of hemisphere is v.**



(A) $\frac{4v}{R\cos\theta}$

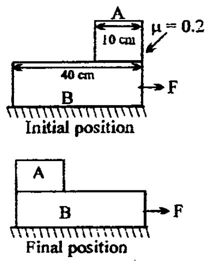
(B) $\frac{3v}{R\cos\theta}$

(C) $\frac{5v}{R\cos\theta}$

(D) $\frac{2v}{R\cos\theta}$

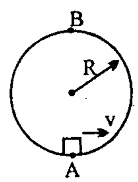
Notes

Q.11 **A block 'A' of mass 45 kg is placed on a block 'B' of mass 123 kg. Now block 'B' is displaced by external agent by 50 cm horizontally towards right. During the same time block 'A' just reaches to the left end of block B. Initial & final position are shown in figure. Refer to the figure & find the work done by frictional force on block A in ground frame during above time.**



(A) – 18 Nm
(B) 18 Nm
(C) 36 Nm
(D) – 36 Nm

Q.12 **A block of mass m is projected on a smooth horizontal circular track with velocity v. What is average normal force exerted by the circular walls on the block during its motion from A to B.**



(A) $\frac{mv^2}{R}$

(B) $\frac{mv^2}{\pi R}$

(C) $\frac{2mv^2}{R}$

(D) $\frac{2mv^2}{\pi R}$

Q.13 **A force of constant magnitude F acts on a particle moving in a plane such that it is perpendicular to the velocity $\vec{v}$ ($|\vec{v}|$ = v) of the body, and the force is always directed towards a fixed point. Then the angle turned by the velocity vector of the particle as it covers a distance S is : (take mass of the particle as m)**

(A) $\frac{FS}{2mv^2}$

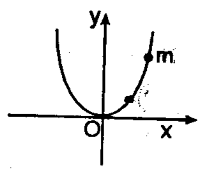
(B) $\frac{FS}{mv^2}$

(C) $\frac{FS^2}{mv}$

(D) $\frac{2FS}{mv^2}$

Notes

Q.14 **A bead of mass m is located on a parabolic wire with its axis vertical and vertex at the origin as shown in figure and whose equation is $x^2 = 4ay$. The wire frame is fixed and the bead can slide on it without friction. The bead is released from the point y = 4a on the wire frame from rest. The tangential acceleration of the bead when it reaches the position given by y = a is-**



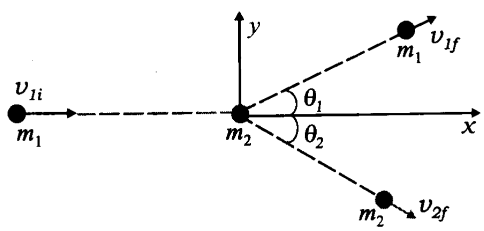
(A) $\frac{g}{2}$

(B) $\frac{\sqrt{3}g}{2}$

(C) $\frac{g}{\sqrt{5}}$

(D) $\frac{g}{\sqrt{2}}$

Q.15 **Consider the collision depicted in fig. to be between two billiard balls with equal masses $m_1 = m_2$. The first ball is called the cue while the second ball is called the target. The billiard player wants to 'sink' the target ball in a corner pocket, which is at an angle q_2 = 37°. Assume that the collision is elastic and that friction and rotational motion are not important. Obtain q_1.**



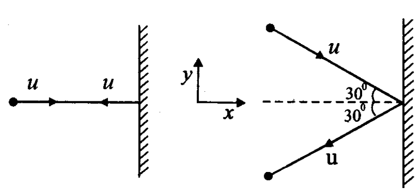
(A) 35°

(B) 53°

(C) 127°

(D) None

Q.16 **Two identical billiard ball strike a rigid wall with the same speed but at different angles, and get reflected without any loss of speed, as shown in the figure below. What the ratio of the magnitudes of impulses imparted on the two balls by the wall ?**



(a) (b)

