DYNAMICS

SYNOPSIS

LINEAR MOMENTUM

- Linear momentum is a measure of *quantity of motion* possessed by a moving body.
- Linear momentum is the product of the mass of a body and its velocity. $\overline{p} = m\ \overline{\text{v}}$, where *m* is the mass of the body and $\overline{\text{v}}$ is its velocity. This is a product involving a scalar(m) and a vector $(\overline{\text{v}})$.
- Linear momentum is a vector. It has the same direction as the direction of velocity of a body.
- Units of linear momentum: In SI, it is expressed in kg m s^{-1} or N s and in CGS it is expressed in gm cm s^{-1} or dyne second.
- Dimensional formula of linear momentum is $[M L T^{-1}]$
- Change in momentum is always calculated as *final momentum – initial momentum*. $\Delta\overline{\text{p}} = \overline{\text{v}}_f - \overline{\text{v}}_i$. As momentum is a vector, vector subtraction must be used in finding the change in momentum.
- A ball of mass '*m*' falls on to a floor striking it normally with a velocity 'u' and bounces again normal to the surface with a velocity 'v', then the change in momentum in magnitude is *m* (v + u) and is directed vertically upward.
- A ball of mass '*m*' strikes a surface normally with a velocity 'v' and bounces again normal to that surface with a velocity 'v', then the change in momentum is 2 mv directed away from the surface and normal to it.
- A ball of mass '*m*' strikes a wall with a velocity 'v' making an angle 'θ' with the **surface** and bounces with same speed 'v' at same angle θ with the surface, then the change in momentum is 2 mv sin θ and is directed away from the surface along the normal.
- A ball of mass '*m*' strikes a wall with a velocity 'v' making an angle 'θ' with the **normal to its surface** and bounces with same speed 'v' at same angle θ with the normal, then the change in momentum is 2 mv cos θ and is directed away from the surface along the normal.
- A particle of mass '*m*' is moving uniformly with a speed 'v' along a circular path of radius '*r*'. As it moves from a point A to another point B, such that the arc AB subtends an angle θ at the center, then the change in momentum is 2 mv sin(θ/2) and is directed towards the center of the circle.

NEWTON'S FIRST LAW OF MOTION

- When no unbalanced force acts on a body, it will be either at rest or moving along a straight line with uniform velocity.
- In the absence of unbalanced force or net force, the momentum of a body remains constant.
- Newton's first law gives definition of force and the concept of inertia.
- Newton's first law of motion is also known as the law of inertia.
- Newton's first law is known as the law of equilibrium, as it deals with equilibrium (*zero* acceleration).
- Inertia is a property of a body by virtue of which it maintains its state of rest or state of uniform motion along a straight line.
- The mass of an object is a measure of its inertia in translatory motion.
- Moment of inertia is a measure of the inertia of a rotating body.
- Types of inertia: There are three types of inertia. (i) Inertia of rest (ii) Inertia of motion and (iii) Inertia of direction.
- Inertia of rest: A body cannot change its state of rest by itself. This is called inertia of rest. Ex. When a bus is at rest and starts suddenly moving forward the passengers inside fall back.
- Inertia of motion: A body moving along a straight line cannot increase or decrease its velocity by itself. This is called inertia of motion. Ex. Passengers in a moving bus fall forward, when brakes are applied suddenly.
- Inertia of direction: The inability of a body to change its direction of motion by itself is called inertia of direction. Ex. When a bus takes a turn, passengers in it experience an outward force.
- A person sitting in a moving train, throws a coin vertically upward, then
  i) it falls behind him, if the train is accelerating
  ii) it falls in front of him, if the train is retarding
  iii) it falls into the hand of the person, if the train is moving with uniform velocity.
  iv) It falls into the hand of the person if the train is at rest

NEWTON'S SECOND LAW OF MOTION

- The rate of change of momentum of a body is directly proportional to the external force and the change in momentum takes place in the direction of the force.

- Newton's second law of motion leads to a formula useful for measuring force. $\bar{F} = m\,\bar{a}$.
- Force is a vector. It is always in the direction of change in momentum. Force is also always in the direction of acceleration.
- SI unit of force is *newton* (N). If a force acting on a mass of 1 kg produces in it an acceleration of 1 m s^{-2} in its direction, it is called a *newton*.
- CGS unit of force is dyne. If a force acting on a mass f 1 gm produces in it an acceleration of 1 cm s^{-2} in its direction, it is called a *dyne*.
- One *newton* = 10^5 *dyne*.
- Gravitational units of force: kilogram weight (kg.wt) and gram weight (gm.wt) are called the gravitational units of force. 1 kg.wt or kg. f = 9.8 N, 1 gm.wt of gm.f = 980 dyne.
- To calculate a force '*F*', there are several useful variants of the formula $\bar{F} = m\,\bar{a}$.
  - $F = \dfrac{m\text{v} - mu}{t}$
  - $F = m\dfrac{d\text{v}}{dt}$
  - $F = \text{v}\dfrac{dm}{dt}$

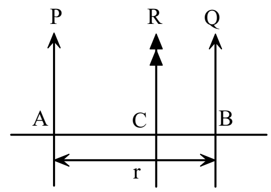
MASS AND WEIGHT

- Mass of a body is a base quantity and is not defined. However, it may be described as the quantity of matter contained by a body.
- Mass is a scalar quantity.
- SI unit of mass is *kilogram* and CGS unit of mass is *gram*. 1 *kilogram* = 10^3 *gram*.
- Mass of a body is the same at all places.
- Weight of a body is the force with which the earth attracts it. It is gravitational force acting on a body.
- Weight being a force is a vector always directed towards the center of Earth.
- SI unit of weight is *newton* (N) and CGS unit is *dyne*. Dimensional formula of weight is $[M\,L\,T^{-2}]$.
- Relation between mass and weight is $W = m\,g$.
- As the weight depends on the acceleration due to gravity, it changes from place to place. At equator bodies weigh less and at poles bodies weigh more.
- Weight of a body is zero (i) at the center of earth (ii) in gravity free space (iii) in an artificial satellite orbiting the earth.
- Mass of a body is measured by a common balance, while the weight of a body is measured with a spring balance.
- If a force '*F*' acts on a body and produces an acceleration '*a*', then the ratio '*F/a*' is called the inertial mass of the body.
- If '*W*' is the weight of a body at a place where '*g*' is the acceleration due to gravity, then the ratio '*W/g*' is called the gravitational mass of the body.

RESULTANT FORCE

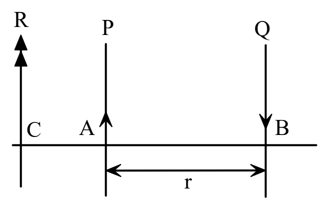
- When a number of forces act simultaneously on a body, they can be added vectorially to give a single force, which is called the resultant force.
- If two forces 'P' and 'Q' are acting on a body in the same direction, their resultant is given by R = P + Q. The direction of 'R' is same as that of either 'P' or 'Q'.
- If two forces 'P' and 'Q' are acting on a body in opposite directions, their resultant is given by R = P – Q. The direction of 'R' is same as that of 'P'. Here, it is assumed that 'P' has more magnitude than 'Q'.
- If two forces 'P' and 'Q' are acting on a body in different directions that are inclined to each other at an angle 'α', the resultant is calculated by parallelogram law.
  $R = \sqrt{P^2 + Q^2 + 2PQ\cos\alpha}$. If 'θ' is the angle between 'R' and 'P', then $\tan\theta = \dfrac{Q\sin\alpha}{P + Q\cos\alpha}$.
- If two forces each of magnitude 'F' are acting on a body in different directions that are inclined to each other at an angle 'α', the resultant is given by $R = 2F\cos\left(\dfrac{\alpha}{2}\right)$ and the direction is along the bisector of the angle between them.
- Resultant of concurrent forces: If several forces are acting at a point, they are called concurrent forces. Their resultant is obtained by the following methods.
  - Select two of the forces and find their resultant by parallelogram law of addition. Combine this resultant force with one of the remaining forces and repeat this procedure until all the forces are added.
  - Choose two perpendicular co-ordinate axes passing through the point where the forces are acting. Resolve each force in to X-component and Y-component. Add all the X-components (Σx). Similarly add all the Y-components (Σy). The resultant force is given by $R = \sqrt{(\Sigma x)^2 + (\Sigma y)^2}$. It makes an angle θ with the X-axis given by $\tan^{-1}(\Sigma y / \Sigma x)$

- **Resultant of parallel forces:**



Like parallel forces P and Q are acting at points A and B as shown. Their resultant 'R' is given by R = P + Q and its point of application C is located with the help of $AC = \frac{Qr}{P+Q}$ *and* $BC = \frac{Pr}{P+Q}$

- **Resultant of anti-parallel forces:**



Anti-parallel forces P and Q (P > Q) are acting at points A and B as shown. Their resultant 'R' is given by R = P – Q (P > Q) and its point of application C is located with the help of $AC = \frac{Qr}{P-Q}$ *and* $BC = \frac{Pr}{P-Q}$. Observe that C is outside of AB.

