# EXERCISE-I

## Fundamentals of Vectors

**1.** 100 coplanar forces each equal to 10 N act on a body. Each force makes angle $\pi/50$ with the preceding force. What is the resultant of the forces

(A) 1000 $N$ (B) 500 $N$
(C) 250 $N$ (D) Zero

**2.** The magnitude of a given vector with end points (4, – 4, 0) and (– 2, – 2, 0) must be

(A) 6 (B) $5\sqrt{2}$
(C) 4 (D) $2\sqrt{10}$

**3.** The expression $\left(\frac{1}{\sqrt{2}}\hat{i}+\frac{1}{\sqrt{2}}\hat{j}\right)$ is a

(A) Unit vector
(B) Null vector
(C) Vector of magnitude $\sqrt{2}$
(D) Scalar

**4.** Given vector $\vec{A}=2\hat{i}+3\hat{j}$, the angle between $\vec{A}$ and $y$-axis is

(A) $\tan^{-1}3/2$ (B) $\tan^{-1}2/3$
(C) $\sin^{-1}2/3$ (D) $\cos^{-1}2/3$

**5.** The unit vector along $\hat{i}+\hat{j}$ is

(A) $\hat{k}$ (B) $\hat{i}+\hat{j}$
(C) $\frac{\hat{i}+\hat{j}}{\sqrt{2}}$ (D) $\frac{\hat{i}+\hat{j}}{2}$

**6.** A vector is represented by $3\hat{i}+\hat{j}+2\hat{k}$. Its length in $XY$ plane is

(A) 2 (B) $\sqrt{14}$
(C) $\sqrt{10}$ (D) $\sqrt{5}$

**7.** Five equal forces of 10 $N$ each are applied at one point and all are lying in one plane. If the angles between them are equal, the resultant force will be

(A) Zero (B) 10 $N$
(C) 20 $N$ (D) $10\sqrt{2}N$

**8.** The angle made by the vector $A=\hat{i}+\hat{j}$ with $x$- axis is

(A) 90° (B) 45°
(C) 22.5° (D) 30°

**9.** Any vector in an arbitrary direction can always be replaced by two (or three)

(A) Parallel vectors which have the original vector as their resultant
(B) Mutually perpendicular vectors which have the original vector as their result an
(C) Arbitrary vectors which have the original vector as their resultant
(D) It is not possible to resolve a vector

**10.** Angular momentum is

(A) A scalar (B) A polar vector
(C) An axial vector (D) None of these

**11.** Which of the following is a vector

(A) Pressure (B) Surface tension
(C) Moment of inertia (D) None of these

**12.** If $\vec{P}=\vec{Q}$ then which of the following is NOT correct

(A) $\hat{P}=\hat{Q}$ (B) $|\vec{P}|=|\vec{Q}|$
(C) $P\hat{Q}=Q\hat{P}$ (D) $\vec{P}+\vec{Q}=\hat{P}+\hat{Q}$

**13.** The position vector of a particle is $\vec{r}=(a\cos\omega t)\hat{i}+(a\sin\omega t)\hat{j}$. The velocity of the particle is

(A) Parallel to the position vector
(B) Perpendicular to the position vector
(C) Directed towards the origin
(D) Directed away from the origin

**14.** Which of the following is a scalar quantity

(A) Displacement (B) Electric field
(C) Acceleration (D) Work

**15.** If a unit vector is represented by $0.5\hat{i}+0.8\hat{j}+c\hat{k}$, then the value of '$c$' is

(A) 1 (B) $\sqrt{0.11}$
(C) $\sqrt{0.01}$ (D) $\sqrt{0.39}$

## Addition and Subtraction of Vectors

**16.** Magnitude of vector which comes on addition of two vectors, $6\hat{i}+7\hat{j}$ and $3\hat{i}+4\hat{j}$ is

(A) $\sqrt{136}$ (B) $\sqrt{13.2}$

(C) $\sqrt{202}$ (D) $\sqrt{160}$

**17.** A particle has displacement of 12 *m* towards east and 5 *m* towards north then 6 *m* vertically upward. The sum of these displacements is

(A) 12 (B) 10.04 *m*

(C) 14.31 *m* (D) None of these

**18.** The three vectors $\vec{A}=3\hat{i}-2\hat{j}+\hat{k}$, $\vec{B}=\hat{i}-3\hat{j}+5\hat{k}$ and $\vec{C}=2\hat{i}+\hat{j}-4\hat{k}$ form

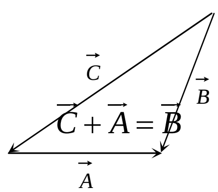
(A) An equilateral triangle

(B) Isosceles triangle

(C) A right angled triangle

(D) No triangle

**19.** For the figure




(A) $\vec{A}+\vec{B}=\vec{C}$

(B) $\vec{B}+\vec{C}=\vec{A}$

(C) $\vec{C}+\vec{A}=\vec{B}$

(D) $\vec{A}+\vec{B}+\vec{C}=0$

**20.** Let $\vec{C}=\vec{A}+\vec{B}$ then

(A) $|\vec{C}|$ is always greater then $|\vec{A}|$

(B) It is possible to have $|\vec{C}|<|\vec{A}|$ and $|\vec{C}|<|\vec{B}|$

(C) $C$ is always equal to $A + B$

(D) $C$ is never equal to $A + B$

**21.** The value of the sum of two vectors $\vec{A}$ and $\vec{B}$ with $\theta$ as the angle between them is

(A) $\sqrt{A^2+B^2+2AB\cos\theta}$

(B) $\sqrt{A^2-B^2+2AB\cos\theta}$

(C) $\sqrt{A^2+B^2-2AB\sin\theta}$

(D) $\sqrt{A^2+B^2+2AB\sin\theta}$

**22.** Following sets of three forces act on a body. Whose resultant cannot be zero

(A) 10, 10, 10 (B) 10, 10, 20

(C) 10, 20, 23 (D) 10, 20, 40

**23.** When three forces of 50 *N*, 30 *N* and 15 *N* act on a body, then the body is

(A) At rest

(B) Moving with a uniform velocity

(C) In equilibrium

(D) Moving with an acceleration

**24.** The sum of two forces acting at a point is 16 *N*. If the resultant force is 8 *N* and its direction is perpendicular to minimum force then the forces are