(A) 1.2

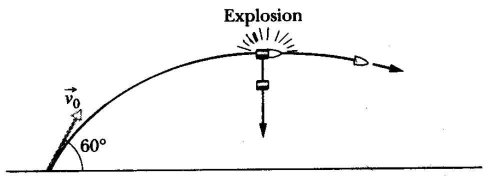
(B) 2.1

(C) 0.12

(D) None

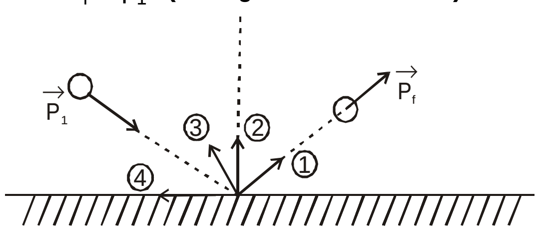
Notes

Q.17 **A shell is shot with an initial velocity $\vec{v}_0$ of 20 m/s, at an angle of 60° with the horizontal. At the top of the trajectory, the shell explodes into two fragments of equal mass (fig). One fragment, whose speed immediately after the explosion is zero, falls vertically. How far from the gun does the other fragment land ?**



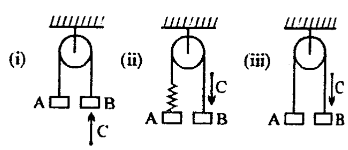
(A) 30 m
(B) 40 m
(C) 53 m
(D) None

Q.18 **A ball strike the horizontal rough surface and bounce back as shown. The direction of $\vec{P}_f - \vec{p}_1$. (change in momentum) will be along arrow**



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

Q.19 **In the figure (i), (ii) & (iii) shown the objects A, B and C are of same mass. String, spring & pulley are mass less. C strikes B with velocity 'u' in each case and sticks to it. The ratio of velocity of B in case (i) to (ii) to (iii) is**



(A) 1 : 1 : 1
(B) 3 : 3 : 2
(C) 3 : 2 : 2
(D) None of these

Q.20 **A body of mass 'm' is dropped from a height of 'h' . Simultaneously another body of mass 2m is thrown up vertically with such a velocity v that they collide at the height h/2. If the collision is perfectly inelastic, the velocity at the time of collision with the ground will be :**

Notes

(A) $\sqrt{\frac{5gh}{4}}$

(B) $\sqrt{gh}$

(C) $\sqrt{\frac{gh}{4}}$

(D) $\sqrt{\frac{10gh}{3}}$

Q.21 **Velocity vector of a particle just before making an inelastic impact with horizontal smooth surface with coefficient of restitution 0.2 is $(3\hat{i} - 10\hat{j} - 50\hat{k})$ m/s with z-axis being vertically upwards. Velocity of the particle 1 sec. after collision will be-**

(A) $(3\hat{i} - 10\hat{j} + 10\hat{k})$ m/s

(B) $-(3\hat{i} - 10\hat{j} + 10\hat{k})$ m/s

(C) $(3\hat{i} - 10\hat{j})$ m/s

(D) $-(3\hat{i} - 10\hat{j})$ m/s

ASSERTION & REAASON TYPE QUESTIONS

(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not correct explanation of A
(C) A is true but R is false
(D) A is false but R is true.
(E) A and R both are false.

Q.22 **Assertion :** A wooden ball dropped from a height of 2m can reach a height of 0.5 m only, if the coefficent of restitution is 1.

Reason : $e = \frac{v_2 - v_1}{u_2 - u_1}$ is the relation for coefficent of restitution.

Q.23 **Assertion :** The work energy theorem may be viewed as a scalar form of the second law.

Reason : Since $W = \Delta KE$, $F = \frac{dW}{dx} = \frac{1}{2}\frac{mdv^2}{dx} = mv = \frac{dv}{dx} = ma$

Q.24 **Assertion :** For stable equilibrium force has to be zero and potential energy should be minimum.

Reason : For equilibrium, it is not necessary that the force is not zero.

Q.25 **Assertion :** A bomb explodes while being 'at rest. The momentum just after explosion is zero.

Reason : In the absence of an external force, momentum remains conserved.

