Chapter 3

MOTION AND FORCE

KEY POINTS

Displacement:

Displacement is the change in the position of a body from its initial position to its fin position. It is vector quantity and S.I unit is meter (m).

Velocity:

Time rate of change of displacement is called velocity. It is vector quantity and S.I unit ms^{-1}. It is given by

$$v_{av} = \frac{\vec{d}}{t}$$

Instantaneous Velocity:

Instantaneous velocity at a particular instant of time. When the time interval, over whi the velocity is measured, approaches zero, the average velocity becomes equal to t instantaneous velocity at that time.

$$v_{ins} = \text{Lim}_{\Delta t \to 0} \frac{\Delta \vec{d}}{\Delta t}$$

ACCELERATION:

Rate of change of velocity is called acceleration.

$$\vec{a} = \frac{\Delta \vec{v}}{\Delta t}$$

- Acceleration is a vector quantity measured in $m.s^{-2}$. Its dimensions are $[LT^{-2}]$

Instantaneous Acceleration:

The acceleration at a particular instant of time. It is the value obtained from th acceleration as time Δt is made smaller and smaller approaches zero.

$$a_{ins} = \text{Lim}_{\Delta t \to 0} \frac{\Delta \vec{v}}{\Delta t}$$

Graphs:

Graph is a pictorial display between two dependent quantities.

Displacement-Time Graph:

- *d-t* graph shows relation between displacement and time.
- *Slope of* the graph is equal to velocity

Velocity-Time Graph:

- v-t graph shows the relation between velocity and time.
- Slope of the v-t graph is equal to acceleration.

Equations Of Motion:

$V_f = V_i + at$ or $V_f = V_i + gt$

$S = V_it + 1/2at^2$ or $S = V_it + 1/2gt^2$

$V_f^2 = V_i^2 + 2as$ or $V_f^2 = V_i^2 + 2gs$

Newton's Laws of motion:

- 1st Law: The velocity of an object be constant if net force on it is zero.
- 2nd Law: An object gains momentum in the direction of applied force, and the rate of change of momentum is proportional to the magnitude of the force.
- 3rd Law: When two objects interact, they exert equal and opposite force on each other for the same length of time, and so receive equal and opposite impulses.

Momentum:

- The product of mass and velocity is known as momentum.

$$\vec{p} = m\vec{v}$$

- Linear momentum is a vector quantity and has direction of velocity.
- SI unit of linear momentum are kg ms^{-1} or Ns. Dimension of momentum are $[MLT^{-1}]$

Impulse:

The impulse provided by the force is the product of force and time for which it acts. It equals change in momentum of the object.

$$\vec{I} = \Delta \vec{p} = \vec{F} \times \Delta t$$

Law of conservation of linear momentum:

The total linear momentum of an isolated system remains constant.

$$m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'$$

Collisions:

Collision is said to be taken place if some sort of interaction appears between bodies due to their closeness.

Inelastic Collision:

The collision in which the K.E of the system is not conserved, is called the inelastic collision.

Elastic Collision:

In the ideal case when no K.E is lost, the collision is said to be perfectly elastic.

Elastic Collision in one Dimension:

- Elastic collision in one dimension is that one, in which colliding bodies do not deviate from their line of motion, after the collision.

$$V_1 + V'_1 = V_2 + V'_2$$

or $V_1 - V_2 = -(V'_1 - V'_2)$.

Speed of approach = Speed of recession $[V_{rel} = -V'_{rel}]$

After collision,

$$V'_1 = \frac{(m_1 - m_2)V_1}{(m_1 + m_2)} + \frac{2m_2 V_2}{(m_1 + m_2)}$$

$$V'_2 = \frac{2m_1 V_1}{(m_1 + m_2)} + \frac{(m_2 - m_1)V_2}{(m_1 + m_2)}$$

Cases of elastic collision:

Case I: If $m_1 = m_2$ & $V_2 \neq 0$

then $V'_1 = V_2$ & $V'_2 = V_1$

Case II: If $m_1 = m_2$ & $V_2 = 0$

then $V'_1 = 0$ & $V'_2 = V_1$

In both cases I & II due to the same masses of the colliding bodies their velocities after collision got interchanged.

Case III: If $m_1 << m_2$ & $V_2 = 0$ and $m_1 \approx 0$

then $V'_1 = -V_1$ & $V'_2 = 0$

Case IV: If $m_1 >> m_2$ & $V_2 = 0$ and $m_2 \approx 0$

then $V'_1 = V_1$ & $V'_2 = 2V_1$

Force Due To Water Flow:

Water exerts force on a wall, when impinges over it. This force is equal to the product of mass flow rate of water and its velocity.

$$\vec{F} = \frac{m}{t}\vec{v}$$

Projectile Motion:

Projectile motion is two dimensional motion under constant acceleration due to gravity.

- Horizontal and vertical coordinates of projectile at time 't' are given as;

  $x = V_i \cos\theta\, t$ and $y = V_i \sin\theta\, t - 1/2gt^2$

- Time to reach maximum height is given as;

  $t = V_i \sin\theta/g$

- Total time of flight is given as;

  $T = 2V_i \sin\theta / g$

- Vertical range (height) is given as;

  $H = V_i^2 \sin^2\theta/2g$

- Range (horizontal) is a distance between point of projection and point at which it comes back to its level of projection. It is given as;

  $R = V_i^2 \sin 2\theta/g$

- Maximum horizontal range is at angle $\theta = 45°$ and given as;

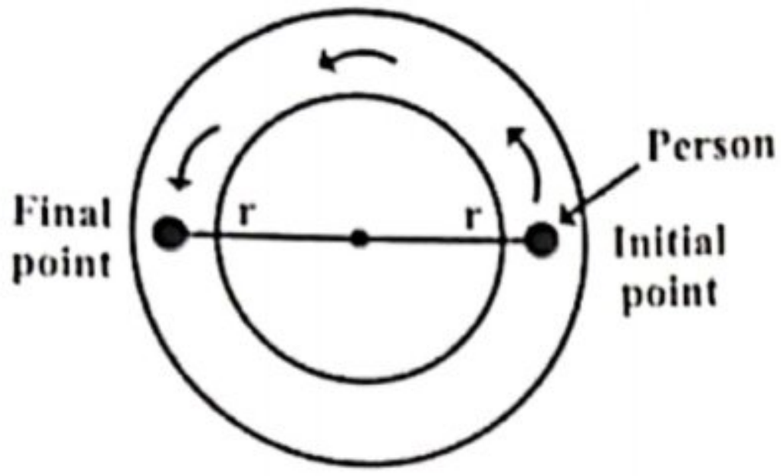
  $R_{max} = V_i^2/g$

TOPICAL MULTIPLE CHOICE QUESTIONS

Topic 3.1:

Displacement

(1) A person moves along a circular track and covers half of the path as shown in figure. What will be the ratio of its distance to displacement covered?