(A) 6 *N* and 10 *N* (B) 8 *N* and 8 *N*

(C) 4 *N* and 12 *N* (D) 2 *N* and 14 *N*

**25.** If vectors *P*, *Q* and *R* have magnitude 5, 12 and 13 units and $\vec{P}+\vec{Q}=\vec{R}$, the angle between *Q* and *R* is

(A) $\cos^{-1}\frac{5}{12}$ (B) $\cos^{-1}\frac{5}{13}$

(C) $\cos^{-1}\frac{12}{13}$ (D) $\cos^{-1}\frac{7}{13}$

**26.** The resultant of two vectors $\vec{P}$ and $\vec{Q}$ is $\vec{R}$. If $Q$ is doubled, the new resultant is perpendicular to *P*. Then *R* equals

(A) *P* (B) (*P*+*Q*)

(C) *Q* (D) (*P*–*Q*)

**27.** Two forces, $F_1$ and $F_2$ are acting on a body. One force is double that of the other force and the resultant is equal to the greater force. Then the angle between the two forces is

(A) $\cos^{-1}(1/2)$ (B) $\cos^{-1}(-1/2)$

(C) $\cos^{-1}(-1/4)$ (D) $\cos^{-1}(1/4)$

**28.** Given that $\vec{A}+\vec{B}=\vec{C}$ and that $\vec{C}$ is $\perp$ to $\vec{A}$. Further if $|\vec{A}|=|\vec{C}|$, then what is the angle between $\vec{A}$ and $\vec{B}$

(A) $\frac{\pi}{4}$ *radian* (B) $\frac{\pi}{2}$ *radian*

(C) $\frac{3\pi}{4}$ *radian* (D) $\pi$ *radian*

**29.** A body is at rest under the action of three forces, two of which are $\vec{F}_1 = 4\hat{i}, \vec{F}_2 = 6\hat{j}$, the third force is

(A) $4\hat{i} + 6\hat{j}$ (B) $4\hat{i} - 6\hat{j}$
(C) $-4\hat{i} + 6\hat{j}$ (D) $-4\hat{i} - 6\hat{j}$

**30.** A plane is revolving around the earth with a speed of 100 *km/hr* at a constant height from the surface of earth. The change in the velocity as it travels half circle is

(A) 200 *km/hr* (B) 150 *km/hr*
(C) $100\sqrt{2}\, km/hr$ (D) 0

**31.** A person goes 10 *km* north and 20 *km* east. What will be displacement from initial point

(A) 22.36 *km* (B) 2 *km*
(C) 5 *km* (D) 20 *km*

**32.** Two forces $\vec{F}_1 = 5\hat{i} + 10\hat{j} - 20\hat{k}$ and $\vec{F}_2 = 10\hat{i} - 5\hat{j} - 15\hat{k}$ act on a single point. The angle between $\vec{F}_1$ and $\vec{F}_2$ is nearly

(A) 30° (B) 45°
(C) 60° (D) 90°

**33.** Which pair of the following forces will never give resultant force of 2 *N*

(A) 2 *N* and 2 *N* (B) 1 *N* and 1 *N*
(C) 1 *N* and 3 *N* (D) 1 *N* and 4 *N*

**34.** Two forces 3*N* and 2 *N* are at an angle $\theta$ such that the resultant is *R*. The first force is now increased to 6*N* and the resultant become 2*R*. The value of $\theta$ is

(A) 30° (B) 60°
(C) 90° (D) 120°

**35.** Three concurrent forces of the same magnitude are in equilibrium. What is the angle between the forces? Also name the triangle formed by the forces as sides

(A) 60° equilateral triangle
(B) 120° equilateral triangle
(C) 120°, 30°, 30° an isosceles triangle
(D) 120° an obtuse angled triangle

## Multiplication of Vectors

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

(A) – 7 *J* (B) +13 *J*
(C) +7 *J* (D) +11 *J*

**37.** The angle between two vectors $-2\hat{i} + 3\hat{j} + \hat{k}$ and $\hat{i} + 2\hat{j} - 4\hat{k}$ is

(A) 0° (B) 90°
(C) 180° (D) None of the above

**38.** The angle between the vectors $(\hat{i} + \hat{j})$ and $(\hat{j} + \hat{k})$ is

(A) 30° (B) 45°
(C) 60° (D) 90°

**39.** A particle moves with a velocity $6\hat{i} - 4\hat{j} + 3\hat{k}\, m/s$ under the influence of a constant force $\vec{F} = 20\hat{i} + 15\hat{j} - 5\hat{k}\, N$. The instantaneous power applied to the particle is

(A) 35 *J/s* (B) 45 *J/s*
(C) 25 *J/s* (D) 195 *J/s*

**40.** If $\vec{P}.\vec{Q} = PQ$, then angle between $\vec{P}$ and $\vec{Q}$ is

(A) 0° (B) 30°
(C) 45° (D) 60°

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

(A) 10 units (B) 18 units
(C) 11 units (D) 5 units

**42.** The angle between the two vectors $\vec{A} = 5\hat{i} + 5\hat{j}$ and $\vec{B} = 5\hat{i} - 5\hat{j}$ will

(A) Zero (B) 45°
(C) 90° (D) 180°

**43.** The vector $\vec{P} = a\hat{i} + a\hat{j} + 3\hat{k}$ and $\vec{Q} = a\hat{i} - 2\hat{j} - \hat{k}$ are perpendicular to each other. The positive value of *a* is

(A) 3 (B) 4
(C) 9 (D) 13

**44.** A body, constrained to move in the $Y$-direction is subjected to a force given by $\vec{F} = (-2\hat{i} + 15\hat{j} + 6\hat{k})\,N$. What is the work done by this force in moving the body a distance 10 $m$ along the $Y$-axis

(A) 20 $J$ (B) 150 $J$

(C) 160 $J$ (D) 190 $J$

**45.** A particle moves in the $x$-$y$ plane under the action of a force $\vec{F}$ such that the value of its linear momentum $(\vec{P})$ at anytime $t$ is $P_x = 2\cos t,\, p_y = 2\sin t$. The angle $\theta$ between $\vec{F}$ and $\vec{P}$ at a given time $t$. will be