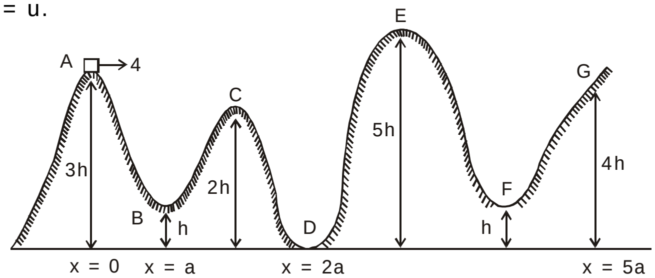
Q.26 **Assertion :** A body of mass m_1 head on elastically collides with another stationary body of mass m_2. After the collision velocity of mass m_2 is maximum, when $m_1 << m_2$.

Reason : Velocity of second body is always maximum, when its mass m_2 is greater than mass of the hitting body.

Notes

PASSAGE 1 [LEVEL : MODERATE]

A smooth curved shape track is shown in figure. A, B, C, D, E, F and G are seven points on the track. The height of each point and x-coordinate are also shown. In the entire space there is uniform gravity field. A small block of mass m is released from point A. With a speed = u.



Radius of curvature of the track at all the given point is R. Assume that the block doesn't loose the contact with the track at any point.

Q.27 What will be the speed of the block, as it reaches point D-

(A) $\sqrt{u^2+6gh}$

(B) $\sqrt{u^2-6gh}$

(C) $\sqrt{u^2-4gh}$

(D) $\sqrt{u^2+4gh}$

Q.28 The normal reaction between the block and the track is minimum at point-

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

Q.29 What should be minimum value of u, so that the block can reach point G-

(A) $\sqrt{2gh}$

(B) $\sqrt{4gh}$

(C) $\sqrt{5gh}$

(D) None

Q.30 For that minimum speed, with what speed, will the block reach point G :

(A) $\sqrt{2gh}$

(B) $\sqrt{3gh}$

(D) $\sqrt{4gh}$

(D) None

Notes

Q.31 **Instead of gravity, there is also a conservative horizontal force field F (right ward) in the entire space, then speed of the block at point G-**

(A) $\sqrt{u^2 + \frac{10Fa}{m} - 2gh}$

(B) $\sqrt{u^2 - \frac{10Fa}{m} - 2gh}$

(C) $\sqrt{u^2 + \frac{10Fa}{m} + 2gh}$

(D) None of these

Q.32 **If the track were rough with friction coefficient m, then speed of the block at point D would be-**

(A) $\sqrt{u^2 + \frac{4Fa}{m} - 4\mu ga}$

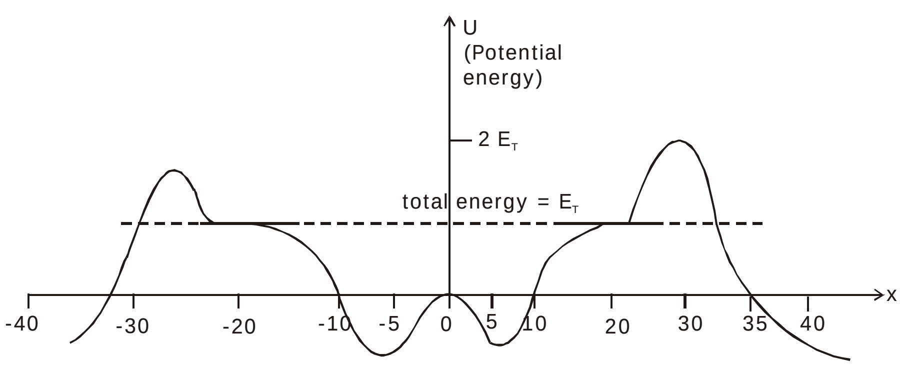
(B) $\sqrt{u^2 + 6gh + \frac{4Fa}{m} - 4\mu ga}$

(C) $\sqrt{u^2 - \frac{4Fa}{m} - 4\mu ga}$

(D) None of these

PASSAGE 2 [LEVEL : MODERATE]

A particle is projected from origin with some velocity such that its total mechanical energy E_T is indicated by the dotted line on the ordinate axis. The potential energy function in the space is shown in figure. Neglect any non-conservative force -



Q.33 **The velocity of particle at x = 40 will be**

(A) $\sqrt{\frac{E_T}{m}}$

(B) $\sqrt{\frac{2E_T}{m}}$

(C) $\sqrt{\frac{E_T}{2m}}$

(D) Particle cannot reach there

Notes

Q.34 The kinetic energy of the particle will be maximum at -

(A) $x = 0$
(B) $x = 5$
(C) $x = 10$
(D) $x = 40$

Q.35 Starting with any point and with the given total energy, the particle cannot be found in the region