(a) 2r
(b) 4r
(c) $\frac{r}{2}$
(d) $\frac{\pi}{2}$

(2) **Which of the following statements is true?**
(a) displacement can be greater then distance
(b) along a closed path distance can be zero.
(c) the distance of a moving body cant be zero
(d) All of these

(3) **The shortest distance between two points is called**
(a) acceleration
(b) velocity
(c) speed
(d) displacement

(4) **Displacement is a quantity**
(a) scalar
(b) linear
(c) vector
(d) both a & c

(5) **Rest and motion are**
(a) relative terms
(b) vector quantities
(c) scalar quantities
(d) none of these

(6) **Displacement can be zero but distance**
(a) can be zero
(b) is always zero
(c) may be zero
(d) can never be zero

Topic 3.2:

Velocity

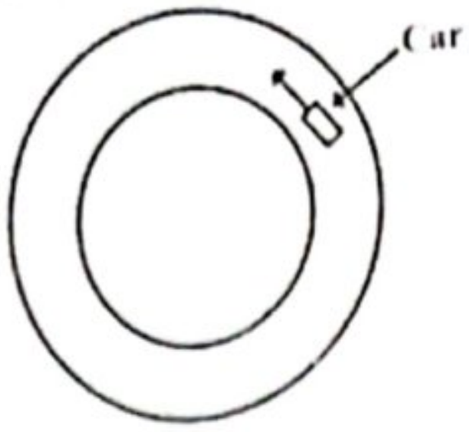
(7) **A person goes to Islamabad at a velocity of 60km/h. He returns back at a velocity of 70km/h. What will be his average velocity?**
(a) 65 km/h
(b) 60km/h
(c) 70km/h
(d) zero

(8) **The dimensions of velocity is**
(a) $[MLT^{-1}]$
(b) $[ML^{-1}]$
(c) $[ML^{-1}T]$
(d) $[LT^{-1}]$

(9) **If a body covers different displacements in equal interval of time, it is said to have**
(a) uniform velocity
(b) variable velocity
(c) variable acceleration
(d) uniform acceleration

(10) **When average velocity of an object is equal to the instantaneous velocity then body has**
(a) uniform velocity
(b) variable velocity
(c) variable acceleration
(d) uniform acceleration

(11) A car is moving along a circular track and covering equal distances in equal intervals of time. What is true about its motion?



(a) Speed remains uniform
(b) It is constantly accelerated
(c) Velocity changes at every moment yet magnitude remains same
(d) All of these

(12) **The typical speed of moon around the earth is**
(a) $1000ms^{-1}$ (b) $333ms^{-1}$
(c) $29600ms^{-1}$ (d) $210000ms^{-1}$

(13) **The SI unit of velocity is**
(a) ms^{-2} (b) cms^{-1}
(c) ms^{-1} (d) mms^{-1}

(14) **An object moving in a circular path with constant speed, then its**
(a) velocity is changing (b) velocity is uniform
(c) acceleration is constant (d) none of these

(15) **If a moving object does not changes its velocity by an equal amount in equal interval of time then the object is said to be in**
(a) variable velocity (b) uniform velocity
(c) instantaneous velocity (d) all of these

(16) **At a certain instant of time the velocity is said to be**
(a) uniform velocity (b) variable velocity
(c) instantaneous velocity (d) constant velocity

(17) **Which of the quantity is the magnitude of velocity**
(a) distance (b) acceleration
(c) displacement (d) speed

(18) **At what condition the instantaneous and average velocity are equal**
(a) if a body moves with uniform velocity (b) if a body moves with variable velocity
(c) if a body moves with instantaneous velocity (d) if a body moves with constant acceleration

(19) **If instantaneous velocity of an object is changing then the object is said to have**
(a) uniform velocity (b) non-uniform velocity
(c) angular velocity (d) constant velocity

Topic 3.3

Acceleration

(20) **A cyclist riding at a speed of 5m/sec braked with uniform deceleration and stopped in 3m. the acceleration is**
(a) $2.16m/sec^2$ (b) $4.16m/sec^2$
(c) $-2.16m/sec^2$ (d) $-4.16m/sec^2$

(21) **An acceleration is produced in a body if**
(a) Magnitude of velocity increase or decrease (b) Direction of velocity changes
(c) A force is applied (d) All of these

(22) A car is moving on a straight track such that a force $\vec{F}$ is applied on it for which orientation of applied force acceleration is negative?

(a) $\theta = 90°$
(b) $\theta = 180°$
(c) $\theta = 0°$
(d) $90° < \theta \leq 180°$

(23) The velocity of car is decreasing along the straight line, then velocity and acceleration are
(a) perpendicular
(b) parallel
(c) anti parallel
(d) none of these

(24) The instantaneous acceleration is obtained if put limit on average acceleration as
(a) $\Delta t \to 0$
(b) $\Delta d \to 0$
(c) $\Delta F \to 0$
(d) $\Delta v \to 0$

(25) The instantaneous acceleration is the limit of average acceleration as $\Delta t \to 0$ is given by
(a) $\vec{a}_{ins} = \lim_{\Delta t \to 0} \frac{\Delta \vec{d}}{\Delta t}$
(b) $\vec{a}_{ins} = \lim_{\Delta t \to 0} \frac{\Delta \vec{v}}{\Delta t}$
(c) $\vec{a}_{ins} = \lim_{\Delta v \to 0} \frac{\Delta t}{\Delta \vec{v}}$
(d) $\vec{a}_{ins} = \lim_{\Delta t \to 0} \frac{\Delta \vec{a}}{\Delta t}$