(A) $\theta = 0°$ (B) $\theta = 30°$

(C) $\theta = 90°$ (D) $\theta = 180°$

**46.** The area of the parallelogram represented by the vectors $\vec{A} = 2\hat{i} + 3\hat{j}$ and $\vec{B} = \hat{i} + 4\hat{j}$ is

(A) 14 units (B) 7.5 units

(C) 10 units (D) 5 units

**47.** A vector $\vec{F}_1$ is along the positive $X$-axis. If its vector product with another vector $\vec{F}_2$ is zero then $\vec{F}_2$ could be

(A) $4\hat{j}$ (B) $-(\hat{i} + \hat{j})$

(C) $(\hat{j} + \hat{k})$ (D) $(-4\hat{i})$

**48.** If for two vectors $\vec{A}$ and $\vec{B}, \vec{A} \times \vec{B} = 0$, the vectors

(A) Are perpendicular to each other

(B) Are parallel to each other

(C) Act at an angle of 60°

(D) Act at an angle of 30°

**49.** The angle between vectors $(\vec{A} \times \vec{B})$ and $(\vec{B} \times \vec{A})$ is

(A) Zero (B) $\pi$

(C) $\pi/4$ (D) $\pi/2$

**50.** What is the angle between $(\vec{P} + \vec{Q})$ and $(\vec{P} \times \vec{Q})$

(A) 0 (B) $\frac{\pi}{2}$

(C) $\frac{\pi}{4}$ (D) $\pi$

**51.** Three vectors $\vec{a}, \vec{b}$ and $\vec{c}$ satisfy the relation $\vec{a}.\vec{b} = 0$ and $\vec{a}.\vec{c} = 0$. The vector $\vec{a}$ is parallel to

(A) $\vec{b}$ (B) $\vec{c}$

(C) $\vec{b}.\vec{c}$ (D) $\vec{b} \times \vec{c}$

**52.** The diagonals of a parallelogram are $2\hat{i}$ and $2\hat{j}$. What is the area of the parallelogram

(A) 0.5 units (B) 1 unit

(C) 2 units (D) 4 units

**53.** What is the unit vector perpendicular to the following vectors $2\hat{i} + 2\hat{j} - \hat{k}$ and $6\hat{i} - 3\hat{j} + 2\hat{k}$

(A) $\frac{\hat{i} + 10\hat{j} - 18\hat{k}}{5\sqrt{17}}$ (B) $\frac{\hat{i} - 10\hat{j} + 18\hat{k}}{5\sqrt{17}}$

(C) $\frac{\hat{i} - 10\hat{j} - 18\hat{k}}{5\sqrt{17}}$ (D) $\frac{\hat{i} + 10\hat{j} + 18\hat{k}}{5\sqrt{17}}$

**54.** The area of the parallelogram whose sides are represented by the vectors $\hat{j} + 3\hat{k}$ and $\hat{i} + 2\hat{j} - \hat{k}$ is

(A) $\sqrt{61}$ sq.unit (B) $\sqrt{59}$ sq.unit

(C) $\sqrt{49}$ sq.unit (D) $\sqrt{52}$ sq.unit

**55.** The position of a particle is given by $\vec{r} = (\vec{i} + 2\vec{j} - \vec{k})$ momentum $\vec{P} = (3\vec{i} + 4\vec{j} - 2\vec{k})$. The angular momentum is perpendicular to

(A) $x$-axis

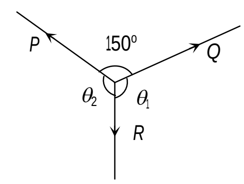
(B) $y$-axis

(C) $z$-axis

(D) Line at equal angles to all the three axes

## Lami's Theorem

**56.** $P$, $Q$ and $R$ are three coplanar forces acting at a point and are in equilibrium. Given $P$ = 1.9318 $kg\ wt$, $\sin\theta_1 = 0.9659$, the value of $R$ is ( in $kg\ wt$)



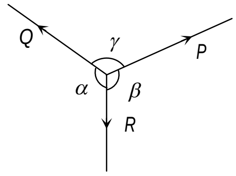

(A) 0.9659

(B) 2

(C) 1

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

**57.** A body is in equilibrium under the action of three coplanar forces $P$, $Q$ and $R$ as shown in the figure. Select the correct




(A) $\dfrac{P}{\sin\alpha} = \dfrac{Q}{\sin\beta} = \dfrac{R}{\sin\gamma}$

(B) $\dfrac{P}{\cos\alpha} = \dfrac{Q}{\cos\beta} = \dfrac{R}{\cos\gamma}$

(C) $\dfrac{P}{\tan\alpha} = \dfrac{Q}{\tan\beta} = \dfrac{R}{\tan\gamma}$

(D) $\dfrac{P}{\sin\beta} = \dfrac{Q}{\sin\gamma} = \dfrac{R}{\sin\alpha}$

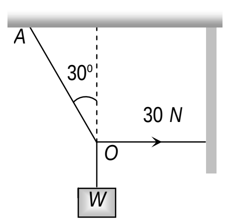
**58.** If a body is in equilibrium under a set of non-collinear forces, then the minimum number of forces has to be

(A) Four (B) Three
(C) Two (D) Five

**59.** How many minimum number of non-zero vectors in different planes can be added to give zero resultant

(A) 2 (B) 3
(C) 4 (D) 5

**60.** As shown in figure the tension in the horizontal cord is 30 $N$. The weight $W$ and tension in the string $OA$ in Newton are




(A) $30\sqrt{3}, 30$

(B) $30\sqrt{3}, 60$

(C) $60\sqrt{3}, 30$

(D) None of these

## Relative Velocity

**61.** Two cars are moving in the same direction with the same speed 30 *km/hr*. They are separated by a distance of 5 *km*, the speed of a car moving in the opposite direction if it meets these two cars at an interval of 4 minutes, will be

(A) 40 *km/hr* (B) 45 *km/hr*
(C) 30 *km/hr* (D) 15 *km/hr*

**62.** A man standing on a road hold his umbrella at 30° with the vertical to keep the rain away. He throws the umbrella and starts running at 10 *km/hr*. He finds that raindrops are hitting his head vertically, the speed of raindrops with respect to the road will be