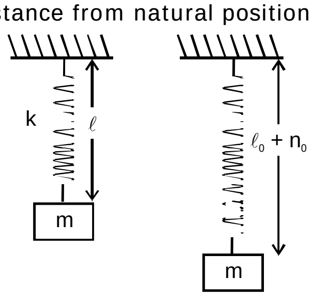
(A) $x \in (10, 20)$
(B) $x \in (20, 40)$
(C) $x \in (30, 40)$
(D) $x \in (20, 30)$

Q.36 What should be minimum total energy, so that the particle can be found every where in x Î (–40, 40)

(A) E_T
(B) $2E_T$
(C) $3E_T$
(D) None

PASSAGE 3 [LEVEL : EASY]

A block of mass m is attached to a light spring of stiftness k and natural length ℓ_0. The block is pushed further x_0 distance from natural position and then released.



If there were no resistance force, the block would continue to oscillate up and down. But there is also air resistance, which is proportional to its velocity given by $f_r = bV$ where b is some constant. Now air resistance continously sucks energy from block and finally the block come to rest at its equilibrium possitron-

Q.37 What will be the acceleration of the block just after releasing-

(A) $g + \frac{kx_0}{m}$
(B) $g - \frac{kx_0}{m}$
(C) g
(D) Zero

Q.38 At certain time, its velocity if V downwards and length of spring is $\ell_0 - x$. The acceleration of the block at this instant is

(A) $g + \frac{kx}{m} - \frac{kV}{m}$
(B) $g - \frac{kx}{m} + \frac{kV}{m}$
(C) $g + \frac{kx}{m} + \frac{kV}{m}$
(D) None of these

Notes

Q.39 In the previous question What will be energy lost against air resistance till that possition-

(A) $2(x_0 + x)(k(x_1 - a_0) - mg) - \frac{1}{2}mv^2$
(B) $4(x_0 + x)(k(x_1 - a_0) - mg) + \frac{1}{2}mv^2$
(C) $3(x_0 + x)(k(x_1 - a_0) - mg) + \frac{1}{2}mv^2$
(D) $\frac{1}{2}(x_0 + x)(k(x_1 - a_0) - mg) - \frac{1}{2}mv^2$

Q.40 When the block will come to rest, the length of the spring will be-

(A) $\ell_0 + \frac{mg}{k}$

(B) $\ell_0 + \frac{2mg}{k}$

(C) $\ell_0 - \frac{mg}{k}$

(D) None of these

Q.41 Total energy loss against air resistance the block come to rest is -

(A) $\frac{1}{2}kx_0^2 - mgx_0 + \frac{(mg)^2}{2k}$

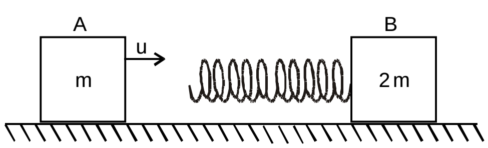
(B) $\frac{1}{2}kx_0^2 + mgx_0 + \frac{(mg)^2}{2k}$

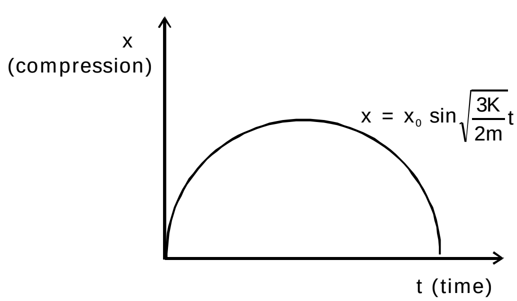
(C) $\frac{1}{2}kx_0^2 - mgx_0 - \frac{(mg)^2}{2k}$

(D) $\frac{1}{2}kx_0^2 + mgx_0 - \frac{(mg)^2}{2k}$

PASSAGE 4 [LEVEL : MODERATE]

A block A and B of mass m strike another block of mass 2m through an ellastic light spring of stiffness k. At t = 0, the block just tauches the spring. During the contact, the compression in the spring varies with time as $x = x_0 \sin\sqrt{\frac{3K}{2m}}\,t$, where x_0 is a constant.