(26) When force of 1N is applied on a body of mass 100g then the acceleration would be
(a) $5ms^{-2}$
(b) $10ms^{-2}$
(c) $10ms^{-1}$
(d) $0.1ms^{-2}$

(27) The magnitude of acceleration produced in an object is inversely proportional with
(a) momentum
(b) mass
(c) velocity
(d) force

(28) The rate of change of decreasing velocity is called
(a) positive acceleration
(b) negative acceleration
(c) uniform acceleration
(d) both b and c

(29) The SI unit of acceleration is
(a) ms^{-1}
(b) ms^{-2}
(c) cms^{-2}
(d) mms^{-2}

(30) In which of the following cases acceleration can be assumed to be uniform.
(a) Velocity increase at a constant rate
(b) Velocity decrease at a constant rate
(c) Velocity may not change at all
(d) All of these

(31) If the velocity of a car is increasing along a straight line then velocity and acceleration are
(a) perpendicular
(b) parallel
(c) anti-parallel
(d) coplanar

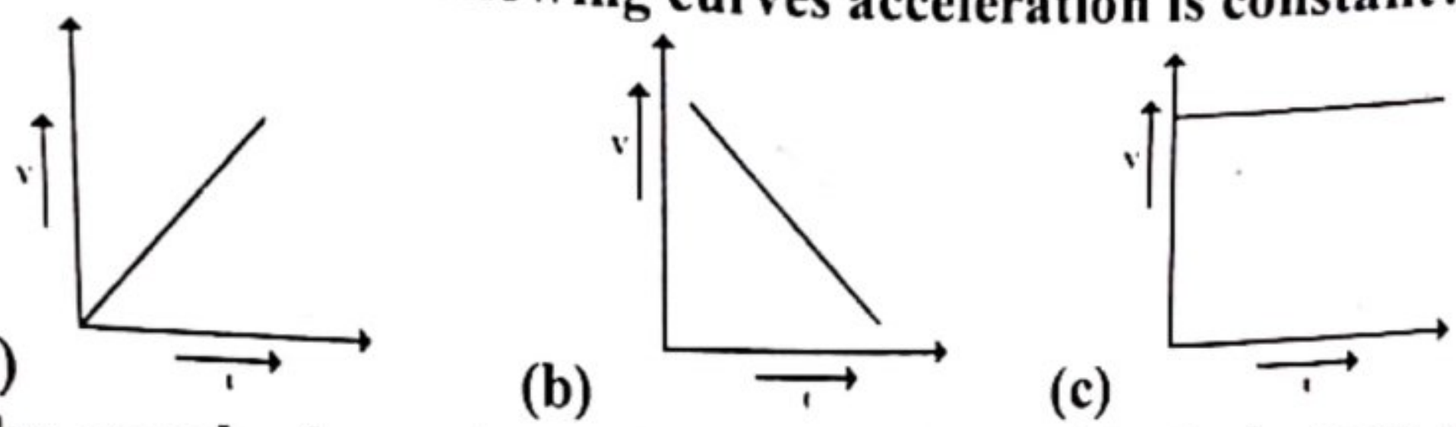
(32) For uniform motion of a car along a straight line, the acceleration will be
(a) uniform
(b) variable
(c) average
(d) zero

(33) If a body moving in a circular path with constant speed then the
(a) velocity and acceleration are perpendicular to each other
(b) velocity and acceleration are parallel to each other
(c) velocity and acceleration are anti-parallel
(d) both are opposite

4) When a body moves with constant acceleration then the average and instantaneous acceleration will be
(a) equal
(b) unequal
(c) zero
(d) none of these

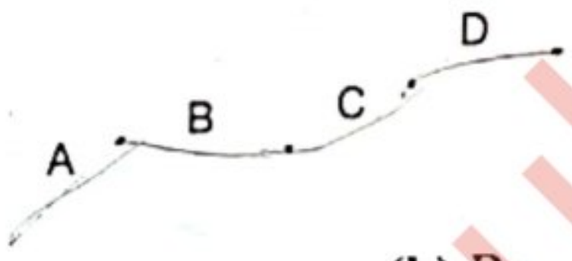
opic 3.4: Velocity-Time Graph

5) For which of the following curves acceleration is constant?



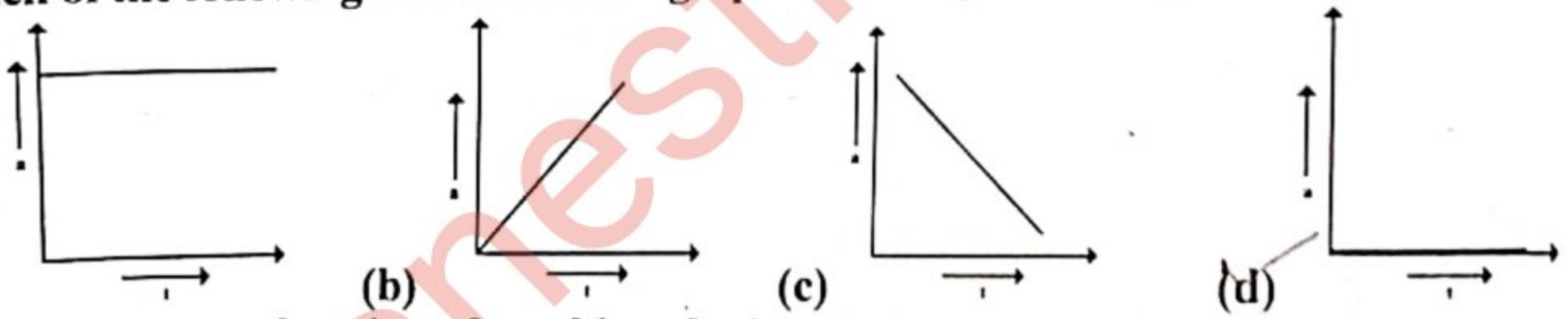
(a) (b) (c) (d) All

36) The graph shows how the speed of an object changes with time. Which section shows that object is moving with an increasing acceleration?