APPARENT WEIGHT IN A LIFT or ELEVATOR

- When a person of mass '*m*' is standing on the floor of a lift, the force exerted by the floor of the lift on the feet of the person is called the apparent weight. This may be different from the true weight(mg), if the lift has acceleration.
- The apparent weight when the lift has an upward uniform acceleration is given by $W' = m(g + a)$.
- The apparent weight when the lift has a downward uniform acceleration is given by $W' = m(g - a)$.
- The apparent weight becomes zero, if the lift is freely falling. i.e. moving down with an acceleration '*g*'.
- When a lift is moving up but slowing down, then the apparent weight of a person in the lift is *less than* his true weight.
- When a lift is moving down but slowing down, then the apparent weight of a person in the lift is *more than* his true weight.
- Concept of effective acceleration:
  - Inside a lift ascending with uniform acceleration '*a*', the effective acceleration of fall relative to an observer inside the lift is $(g + a)$ downwards.
  - Inside a lift descending with uniform acceleration 'a', the effective acceleration of fall relative to an observer inside the lift is $(g - a)$ downwards.
  - Inside a lift freely falling lift, the effective acceleration of fall relative to an observer inside the lift is zero.
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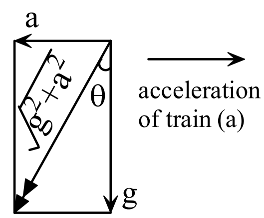


Inside a train moving horizontally with uniform acceleration 'a', the effective acceleration (relative to an observer inside the train) is $\sqrt{g^2 + a^2}$ in a direction making an angle of $\tan^{-1}$(a/g) with the *vertical.*

TENSION IN STRING SUPPORTING A BOB

- A bob of mass '*m*' is suspended by a string.
  - when the bob is stationary, the tension 'T' in the string is given by $T = mg$.
  - when the bob is pulled up with an acceleration '*a*', the tension 'T' in the string is given by $T = m(g + a)$.
  - when the bob is allowed to move down with an acceleration '*a*', the tension 'T' in the string is given by $T = m(g - a)$.
  - when the bob is pulled up or moving down with uniform velocity 'v', the tension 'T' in the string is given by $T = mg$.
  - when the bob is falling freely, the tension 'T' in the string becomes *zero*.
  - when the suspended bob is moving horizontally with an acceleration '*a*', the tension 'T' in the string is given by $T = m\sqrt{g^2 + a^2}$

IMPULSE AND IMPULSIVE FORCE

- Impulse is product of force and time for which the force acts. If force is constant, the impulse is $\bar{I} = t\,\bar{F}$. If the force is variable impulse is calculated by $\bar{I} = \int \bar{F}dt$. Area of the force-time graph against time axis also gives the magnitude of the impulse.
- If a force linearly changes from F_1 to F_2 in a time interval 't', the impulse '*I*' is given by $I = t\left(\frac{F_1 + F_2}{2}\right)$

- Impulse is a vector quantity and is always in the direction of the force.
- SI unit of impulse is N s or kg m s^{-1} and CGS unit of impulse is dyne second or gm cm s^{-1}.
- Dimensional formula of impulse is $[M L T^{-1}]$. This is same as the dimensional formula of linear momentum.
- Impulse is equal to the change in momentum. $\bar{I} = m\bar{v} - m\bar{u}$. This shows that the impulse is always in the direction of the change in momentum.
- For a given impulse or change in momentum the more the time, the less the force.
- In catching a cricket ball, a fielder withdraws the hands in the direction of motion of the ball, thereby he increases the time of contact and thus reduces the force acting on his hands.
- A force F_1 acts on a body at rest for a time t_1, and another force F_2 applied in opposite direction brings the body to rest in time t_2. Then the impulse in the two cases are equal in magnitude and so $F_1 t_1 = F_2 t_2$.
- A very large force acting for a very short interval of time is called an '*impulsive force*' or a '*shock force*'. Ex. Blow of a hammer, hitting a ball with a bat.
- Impulsive force or shock force has the dimensions of force $[M L T^{-2}]$ and is expressed in *newton* or *dyne*.
- Impulsive forces being very large forces may cause deformation of objects. To avoid this, shock absorbers which increase the time of action are used in vehicles to reduce the magnitude of impulsive force.

NEWTON'S THIRD LAW OF MOTION

- For every action force there will be an *equal and opposite* reaction force. However, the action force acts on one body and the reaction force acts on another body.
- Third law of motion reveals the symmetry of forces in nature. Forces are always produced in pairs as action forces and reaction forces.
- In the case of a falling apple, action force is weight of the apple *mg* vertically downward and reaction force is also *mg* acting at the center of earth in a direction opposite to the action force.
  Here, the two bodies namely apple and earth are not in contact. This is an example of action at a distance.
- In the case of a paper weight in equilibrium on a horizontal table top, the forces acting on it are $mg\downarrow$ and contact force $R\uparrow$. Though these are equal and opposite, they cannot be named as action and reaction forces, because they are acting on the same body. The reaction to $mg\downarrow$ acts at the centre of earth and is directed towards the paper weight. The reaction to $R\uparrow$ acts on the table top in the downward direction.
- Walking, running, swimming, jet propulsion, motion of rockets, rowing of a boat, recoil of a gun etc., can be explained by Newton's third law of motion.
- Newton's third law of motion leads to the law of conservation of linear momentum.
- When the resultant external force acting on a system is zero, the total momentum (vector sum) of the system remains constant. This is called the "law of conservation of linear momentum".
- Explosions, disintegration of nuclei, recoil of gun etc., can be explained on the basis of the law of conservation of linear momentum.
- When a shot is fired from a gun, while the shot moves forwards, the gun moves backwards. This motion of gun is called **recoil of the gun**. When a gun of mass 'M' fires a bullet of mass 'm' with a muzzle velocity 'v', the gun recoils with a velocity 'V' given by V = mv/M.
- When a shot is fired from a gun, the kinetic energies of the shot and gun are in the inverse ratio of their masses. $\frac{K.E. of\ the\ shot}{K.E. of\ the\ gun} = \frac{M}{m}$, where M is mass of the gun and m is mass of the shot.
- When a bullet of mass 'm' moving with a velocity 'v' gets embedded into a block of mass y at rest and free to move on a smooth horizontal surface, then their common velocity V = mv/ (M + m).
- A boy of mass 'm' walks a distance 's' on a boat of mass 'M' that is floating on water and initially at rest. If the boat is free to move, it moves back a distance = ms / (M + m).
- A shell of mass 'M' explodes into two fragments and one of mass 'm' moves out with a velocity 'v' the other piece of mass (M – m) moves in opposite direction with a velocity of mv/ (M – m).
- When a machine gun fires 'n' bullets each of mass 'm' with a velocity 'v' in a time interval 't' the force needed to hold the gun steady is F = mnv/t.

COLLISIONS

- When two bodies one of which at least is in motion strike against each other, a collision is said to take place.
- For a collision the two bodies involved need not '*touch*' each other. For example, in the collision of α-particle with a gold nucleus, the particles do not touch, still we can say a collision occurs, because a large electrostatic repulsive force, acts

for a short time, between the α-particle and the nucleus and the motion of the particles abruptly changes.

- If the velocities of the colliding bodies before and after the collision are confined to a straight line (usually the line joining the centers of the colliding bodies), it is called a head-on or one-dimensional collision.
- If the velocities of the colliding bodies before and after the collision are **NOT** confined to a straight line, it is called an oblique collision.
- During a collision, a relatively large force acts on each colliding particle or body for a relatively short time. Such forces are called impulsive forces and they abruptly change the motion of the colliding bodies.
- There are three types of collisions: (i) Elastic collisions, (ii) Inelastic collisions (iii) completely inelastic collisions.
- In all the three types of collisions, the law of conservation of energy is obeyed.
- In the case of *elastic* collisions, both linear momentum and kinetic energy are conserved. Ex. Molecular and atomic collisions and collisions between fundamental particles.
- In the case of *inelastic* collisions, only linear momentum is conserved. There will be a loss of kinetic energy which appears in the form of heat, sound etc.,. Ex. Collision between the striker and a coin in the caroms board.
- In the case of *completely inelastic* collisions, the two colliding bodies stick together and move with a common velocity. In these collisions, only momentum is conserved. The loss of kinetic energy is maximum. Ex. Collision between a bullet and its target is completely inelastic when the bullet remains embedded in the target.
- Completely inelastic collision (i): Two bodies of masses m_1 and m_2 are moving along the line joining their centres in the same direction with velocities u_1 and u_2 and collide ($u_1 > u_2$). After the collision, they coalesce and move together with a common velocity given by

$$v = \frac{m_1u_1 + m_2u_2}{m_1 + m_2}$$. This velocity will be in the same direction as the initial direction of motion of either body.

- Completely inelastic collision (ii): Two bodies of masses m_1 and m_2 are moving along the line joining their centres in opposite directions with velocities u_1 and u_2 and collide. After the collision, they coalesce and move together with a common velocity given by

$$v = \frac{m_1u_1 - m_2u_2}{m_1 + m_2}$$. This velocity will be in the same direction as the initial direction of motion of the first body.

- Elastic collision: Two bodies of masses m_1 and m_2 are moving along the line joining their centers in the same direction with velocities u_1 and u_2 and collide ($u_1 > u_2$). After the collision, which is elastic, they move with velocities v_1 and v_2 respectively. The velocities after collision are given by

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

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

- Elastic collision between two bodies of equal masses: Two bodies of masses '*m*' and '*m*' are moving along the line joining their centers in the same direction with velocities u_1 and u_2 and collide ($u_1 > u_2$). After the collision, which is elastic, they move with velocities v_1 and v_2 respectively. Then $v_1 = u_2$ and $v_2 = u_1$. Thus they exchange their velocities. This result holds good even if they travel in opposite directions before the collision.
- A body collides head-on with an identical body at rest. If the collision is elastic, the first body comes to rest while the second one which was at rest before collision begins to move after collision with the initial velocity of the first one.
- Elastic collision between a light body and a heavy body: (i) A light body of mass '*m*' moves directly towards a heavy body of mass '*M*' at rest, with a velocity '*u*'. If the collision is elastic, the velocities v_1 and v_2 of the two bodies after the collision are given by

$$v_1 = \left(\frac{m - M}{m + M}\right)u \cong -u$$ and

$$v_2 = \left(\frac{2m}{m + M}\right)u \cong 0$$

- Elastic collision between a heavy body and a light body: (ii) A heavy body of mass '*M*' moves directly towards a light body of mass '*m*' at rest, with a velocity '*u*'. If the collision is elastic, the velocities v_1 and v_2 of the two bodies after the collision are given by $$v_1 = \left(\frac{M - m}{M + m}\right)u \cong u$$