Initrally compression of spring increases, then after getting the maximum value, if decreases to zero. As soon as the value of x trys to be negitive, the block A will be sparated from this spring.

Notes

Q.42 The value of x_0 should be

(A) $\sqrt{\frac{3m}{2k}}u$

(B) $\sqrt{\frac{2m}{3k}}u$

(C) $\sqrt{\frac{m}{2k}}u$

(D) None

Q.43 When velocity of block A will be u/2, what will be velocity of B at that instant -

(A) $\frac{u}{2}$

(B) 2u

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

(D) None

Q.44 Displacement of centre of mass from t = 0 to t = $\sqrt{\frac{m}{K}}$ will be -

(A) $\frac{u}{3}\sqrt{\frac{m}{k}}$

(B) $\frac{u}{3}\sqrt{\frac{2m}{k}}$

(C) $\frac{u}{3}\sqrt{\frac{m}{2k}}$

(D) None of these

Q.45 Acceleration of block A at t = $\sqrt{\frac{2m}{3k}}\left(\frac{\pi}{6}\right)$ will be

(A) $\frac{kx_0}{2m}$ toward rigth

(B) $\frac{kx_0}{2m}$ toward left

(C) $\frac{2kx_0}{m}$ toward left

(D) None

Notes

Q.46 After How much time, block A will saperate from the spring -

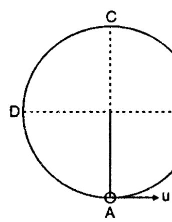
(A) $\sqrt{\frac{2m}{3k}}\frac{\pi}{2}$

(B) $\sqrt{\frac{2m}{3k}}\pi$

(C) $\sqrt{\frac{2m}{3k}}(2\pi)$

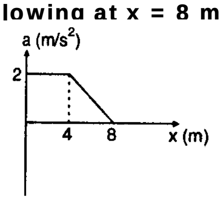
(D) None of these

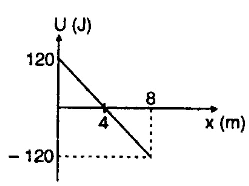
Q.47 A particle is suspended from a string of length R. It is given a velocity $u = 3\sqrt{gR}$ at the bottom. Match the following



	Column I	Column II
(A)	Velocity at B	(p) 7 mg
(B)	Velocity at C	(q) $\sqrt{5gR}$
(C)	Tension in string at B	(r) $\sqrt{7gR}$
(D)	Tension in string at C	(s) 5 mg
		(t) None

Q.48 Acceleration versus x and potential energy versus x graph of a particle moving along x – axis is as shown in figure. Mass of the particle is 1 kg and velocity at x = 0 is 4 m/s.
Match the following at x = 8 m:

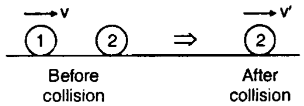




	Column I	Column II
(A)	Kinetic energy	(p) 120 J
(B)	Work done by conservative forces	(q) 240 J
(C)	Total work done	(r) 128 J
(D)	Work done by external forces	(s) 112 J
		(t) None

Notes

Q.49 In the diagram shown in figure mass of both the balls is same. Match the following table:



Column I		Column II	
(A)	for v' = v	(p)	e = 0
(B)	For v' $\frac{v}{2}$	(q)	e = 1
(C)	For v' = $\frac{3}{4}$v	(r)	e = $\frac{1}{2}$
		(s)	Data is insufficient

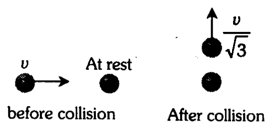
ANSWERKEY

Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Ans.	A	B	D	A	C	A	C	B	C	A	B	A	D	D	B
Que.	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Ans.	**A**	C	C	B	D	A	E	A	C	A	D	A	B	B	A
Que.	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**
Ans.	A	B	D	B	D	B	B	A	D	A	A	B	C	A	B
Que.	**46**	**47**				**48**				**49**					
Ans.	B	A-r	B-q	C-p	D-t	A-r	B-q	C-p	D-q	A-q	B-p	C-r			