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

(37) Which of the following curves is the a-t graph for an object moving with constant velocity?



(a) (b) (c) (d)

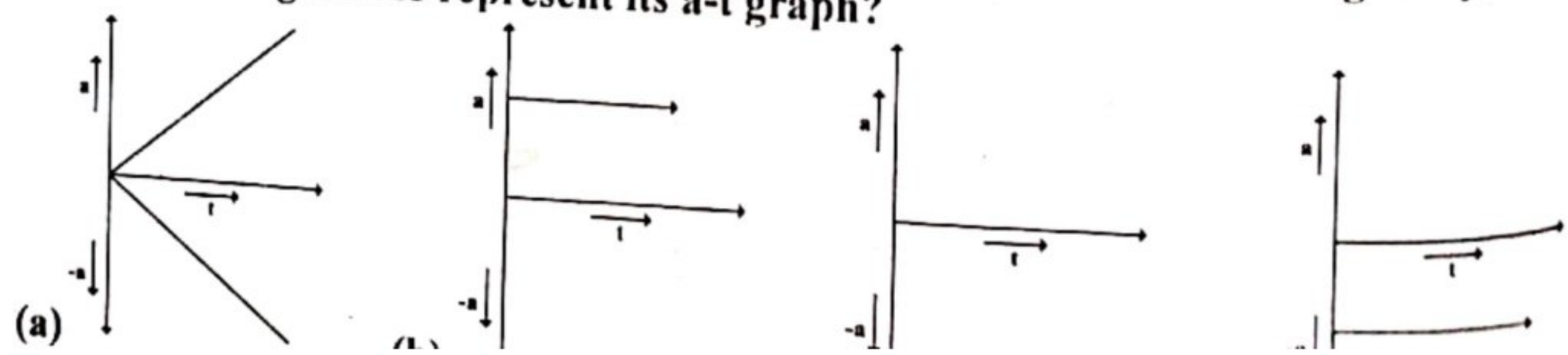
(38) The average acceleration of an object during the interval t is given by the slope of
(a) speed-time graph
(b) velocity-time graph
(c) distance-time graph
(d) none of these

(39) If the slope of displacement-time graph increases then
(a) acceleration increases
(b) velocity increases
(c) speed decreases
(d) none of these

(40) If the slope of velocity time graph gradually decreases then the body would have
(a) negative acceleration
(b) positive acceleration
(c) uniform velocity
(d) none of these

(41) The area under the curve of velocity-time graph gives
(a) acceleration
(b) distance
(c) velocity
(d) momentum

(42) A body is thrown upwards such that it moves freely under action of gravity. Which of the following curves represent its a-t graph?



(a)

Topic 3.5: Equations of Uniformly Accelerated Motion

(43) Equations of motion hold only when there is
(a) linear motion with constant velocity (b) linear motion with variable acceleration
(c) linear motion with uniform acceleration (d) none of these

(44) Velocity of an object dropped from a building at any instant 't' is given by
(a) gt (b) $1/2gt^2$
(c) $v_it + 1/2\ gt^2$ (d) none of these

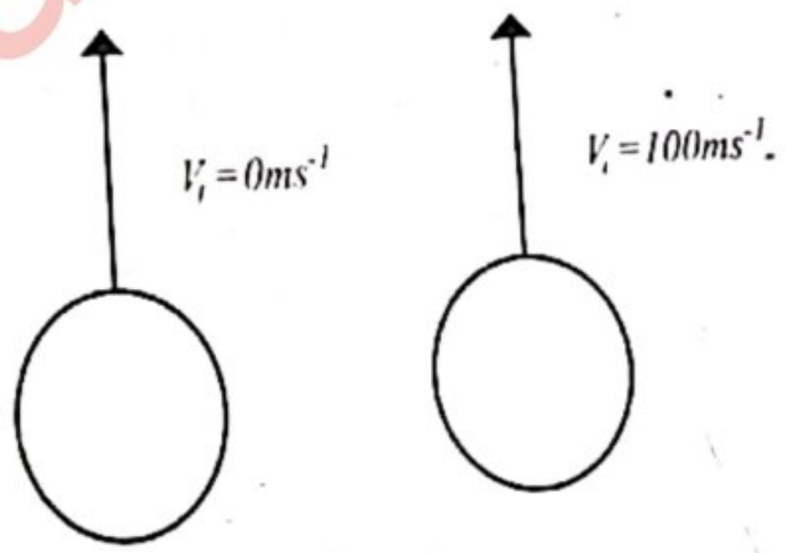
(45) Acceleration due to gravity near the surface of the earth is
(a) $0ms^{-2}$ (b) $9.8ms^{-2}$
(c) $1.6\ m/s^2$ (d) $11.2\ m/s^2$

(46) Distance covered by a free falling body during 1st second of its motion is
(a) 4.9m (b) 9.8m
(c) 14.7m (d) 19.6m

(47) A paratrooper moves downward with
(a) zero acceleration (b) negative acceleration
(c) positive acceleration (d) none of these

(48) If an object is moving with constant velocity of $20ms^{-1}$ towards north then its acceleration will be
(a) $5\ ms^{-2}$ (b) $10ms^{-2}$
(c) $9ms^{-2}$ (d) $0ms^{-2}$

(49) A ball is projected upwards with an initial velocity $V_i=100ms^{-1}$ as shown in the figure. It comes back after sometime and strikes ground with the same velocity but pointing downward. What is the angle between acceleration when moving upward to acceleration coming down?