(A) 10 *km/hr* (B) 20 *km/hr*
(C) 30 *km/hr* (D) 40 *km/hr*

**63.** In the above problem, the speed of raindrops *w.r.t.* the moving man, will be

(A) $10/\sqrt{2}\,km/h$ (B) 5 *km/h*
(C) $10\sqrt{3}\,km/h$ (D) $5/\sqrt{3}\,km/h$

**64.** A boat is moving with a velocity $3i + 4j$ with respect to ground. The water in the river is moving with a velocity $-3i - 4j$ with respect to ground. The relative velocity of the boat with respect to water is

(A) $8j$ (B) $-6i - 8j$
(C) $6i + 8j$ (D) $5\sqrt{2}$

**65.** A 150 m long train is moving to north at a speed of 10 m/s. A parrot flying towards south with a speed of 5 m/s crosses the train. The time taken by the parrot the cross to train would be:

(A) 30 s (B) 15 s
(C) 8 s (D) 10 s

**66.** A river is flowing from east to west at a speed of 5 m/min. A man on south bank of river, capable of swimming 10m/min in still water, wants to swim across the river in shortest time. He should swim

(A) Due north
(B) Due north-east
(C) Due north-east with double the speed of river
(D) None of these

**67.** A person aiming to reach the exactly opposite point on the bank of a stream is swimming with a speed of 0.5 $m/s$ at an angle of $120^0$ with the direction of flow of water. The speed of water in the stream is

(A) 1 $m/s$ (B) 0.5 $m/s$
(C) 0.25 $m/s$ (D) 0.433 $m/s$

**68.** A moves with 65 $km/h$ while $B$ is coming back of $A$ with 80 $km/h$. The relative velocity of $B$ with respect to $A$

(A) 80 $km/h$ (B) 60 $km/h$
(C) 15 $km/h$ (D) 145 $km/h$

**69.** A thief is running away on a straight road on a jeep moving with a speed of 9 $m/s$. A police man chases him on a motor cycle moving at a speed of 10 $m/s$. If the instantaneous separation of jeep from the motor cycle is 100 $m$, how long will it take for the policemen to catch the thief

(A) 1 second (B) 19 second
(C) 90 second (D) 100 second

**70.** A man sitting in a bus travelling in a direction from west to east with a speed of 40 $km/h$ observes that the rain-drops are falling vertically down. To the another man standing on ground the rain will appear

(A) To fall vertically down
(B) To fall at an angle going from west to east
(C) To fall at an angle going from east to west
(D) The information given is insufficient to decide the direction of rain.

## Horizontal Projectile Motion

**71.** A man projects a coin upwards from the gate of a uniformly moving train. The path of coin for the man will be

(A) Parabolic
(B) Inclined straight line
(C) Vertical straight line
(D) Horizontal straight line

**72.** An aeroplane is flying horizontally with a velocity of 600 $km/h$ at a height of 1960 $m$. When it is vertically at a point A on the ground, a bomb is released from it. The bomb strikes the ground at point $B$. The distance $AB$ is

(A) 1200 $m$ (B) 0.33 $km$
(C) 3.33 $km$ (D) 33 $km$

**73.** An aeroplane flying 490 $m$ above ground level at 100 $m/s$, releases a block. How far on ground will it strike

(A) 0.1 $km$ (B) 1 $km$
(C) 2 $km$ (D) None

**74.** A body is thrown horizontally from the top of a tower of height 5 $m$. It touches the ground at a distance of 10 $m$ from the foot of the tower. The initial velocity of the body is ($g$ =10 $ms^{-2}$)

(A) 2.5 $ms^{-1}$ (B) 5 $ms^{-1}$
(C) 10 $ms^{-1}$ (D) 20 $ms^{-1}$

**75.** An aeroplane moving horizontally with a speed of 720 $km/h$ drops a food pocket, while flying at a height of 396.9 $m$. the time taken by a food pocket to reach the ground and its horizontal range is (Take $g$ = 9.8 $m/sec^2$)

(A) 3 $sec$ and 2000 $m$ (B) 5 $sec$ and 500 $m$
(C) 8 $sec$ and 1500 $m$ (D) 9 $sec$ and 1800 $m$

**76.** A particle (A) is dropped from a height and another particle (B) is thrown in horizontal direction with speed of 5 $m/sec$ from the same height. The correct statement is

(A) Both particles will reach at ground simultaneously
(B) Both particles will reach at ground with same speed
(C) Particle (A) will reach at ground first with respect to particle (B)
(D) Particle (B) will reach at ground first with respect to particle (A)

**77.** A particle moves in a plane with constant acceleration in a direction different from the initial velocity. The path of the particle will be

(A) A straight line (B) An arc of a circle
(C) A parabola (D) An ellipse

**78.** At the height 80 $m$, an aeroplane is moving with 150 $m/s$. A bomb is dropped from it so as to hit a target. At what distance from the target should the bomb be dropped (given $g$ = 10 $m/s^2$)

(A) 605.3 *m* (B) 600 *m*

(C) 80 *m* (D) 230 *m*

**79.** A bomber plane moves horizontally with a speed of 500 *m/s* and a bomb released from it, strikes the ground in 10 sec. Angle at which it strikes the ground will be $(g = 10\ m/s^2)$

(A) $\tan^{-1}\left(\frac{1}{5}\right)$ (B) $\tan\left(\frac{1}{5}\right)$

(C) $\tan^{-1}(1)$ (D) $\tan^{-1}(5)$

**80.** A large number of bullets are fired in all directions with same speed $v$. What is the maximum area on the ground on which these bullets will spread

(A) $\pi\frac{v^2}{g}$ (B) $\pi\frac{v^4}{g^2}$

(C) $\pi^2\frac{v^4}{g^2}$ (D) $\pi^2\frac{v^2}{g^2}$

## Oblique Projectile Motion

**81.** Referring to the above two questions, the acceleration due to gravity is given by

(A) $10\,m/\sec^2$ (B) $5m/\sec^2$

(C) $20\ m/\sec^2$ (D) $2.5\ m/\sec^2$

**82.** The range of a particle when launched at an angle of $15^o$ with the horizontal is 1.5 *km*. What is the range of the projectile when launched at an angle of $45^o$ to the horizontal