and $$v_2 = \left(\frac{2M}{M + m}\right)u \cong 2u$$

COEFFICIENT OF RESTITUTION

- Two bodies moving with velocities u_1 and u_2 along same line collide and after the collision they move with velocities v_1 and v_2. Then the ratio of relative velocity of separation after the collision $(v_2 - v_1)$ to the relative velocity of approach before collision $(u_1 - u_2)$ is known as coefficient of restitution, and is represented by the symbol 'e'. $e = \left(\frac{v_2 - v_1}{u_1 - u_2}\right)$ or $e = -\left(\frac{v_1 - v_2}{u_1 - u_2}\right)$
- If a body falls from a height 'h_1' on to a horizontal floor and bounces to a height 'h_2', then the coefficient of restitution $e = \sqrt{\frac{h_2}{h_1}}$.
- If a body strikes along the normal to a fixed surface with a velocity 'u' and bounces back with a velocity 'v', then the coefficient of restitution $e = \frac{v}{u}$.
- For elastic collisions, the coefficient of restitution $e = 1$. For completely inelastic collision $e = 0$. For inelastic collisions e lies between 0 and 1.
- Limits of coefficient of restitution: The coefficient of restitution 'e' lies in the closed interval [0, 1] i.e., $0 \le e \le 1$.
- Inelastic collision between two bodies of equal masses: A sphere of mass "m" moves with a velocity "u" directly towards an identical sphere at rest. The coefficient of restitution is "e", the velocity of the first sphere after the collision is $u(1 - e)/2$ and the velocity of the second sphere after the collision is $u(1 + e)/2$.
- A body of mass "m" moving with a velocity 'u', makes an inelastic one dimensional collision with another body of mass "nm" initially at rest. If '$e = 1/n$' be the coefficient of restitution, then the velocities after collision are *zero* and 'u/n' respectively.
- A small sphere falls from a height 'h' on to a fixed horizontal surface. If the coefficient of restitution is 'e', after 'n' collisions it bounces to a height $h_n = e^{2n}h$. After 'n' collisions it bounces with a velocity $v_n = v e^n$, here 'v' is the velocity with which the sphere strikes the surface in the first collision.
- Inelastic collision: Two bodies of masses m_1 and m_2 are moving along the line joining their centers in the same direction with velocities u_1 and u_2 and collide $(u_1 > u_2)$. After the collision, which is inelastic with a coefficient of restitution 'e', they move with velocities v_1 and v_2 respectively.

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

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

EXPLOSIONS AND DISINTEGRATIONS

- When a body breaks up suddenly in to two or more fragments, it is called an explosion. On the other hand, if a nucleus breaks up suddenly in to two or more fragments it is called a disintegration. Both explosion and disintegration obey the law of conservation of momentum.
- When a stationary shell breaks up into two identical fragments, they move in opposite directions with equal speeds. The kinetic energy of the fragments is derived from the internal energy (chemical energy) of the shell.
- When a stationary shell breaks up into two fragments of unequal masses, they move in opposite directions with speeds in the inverse ratio of their masses. If m_1 and m_2 are the masses of the fragments, and v_1 and v_2 are the speeds, then $m_1v_1 = m_2v_2$.
- When a stationary shell explodes into three fragments, then the vector sum of the momentums of two fragments must be equal and opposite to the momentum of the third fragment. If $\bar{p}_1$, $\bar{p}_2$ and $\bar{p}_3$ are the momentums of the three fragments, according to the law of conservation of linear momenta, $\bar{p}_1 + \bar{p}_2 + \bar{p}_3 = 0$. This leads to the result $\bar{p}_1 + \bar{p}_2 = -\bar{p}_3$

BALLISTIC PENDULUM

- A wooden block of mass 'M' is suspended by a string of length 'l', from a fixed support. When the block is at rest in the lowest position, a bullet of mass 'm' is fired horizontally with a velocity 'u' into the block. The bullet gets embedded in the block. The common velocity of the bullet and block system just after the impact $v = \frac{mu}{M+m}$. The block with embedded bullet rises to a height 'h' given by $h = \frac{v^2}{2g}$. The ballistic pendulum is used to determine the speeds of bullets.

CONCEPTUAL QUESTIONS

1. The quantity of motion of a body is best represented by
1) its mass 2) its speed
3) its velocity 4) its linear momentum

2. A certain particle undergoes erratic motion. At every point in its motion, the direction of the particle's momentum is ALWAYS
1) the same as the direction of its velocity
2) the same as the direction of its acceleration
3) the same as the direction of its net force
4) the same as the direction of its kinetic energy vector

3. The behavior of a body under zero resultant force is given by
1) Newton's third law of motion
2) Newton's second law of motion
3) Newton's first law of motion
4) Newton's law of gravitation

4. Which law of Newton is called the law of equilibrium?
1) Newton's first law of motion
2) Newton's second law of motion
3) Newton's third law of motion
4) Newton's law of gravitation

5. Which law of Newton defines an 'inertial frame of reference'?
1) First law of motion
2) Second law of motion
3) Third law of motion
4) Law of gravitation

6. The statement "acceleration is *zero* if and only if the net force is *zero*" is valid in
1) non-inertial frames 2) inertial frames
3) both in an inertial frames and non-inertial frames
4) neither inertial frames nor non-inertial frames

7. A packing crate slides down an inclined ramp at constant velocity. Thus we can deduce that
1) a frictional force is acting on it
2) a net force is acting on it
3) it may be accelerating
4) gravity is not acting on it

8. You lunge forward when your car suddenly comes to a halt and you are thrown backward when your car rapidly accelerates. Which law of Newton in involved in these?
1) third law 2) second law
3) first law 4) law of gravitation

9. You are thrown outer side when your car suddenly takes a turn. Which law of Newton is involved in this?
1) third law 2) second law
3) first law 4) law of gravitation

10. An object is thrown vertically upward with a non-zero velocity. If gravity is turned off at the instant the object reaches the maximum height, what happens?
1) the object continues to move in a straight line
2) the object will be at rest
3) the object falls back with uniform velocity
4) the object falls back with uniform acceleration

11. An object is thrown at an angle to the horizontal with a non-zero velocity. If gravity is turned off at the instant the object reaches the maximum height, what happens?
1) the object continues to move in a straight line
2) the object will be at rest
3) the object falls back with uniform velocity
4) the object falls back with uniform acceleration

12. Which of the following is the most significant law of motion given by Newton?
1) First law of motion 2) Second law of motion
3) Third law of motion 4) Zeroth law of motion

13. Which of the following forces is called a conservative force?
1) frictional 2) air resistance
3) electrostatic 4) viscous

14. Identify the non-conservative force in the following
1) weight of a body 2) force between two ions
3) magnetic force 4) air resistance

15. When the force acting on a body is conservative, the work done by the force for a complete closed cycle
1) depends on the path followed
2) does not depend on the path followed
3) is negative 4) is positive

16. A student of mass 60 kg stands on bathroom scales with his hands by his sides. He has heavy dumb bell in each hand. If the student quickly rises the dumb bells above his head level, the reading in the bathroom scales
1) momentarily decreases
2) momentarily increases 3) remains constant
4) cannot be decided without additional data

17. If a car is traveling eastward and slowing down, what is the direction of the net force on the car that causes it to slow down?
1) eastward 2) westward
3) vertically down ward 4) vertically up ward

18. While we catch a cricket ball, we catch it at the front and make the hands move with the ball backwards. Why is that?
1) to reduce the impulse
2) to increase the time of contact, there by increase the force
3) to increase the impulse
4) to increase the time of contact, there by decrease the force

19. Inside a railway car a plumb bob is suspended from the roof and a helium filled balloon is tied by a string to the floor of the car. When the railway car accelerates to the right, then
1) both the plumb bob and balloon move to the left
2) both the plumb bob and balloon move to the right
3) plumb bob moves to the left and the balloon moves to the right
4) plumb bob moves to the right and the balloon moves to the left

20. It is easier to draw up a wooden block along an inclined plane than to lift it vertically, mainly because
1) the friction is reduced
2) the mass becomes smaller
3) only part of the weight has to be overcome
4) 'g' becomes smaller

21. The change in momentum per unit time of a body represents
1) impulse 2) force
3) kinetic energy 4) resultant force

22. A lift is going up with uniform velocity. When brakes are applied, it slows down. A person in that lift, experiences
1) more weight 2) less weight
3) normal weight 4) zero weight

23. If action force acting on a body is gravitational in nature, the reaction force
1) may be a contact force
2) must be gravitational too
3) may be a gravitational or contact force
4) may be a force of any origin

24. Action and reaction can never balance out because
1) they are equal but not opposite always
2) they are unequal in magnitude even though opposite in direction
3) though they are equal in magnitude and opposite in direction they act on different bodies
4) they are unequal in magnitudes

25. The propulsion of a rocket is based on the principle of conservation of
1) linear momentum 2) energy
3) angular momentum 4) mass

26. An automobile that is towing a trailer is accelerating on a level road. The force that the automobile exerts on the trailer is
1) equal to the force the trailer exerts on the automobile
2) greater than the force the trailer exerts on the automobile
3) equal to the force the trailer exerts on the road
4) equal to the force the road exerts on the trailer

27. A man is stranded in the middle of a perfectly smooth 'island of ice' where there is no friction between the ground and his feet. Under these circumstances
1) he can reach the desired corner by throwing any object in the same direction
2) he can reach the desired corner by throwing any object in the opposite direction
3) he has no chance of reaching any corner of the island
4) he can reach the desired corner by pursuing on the ground in that direction

28. A balloon is floating in mid air with a long rope ladder hanging from it with a man standing on the bottom most rung of the ladder. If the man starts ascending the ladder, then the balloon
1) remains stationary 2) starts moving up
3) starts moving down 4) starts moving horizontally

29. Which law of Newton reveals the underlying symmetry in the forces that occur in nature?
1) first law 2) second law
3) third law 4) law of gravitation

30. A father and his seven year old son are facing each other on ice skates. With their hands, they push off against one another. Regarding the forces that act on them as a result of this and the accelerations they experience, which of the following is correct?
1) father exerts more force on the son and experiences less acceleration
2) son exerts less force on the father and experiences more acceleration
3) father exerts as much force on the son as the son exerts on the father, but the father experiences less acceleration
4) father exerts as much force on the son as the son exerts on the father, but the father experiences more acceleration

31. A student initially at rest on a frictionless frozen pond throws a 2 kg hammer in one direction. After the throw, the hammer moves off in one direction while the student moves off in the other direction. Which of the following correctly describes the above situation?
1) the hammer will have the momentum with greater magnitude
2) the student will have the momentum with greater magnitude
3) the hammer will have the greater kinetic energy
4) the student will have the greater kinetic energy

32. You hold a rubber ball in your hand. The Newton's third law companion force to the force of gravity on the ball is the force exerted by the
1) ball on the earth 2) ball on the hand
3) hand on the ball 4) earth on the ball