(a) 180° (b) 90°
(c) 60° (d) 0°

(50) As we go at a greater height from the surface of earth, the value of g
(a) increases (b) decreases
(c) remain same (d) none of these

(51) Which one is the correct relation
(a) $a=\frac{V_f-V_i}{2t}$ (b) $a=\frac{V_f^2+V_i^2}{2S}$
(c) $a=\frac{2(S-V_it)}{t^2}$ (d) $a=\frac{(S+V_it)}{2t^2}$

Topic 3.6: Newton's Laws of Motion

(52) For a freely falling object the rate of change of momentum is
(a) Force (b) Weight
(c) Less then weight (d) Greater then weight

(53) Basic law which relates the force and motion is
(a) Newton's laws of motion (b) Einstein's equation
(c) Maxwell equation (d) none of these

54) **Newton's law of motion hold for those objects which moves with**
(a) speed comparable to speed of light
(b) low speed as compared to the speed of lig
(c) speed of the order of $10^8 ms^{-1}$
(d) none of these

55) **The famous book "Principia" is written by**
(a) Newton
(b) Galileo
(c) Einstein
(d) Joule

56) **The first anticipation "No body begins to move or comes to rest of itself" was given b**
(a) Newton
(b) Abu Ali Sena
(c) Ibn-ul-Haithem
(d) Al-Khawarzimi

57) **Action and reaction equal in magnitude and opposite in direction they**
(a) balance each other
(b) never balance each other
(c) balance if bodies are light
(d) Balance if bodies are heavy.

58) **Inertia of body is measured in terms of**
(a) its weight
(b) its mass
(c) its velocity
(d) its force

59) **A mass of 10kg moves with an acceleration of $10ms^{-2}$, the force on it is**
(a) 5N
(b) 50N
(c) 100N
(d) 25N

60) **According to Newton's second law**
(a) F = mv
(b) F=m/a
(c) F=ma
(d) F=a/m

61) **The force which produces an acceleration of $1ms^{-2}$ in a body of 1kg in the directio of force is equal to**
(a) one dyne
(b) one pound
(c) one joule
(d) one newton

62) **The dimension of weight is**
(a) $[MLT^{-1}]$
(b) $[MLT^{-2}]$
(c) $[LT^{-1}]$
(d) $[ML^{-1}T^{-2}]$

63) **Single force does not exist, is the result of which law of motion**
(a) 1st law
(b) 2nd law
(c) 3rd law
(d) all of these

64) **Mass is the quantitative measure of**
(a) inertia
(b) gravity
(c) velocity
(d) both a and b

65) **The property of a body which tends to maintain the state of rest or of uniform motion is called**
(a) mass
(b) inertia
(c) force
(d) both a and b

66) **Newton's first law defines**
(a) acceleration
(b) displacement
(c) velocity
(d) force

67) **Newton's 2nd law determines**
(a) acceleration
(b) displacement
(c) velocity
(d) force

68) **Action and reaction forces act**

(69) **If the force acting on a body is doubled, then acceleration becomes**
(a) half (b) doubled
(c) one fourth (d) constant

(70) **Newton's first law of motion is also called**
(a) law of inertia (b) law of gravitation
(c) law of conservation of energy (d) law of conservation of mass

(71) **Mass of an object is 20kg, then the pull of earth on the object is**
(a) 98N (b) 9.8N
(c) 196N (d) 296N

Topic 3.7: Momentum

(72) **When a large force "F" acts on a body for a large time then product of "F" and time is called.**
(a) Impulse (b) Change in momentum
(c) Momentum (d) All of these

(73) **A force of 10N act on a body of mass 10kg for 5 sec. The change in momentum of the body is**
(a) 10 Ns (b) 100 Ns
(c) 50 Ns (d) 150 Ns

(74) **Force acting on a body is equal to**
(a) rate of change of momentum (b) change of momentum
(c) momentum (d) both a & b

(75) **Dimension of momentum is**
(a) [MLT] (b) $[MLT^2]$
(c) $[ML^{-1}T]$ (d) $[MLT^{-1}]$

(76) **Which of the following is true?**
(a) There is impulse in every change in momentum
(b) There is change in momentum in every impulse
(c) For impulse force must be small
(d) All of these

(77) **Direction of impulse is same that of**
(a) change in momentum (b) velocity
(c) acceleration (d) no direction

(78) **SI unit of impulse is same that of**
(a) momentum (b) velocity
(c) force (d) acceleration

(79) **Which bullet of same momentum is more effective in knocking a bear down**
(a) rubber bullet (b) lead bullet
(c) both are equally effective (d) none of these

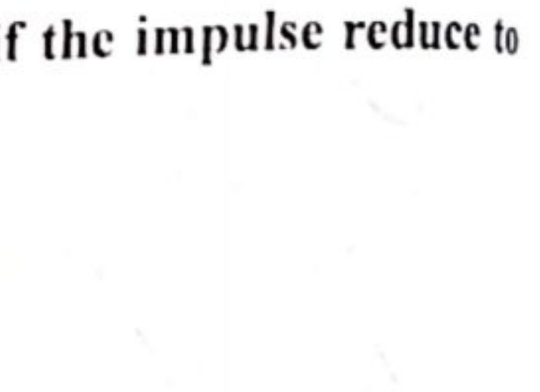
(80) **If the force of 250N acts on an object for 2 seconds then change in momentum will be**
(a) 50Ns (b) 450Ns
(c) 500Ns (d) 125Ns

(81) **In the absence of an unbalanced force, the momentum of an isolated system always**
(a) increase (b) decreases
(c) conserved (d) none of these

2) **Does a moving object has impulse?**
(a) may or may not be (b) yes always
(c) never (d) none of these

3) **The force which might be enough to fracture the naked skull is**
(a) 50N (b) 10N
(c) 15N (d) 5N

4) **A brick is allowed to fell down against air friction then the rate of change fo momentum is**



(a) momentum (b) power
(c) impulse (d) work

5) **The rate of change in momentum is called**
(a) Equal to weight (b) Less then weight
(c) Greater then weight (d) None of these

6) **When the retarding time is increased during the impact then the average force**
(a) increases (b) decreases
(c) zero (d) no change

7) **The motor cycle's safety helmet prevent the serious injury due to padding because it**
(a) extends the time of impact (b) increases impulsive force
(c) decreases the impulsive force (d) both a and c

8) **A tennis ball hits with the wall for collision time of 0.2 sec, if the impulse reduce to 10Ns then the impulsive force will be**
(a) 10N (b) 100N
(c) 5N (d) 50N

Topic 3.8:

Elastic and Inelastic Collision

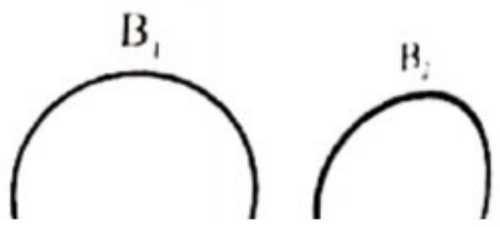
(89) **The collision in which linear momentum as well as K.E is conserved is called**
(a) nearly elastic collision (b) perfectly elastic collision
(c) non elastic collision (d) none of these

(90) **In an inelastic collision**
(a) momentum is conserved (b) energy is conserved
(c) both a & b (d) none

(91) **In case of elastic collision**
(a) magnitude of relative speed of approach equal to the magnitude of relative speed of separation
(b) magnitude of relative speed of approach is doubled of the magnitude of relative speed of separation
(c) magnitude of relative speed of approach greater to magnitude of relative speed of separation
(d) magnitude of relative speed of approach very less to the magnitude of relative speed of separation

(92) **For two colliding balls which condition is applicable for one dimensional elastic collision**
(a) they should be non-rotating (b) they should be smooth
(c) both a and b (d) none of these

(93) **When a very heavy ball 'B_1' collide with a stationary target 'B_2' of negligible mass, after collision the final velocity of ball 'B_2' will**
(a) become zero (b) become half
(c) become doubled as compared to B_1 (d) same as the B_1



(94) **When a ball bounces back from floot such that sound and heat is produced then collision**

(a) Must be elastic
(b) Must be inelastic
(c) Momentum is conserved but K.E is not conserved
(d) Both B and C

Topic 3.9:

Force Due to Water Flow

(95) **When water strikes a wall the force exerted by water on the wall is**

(a) $F=m\vec{v}$ (b) $F=\frac{m\vec{v}}{t}$

(c) $F=\frac{mt}{\vec{v}}$ (d) $F=\frac{m}{\vec{v}}$

(96) **Suppose a water flows out from a pipe at $3kgs^{-1}$ and its velocity changes from $5ms^{-1}$ to zero on striking the wall, then force of water will be**

(a) 15N (b) 20N
(c) $5kgms^{-1}$ (d) $15kgms^{-1}$

(97) **The system on which no external force acts is called**

(a) isolated system (b) open system
(c) non-inertial system (d) thermal system

Topic 3.10:

Momentum and Explosive Forces

(98) **A fighter jet opens fire on the jet then the velocity of the jet itself**

(a) Increases (b) Decreases
(c) Remains same (d) All of these

(99) **A fighter plane drops a bomb when it is at the top of enemies target. Bomb misses the target due to**

(a) horizontal component of velocity (b) action of gravity
(c) vertical component of velocity d) bad weather

Topic 3.11:

Rocket Propulsion

(100) **In the figure a rocket is shown which is properlling upwards. Which of the following statement is true?**

(a) Its acceleration goes on increasing due to decrement of mass
(b) Its K.E is not conserved
(c) Its momentum remains same
(d) Both A & C

(101) **_____ mass of rocket is in the form of fuel**

(a) 60% (b) 70%
(c) 80% (d) 90%

(102) A mass of fuel consumed by a typical rocket to overcome earth's gravity is
(a) 10000 kgs^{-1} (b) 1000kgs^{-1}
(c) 100kgs^{-1} (d) 10kgs^{-1}

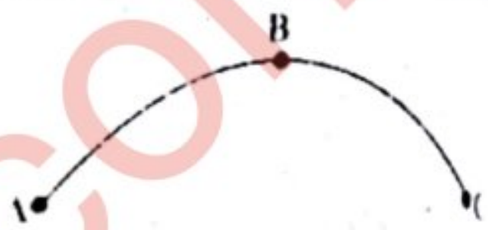
(103) A typical rocket ejects the burnt gases at speeds of over
(a) 400ms^{-1} (b) 4000ms^{-1}
(c) 40ms^{-1} (d) 4.000ms^{-1}

(104) The rocket carries its fuel in the form of
(a) solid only (b) liquid only
(c) solid and liquid (d) gases and solid

Topic 3.12:

Projectile Motion

(105) A parabolic path for a projectile is shown in the figure. At which point acceleration is minimum?

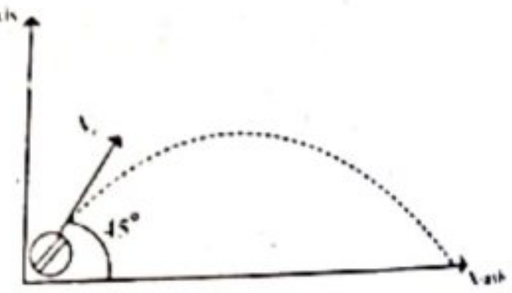


(a) B (b) A
(c) A (d) Not possible

(106) In projectile motion the acceleration in vertical direction is
(a) 9.8 m/s^2 (b) zero
(c) Variable (d) none of these

(107) In projectile motion horizontal velocity
(a) Reduces to zero (b) remains constant
(c) Zero (d) all of these

(108) A projectile is projected upwards with an angle of 45° with x-axis at shown in the figure such that its K.E at projection is 100J. What will be its K.E at the top?



(a) 0J (b) 100J
(c) 25J (d) 50J

(109) Which of them is not a projectile motion?
(a) football kicked off by a player (b) an object dropped from an aero plane
(c) a missile launched from a launching pad (d) a ball thrown vertically up

(110) Projectile motion is a
(a) one dimensional motion (b) two dimensional motion
(c) three dimensional motion (d) none

(111) At the highest point during projectile motion
(a) Acceleration is zero (b) velocity is zero
(c) Vertical component of velocity is zero (d) none of these

(112) At the highest point of a projectile's trajectory the angle between the acceleration and velocity becomes
(a) 0° (b) 45°
(c) 180° (d) 90°

(113) A body is projected at angle '0' with horizontal by velocity v_i, the vertical component of its velocity at any time t is
(a) vi Sin 20 + gt (b) vi Cos 0
(c) vi Cos 0- gt (d) vi sin 0- gt

(114) The horizontal velocity at the point of hitting is given
(a) vi Sin 0 (b) vi Cos 0
(c) vi Cos 0 t (d) vi Cos 0/t