(A) 1.5 *km* (B) 3.0 *km*

(C) 6.0 *km* (D) 0.75 *km*

**83.** A cricketer hits a ball with a velocity $25\ m/s$ at $60^o$ above the horizontal. How far above the ground it passes over a fielder 50 $m$ from the bat (assume the ball is struck very close to the ground)

(A) 8.2 *m* (B) 9.0 *m*

(C) 11.6 *m* (D) 12.7 *m*

**84.** A stone is projected from the ground with velocity $25\,m/s$. Two seconds later, it just clears a wall 5 *m* high. The angle of projection of the stone is $(g = 10m/\sec^2)$

(A) $30^o$ (B) $45^o$

(C) $50.2^o$ (D) $60^o$

**85.** Galileo writes that for angles of projection of a projectile at angles $(45+\theta)$ and $(45-\theta)$, the horizontal ranges described by the projectile are in the ratio of (if $\theta \le 45$)

(A) 2 : 1 (B) 1 : 2

(C) 1 : 1 (D) 2 : 3

**86.** A projectile thrown with a speed $v$ at an angle $\theta$ has a range $R$ on the surface of earth. For same $v$ and $\theta$, its range on the surface of moon will be

(A) $R/6$ (B) $6R$

(C) $R/36$ (D) $36R$

**87.** The greatest height to which a man can throw a stone is $\sqrt{\frac{F}{mr}}$. The greatest distance to which he can throw it, will be

(A) $2\pi r^2/T$ (B) $\upsilon, \upsilon$ and $\upsilon$

(C) $2h$ (D) $3h$

**88.** The horizontal range is four times the maximum height attained by a projectile. The angle of projection is

(A) $90^o$ (B) $60^o$

(C) $45^o$ (D) $30^o$

**89.** A ball is projected with kinetic energy $E$ at an angle of $45^o$ to the horizontal. At the highest point during its flight, its kinetic energy will be

(A) Zero (B) $\frac{E}{2}$

(C) $\frac{E}{\sqrt{2}}$ (D) $E$

**90.** A particle of mass $m$ is projected with velocity $v$ making an angle of $45^o$ with the horizontal. The magnitude of the angular momentum of the particle about the point of projection when the particle is at its maximum height is (where $g =$ acceleration due to gravity)

(A) Zero (B) $mv^3/(4\sqrt{2}g)$

(C) $mv^3/(\sqrt{2}g)$ (D) $mv^2/2g$

**91.** A particle reaches its highest point when it has covered exactly one half of its horizontal range. The corresponding point on the displacement time graph is characterised by

(A) Negative slope and zero curvature

(B) Zero slope and negative curvature

(C) Zero slope and positive curvature

(D) Positive slope and zero curvature

**92.** At the top of the trajectory of a projectile, the acceleration is

(A) Maximum (B) Minimum

(C) Zero (D) $g$

**93.** When a body is thrown with a velocity $u$ making an angle $\theta$ with the horizontal plane, the maximum distance covered by it in horizontal direction is

(A) $\frac{u^2\sin\theta}{g}$ (B) $\frac{u^2\sin 2\theta}{2g}$

(C) $\frac{u^2\sin 2\theta}{g}$ (D) $\frac{u^2\cos 2\theta}{g}$

**94.** A football player throws a ball with a velocity of 50 *metre/sec* at an angle 30 degrees from the horizontal. The ball remains in the air for $(g = 10\,m/s^2)$

(A) 2.5 *sec* (B) 1.25 *sec*

(C) 5 *sec* (D) 0.625 *sec*

**95.** A body of mass 0.5 *kg* is projected under gravity with a speed of 98 *m/s* at an angle of $30^o$ with the horizontal. The change in momentum (in magnitude) of the body is

(A) $24.5\,N-s$ (B) $49.0\,N-s$

(C) $98.0\,N-s$ (D) $50.0\,N-s$

**96.** A body is projected at such an angle that the horizontal range is three times the greatest height. The angle of projection is

(A) $25^o8'$ (B) $33^o7'$

(C) $42^o8'$ (D) $53^o8'$

**97.** A gun is aimed at a target in a line of its barrel. The target is released and allowed to fall under gravity at the same instant the gun is fired. The bullet will

(A) Pass above the target

(B) Pass below the target

(C) Hit the target

(D) Certainly miss the target

**98.** Two bodies are projected with the same velocity. If one is projected at an angle of $30^o$ and the other at an angle of $60^o$ to the horizontal, the ratio of the maximum heights reached is

(A) 3 : 1 (B) 1 : 3

(C) 1 : 2 (D) 2 : 1

**99.** If the range of a gun which fires a shell with muzzle speed $V$ is $R$, then the angle of elevation of the gun is

(A) $\cos^{-1}\left(\frac{V^2}{Rg}\right)$ (B) $\cos^{-1}\left(\frac{gR}{V^2}\right)$

(C) $\frac{1}{2}\left(\frac{V^2}{Rg}\right)$ (D) $\frac{1}{2}\sin^{-1}\left(\frac{gR}{V^2}\right)$

**100.** If time of flight of a projectile is 10 seconds. Range is 500 *meters*. The maximum height attained by it will be

(A) 125 *m* (B) 50 *m*

(C) 100 *m* (D) 150 *m*

**101.** A ball thrown by one player reaches the other in 2 *sec*. the maximum height attained by the ball above the point of projection will be about

(A) 10 *m* (B) 7.5 *m*

(C) 5 *m* (D) 2.5 *m*

**102.** In a projectile motion, velocity at maximum height is

(A) $\frac{u\cos\theta}{2}$ (B) $u\cos\theta$

(C) $\frac{u\sin\theta}{2}$ (D) None of these

**103.** If two bodies are projected at $30^o$ and $60^o$ respectively, with the same velocity, then

(A) Their ranges are same

(B) Their heights are same

(C) Their times of flight are same

(D) All of these

**104.** A body is thrown with a velocity of 9.8 *m/s* making an angle of $30^o$ with the horizontal. It will hit the ground after a time

(A) 1.5 *s* (B) 1 *s*

(C) 3 *s* (D) 2 *s*

**105.** The equation of motion of a projectile are given by $x = 36\,t$ *metre* and $2y = 96\,t - 9.8\,t^2$ *metre*. The angle of projection is