33. A ball falls towards the earth. Which of the following is correct?
1) if the system contains ball, the momentum is conserved
2) if the system contains earth, the momentum is conserved
3) if the system contains the ball and the earth, the momentum is conserved
4) if the system contains the ball and the earth and the sun, the momentum is conserved

34. If cannon balls are fired from a ship in the direction of its motion, then its speed
1) remains same 2) increases
3) decreases 4) none

35. Which of the following is used to determine the speed of bullet fired from a gun?
1) inertial pendulum 2) compound pendulum
3) ballistic pendulum 4) torsional pendulum

36. Which of the following cannot be the value of coefficient of restitution
1) 0 2) 1 3) ½ 4) – ½

37. Two bodies A and B of masses M_1 and M_2 and velocities V_1 and V_2 respectively moving towards each other suffer a head on collision and stick together. The combined body after the collision will move in the direction of the
1) mass possessing lower momentum
2) the mass possessing higher momentum
3) heavier mass
4) lighter mass

38. A shell is fired from a cannon and it explodes in mid air, then which of the following is true regarding its total momentum 'p' and kinetic energy 'K'
1) p increases, K remains constant
2) p remains constant, K increases
3) p remains constant, K decreases
4) p decreases, K increases

39. When a ball collides head-on elastically with an identical ball at rest on a smooth horizontal surface, the first one comes to rest while the second one moves with the same velocity as the original velocity of the first ball. This result is in accordance with
1) the law of conservation of momentum
2) the law of conservation of kinetic energy
3) the law of conservation of momentum and the law of conservation of kinetic energy
4) the law of conservation of momentum but not the law of conservation of kinetic energy

40. A ball falls freely from a certain height on to a hard horizontal floor and is found to bounce to a height less than the initial height from which it has fallen. Which of the following is correct in the case of this collision?
1) the total mechanical energy of the ball and earth remains constant
2) the momentum of the ball before the collision is the same as that after the collision
3) the total momentum of the ball and the earth remains constant
4) the kinetic energy of the ball before the collision is the same as that after the collision

41. Ball A moves with a velocity u_1 towards ball B moving in the same direction with a velocity u_2 and makes a head on elastic collision. Choose the correct statement from the following?
1) the impulse of A is always negative and that of B is positive
2) the impulse of A is always positive and that of B is negative
3) the impulses of A and B may both be positive
4) the impulses of A and B may both be negative

KEY

1) 4	2) 1	3) 3	4) 1	5) 1	6) 2
7) 1	8) 3	9) 3	10) 2	11) 1	12) 2
13) 3	14) 4	15) 2	16) 2	17) 2	18) 4
19) 3	20) 3	21) 4	22) 2	23) 2	24) 3
25) 1	26) 1	27) 2	28) 3	29) 3	30) 3
31) 3	32) 1	33) 3	34) 3	35) 3	36) 4
37) 2	38) 2	39) 3	40) 3	41) 1	

LEVEL-I

1. A ball of mass 'm' moves normal to a wall with a velocity 'u' and rebounds with the same speed. The change in momentum of the ball during the rebounding is
1) $2mu$ towards the wall
2) $2mu$ away from the wall
3) $zero$
4) mu away from the wall

2. A ball of mass 'm' moves normal to a wall with a velocity 'u' and rebounds with a velocity 'v'. The change in momentum of the ball during the rebounding is
1) $m(u+v)$ towards the wall
2) $m(u-v)$ towards the wall
3) $m(u+v)$ away from the wall
4) $m(u-v)$ away from the wall

3. A ball of mass 'm' is projected from the ground with a speed 'u' at an angle 'α' with the horizontal. The magnitude of the change in momentum of the ball over a time interval from beginning till it strikes the ground again is

1) $\frac{mu\sin\alpha}{2}$ 2) $2mu\cos\alpha$

3) $\frac{mu\cos\alpha}{2}$ 4) $2mu\sin\alpha$

4. Three particles each of mass 'm' are at the corners of an equilateral triangle. If they are all moving towards the centroid of the triangle with equal velocities each 'v', the magnitude of the total momentum of the system of particles is
1) 3mv 2) 2mv 3) mv 4) zero

5. A 2 kg box sits on a 3 kg box which sits on a 5 kg box. The 5 kg box rests on a table top. What is the normal force exerted by the 5 kg box on the 3 kg box?
1) 19.6 N 2) 29.4 N 3) 49 N 4) 98 N

6. A parachutist along with the parachute has a mass of 75 kg. He jumps from a large height and is coming down with a uniform velocity with parachute fully opened. The force due to the air resistance is (take $g = 10$ m/s^2)
1) *zero* 2) < 750 N
3) > 750 N 4) = 750 N

7. Four rectangular blocks A, B, C and D have masses 2 kg, 3 kg, 5 kg and 10 kg respectively. They are placed on a horizontal surface on over the other with A at the top and D at the bottom in an order. The normal reaction force between C and D is (take $g = 10$ m s^{-2})
1) 100 N 2) 50 N 3) 150 N 4) 200 N

8. A 500-gm ball moving at 15 m/s slows down uniformly until it stops. If the ball travels 15 meters, what was the average net force applied while it was coming to a stop?
1) 0.375 N 2) 3.75 N 3) 37.5 N 4) 6.25 N

9. An object near the surface of the earth with a weight of 50 N is accelerated vertically upward at 4 m/s^2 with a rope of negligible weight tied to it. What is the force exerted by the rope on the object?
1) 30 N 2) 20 N 3) 70 N 4) 250 N

10. 'P' and 'Q' horizontally push in the same direction on a 1200 kg crate. 'P' pushes with a force of 500 newton and 'Q' pushes with a force of 300 newton. If a frictional force provides 200 newton of resistance, what is the acceleration of the crate?
1) 1.3 m/s^2 2) 1.0 m/s^2
3) 0.75 m/s^2 4) 0.5 m/s^2

11. If a net force F is applied to an object of mass m will produce an acceleration of a, what is the mass of a second object which accelerates at $5a$ when acted upon by a net force of $2F$?
1) $2m/5$ 2) $2m$ 3) $5m/2$ 4) $5m$

12. A 5000 kg rocket is set for vertical firing. The exhaust speed is 800 m s^{-1}. To give an upward acceleration of 20 m s^{-2}, the amount of gas ejected per second to supply the needed thrust is ($g = 10$ m s^{-2})
1) 127. 5 kg s^{-1} 2) 137. 5 kg s^{-1}
3) 187.5 kg s^{-1} 4) 185.5 kg s^{-1}

13. A ball of mass m is thrown vertically upward. Air resistance is not negligible. Assume the force of air resistance has magnitude proportional to the velocity, and direction opposite to the velocity's direction. At the highest point, the ball's acceleration is (g = acceleration due to gravity)
1) *zero* 2) less than g
3) equal to g 4) greater than g

14. Three forces $\overline{F_1}$, $\overline{F_2}$ and $\overline{F_3}$ are simultaneously acting on a particle of mass 'm' and keep it in equilibrium. If $\overline{F_1}$ force were reversed in direction only, the acceleration of the particle will be
1) $\overline{F_1}/m$ 2) $2\overline{F_1}/m$ 3) $-\overline{F_1}/m$ 4) $-2\overline{F_1}/m$

15. A body of mass 2 kg is moving with a velocity of $3\hat{i}+4\hat{j}\ m/s$. A steady force $\overline{F}=\hat{i}-2\hat{j}\ N$ begins to act on it. After four seconds, the body will be moving along
1) X-axis with a velocity of 2 m/s
2) Y-axis with a velocity of 5 m/s
3) X-axis with a velocity of 5 m/s
4) Y-axis with a velocity of 2 m/s

16. A block weighing 30 N is on a smooth horizontal surface and it is accelerated in the horizontal direction at the rate of 4 m/s^2 by a force. The net force acting on the block is ($g = 10$ m/s^2)
1) 12 N 2) 120 N 3) 50 N 4) 10 N

17. A stone is released from the roof of an elevator going up with an acceleration of 5 m s^{-2}. The acceleration of the stone after the release is:
1) 5 m s^{-2} downwards 2) 4.8 m s^{-2} upward
3) 4.8 m s^{-2} downward 4) 9.8 ms^{-2} downward

18. A man weighing 65 kgf is in a lift that is ascending with a uniform acceleration that is equal to the acceleration due to gravity. His apparent weight in the lift will be
1) zero 2) 65 kgf 3) 32.5 kgf 4) 130 kgf

19. A person of mass 60 kg is in a lift. The change in the apparent weight of the person, when the lift moves up with an acceleration of 2 m s^{-2} and then down with an acceleration of 2 m s^{-2}, is
1) 120 N 2) 240 N
3) 480 N 4) 720 N

20. A 5 kg block and a 10 kg block slide down a frictionless incline and
1) they both have the same acceleration
2) the 5 kg block has an acceleration of twice that of the 10 kg block
3) the 10 kg block has an acceleration of twice that of the 5 kg block
4) their acceleration depends on the normal force

21. A 6.0-kg object is suspended by a vertical string from the ceiling of an elevator which is accelerating upward at a rate of 1.8 m/s^2. The tension in the string is
1) 11 N 2) 70 N 3) 48 N 4) 59 N

22. A ball reaches a racket at 60 m/s along +X direction, and leaves the racket in the opposite direction with the same speed. Assuming that the mass of the ball as 50 gm and the contact time is 0.02 second, the force exerted by the racket on the ball is
1) 300 N along +X direction
2) 300 N along -X direction
3) 3,00,000 N along +X direction
4) 3,00,000 N along -X direction

23. Two skaters on a frictionless frozen pond push apart from one another. One skater has a mass *M* much greater than the mass *m* of the second skater. After some time the two skaters are a distance *d* apart. How far has the lighter skater moved from her original position?
1) dm/M 2) dm/(M+m)
3) dM/m 4) dM/(M+m)

24. The momentum of a particle is trebled on receiving an impulse. The impulse received must have been equal to
1) the initial momentum of the particle
2) four times of the initial momentum of the particle
3) twice of the initial momentum of the particle
4) three times the initial momentum of the particle

25. A ball of mass 'm' is thrown at an angle of 'θ' with the horizontal with an initial velocity 'u'. The change in its momentum during its flight in a time interval of 't' is
1) mgt 2) mgt cos θ
3) mgt sin θ 4) ½ mgt