EXERCISE#4

Notes

Q.1 **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 [AIEEE 2002]**



(A) MgL
(B) MgL/3
(C) MgL/9
(D) MgL/18

Q.2 **A spring of force constant 800 N/m has an extension of 5 cm. The work done in extending it from 5 cm to 15 cm is [AIEEE 2002]**

(A) 16 J
(B) 8 J
(C) 32 J
(D) 24 J

Q.3 **If a body looses half of its velocity on penetrating 3 cm in a wooden block, then how much will it penetrate more before coming to rest [AIEEE 2002]**

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

Q.4 **A bomb of mass 9 kg explodes into 2 pieces of mass 3 kg and 6 kg. The velocity of mass 3 kg is 1.6 m/s, the K.E. of mas 6 kg is [AIEEE 2002]**

(A) 3.84 J
(B) 9.6 J
(C) 1.92 J
(D) 2.92 J

Q.5 **A ^{238}U nucleus decays by emitting an alpha particle of speed u ms^{-1}. The recoil speed of the residual nucleus is (in ms^{-1}). [AIEEE 2003]**

(A) $-4\upsilon/234$
(B) $\upsilon/4$
(C) $-4\upsilon/238$
(D) $4\upsilon/238$

Q.6 **A spring o$\vec{r} = \left(2\hat{i} - \hat{j}\right)$ m f 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 [AIEEE 2003]**

(A) 6.25 N-m
(B) 12.50 N-m
(C) 18.75 N-m
(D) 25.00 N-m

Notes

Q.7 **A uniform chain of length 2m is kept on a table such that a length of 60 cm hangs freely from the edge of the table. The total mass of the chain is 4kg. What is the work done in pulling the entire chain on the table. [AIEEE 2004]**

(A) 7.2 J
(B) 3.6 J
(C) 120 J
(D) 1200 J

Q.8 **A particle is acted upon by a force of constant magnitude which is always perpendicular to the velocity of the particle, the motion of the particle takes place in a plane. It follows that [AIEEE 2004]**

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

Q.9 **A force $\vec{F} = (5\hat{i} + 3\hat{j} + 2\hat{k})$ N is applied over a particle which displaces it from its origin to the point $\vec{r} = (2\hat{i} - \hat{j})$ m. the work done on the particle in joules is [AIEEE 2004]**

(A) –7
(B) +7
(C) +10
(D) +13

Q.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 [AIEEE 2004]**

(A) x^2
(B) e^x
(C) x
(D) $\log_e x$

Q.11 **A body of mass m accelerates uniformly from rest to υ_1 in time t_1. As a function of time t, the instantaneous power delivered to the body is [AIEEE 2004]**

(A) $\frac{m\upsilon_1 t}{t_1}$

(B) $\frac{m\upsilon_1^2 t}{t_1}$

(C) $\frac{m\upsilon_1 t^2}{t_1}$

(D) $\frac{m\upsilon_1^2 t}{t_1^2}$

Notes

Q.12 **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 velocity attained by the ball is [AIEEE 2005]**

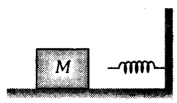
(A) 10 m/s

(B) $10\sqrt{30}$ m/s

(C) 40 m/s

(D) 20 m/s

Q.13 **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]**



(A) Zero

(B) $\frac{ML^2}{K}$

(C) $\sqrt{MKL}$

(D) $\frac{KL^2}{2M}$

Q.14 **A mass 'm' moves with a velocity 'u' and collides inelastically with velocity $\frac{u}{\sqrt{3}}$ in a direction perpendicular to the initial direction of motion. Find the speed of the 2nd mass after collision [AIEEE 2005]**

(A) $\frac{2}{\sqrt{3}}\upsilon$

(B) $\frac{\upsilon}{\sqrt{3}}$

(C) υ

(D) $\sqrt{3}\,\upsilon$

Q.15 **A particle of mass 100 g is thrown vertically upwards with a speed of 5 m/s. The work done by the force of gravity during the time the particle goes up is [AIEEE 2006]**

(A) –1.25 J

(B) 1.25 J

(C) 0.5 J

(D) – 0.5 J

Notes

Q.16 **A bomb of mass 16 kg at rest explodes into two pieces of masses 4 kg and 12 kg. The velocity of the 12 kg mass is 4 ms^{-1}. The kinetic energy of the other mass is [AIEEE 2006]**