(A) $\sin^{-1}\left(\frac{4}{5}\right)$ (B) $\sin^{-1}\left(\frac{3}{5}\right)$

(C) $\sin^{-1}\left(\frac{4}{3}\right)$ (D) $\sin^{-1}\left(\frac{3}{4}\right)$

**106.** For a given velocity, a projectile has the same range *R* for two angles of projection if $t_1$ and $t_2$ are the times of flight in the two cases then

(A) $t_1t_2 \propto R^2$ (B) $t_1t_2 \propto R$

(C) $t_1t_2 \propto \frac{1}{R}$ (D) $t_1t_2 \propto \frac{1}{R^2}$

**107.** A body of mass *m* is thrown upwards at an angle $\theta$ with the horizontal with velocity *v*. While rising up the velocity of the mass after *t seconds* will be

(A) $\sqrt{(v\cos\theta)^2 + (v\sin\theta)^2}$

(B) $\sqrt{(v\cos\theta - v\sin\theta)^2 - gt}$

(C) $\sqrt{v^2 + g^2t^2 - (2v\sin\theta)gt}$

(D) $\sqrt{v^2 + g^2t^2 - (2v\cos\theta)gt}$

**108.** A cricketer can throw a ball to a maximum horizontal distance of 100 *m*. With the same effort, he throws the ball vertically upwards. The maximum height attained by the ball is

(A) 100 *m* (B) 80 *m*

(C) 60 *m* (D) 50 *m*

**109.** A cricketer can throw a ball to a maximum horizontal distance of 100 *m*. The speed with which he throws the ball is (to the nearest integer)

(A) 30 $ms^{-1}$ (B) 42 $ms^{-1}$

(C) 32 $ms^{-1}$ (D) 35 $ms^{-1}$

**110.** A ball is projected with velocity $V_o$ at an angle of elevation 30°. Mark the correct statement

(A) Kinetic energy will be zero at the highest point of the trajectory

(B) Vertical component of momentum will be conserved

(C) Horizontal component of momentum will be conserved

(D) Gravitational potential energy will be minimum at the highest point of the trajectory

## Uniform Circular Motion

**111.** A particle is moving in a horizontal circle with constant speed. It has constant

(A) Velocity (B) Acceleration

(C) Kinetic energy (D) Displacement

**112.** A motor cyclist moving with a velocity of 72 *km/hour* on a flat road takes a turn on the road at a point where the radius of curvature of the road is 20 *meters*. The acceleration due to gravity is 10 $m/sec^2$. In order to avoid skidding, he must not bend with respect to the vertical plane by an angle greater

(A) $\theta = \tan^{-1} 6$ (B) $\theta = \tan^{-1} 2$

(C) $\theta = \tan^{-1} 25.92$ (D) $\theta = \tan^{-1} 4$

**113.** A train is moving towards north. At one place it turns towards north-east, here we observe that

(A) The radius of curvature of outer rail will be greater than that of the inner rail

(B) The radius of the inner rail will be greater than that of the outer rail

(C) The radius of curvature of one of the rails will be greater

(D) The radius of curvature of the outer and inner rails will be the same

**114.** The angular speed of a fly wheel making 120 *revolutions/minute* is

(A) $2\pi\ rad/s$ (B) $4\pi^2\ rad/s$

(C) $\pi\ rad/s$ (D) $4\pi\ rad/s$

**115.** A particle is moving on a circular path with constant speed, then its acceleration will be

(A) Zero

(B) External radial acceleration

(C) Internal radial acceleration

(D) Constant acceleration

**116.** A car is moving on a circular path and takes a turn. If $R_1$ and $R_2$ be the reactions on the inner and outer wheels respectively, then

(A) $R_1 = R_2$ (B) $R_1 < R_2$

(C) $R_1 > R_2$ (D) $R_1 \geq R_2$

**117.** A mass of 100 *gm* is tied to one end of a string 2 *m* long. The body is revolving in a horizontal circle making a maximum of 200 revolutions per min. The other end of the string is fixed at the centre of the circle of revolution. The maximum tension that the string can bear is (approximately)

(A) 8.76 *N* (B) 8.94 *N*

(C) 89.42 *N* (D) 87.64 *N*

**118.** A road is 10 *m* wide. Its radius of curvature is 50 *m*. The outer edge is above the lower edge by a distance of 1.5 *m*. This road is most suited for the velocity

(A) 2.5 *m/sec* (B) 4.5 *m/sec*

(C) 6.5 *m/sec* (D) 8.5 *m/sec*

**119.** Certain neutron stars are believed to be rotating at about $1 rev/\sec$. If such a star has a radius of 20 *km*, the acceleration of an object on the equator of the star will be

(A) $20\times10^8 m/\sec^2$ (B) $8\times10^5 m/\sec^2$

(C) $120\times10^5 m/\sec^2$ (D) $4\times10^8 m/\sec^2$

**120.** A particle revolves round a circular path. The acceleration of the particle is

(A) Along the circumference of the circle

(B) Along the tangent

(C) Along the radius

(D) Zero

**121.** The length of second's hand in a watch is 1 *cm*. The change in velocity of its tip in 15 seconds is

(A) Zero (B) $\frac{\pi}{30\sqrt{2}} cm/\sec$

(C) $\frac{\pi}{30} cm/\sec$ (D) $\frac{\pi\sqrt{2}}{30} cm/\sec$

**122.** A particle moves in a circle of radius 25 *cm* at two revolutions per second. The acceleration of the particle in $m/s^2$ is

(A) $\pi^2$ (B) $8\pi^2$

(C) $4\pi^2$ (D) $2\pi^2$

**123.** An electric fan has blades of length 30 *cm* as measured from the axis of rotation. If the fan is rotating at 1200 *r.p.m.* The acceleration of a point on the tip of the blade is about

(A) 1600 $m/\sec^2$ (B) 4740 $m/\sec^2$

(C) 2370 $m/\sec^2$ (D) 5055 $m/\sec^2$

**124.** The force required to keep a body in uniform circular motion is

(A) Centripetal force (B) Centrifugal force

(C) Resistance (D) None of the above

**125.** Cream gets separated out of milk when it is churned, it is due to

(A) Gravitational force (B) Centripetal force

(C) Centrifugal force (D) Frictional force

**126.** A string breaks if its tension exceeds 10 *newtons*. A stone of mass 250 *gm* tied to this string of length 10 *cm* is rotated in a horizontal circle. The maximum angular velocity of rotation can be