26. A body is acted on by a force given by $F = (10 + 2t)$ N. The impulse received by the body during the first four seconds is
1) 40 N s 2) 56 N s 3) 72 N s 4) 32 N s

27. A small sphere of mass $m = 2$ kg moving with a velocity $\overline{u} = 4\hat{i} - 7\hat{j}\ m/s$ collides with a smooth wall and returns with a velocity $\overline{v} = \hat{i} - 3\hat{j}\ m/s$. The magnitude of the impulse received by the ball is
1) 5 kg m s^{-1} 2) 10 kg m s^{-1}
3) 20 kg m s^{-1} 4) 15 kg m s^{-1}

28. Two identical balls A and B each of mass "m" are moving toward each other at equal speed each "v". Ball A initially is moving along the x-positive direction while ball B is moving along x-negative direction. If the collision is perfectly elastic, the impulse received by the ball B is
1) - mv 2) - 2mv 3) mv 4) 2mv

29. A man and a cart move towards each other. The man weighs 64 kg and the cart 32 kg. The velocity of the man is 5.4 km/hr and that of the cart is 1.8 km/hr. When the man approaches the cart, he jumps on to it. The velocity of the cart carrying the man will be
1) 3 km/hr 2) 30 km/hr 3) 1.8 km/hr 4) zero

30. A bullet of mass 20 gm is fired from a riffle of mass 8 kg with a velocity of 100 m/s. The velocity of recoil of the riffle is
1) 0.25 m/s 2) 25 m/s 3) 2.5 m/s 4) 250 m/s

31. A 350 kg boat is 6 m long and is floating without motion on still water. A boy of mass 50 kg is at one end. The boy walks to the other end of the boat and stops. The distance in meters moved by the boat is
1) 0 2) 0.75 3) 1.33 4) 0.85

32. A ball falls from a height of 640 cm on to a horizontal floor. The coefficient of restitution is 1/2. After 4^{th} bounce it rises to a height of
1) 80 cm 2) 160 cm 3) 320 cm 4) 2.5 cm

33. A space craft of mass 2000 kg moving with a velocity of 600 m/s suddenly explodes into two pieces. One piece of mass 500 kg is left stationary. The velocity of the other part must be
1) 600 m/s 2) 800 m/s
3) 1500 m/s 4) 1000 m/s

34. The coefficient of restitution of a ball falling from a certain height onto a horizontal floor is ½. The percent of initially energy lost during the impact will be
1) 50 % 2) 25 % 3) 75 % 4) 12.5 %

35. A ball falling from a certain height and bouncing off a horizontal floor is found to lose 50 % of its initial energy during the impact. The coefficient of restitution is
1) 1/4 2) 1/2 3) 3/4 4) $1/\sqrt{2}$

36. A person weighing 60 kg in a small boat of mass 140 kg that is at rest, throws a 5 kg stone in the horizontal direction with a velocity of 14 m s^{-1}. The velocity of the boat immediately after the throw is
1) 1.2 m s^{-1} 2) 0.5 m s^{-1}
3) 0.35 m s^{-1} 4) 0.65 m s^{-1}

37. A 3 kg ball moving with a velocity of 10 m/s strikes head on with a second ball initially at rest. After the collision the 3 kg ball continues to move in the same direction with a velocity of 5 m/s. If the collision is assumed to be perfectly elastic, the mass of the second ball is
1) 1 kg 2) 2 kg 3) ½ kg 4) 4 kg

38. A ball of mass 2 kg moving with a speed of 6 m/s collides head on with another ball of mass 4 kg at rest. After collision the lighter ball is found to come to rest. The percentage loss of kinetic energy during the collision is
1) 100 % 2) 25 % 3) 50 % 4) 0 %

39. A bomb of mass 6 kg initially at rest explodes in to three identical fragments. One of the fragments moves with a velocity of $10\sqrt{3}\ \hat{i}$ m/s, another fragment moves with a velocity of $10\ \hat{j}$ m/s, then the third fragment moves with a velocity of magnitude
1) 30 m/s 2) 20 m/s 3) 15 m/s 4) 5 m/s

40. A particle of mass "m" makes elastic and one dimensional collision with a stationary particle of mass "2m". What fraction of the kinetic energy of the lighter particle is carried away by the other?
1) 4/9 2) ½ 3) 8/9 4) 1/3

41. A nucleus of mass number "A" initially at rest is hit directly by an α-particle with a velocity "v". Assuming that the collision is elastic, the velocity of the nucleus after the collision is
1) $\frac{4v}{A+4}$ 2) $\frac{8v}{A-4}$ 3) $\frac{4v}{A-4}$ 4) $\frac{8v}{A+4}$

42. A wooden plank of mass *M* and length *L* is resting on a smooth horizontal floor. A boy of mass *m* starts moving from one end of the plank to the other end with a uniform velocity 'v' relative to the plank. The recoil velocity of the plank is
1) $\frac{m\text{v}}{M}$ 2) $\frac{M\text{v}}{m}$ 3) $\frac{M\text{v}}{M+m}$ 4) $\frac{m\text{v}}{M+m}$

43. Two perfectly elastic spheres of masses 2 kg and 3 kg moving along X-axis, with velocities 8 m s^{-1} and - 6 m s^{-1} respectively collide head-on with each other. Their velocities after the collision are
1) - 1.6 m s^{-1}, 0.4 m s^{-1} 2) 1.6 m s^{-1}, - 0.4 m s^{-1}
3) 8.8 m s^{-1}, - 5.2 m s^{-1} 4) - 8.8 m s^{-1}, 5.2 m s^{-1}

KEY

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

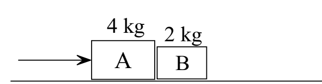
LEVEL - II

1. A ball of mass '*m*' moves towards a wall with a velocity '*u*', the direction of motion making an angle θ with the surface of the wall and rebounds with the same speed. The change in momentum of the ball during the collision is
1) $2mu\sin\theta$ towards the wall
2) $2mu\sin\theta$ away from the wall
3) $2mu\cos\theta$ towards the wall
4) $2mu\cos\theta$ away from the wall

2. The linear momentum of a ½ kg body initially starting from rest is given by p = 5t kg m/s. Here 't' is time. Then it can be concluded that the body is moving with
1) uniform velocity 2) uniform acceleration
3) increasing acceleration
4) decreasing acceleration

3. A man of 60 kg is standing on the floor of a room. A light rope is rigidly fixed to the floor and is held vertically by the man who starts pulling the rope upwards with a force of 200 N, the reaction force on the feet of the man will be (Take g = 10 m/s²)
1) 400 N 2) 600 N 3) 200 N 4) 800 N

4. A horizontal force F pushes on a 4 kg block (A) which pushes against a 2 kg block (B) as shown. The blocks have an acceleration of 3 m/s² to the right. There is no friction between the blocks and the surfaces on which they slide. What is the net force B exerts on A?



1) 6 N to the right 2) 12 N to the right
3) 6 N to the left 4) 12 N to the left

5. The same horizontal force acts on two blocks of masses 4 kg and 2 kg resting on a smooth horizontal surface. The ratio of the times taken by them to cover equal distances is
1) 2 : 1 2) 1 : 2 3) 1 : $\sqrt{2}$ 4) $\sqrt{2}$: 1

6. What is the magnitude of the total force on a driver by the racing car he operates as it accelerates horizontally along a straight line from rest to 60 m/s in 8.0 s? (mass of driver = 80 kg)
1) 0.60 kN 2) 0.78 kN
3) 1.4 kN 4) 1.0 kN

7. A car of mass 'm' and a loaded lorry of mass 'M' are moving with same velocity. If same brake force is applied on them, the ratio of the times taken by them before coming to rest is

1) 1:1 2) m : M 3) M : m 4) $\sqrt{M} : \sqrt{m}$

8. A horizontal force of "F" produces an acceleration of 6 m/s² on a block resting on a smooth horizontal surface. The same force produces an acceleration of 3 m/s² on a second block resting on a smooth horizontal surface. If the two blocks are tied together and the same force acts, the acceleration produced will be

1) 9 m/s² 2) 2 m/s² 3) 4 m/s² 4) ½ m/s²

9. A small rectangular block starts from rest and slides down a smooth inclined plane. Its displacement 's' in meters as a function of time 't' in seconds is given by: $s = 2.5 \times t^2$. If acceleration due to gravity is 10 m/s², the angle made by the inclined plane with the horizontal is

1) 37° 2) 53° 3) 30° 4) 60°

10. A constant force acts on a body of mass m_1 at rest and produces a velocity 'v' over a displacement 's_1'. The same force acts on another body of mass m_2 at rest and produces the same velocity 'v' over a displacement 's_2'. The ratio of the displacements $s_1 : s_2$ is

1) $m_1 : m_2$ 2) $m_2 : m_2$
3) $\sqrt{m_1} : \sqrt{m_2}$ 4) $\sqrt{m_2} : \sqrt{m_1}$

11. Two masses (M+m) and (M–m) are attached to the ends of a light inextensible string and the string is made to pass over the surface of a smooth fixed pulley. When the masses are released from rest, the acceleration of the system is

1) gm/M 2) 2gM/m
3) gm/2M 4) $g(M^2-m^2)/2M$

12. A boy is holding a light rope hung from the roof and is in equilibrium. Now the tension in the rope is found to be 500 N. If the same boy were climbing with the help of the same rope with an upward acceleration of 2 m/s², the tension in the rope now will be (take g = 10 m/s²)

1) 400 N 2) 100 N 3) 500 N 4) 600 N

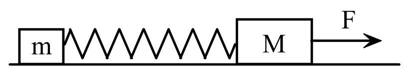
13. A ball reaches a racket at 60 m/s along +X direction, and leaves the racket in the opposite direction with the same speed. Assume that the mass of the ball is 50 gm and the contact time is 0.02 second. With the force exerted by the racket on the ball, which of the following can be done?

1) we can lift a load of 300 kg off the ground
2) we can lift a 30 kg child off the ground
3) we can lift a 3 kg stone off the ground
4) we can lift a 300 tonnes truck off the ground

14. The displacement of a body moving along a straight line is given by: $s = b\,t^n$, where 'b' is a constant and 't' is time. For what value of 'n', the body moves under the action of a constant force?