MULTIPLE CHOICE QUESTIONS

(From past papers 2012-2017)

(Federal Board)

(1) A ball is thrown above the horizon, making an angle of 30°. The height attained by the ball is 11.5m. The launching velocity of the balls is _____ (FED 2012)

(a) $20ms^{-1}$ (b) $60ms^{-1}$

(c) $30ms^{-1}$ (d) $45ms^{-1}$

(2) A brick of mass 2.0 kg is dropped from a rest position 5.0 m above the ground. Its velocity at a height of 3.0m above the ground will be _____ (FED 2012)

(a) 3.6 ms^{-1} (b) $8.6ms^{-1}$

(c) $6.3ms^{-1}$ (d) $7.8ms^{-1}$

(3) The component of velocity that remains constant during the projectile motion is its _____. (FED 2013)

(a) Vertical component (b) Horizontal component

(c) Both A and B (d) Initial component

(4) Two bodies of masses 2 kg and 3 kg having final velocities as 2m/sec and 3m/sec, respectively, are initially at rest. Their initial momentum will be _____. (FED 2013)

(a) 7 kg –m.sec^{-1} (b) 0 kg –m.sec^{-1}

(c) 60 kg –m.sec^{-1} (d) None of these

(5) One dyne is equal to _____. (FED 2013)

(a) 10^{3} N (b) 10^{5} N

(c) 10^{-5} N (d) 10^{-3} N

(6) The slope of velocity –time graph at any instant represents_____. (FED 2013)

(a) Gravity (b) Average acceleration

(c) Instantaneous acceleration (d) velocity

(7) If the range of project is half to its maximum range, the angle of projection is _____ (FED 2014)

(a) 30^{o} (b) 22.5^{o}

(c) 15^{o} (d) 45^{o}

(8) The unit of impulse is _____ (FED 2014)

(a) Newton (b) Joule-sec

(c) Joule (d) Newton-sec

(9) A body is moving with constant velocity of 10 ms^{-1} in the north west direction. After 3 seconds its accelerate will be (FDR-2015)

(a) 10 ms^{-2} (b) 20 ms^{-2}

(c) 30 ms^{-2} (d) zero

(10) Time taken by the projectile to move from its point of projection to the point of maximum height is given by (FDR-2015)

(a) $\frac{2v_i \sin\theta}{g}$

(b) $\frac{v_i \sin\theta}{g}$

(c) $\frac{v_i \sin\theta}{2g}$

(d) $\frac{v_i^2}{g}\sin 2\theta$

(11) Maximum range of projectile is given by (FDR-2015)

(a) $\frac{v_i^2}{2g}$

(b) $\frac{2v_i}{g}$

(c) $\frac{v_i^2}{g}$

(d) $\frac{2v_i^2}{g}$

(12) A girl throws a ball vertically upward with a velocity of 20 ms^{-1}. Ignore the air resistance, how long will it take to fall back to her hands? ($g=10ms^{-2}$) (FDR-2016)

(a) 4 seconds

(b) 6 seconds

(c) 2 seconds

(d) 3 seconds

(13) Which of the following quantities is equal to area under velocity-time graph? (FDR-2016)

(a) Power

(b) Distance

(c) Acceleration

(d) Work done

(14) A projectile is thrown with same initial velocity. For which pair of angles its range is equal? (FDR-2016)

(a) 10°,70°

(b) 10°, 80°

(c) 10°, 40°

(d) 10°, 50°

(15) A ball rolls off the edge of a table. The horizontal component of the ball's velocity remains constant during its entire trajectcry because: (FDR-2017)

(a) The net force acting on the ball is zero

(b) The ball is not acted upon by a force in the horizontal direction

(c) The ball is acted upon by a force in the horizontal direction

(d) The ball is acted upon by a force in the only vertical direction

SHORT QUESTIONS

(From Textbook Exercise)

3.1. What is the difference between uniform and variable velocity? From the explanation of variable velocity, define acceleration. Give SI units of velocity and acceleration.

Ans:

Uniform Velocity	Variable Velocity
(i) When a body covers equal displacements in equal intervals of times then the body moves with uniform velocity	When a body covers unequal displacements in equal intervals of time then the body is said to move with variable velocity.
(ii) In this case acceleration is zero.	(ii) In this case acceleration has some value

Acceleration

The time rate of change of velocity of a body is called acceleration. If the velocity of a body changes by an amount $\overrightarrow{\Delta V}$ in time Δt

then $\vec{a}_{av} = \frac{\overrightarrow{\Delta V}}{\Delta t}$

S.I Units

1. The S.I unit of velocity is ms^{-1}.
2. The S.I unit of acceleration is ms^{-2}.

3.2. An object is thrown vertically upward. Discuss the sign of acceleration due to gravity, relative to velocity, while the object is in air.

Ans: When an object is thrown vertically upward, as acceleration due to gravity is directed downward but the velocity is directed upward. Therefore the sign of acceleration due to gravity relative to velocity is negative. When object moves in the downward direction, acceleration and velocity are parallel. So sign of acceleration will be positive.

3.3. Can the velocity of an object reverse the direction when acceleration is constant? If so, give an example.

Ans: Yes, it is possible

Example

When a body is thrown vertically upward, its velocity decreases because of downward force of gravity and becomes zero at the highest point then the body starts moving downward. Upward direction of velocity taken as positive and downward direction of velocity is taken as negative

In the whole motion the magnitude of acceleration due to gravity remains constant.

3.4. Specify the correct statements.

(a) An object can have a constant velocity even its speed is changing.
(b) An object can have a constant speed even its velocity is changing.
(c) An object can have zero velocity even its acceleration is not zero.
(d) An object subjected to a constant acceleration can reverse its velocity.

Ans: All the statements are correct except statement **(a)**.

(b) When object moves along a circle with constant speed, velocity changes due to change in direction.

(c) When a body thrown vertically upward. At the maximum height its velocity zero but acceleration is not zero.

(d) If an object is thrown vertically upward, after getting maximum height its velocity reverses direction and it moves downward. During the whole motion accelerations remains constant.

3.5. A man standing on the top of a tower throws a ball straight up with initial velocity v_i and at the same time throws a second ball straight downward with the same speed. Which ball will have larger speed when it strikes the ground? Ignore air friction.