(A) 20 *rad/s* (B) 40 *rad/s*

(C) 100 *rad/s* (D) 200 *rad/s*

**127.** A 500 *kg* car takes a round turn of radius 50 *m* with a velocity of 36 *km/hr*. The centripetal force is

(A) 250 *N* (B) 750 *N*
(C) 1000 *N* (D) 1200 *N*

**128.** A ball of mass 0.25 *kg* attached to the end of a string of length 1.96 *m* is moving in a horizontal circle. The string will break if the tension is more than 25 *N*. What is the maximum speed with which the ball can be moved

(A) 14 *m/s* (B) 3 *m/s*
(C) 3.92 *m/s* (D) 5 *m/s*

**129.** A body of mass 5 *kg* is moving in a circle of radius 1*m* with an angular velocity of 2 *radian/sec*. The centripetal force is

(A) 10 *N* (B) 20 *N*
(C) 30 *N* (D) 40 *N*

**130.** If a particle of mass $m$ is moving in a horizontal circle of radius $r$ with a centripetal force $(-k/r^2)$, the total energy is

(A) $-\frac{k}{2r}$ (B) $-\frac{k}{r}$
(C) $-\frac{2k}{r}$ (D) $-\frac{4k}{r}$

**131.** A stone of mass of 16 *kg* is attached to a string 144 *m* long and is whirled in a horizontal circle. The maximum tension the string can withstand is 16 *Newton*. The maximum velocity of revolution that can be given to the stone without breaking it, will be

(A) $20\ ms^{-1}$ (B) $16\ ms^{-1}$
(C) $14\ ms^{-1}$ (D) $12\ ms^{-1}$

**132.** A circular road of radius 1000 *m* has banking angle $45^o$. The maximum safe speed of a car having mass 2000 *kg* will be, if the coefficient of friction between tyre and road is 0.5

(A) 172 *m/s* (B) 124 *m/s*
(C) 99 *m/s* (D) 86 *m/s*

**133.** The second's hand of a watch has length 6 *cm*. Speed of end point and magnitude of difference of velocities at two perpendicular positions will be

(A) 6.28 and 0 *mm/s*
(B) 8.88 and 4.44 *mm/s*
(C) 8.88 and 6.28 *mm/s*
(D) 6.28 and 8.88 *mm/s*

**134.** A sphere of mass $m$ is tied to end of a string of length $l$ and rotated through the other end along a horizontal circular path with speed $v$. The work done in full horizontal circle is

(A) 0 (B) $\left(\frac{mv^2}{l}\right).2\pi l$
(C) $mg.2\pi l$ (D) $\left(\frac{mv^2}{l}\right).(l)$

**135.** A body is whirled in a horizontal circle of radius 20 *cm*. It has angular velocity of 10 *rad/s*. What is its linear velocity at any point on circular path

(A) 10 *m/s* (B) 2 *m/s*
(C) 20 *m/s* (D) $\sqrt{2}$ *m/s*

**136.** A particle of mass *M* moves with constant speed along a circular path of radius *r* under the action of a force *F*. Its speed is

(A) $\sqrt{\frac{rF}{m}}$ (B) $\sqrt{\frac{F}{r}}$
(C) $\sqrt{Fmr}$ (D) $\sqrt{\frac{F}{mr}}$

**137.** In an atom for the electron to revolve around the nucleus, the necessary centripetal force is obtained from the following force exerted by the nucleus on the electron

(A) Nuclear force (B) Gravitational force
(C) Magnetic force (D) Electrostatic force

**138.** A particle moves with constant speed *v* along a circular path of radius *r* and completes the circle in time *T*. The acceleration of the particle is

(A) $2\pi v/T$ (B) $2\pi r/T$
(C) $2\pi r^2/T$ (D) $2\pi v^2/T$

**139.** The maximum velocity (in $ms^{-1}$) with which a car driver must traverse a flat curve of radius 150 $m$ and coefficient of friction 0.6 to avoid skidding is

(A) 60 (B) 30
(C) 15 (D) 25

**140.** A car is moving with high velocity when it has a turn. A force acts on it outwardly because of

(A) Centripetal force (B) Centrifugal force
(C) Gravitational force (D) All the above

**141.** A motor cycle driver doubles its velocity when he is having a turn. The force exerted outwardly will be

(A) Double (B) Half
(C) 4 times (D) $\frac{1}{4}$ times

**142.** The coefficient of friction between the tyres and the road is 0.25. The maximum speed with which a car can be driven round a curve of radius 40 $m$ without skidding is (assume $g = 10\ ms^{-2}$)

(A) 40 $ms^{-1}$ (B) 20 $ms^{-1}$
(C) 15 $ms^{-1}$ (D) 10 $ms^{-1}$

**143.** An athlete completes one round of a circular track of radius 10 $m$ in 40 $sec$. The distance covered by him in 2 $min$ 20 $sec$ is

(A) 70 $m$ (B) 140 $m$
(C) 110 $m$ (D) 220 $m$

**144.** A proton of mass $1.6 \times 10^{-27}$ $kg$ goes round in a circular orbit of radius 0.10 $m$ under a centripetal force of $4 \times 10^{-13}$ $N$. then the frequency of revolution of the proton is about

(A) $0.08 \times 10^8$ *cycles per sec*
(B) $4 \times 10^8$ *cycles per sec*
(C) $8 \times 10^8$ *cycles per sec*
(D) $12 \times 10^8$ *cycles per sec*

**145.** A particle is moving in a circle with uniform speed $v$. In moving from a point to another diametrically opposite point

(A) The momentum changes by $mv$
(B) The momentum changes by $2mv$
(C) The kinetic energy changes by $(1/2)mv^2$
(D) The kinetic energy changes by $mv^2$

## Non-uniform Circular Motion

**146.** A car is moving with speed 30 $m/\sec$ on a circular path of radius 500 $m$. Its speed is increasing at the rate of $2m/\sec^2$, What is the acceleration of the car