1) 3/2 2) 1 3) 2 4) ½

15. Two blocks of masses *m* and *M* are placed on a horizontal frictionless table connected by a light spring as shown in the figure. Mass *M* is pulled to the right with a force *F*. If the acceleration of mass *m* is *a*, the acceleration of mass *M* will be



1) $\frac{(F-ma)}{M}$ 2) $\frac{(F+ma)}{M}$ 3) $\frac{F}{M}$ 4) $\frac{am}{M}$

16. A pendulum bob is hanging from the roof of an elevator with the help of a light string. When the elevator moves up with uniform acceleration 'a', the tension in the string is T_1. When the elevator moves down with the same acceleration, the tension in the string is T_2. If the elevator were stationary, the tension in the string would be

1) $\frac{T_1+T_2}{2}$ 2) $\sqrt{T_1 T_2}$ 3) $\frac{T_1 T_2}{T_1+T_2}$ 4) $\frac{2T_1 T_2}{T_1+T_2}$

17. A hot air balloon of mass 'M' is rising with a uniform acceleration 'a'. On removing a mass 'm' (m < M) the acceleration of the balloon is doubled. Assuming that the buoyancy force is not affected by the removal of the mass, the value of 'm' is (g = acceleration due to gravity)

1) $\frac{Ma}{g+a}$ 2) $\frac{Ma}{2g+a}$ 3) $\frac{Ma}{g+2a}$ 4) $\frac{2Ma}{g+a}$

18. A baseball of mass 150 gm travelling at 20 m/s is caught by a fielder and brought to rest in 0.04 s. The force applied to the ball and the distance over which this force acts are respectively

1) 75 N, 0.8 m 2) 37.5 N, 0.4 m
3) 75 N, 0.4 m 4) 37.5 N, 0.8 m

19. An impulse "I" given to a body changes its velocity from "v_1" to "v_2". The increase in the kinetic energy of the body is given by

1) $I(v_1 + v_2)$ 2) $I(v_1 + v_2)/2$
3) $I(v_1 - v_2)$ 4) $I(v_1 - v_2)/2$

20. A simple pendulum bob has a mass "m" and length "L". The bob is drawn aside such that the string now makes an angle of 60° with the vertical and then it is released. The tension in the string while it crosses the equilibrium position will be

1) mg 2) 2 mg 3) 3 mg 4) 6 mg

21. If the average velocity of a body moving with uniform acceleration under the action of a force is "v" and the impulse it receives during a displacement of "s" is "I", the constant force acting on the body is given by

1) $\frac{I \times v}{2\ s}$ 2) $\frac{2\ I \times v}{s}$

3) $\frac{I \times v}{s}$ 4) $\frac{I \times s}{v}$

22. A ball of mass 0.2 *kg* strikes an obstacle and moves at 60° to its original direction. If its speed also changes from 20 *m/s* to 10 *m/s*, the magnitude of the impulse received by the ball is

1) $2\sqrt{7}$ *N s* 2) $2\sqrt{3}$ *N s*
3) $2\sqrt{5}$ *N s* 4) $3\sqrt{2}$ *N s*

23. A force $\bar{F} = 2\hat{i} + 3\hat{j} - 4\hat{k}\ N$ acts on a particle which is constrained to move in the XOY plane along the line x = y. If the particle moves $5\sqrt{2}\ m$, the work done by the force in joules is

1) $25\sqrt{2}$ 2) $5\sqrt{58}$ 3) 25 4) 10

24. A straight rope of length 'L' is kept on a frictionless horizontal surface and a force 'F' is applied to one end of the rope in the direction of its length and away from that end. The tension in the rope at a distance 'l' from that end is

1) $\frac{lF}{L}$ 2) $\frac{LF}{l}$ 3) $F\left(1-\frac{l}{L}\right)$ 4) $F\left(1+\frac{l}{L}\right)$

25. A small sphere of mass 'm' made of a material of density 'd' falls from a height 'h' on to the free surface of a liquid of density '3d' in a large tank. If 'g' is the acceleration due to gravity, the maximum depth the sphere reaches in the liquid is (neglect viscous forces)

1) 2h 2) h 3) h/2 4) h/4

26. Six forces lying in a plane and forming angles of 60° relative to one another are applied to the center of a homogenous sphere with a mass *m* = 6 kg. These forces are radially outward and consecutively 1 N, 2 N, 3 N, 4 N, 5 N and 6 N. The acceleration of the sphere is

1) *zero* 2) ½ m/s^2 3) 1 m/s^2 4) 2 m/s^2

27. A particle of mass *m* is at the center of a regular hexagon and is acted on by six forces each of magnitude *F* directed towards the vertices of the hexagon. If one of the forces is reversed in direction, the acceleration of the particle is

1) *zero* 2) $\frac{F}{m}$ 3) $\frac{\sqrt{3}F}{m}$ 4) $\frac{2F}{m}$

28. Two identical blocks each of mass 'M' are tied to the ends of a string and the string is laid over a smooth fixed pulley. Initially the masses are held at rest at the same level. What fraction of mass must be removed from one block and added to the other, so that the system has an acceleration of $1/5^{th}$ of the acceleration due to gravity?

1) 1/10 2) 1/5 3) 2/5 4) 1/20

29. A particle of mass 'm' moves uniformly with a speed 'v' along a circle of radius 'r'. A and B are two points on the circle, such that the arc AB subtends an angle θ at the center of the circle. The magnitude of change in momentum as the particle moves from A to B is given by

1) $2mv\sin\left(\frac{\theta}{2}\right)$ 2) $2mv\cos\left(\frac{\theta}{2}\right)$

3) *zero* 4) $2mv\tan\left(\frac{\theta}{2}\right)$

30. When a lift is going up with uniform acceleration, the apparent weight of a person is W_1. When the lift is stationary, his apparent weight is W_2. When the lift falls freely his apparent weight is W_3. When the lift is going down with uniform acceleration which is less than the acceleration due to gravity, his apparent weight is W_4. The increasing order of these four weights is

1) W_1, W_3, W_2, W_4 2) W_3, W_4, W_2, W_1
3) W_3, W_2, W_4, W_1 4) W_2, W_3, W_1, W_4

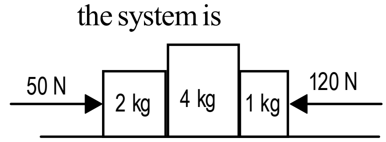
31. Three blocks of masses 3 kg, 2 kg and 1 kg are placed side by side in contact with each other on a smooth horizontal surface with the 3 kg block on the left extreme and 1 kg block on the right extreme. A horizontal force of 12 N is applied on the 3 kg block pushing it towards the 2 kg block. The contact force between the 2 kg block and 1 kg block is

1) 6 N 2) 4 N 3) 2 N 4) 8 N

32. From the roof of a lift a 4 kg block is suspended with the help of a light string. Another 2 kg block is suspended from the bottom surface of the 4 kg block with another light string. If the lift is moving up with uniform acceleration of 5 $m\,s^{-2}$, the tension in the string connecting the two blocks is [g=10 $m\,s^{-2}$]

1) 10 N 2) 20 N 3) 30 N 4) 90 N

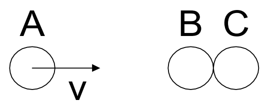
33. Three blocks of masses 1 kg, 4 kg and 2 kg are placed on a smooth horizontal surface as shown in the figure. Two horizontal forces 120 N and 50 N are applied on the system. The acceleration of the system is



1) 17.5 $m\,s^{-2}$ 2) 10 $m\,s^{-2}$
3) 24.3 $m\,s^{-2}$ 4) 70 $m\,s^{-2}$

34. A shell is fired from the ground at an angle θ with horizontal with a velocity ‘v’. At its highest point it breaks into two equal fragments. If one fragment comes back through its initial line of motion with same speed, then speed of second fragment will be
1) 3v cosθ 2) 3v cosθ/2
3) 2v cosθ 4) √3v cosθ/2

35. Two identical steel balls ‘B’ and ‘C’ lie on a smooth horizontal straight groove so that they are touching. A third identical ball ‘A’, moves at a speed ‘v’ along the groove and collides with ‘B’. If all the collisions are perfectly elastic then



1) A comes to a stop, B and C move together at speed v/2
2) A and B come to stop C moves at speed v
3) A and B and C move together at speed v/3
4) A moves back at speed v, B comes to rest and C moves forward at speed v

36. An object initially at rest explodes, disintegrating into 3 parts of equal mass. Parts 1 and 2 have the same initial speed ‘v’, the velocity vectors being perpendicular to each other. Part 3 will have an initial speed of
1) √2v 2) v/2 3) v/√2 4) $\sqrt{2v}$

37. When a gun of mass “M” fires a bullet of mass “m”, the total energy released in the explosion is found to be “E”. The kinetic energy of the bullet is
1) EM/(M+m) 2) Em/(M+m)
3) E(M+m)/M 4) E(M+m)/m

38. Sphere ‘A’ of mass 2 kg moving along a straight line with a velocity of 10 m/s hits another sphere ‘B’ of mass 3 kg which is a rest. If they stick together and move with a common velocity along the same straight line after collision, if the collision lasted 0.1 second, the force exerted on ‘B’ during the impact will be
1) 120 N 2) 1.2 N 3) 12 N 4) 1200 N

39. A bullet of mass 5 gm traveling horizontally with a velocity of 600 ms^{-1} is fired into a block of wood of mass 2 kg suspended from a string of length 2 m. If the bullet penetrates the block of wood and comes out with a velocity of 200 ms^{-1}, the vertical height through which the block of wood will rise ($g = 10\ ms^{-2}$)
1) 2.5 cm 2) 5.0 cm 3) 2.0 cm 4) 4.0 cm

40. A radium ball is at a height ‘h’ above a hard horizontal floor.It is thrown vertically downwards from there with an initial velocity ‘u’. Assuming the collision between the ball and floor as elastic, the height to which the ball would rise will be
1) $h-\frac{u^2}{2g}$ 2) $h+\frac{u^2}{g}$ 3) $h-\frac{u^2}{g}$ 4) $h+\frac{u^2}{2g}$