Ans: Both the up and down balls were thrown with same initial velocity v_i. The ball thrown in upward direction comes back to the starting point with velocity v_i. It starts it's downwards journey with velocity v_i. So the velocities of the balls in downward direction at the point of throw are same. Therefore final velocities will be same.

3.6. Explain the circumstances in which the velocity v and acceleration a of a car are (i) Parallel (ii) Anti-parallel (iii) Perpendicular to one another (iv) v is zero but a is not zero (v) a is zero but v is not zero

Ans: (i) When the velocity of the car is increasing in a straight line then $\vec{v}$ and $\vec{a}$ are parallel.

(ii) When the velocity of the car is decreasing in a straight line then $\vec{v}$ *and* $\vec{a}$ are anti parallel.

(iii) When a car moves in a circle then $\vec{v}$ *and* $\vec{a}$ are perpendicular to each other.

(iv) When an opposing force is acting. The car slow downs and at the end point $\vec{v}$ is zero but $\vec{a}$ is not zero.

(v) When a car is moving with uniform velocity then $\vec{a}$ is zero but $\vec{v}$ is not zero.

3.7. Motion with constant velocity is special case of motion with constant acceleration. Is this statement true? Discuss?

Ans: The acceleration depends on change in velocity. When body moves with constant velocity then $\Delta v = 0, a = \frac{\Delta v}{\Delta t} = 0$ It means velocity changes at a constant rate i.e zero meter per second square. Hence acceleration will remains constant (zero) during motion. This is a special case of motion with constant acceleration.

3.8. Find the change in momentum for an object subjected to a given force for a given time and state law of motion in terms of momentum.

Ans: Let a force $\vec{F}$ acts on a body of mass m, its velocity changes from $\vec{v_i}$ *to* $\vec{v_f}$ in time t seconds. Then the acceleration produced is

$$\vec{a} = \frac{\vec{v_f} - \vec{v_i}}{t}$$

$$\vec{a} = \frac{\vec{F}}{m}$$

Equating the two expressions

$$\frac{\vec{F}}{m} = \frac{\vec{vf} - \vec{vi}}{t}$$

$$\vec{F} = \frac{m\vec{vf} - m\vec{vi}}{t}$$

$$\vec{F} \times t = m\vec{v_f} - m\vec{vi}$$

$$\vec{F} \times t = \vec{\Delta P}$$

Now from above relation, we have

$$\vec{F} = \frac{\Delta \vec{P}}{t}$$

Statement of law of motion in terms of momentum

Time rate of change of momentum of a body equals the applied force.

3.9. Define impulse and show that how it is related to linear momentum?

When the force acts on a body for a very short interval of time then the product of average force and time for which the force acts is called impulse

$$\vec{I} = \vec{F} \times \Delta t$$

As $\vec{F} \times t = m\vec{v_f} - m\vec{v_i}$

$$I = \Delta P$$

Hence Impulse is equal to change in linear momentum.

3.10. State the law of conservation of linear momentum, pointing out the importance of isolated system. Explain, why under certain conditions, the law is useful even though the system is not completely isolated?

Ans: Importance:

For an isolated system, total change in linear momentum due to mutually interacting forces is zero.

Statement:

It states that, the total linear momentum of an isolated system remains constant.

Law is also useful in a situation when mutually interacting forces are much greater then external force because in this situation external force is negligible.

Example

Firing of a bullet from gun.

3.11. Explain the difference between elastic and inelastic collisions. Explain how would a bouncing ball behave in each case? Give plausible reasons for the fact that K.E is not conserved in most cases?

Ans:

Elastic Collision	Inelastic Collision
In Ideal case, when no K.E is lost, the collision is said to be perfectly elastic.	A collision in which the K.E of the system is not conserved is called inelastic collision.

Suppose we drop a ball from a certain height. If it has elastic collision on striking the floor, it will come at the original height but in case of inelastic collision, ball will lose some part of kinetic energy and will not bounce back at the same height.

In most of the cases, some part of kinetic energy is lost as heat and sound energies.

3.12. Explain what is meant by projectile motion. Derive expressions for (a) the time of flight (b) the range of projectile Show that range of projectile is maximum when projectile is thrown at an angle of 45^o with the horizontal.

Ans: See the book

3.13. At what point or points in its path does a projectile have its minimum speed, its maximum speed?

Ans: (i) The projectile has minimum speed at maximum height because at this point the vertical component of the velocity is zero.

(ii) It has maximum speed at the point of projection and point of landing.

(From past papers 2012-2017)
(Federal Board)

1) A 1500 kg car has its velocity reduced from $20ms^{-1}$ to $15ms^{-1}$ in 3.0 sec. How large was the average retarding force? **(FDR 2012)**

2) Can the velocity of an object reverse the direction when acceleration is constant? **(FDR 2012)**

3) What is meant by projectile motion? **(FDR 2012)**

4) Why is the 1st law of motion also titled as the law of inertia? **(FDR 2013)**

5) Two masses m_1 and m_2 are attached to a compressed spring at rest. What will be the ratio of their final velocity? **(FDR 2013)**

6) A projectile is thrown with initial velocity 19.6m/ sec at an angle 30^o with the horizontal. How much time it will take to reach the maximum height? **(FDR 2014)**

7) Why it is the useful to wear safety helmet while driving motorcycle? **(FDR 2015)**

8) Briefly describe the circumstance in which the velocity $\vec{v}$ and acceleration $\vec{a}$ of a car are **(FDR 2015)**

(a) parallel (b) anti parallel (c) perpendicular to one another

9) Safety helmet prevents the motorcyclist from serious injury. Explain. **(FDR 2016)**

10) Find the angle of projection for which maximum height of a projectile is equal to half of its horizontal range. **(FDR 2016)**

11) Find the angle of projection for which its maximum height (Vertical range) achieved and horizontal range of projectile are equal? **(FDR 2017)**

12) A truck weighing 2500 kg and moving with a velocity of 21 m/s collides with stationary car weighing 1000 kg. The truck and the car move together after the impact. Calculate their common velocity. **(FDR 2017)**