(A) $2m/\sec^2$ (B) $2.7m/\sec^2$
(C) $1.8m/\sec^2$ (D) $9.8m/\sec^2$

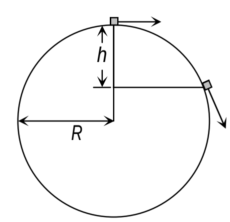
**147.** The string of pendulum of length $l$ is displaced through $90^o$ from the vertical and released. Then the minimum strength of the string in order to withstand the tension, as the pendulum passes through the mean position is

(A) $mg$ (B) $3mg$
(C) $5mg$ (D) $6mg$

**148.** A weightless thread can support tension upto 30 $N$. A stone of mass 0.5 $kg$ is tied to it and is revolved in a circular path of radius 2 $m$ in a vertical plane. If $g = 10m/s^2$, then the maximum angular velocity of the stone will be

(A) 5 $rad/s$ (B) $\sqrt{30}$ $rad/s$
(C) $\sqrt{60}$ $rad/s$ (D) 10 $rad/s$

**149.** A particle originally at rest at the highest point of a smooth vertical circle is slightly displaced. It will leave the circle at a vertical distance $h$ below the highest point such that




(A) $h = R$
(B) $h = \frac{R}{3}$
(C) $h = \frac{R}{2}$
(D) $h = \frac{2R}{3}$

**150.** A heavy mass is attached to a thin wire and is whirled in a vertical circle. The wire is most likely to break

(A) When the mass is at the highest point of the circle

(B) When the mass is at the lowest point of the circle

(C) When the wire is horizontal

(D) At an angle of $\cos^{-1}(1/3)$ from the upward vertical

**151.** A weightless thread can bear tension upto 3.7 *kg wt*. A stone of mass 500 *gms* is tied to it and revolved in a circular path of radius 4 *m* in a vertical plane. If $g = 10\,ms^{-2}$, then the maximum angular velocity of the stone will be

(A) 4 *radians/sec* (B) 16 *radians/sec*

(C) $\sqrt{21}$ *radians/sec* (D) 2 *radians/sec*

**152.** The maximum velocity at the lowest point, so that the string just slack at the highest point in a vertical circle of radius $l$

(A) $\sqrt{gl}$ (B) $\sqrt{3gl}$

(C) $\sqrt{5gl}$ (D) $\sqrt{7gl}$

**153.** If the equation for the displacement of a particle moving on a circular path is given by $(\theta) = 2t^3 + 0.5$, where $\theta$ is in radians and $t$ in seconds, then the angular velocity of the particle after 2 *sec* from its start is

(A) 8 *rad/sec* (B) 12 *rad/sec*

(C) 24 *rad/sec* (D) 36 *rad/sec*

**154.** A body of mass $m$ hangs at one end of a string of length *l*, the other end of which is fixed. It is given a horizontal velocity so that the string would just reach where it makes an angle of $60^o$ with the vertical. The tension in the string at mean position is

(A) $2mg$ (B) $mg$

(C) $3mg$ (D) $\sqrt{3}mg$

**155.** In a vertical circle of radius *r*, at what point in its path a particle has tension equal to zero if it is just able to complete the vertical circle

(A) Highest point

(B) Lowest point

(C) Any point

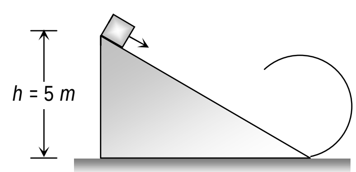
(D) At a point horizontally from the centre of circle of radius *r*

**156.** A stone of mass *m* is tied to a string and is moved in a vertical circle of radius *r* making *n* revolutions per *minute*. The total tension in the string when the stone is at its lowest point is

(A) *mg* (B) $m(g + \pi n r^2)$

(C) $m(g + \pi n r)$ (D) $m\{g + (\pi^2 n^2 r)/900\}$

**157.** As per given figure to complete the circular loop what should be the radius if initial height is 5 *m*




(A) 4 *m*

(B) 3 *m*

(C) 2.5 *m*

(D) 2 *m*

**158.** A coin, placed on a rotating turn-table slips, when it is placed at a distance of 9 *cm* from the centre. If the angular velocity of the turn-table is trippled, it will just slip, if its distance from the centre is

(A) 27 *cm* (B) 9 *cm*

(C) 3 *cm* (D) 1 *cm*

**159.** When a ceiling fan is switched off its angular velocity reduces to 50% while it makes 36 rotations. How many more rotation will it make before coming to rest (Assume uniform angular retardation)

(A) 18 (B) 12

(C) 36 (D) 48

**160.** A body crosses the topmost point of a vertical circle with critical speed. Its centripetal acceleration, when the string is horizontal will be

(A) 6 *g* (B) 3 *g*

(C) 2 *g* (D) *g*

**161.** A simple pendulum oscillates in a vertical plane. When it passes through the mean position, the tension in the string is 3 times the weight of the pendulum bob. What is the maximum displacement of the pendulum of the string with respect to the vertical

(A) $30^o$ (B) $45^o$
(C) $60^o$ (D) $90^o$

**162.** A particle is moving in a vertical circle. The tensions in the string when passing through two positions at angles $30^o$ and $60^o$ from vertical (lowest position) are $T_1$ and $T_2$ respectively. then

(A) $T_1 = T_2$
(B) $T_2 > T_1$
(C) $T_1 > T_2$
(D) Tension in the string always remains the same

**163.** A particle is kept at rest at the top of a sphere of diameter 42 *m*. When disturbed slightly, it slides down. At what height '*h*' from the bottom, the particle will leave the sphere

(A) 14 *m* (B) 28 *m*
(C) 35 *m* (D) 7 *m*

**164.** The coordinates of a moving particle at any time '*t*' are given by $x = \alpha t^3$ and $y = \beta t^3$. The speed of the particle at time '*t*' is given by

(A) $\sqrt{\alpha^2 + \beta^2}$ (B) $3t\sqrt{\alpha^2 + \beta^2}$
(C) $3t^2\sqrt{\alpha^2 + \beta^2}$ (D) $t^2\sqrt{\alpha^2 + \beta^2}$

**165.** A small disc is on the top of a hemisphere of radius $R$. What is the smallest horizontal velocity *v* that should be given to the disc for it to leave the hemisphere and not slide down it ? [There is no friction]

(A) $v = \sqrt{2gR}$ (B) $v = \sqrt{gR}$
(C) $v = \frac{g}{R}$ (D) $v = \sqrt{g^2R}$