41. From a height of 5 m a ball is thrown vertically downwards with an initial velocity of 10 m/s towards a hard horizontal floor. If it bounces to the same height, the coefficient of restitution is ($g = 10\ ms^{-2}$)
1) ½ 2) 1/√2 3) ¼ 4) 2/3

42. A bullet of mass 10 gm moving with a horizontal velocity 100 m/s passes through a wooden block of mass 100 gm. The block is resting on a smooth horizontal floor. After passing through the block the velocity of the bullet is 10 m/s. The velocity of the emerging bullet with respect to the block is
1) 10 m/s 2) 9 m/s 3) 1 m/s 4) 5 m/s

43. A sphere of mass ‘m’ collides head-on with a second sphere of mass ‘M’ at rest. If ‘e’ is the coefficient of restitution, the condition that the first sphere may move in its original direction of motion is
1) $\frac{m}{M} < e$ 2) $\frac{m}{M} = e$
3) $\frac{m}{M} > e$ 4) $\frac{m}{M} < e^2$

44. A bullet moving with a velocity ‘u’ passes through a block at rest and free to move. The two are of equal mass. After passing through the block, the velocity of the emerging bullet is ‘fu’. Its velocity relative to the block is
1) fu 2) $(1-f)u$ 3) $(2f-1)u$ 4) $(2-f)u$

45. In a one-dimensional collision between two identical spheres A and B, B is stationary and A has an initial velocity ‘u’ before impact. After the impact B is found to move with a velocity ‘v’. The coefficient of restitution for the impact is
1) $\frac{v}{u}+1$ 2) $\frac{2v}{u}+1$ 3) $\frac{2v}{u}-1$ 4) $\frac{v}{u}-1$

KEY

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

LEVEL - III

1. The same horizontal force acts on two blocks of masses "M" and "m" resting on a smooth horizontal surface. The ratio of the displacements suffered by them in equal intervals of time is
   1) M : m   2) m : M
   3) √m : √M   4) √M : √m

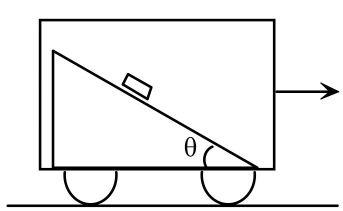
2. The net force on a rocket with a weight of 1.5×10^4 newtons is 2.4×10^4 newtons. About how much time is needed to increase the rocket's speed from 12 m/s to 36 m/s near the surface of the Earth at takeoff?
   1) 15 s   2) 0.78 s   3) 1.5 s   4) 3.8 s

3. A jet of a liquid of density "ρ" with a cross sectional area "A" is incident at an angle "θ" with a surface with a velocity "v" and bounces elastically. The force produced by the jet normal to the surface is
   1) $2\rho Av^2 \cos\theta$ 2) $2\rho Av^2 \sin\theta$
   3) $2\rho Av^2 \cos^2\theta$ 4) $2\rho Av^2 \sin^2\theta$

4. Two bodies of masses 3 kg and 2 kg are connected by a long string, and the string is made to pass over a smooth fixed pulley. Initially the bodies are held at the same level and released from rest. The velocity of the 3 kg body after one second is (take g = 10 m/s^2)
   1) 2 m/s   2) 1 m/s   3) 0.4 m/s   4) 4 m/s

5. When a train starting from rest is uniformly accelerating, a plumb bob hanging from the roof of a compartment is found to be inclined at an angle of 45° with the vertical. The time taken by the train to travel a distance of ½ km will be nearly
   1) 7 s   2) 10 s   3) 15 s   4) 25 s

6. Inside a railway bogie on a horizontal straight track, there is a smooth inclined plane of inclination 'θ' as shown in the figure. A small block is kept on the inclined surface. If the block is to remain stationary on the inclined surface, the acceleration to be given to the bogie is



   1) g sinθ   2) g tanθ
   3) g/tanθ   4) g cosθ

7. The components of the linear momentum of a body moving in the XOY plane are given by p_X = Asin(t) and p_Y = Acos(t), where 'A' is a constant and 't' is time. The angle between the linear momentum and the force acting on the body is
   1) 45°   2) 0°   3) 180°   4) 90°

8. Two identical blocks A and B, each of mass 'm' resting on a smooth horizontal surface, are interconnected by spring of stiffness 'K'. If the block B is acted on by a horizontal force 'F' and the elongation of the spring is 'e', the relative acceleration between the blocks is equal to
   1) $\frac{F}{2m}$ 2) $\frac{F-Ke}{m}$ 3) $\frac{F-2Ke}{m}$ 4) $\frac{Ke}{m}$

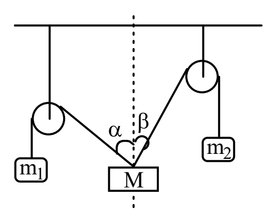
9. A body of mass 'm' moves with a kinetic energy 'K', but without rotation. Because of an internal spring mechanism, it divides in to two non rotating bodies of masses 'm/2' and 'm/2' which now move in directions making equal angles 45° on either side of the original direction of motion. The energy released by the spring mechanism is
   1) 2K   2) 3K   3) 4K   4) K

10. The bob of a simple pendulum is drawn aside, so that the string is horizontal and released. During the subsequent motion, the acceleration of the bob is found to be horizontal when the string makes an angle θ with the vertical. Then the value of cosθ is
   1) 1/√2   2) 1/√3   3) ½   4) 1/√5

11. A train is moving forward at a velocity of 2.0 m/s. At the instant the train begins to accelerate at 0.80 m/s^2 a passenger drops a coin which takes 0.50 s to fall to the floor. Relative to a spot on the floor directly under the coin at release, it lands:
   1) 1.1 m toward the rear of the train
   2) 1.0 m toward the rear of the train
   3) 0.10 m toward the rear of the train
   4) 0.90 m toward the front of the train

12. A small sphere of mass 'm' made of a material of density 'D' is immersed to a depth 's' in a liquid of density '2D' and released. Neglecting the viscous force of the liquid, the velocity with which it emerges out of the surface is (g = acceleration due to gravity)
   1) $\sqrt{gs}$ 2) $\sqrt{2gs}$ 3) $2\sqrt{gs}$ 4) $\sqrt{gs/2}$

13. A mass 'M' hangs by two strings making angles α and β to the vertical. The strings are connected through frictionless pulleys to two masses m_1 and m_2. If the system is in equilibrium, the ratio of $m_1 : m_2$ is



   1) sinα : sinβ   2) sinβ : sinα
   3) cosα : cosβ   4) cosβ : cosα

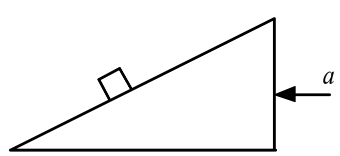
14. Two blocks A and B of masses 2 kg and 4 kg are connected by a light spring of force constant 4800 Nm^{-1}. The system is at rest on a smooth horizontal surface with the spring in its natural state without any compression or extension. Now a velocity of 6 ms^{-1} is given to B in a direction away from A. During the subsequent motion, the maximum extension of the spring is
1) 5 cm 2) 10 cm 3) 15 cm 4) 20 cm

15. A light spring of force constant 'K' is held between two blocks of masses 'm' and '2m'. The two blocks and the spring system rests on a smooth horizontal floor. Now the blocks are moved towards each other compressing the spring by 'x' and suddenly released. The relative velocity between the blocks when the spring attains its natural length will be

1) $\left(\sqrt{\frac{3K}{2m}}\right)x$ 2) $\left(\sqrt{\frac{2K}{3m}}\right)x$

3) $\left(\sqrt{\frac{K}{3m}}\right)x$ 4) $\left(\sqrt{\frac{K}{2m}}\right)x$

16. A smooth inclined plane of inclination 1 in l, has a particle on its inclined surface. The horizontal acceleration to be given to the inclined plane so that the particle remains stationary relative to the inclined surface must be



1) $\frac{g}{\sqrt{l^2-1}}$ 2) $\frac{\sqrt{l^2-1}}{g}$

3) $g\sqrt{l^2-1}$ 4) $g\sqrt{l^2+1}$

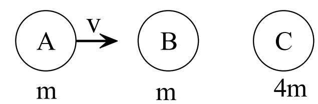
17. A steel ball of mass 50 gm is thrown vertically down ward with a velocity of 15 m s^{-1} from a height of 20 m. It buries itself in the sandy ground to a depth of 20 cm. The magnitude of average force exerted on the ball by the sand is nearly ($g = 10$ ms^{-2})
1) 78.1 N 2) 78.6 N 3) 77.6 N 4) 8.3 N

18. A car of mass M = 1260 kg decelerates from a velocity of 72 kmph to a stop in 10 seconds. At what average rate must the braking surfaces lose heat if their temperature is not to rise significantly? (1 calorie = 4.2 J)
1) 600 cal/s 2) 6000 cal/s
3) 60,000 cal/s 4) 60 cal/s

19. Ball 'A' having 1 kg mass strikes a glancing blow to another identical ball 'B' at rest in an elastic collision with a speed of 5 m/s. Ball A then moves off at right angles to the direction of motion of B at a speed of 4 m/s. The magnitude of momentum of ball B after collision in kg m s^{-1} units would be
1) 1 2) 4 3) 3 4) 2

20. An explosion blows a rock into three pieces. Two pieces go off at right angles to each other. One piece of mass 1 kg moves with 12 m/s and other of mass 2 kg moves with 8 m/s. If the velocity of the third piece is 40 m/sec, then its mass is
1) 5 kg 2) 0.5 kg 3) 0.25 kg 4) 1 kg

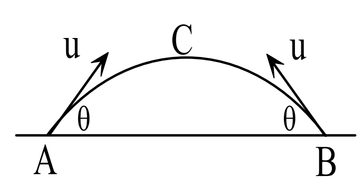
21. Three balls aigure. Ball A has mass m and initial velocity v to the right. Ball B with mass m and ball C with mass 4m are both initially at rest. Ball A collides elastically with ball B, which in turn collides with ball C. After the collision, ball B is reduced to rest. The final velocities of balls A and C are



1) ball A : 0.6 v to the left and ball C: 0.4 v to the right
2) ball A : 2.6 v to the left and ball C: 0.4 v to the right
3) ball A : at rest and ball C: 0.5 v to the right
4) ball A : at rest and ball C: 0.25 v to the right

22. A hunter fires his gun from a light inflated boat. The total mass of the hunter, the gun and the boat is 70 kg. The mass of the bullet is 35 gm and the mean initial velocity of the bullet is 320 m/s and the barrel of the gun is directed at an angle of 60° to the horizon. The velocity imparted to the boat is nearly
1)0.16 m/s 2)1.6 m/s 3)0.8 m/s 4)0.08 m/s

23. Two small identical spheres each of mass 'm' are projected slant wise from the points A and B on the ground with equal velocities 'u' and 'u' making same angles 'θ' and 'θ' as shown in the figure. They collide with each other at the highest point 'C' of the common path. If the collision is completely inelastic, how much time after the collision the particles come back to the ground?