(A) 288 J
(B) 192 J
(C) 96 J
(D) 144 J

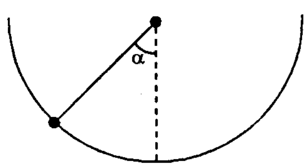
Q.17 **A block of mass 0.50 kg is moving with a speed of 2.00 ms^{-1} on a smooth surface. It strikes another mass of 1.00 kg and then they move together as a single body. The energy loss during the collision is- [AIEEE 2008]**

(A) 1.00 J
(B) 0.67 J
(C) 0.34 J
(D) 0.16 J

Q.18 **An athlete in the olympic games covers a distance of 100 m in 10s. His kinetic energy can be estimated to be in the range- [AIEEE 2008]**

(A) 2×10^5 J – 3×10^5 J
(B) 20,000 J – 50,000 J
(C) 2,000 J – 5,000 J
(D) 200 J – 500 J

Q.19 **An insects crawls up a hemispherical surface very slowly (see fig.) The coefficient of friction between the insect and the surface is 1/3. If the line joining the center of the hemispherical surface to the insect makes an angle α with vertical, the max. possible value of α is given by: [IIT 2001]**



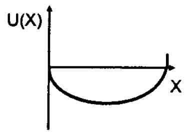
(A) $\cot\alpha = 3$
(B) $\sec\alpha = 3$
(C) $\text{cosec}\,\alpha = 3$
(D) None

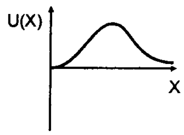
Q.20 **Two particles of masses m_1 and m_2, in projectile motion, have velocities $v_1 < v_2$ respectively at t = 0. They collide at time t_0. Their velocities become $\vec{v}_1'$ and $\vec{v}_2'$ at time $2t_0$ while moving in air. The value of $\left|\left(m_1\vec{v}_1' + m_2\vec{v}_2'\right) - \left(m_1\vec{v}_1 + m_2\vec{v}_2\right)\right|$ is : [IIT-2001]**

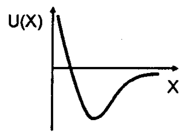
(A) Zero
(B) $(m_1 + m_2)\, g t_0$
(C) $2(m_1 + m_2)\, g t_0$
(D) $\frac{1}{2}(m_1 + m_2)\, g t_0$

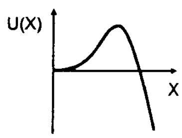
Notes

Q.21 A particle, which is constrained to move along the x-axis, is subjected to a force in the same direction which varies with the distance x of the particle from the origin as $F(x) = -kx + ax^3$. Here k and a are positive constant. For $x \geq 0$, the functional form of the potential energy U(x) of the particle is **[IIT Scr. 2002]**

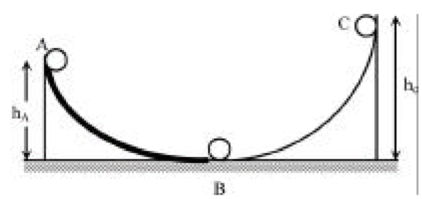
(A) 

(B) 

(C) 

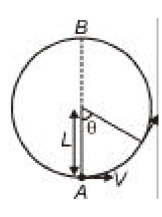
(D) 

Q.22 A ball moves over a fixed track as shown in the figure. From A to B the ball rolls without slipping. Surface BC is frictionless. KA, KB and KC are kinetic energies of the ball at A, B and C, respectively. Then **[IIT-2006]**



(A) $h_A > h_C$; $K_B > K_C$
(B) $h_A > h_C$; $K_C > K_A$
(C) $h_A = h_C$; $K_B = K_C$
(D) $h_A < h_C$; $K_B > K_C$

Q.23 A bob of mass M is suspended by a massless string of length L. The horizontal velocity v at position A is just sufficient to make it reach the point B. The angle θ at which the speed of the bob is half of that at A, satisfies **[IIT-2008]**



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

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

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

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

Notes

Q.24 **Two balls, having linear momenta $\vec{p}_1 = p\hat{i}$ and $\vec{p}_2 = P\hat{i}$, undergo a collision in free space. There is no external force acting on the balls. Let Let $\vec{p}_1$ and $\vec{p}_2$ be their final momenta. The following option (s) is (are) NOT ALLOWED for any non-zero value of p, a_1, a_2, b_1, b_2, c_1 and c_2** **[IIT-2008]**

(A) $\vec{p}'_1 = a_1\hat{i} + b_1\hat{j} + c_1\hat{k}$

$\vec{p}'_2 = a_2\hat{i} + b_2\hat{j}$

(B) $\vec{p}'_1 = c_1\hat{k}$

$\vec{p}'_2 = c_2\hat{k}$

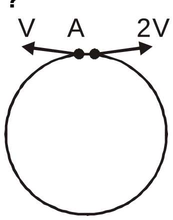
(C) $\vec{p}'_1 = a_1\hat{i} + b_1\hat{j} + c_1\hat{k}$

$\vec{p}'_2 = a_2\hat{i} + b_2\hat{j} - c_1\hat{k}$

(D) $\vec{p}'_1 = a_1\hat{i} + b_1\hat{j}$

$\vec{p}_2 = a_2\hat{i} + b_1\hat{j}$

Q.25 **Two small particles of equal masses start moving in opposite directions from a point A in a horizontal circular orbit. Their tangential velocities are v and 2v, respectively, as shown in the figure. Between collisions, the particles move with constant speeds. After making how many elastic collisions, other than that at A, these two particles will again reach the point A ?** **[IIT-2009]**



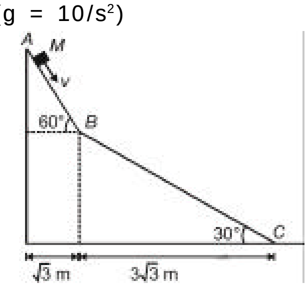
(A) 4
(B) 3
(C) 2
(D) 1

Q.26 **A point mass of 1 kg collides elastically with a stationary point mass of 5 kg. After their collision, the 1 kg mass reverses it direction and moves with a speed of 2 ms^{-1} Which of the following statements (s) is (are) correct for the system of these two masses ?** **[IIT-2010]**

(A) Total momentum of the system is 3 kg ms^{-1}
(B) Momentum of 5 kg mass after collision is 4 kg ms^{-1}
(C) Kinetic energy of the centre of mass is 0.75 J
(D) Total kinetic energy of the system is 4 J

PASSAGE

A small block of mass M moves on a frictionless surface of an inclined plane, as shown in figure. The angle of the incline suddenly changes from 60^0 to 30^0 at point B. The block is initially at rest at A. Assume that collisions between the block and the incline are totally inelastic ($g = 10/s^2$) **[IIT-2008]**



Notes

Q.27 The speed of the block at point B immediately after it strikes the second incline is

(A) $\sqrt{60}$ m/s

(B) $\sqrt{45}$ m/s

(C) $\sqrt{30}$ m/s

(D) $\sqrt{15}$ m/s

Q.28 The speed of the block at point C, immediately before it leaves the second incline is

(A) $\sqrt{120}$ M/s

(B) $\sqrt{105}$ m/s

(C) $\sqrt{90}$ m/s

(D) $\sqrt{75}$ m/s

Q.29 If collision between the blcok and the incline is completely elastic, then the vertical (upward) component of the velocity of the block at point B, immediately after it strikes the second incline is

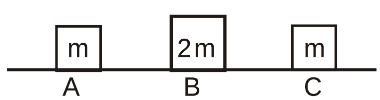
(A) $\sqrt{30}$ m/s

(B) $\sqrt{15}$ m/s

(C) 0

(D) $-\sqrt{15}$ m/s

Q.30 Three object A, B and C are kept in a straight line on a frinctionless horizontal surface. These have masses m, 2m and m, respectively. The object A moves towards B with a speed 9 m/s and makes an elastic collision with it. Thereafter, B makes completely inelastic collision with C. All motions occur on the same straight line. Find the final speed (in m/s) of the object C. [IIT-2009]



ANSWERKEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	D	B	A	C	A	C	B	C	B	A	D	C	C	A	A
Que.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	A	B	C	B	C	D	A,B,D	D	A,D	C	A,C	B	B	C	4