1) 2 u sinθ/g 2) 2 u cosθ/g
3) u cosθ/g 4) u sinθ/g

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

1) $p(1+e)$ 2) $\frac{p}{1-e}$

3) $p\left(1+\frac{1}{e}\right)$ 4) $p\left(\frac{1+e}{1-e}\right)$

25. A ball falls from a height of 'h' on to a horizontal floor and bounces repeatedly until it stops. If the coefficient of restitution 'e' is $1/\sqrt{2}$, the total distance covered by the ball before stopping is

1) $2h$ 2) $3h$ 3) $4h$ 4) $3h/2$

26. A ball moves with a momentum 'p' directly towards an identical ball at rest. If the momentum transferred to the second ball during the collision is 'J', the coefficient of restitution for the collision is

1) $\frac{2J}{p}-1$ 2) $\frac{2J}{p}+1$ 3) $1-\frac{2J}{p}$ 4) $\frac{2J}{p}$

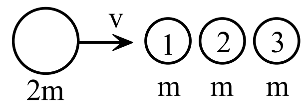
27. A bullet of mass m moving with a velocity u is fired horizontally in to a wooden block of mass M ($M >> m$) which lies on a smooth horizontal surface. If the bullet gets embedded in the block, the velocity of the block is found to be v_1. If the same bullet emerges from the block with half of its initial velocity, the velocity of the block is found to be v_2. The correct relation between v_1 and v_2 is

1) $v_1 = v_2$ 2) $2v_1 = v_2$ 3) $v_1 = 2v_2$ 4) $v_1 = 4v_2$

28. 'n' smooth spheres have masses 'm', 'm/e', 'm/e^2', 'm/e^3', etc.,. are placed in a row with all their centers on a straight line. Initially all the spheres are at rest. The first sphere of mass 'm' is projected with a velocity 'u' towards the second. The velocity of the last sphere after the $(n-1)^{th}$ sphere has made a collision with it is (take 'e' as the coefficient of restitution for all the collisions)

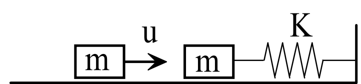
1) $e^n u$ 2) $e^{n-1} u$ 3) $e^{n+1} u$ 4) $e^{n/2} u$

29. If an ivory ball of mass $2m$ moving with a velocity 'v' strikes head-on on to a close row of three identical ivory balls each of mass m as shown in the figure. Then after the collisions which may be assumed as elastic, which of the following would occur?



1) the balls numbered 2 and 3 will move with velocity v, the others staying at rest
2) the ball numbered 3 will move with velocity 2v, all others staying at rest
3) the ball numbered 3 moves with velocity 4v/3 and the striking ball moves with a velocity v/3
4) the balls numbered 1, 2 and 3 move with velocity v/3 and the striking ball stops dead

30. A block of mass 'm' resting on a smooth horizontal floor is attached to a spring of force constant 'K' whose other end is attached to a rigid wall as shown. A second block of mass 'm' is projected directly towards the first block with a velocity 'u'. After collision the two blocks stick together. The maximum compression in the spring is



1) $\sqrt{\frac{mu^2}{K}}$ 2) $\sqrt{\frac{2mu^2}{K}}$ 3) $\sqrt{\frac{mu^2}{2K}}$ 4) $\sqrt{\frac{mu^2}{4K}}$

KEY

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

NEW MODEL QUESTIONS

In the following questions, a statement of Assertion(A) is followed by a statement of Reason(R). Of these statements, select the correct answer according to the scheme given below.

1) Both A and R are individually true and R is the correct explanation of A
2) Both A and R are individually true but R is not the correct explanation of A
3) A is true but R is false
4) Both A and R are false

1. Assertion (A): The momentum of a body and the net force acting on it are always in the same direction.
Reason (R): Momentum is product of mass and acceleration

2. Assertion (A): All collisions obey the law of conservation of energy.
Reason (R): Kinetic energy is conserved during elastic collisions.

3. Assertion (A): Mass is a measure of inertia of a body in translatory motion.
Reason(R): Greater the mass of a body, greater is the force required to change its state of rest or of uniform motion in a straight line.
4. Assertion (A): Newton's first law of motion is called the law of inertia.
Reason (R): Newton's first law of motion deals with bodies in equilibrium.
5. Assertion (A): The cause of motion is inertia while the cause of change of motion is force.
Reason (R): According to Newton's first law of motion, both rest and uniform motion of a body along a straight line are one and the same as they do not involve any external force.
6. Assertion (A): A rocket works on the principle of conservation of linear momentum.
Reason (R): When a rocket is fired, the gases produced due to burning of fuel get a linear momentum in the downward direction and the rocket gets an equal linear momentum in the upward direction.
7. Assertion (A): When a lift is freely falling, a person inside the lift experiences weightlessness.
Reason (R): Both the person and the floor of the lift are falling with same acceleration and there is no contact force developed between the feet of the person and the floor of the lift.
8. Assertion (A): Shock absorbers in motor vehicles increase the time of action of an impulsive force and there by reduce the magnitude of the force experienced.
Reason (R): For a given change in momentum, the more the time the more the force.
9. Assertion (A): The product of mass of a body and its acceleration always gives the net force acting on the body
Reason (R): According to Newton's second law, the net force acting on a body is inversely proportional to the rate of change of momentum.
10. Assertion (A): When a bullet is fired in to a block of wood that is suspended from the roof, only momentum is conserved but not kinetic energy.
Reason (R): The bullet gets embedded in the block and the impact can be considered as completely inelastic

KEY

1) 4 2) 2 3) 1 4) 2 5) 2 6) 1
7) 1 8) 2 9) 3 10) 1

PREVIOUS EAMCET QUESTIONS

1. Two identical blocks A and B, each of mass 'm' resting on smooth floor are connected by a light spring of natural length L and the spring constant K, with the spring at its natural length. A third identical block C (mass m) moving with a speed v along the line joining A and B collides with A. The maximum compression in the spring is: [2003 ENG]

1) $v\sqrt{\frac{m}{2k}}$ 2) $m\sqrt{\frac{v}{2k}}$ 3) $\sqrt{\frac{mv}{2k}}$ 4) $\frac{mv}{2k}$

2. Consider the following statements A and B and identify the correct answer given below:
(A) A body initially at rest is acted upon by a constant force. The rate of change of its kinetic energy varies linearly with time.
(B) When a body is at rest, it must be in equilibrium. [2003 ENG]
1) A and B are correct 2) A and B are wrong
3) A is correct and B is wrong
4) A is wrong and B is correct

3. The horizontal acceleration that should be given to a smooth inclined plane of angle $\sin^{-1}\left(\frac{1}{l}\right)$ to keep an object stationary on the plane, relative to the inclined plane is: [2003 ENG]

1) $\frac{g}{\sqrt{l^2-1}}$ 2) $2\sqrt{l^2-1}$ 3) $\frac{\sqrt{l^2-1}}{g}$ 4) $\frac{g}{\sqrt{l^2+1}}$

4. A stationary body of mass 3 kg explodes into three equal pieces. Two of the pieces fly off at right angles to each other, one with a velocity $2\hat{i}$ m/s and the other with a velocity $3\hat{j}$ m/s. If the explosion takes place in 10^{-5} sec, the average force acting on the third piece in Newtons is:[2003 MED]
1) $(2\hat{i}+3\hat{j})\times 10^{-5}$ 2) $-(2\hat{i}+3\hat{j})\times 10^{5}$
3) $(3\hat{j}-2\hat{i})\times 10^{5}$ 4) $(2\hat{i}-3\hat{j})\times 10^{-5}$

5. Consider the following statements A and B. Identify the correct choice in the given answers:
(A) In a one-dimensional perfectly elastic collision between two moving bodies of equal masses, the bodies merely exchange their velocities after collision.
(B) If a lighter body at rest suffers perfectly elastic collision with a very heavy body moving with a certain velocity, after collision both travel with same velocity. [2003 MED]
1) A and B are correct 2) Both A and B are wrong
3) A is correct B is wrong
4) A is wrong B is correct

6. A 2kg ball moving at 24 m s^{-1} undergoes inelastic head-on collision with a 4 kg ball moving in the opposite direction at 48 m s^{-1}. If the coefficient of restitution is 2/3, their velocities in m s^{-1} after impact are: [2004 ENG]

1) – 56, – 8 2) – 28, – 4
3) – 14, – 2 4) – 7, – 1

7. A body x with a momentum p collides with another identical stationary body y one dimensionally. During the collision x gives an impulse J to the body y. Then the coefficient of restitution is: [2004 MED]

1) $\frac{2J}{p} - 1$ 2) $\frac{J}{p} + 1$
3) $\frac{J}{p} - 1$ 4) $\frac{J}{2p} - 1$

8. Consider the following statements 'A' and 'B' and identify the correct answer:
(A): In an elastic collision, if a body suffers a head on collision with another of same mass at rest, the first body comes to rest while the other starts moving with the velocity of the first one.
(B): Two bodies of equal masses suffering a head-on elastic collision merely exchange their velocities. [2005 ENG]

(1) Both (A) and (B) are true
(2) Both (A) and (B) are false
(3) (A) is true but (B) is false
(4) (A) is false both (B) is true

9. Consider the following statements A and B and identify the correct answer
A:Coefficient of restitution varies between 0 and1
B : In inelastic collision, the law of conservation of energy is satisfied. [2005 MED]

1) A and B are true 2) A and B are false
3) A is true but B is false 4)A is false but B is true
[2004 MED]

KEY

1) 1 2) 3 3) 1 4) 2 5) 3 6) 1
7) 1 8) 1 9) 1