3 Description of Motion in 2 and 3 Dimension

1. Two forces are such that the sum of their magnitudes is 18 N and their resultant is 12 N which is perpendicular to the smaller force. Then the magnitudes of the forces are
(a) 12 N, 6 N (b) 13 N, 5 N
(c) 10 N, 8 N (d) 16 N, 2 N.
(2002)

2. A boy playing on the roof of a 10 m high building throws a ball with a speed of 10 m/s at an angle of 30° with the horizontal. How far from the throwing point will the ball be at the height of 10 m from the ground ? [g = 10 m/s^2, sin30° = 1/2, cos30° = $\sqrt{3}/2$]
(a) 5.20 m (b) 4.33 m
(c) 2.60 m (d) 8.66 m.
(2003)

3. The co-ordinates 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) $3t\sqrt{\alpha^2+\beta^2}$ (b) $3t^2\sqrt{\alpha^2+\beta^2}$
(c) $t^2\sqrt{\alpha^2+\beta^2}$ (d) $\sqrt{\alpha^2+\beta^2}$.
(2003)

4. If $\vec{A}\times\vec{B} = \vec{B}\times\vec{A}$, then the angle between A and B is
(a) π (b) $\pi/3$
(c) $\pi/2$ (d) $\pi/4$.
(2004)

5. A projectile can have the same range R for two angles of projection. If T_1 and T_2 be the time of flights in the two cases, then the product of the two time of flights is directly proportional to
(a) $1/R^2$ (b) $1/R$
(c) R (d) R^2.
(2004)

6. Which of the following statements is false for a particle moving in a circle with a constant angular speed?
(a) The velocity vector is tangent to the circle.
(b) The acceleration vector is tangent to the circle
(c) the acceleration vector points to the centre of the circle
(d) the velocity and acceleration vectors are perpendicular to each other.
(2004)

7. A ball is thrown from a point with a speed v_0 at an angle of projection θ. From the same point and at the same instant a person starts running with a constant speed $v_0/2$ to catch the ball. Will the person be able to catch the ball? If yes, what should be the angle of projection?
(a) yes, 60° (b) yes, 30°
(c) no (d) yes, 45°.
(2004)

8. A particle is moving eastwards with a velocity of 5 m/s. In 10 s the velocity changes to 5 m/s northwards. The average acceleration in this time is
(a) zero
(b) $\frac{1}{\sqrt{2}}$ ms^{-2} towards north-west
(c) $\frac{1}{\sqrt{2}}$ ms^{-2} towards north-east

(d) $\frac{1}{2}$ ms^{-2} towards north

(2005)

9. A projectile can have the same range R for two angles of projection. If t_1 and t_2 be the time of flights in the two cases, then the product of the two time of flights is proportional to

(a) $1/R$ (b) R

(c) R^2 (d) $1/R^2$.

(2005)

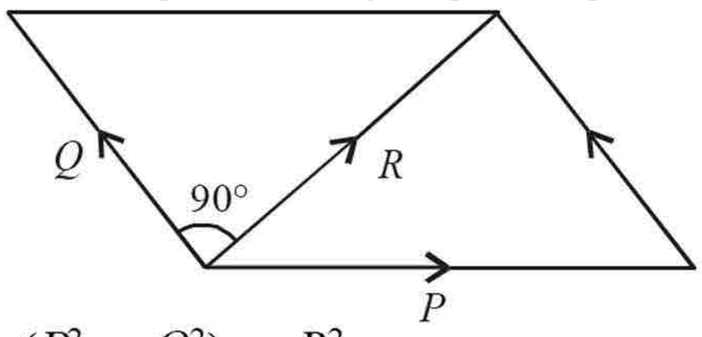
Answer Key

1.	(b)	**2.**	(d)	**3.**	(b)	**4.**	(a)	**5.**	(c)	**6.**	(b)
7.	(a)	**8.**	(b)	**9.**	(b)						

EXPLANATIONS

1. **(b) :** Resultant R is perpendicular to smaller force Q and $(P + Q) = 18$ N

$\therefore$ $P^2 = Q^2 + R^2$ by right angled triangle



or $(P^2 - Q^2) = R^2$

or $(P + Q)(P - Q) = R^2$

or $(18)(P - Q) = (12)^2$ $[\because P+Q=18]$

or $(P - Q) = 8$

Hence $P = 13$ N and $Q = 5$ N.

2. **(d) :** Height of building = 10 m

The ball projected from the roof of building will be back to roof - height of 10 m after covering the maximum horizontal range.

Maximum horizontal range $(R) = \dfrac{u^2 \sin 2\theta}{g}$

or $R = \dfrac{(10)^2 \times \sin 60°}{10} = 10 \times 0.866$

or $R = 8.66$ m.

3. **(b) :** $\because$ $x = \alpha t^3$

$\therefore$ $\dfrac{dx}{dt} = 3\alpha t^2 \Rightarrow v_x = 3\alpha t^2$

Again $y = \beta t^3$

$\therefore$ $\dfrac{dy}{dt} \Rightarrow v_y = 3\beta t^2$ $\therefore$ $v^2 = v_x^2 + v_y^2$

or $v^2 = (3\alpha t^2)^2 + (3\beta t^2)^2 = (3t^2)^2\,(\alpha^2 + \beta^2)$

or $v = 3t^2\sqrt{\alpha^2 + \beta^2}$.

4. **(a) :** $\vec{A} \times \vec{B} = \vec{B} \times \vec{A}$

or $AB \sin\theta\, \hat{n} = AB \sin(-\theta)\, \hat{n}$

or $\sin\theta = -\sin\theta$

or $2 \sin\theta = 0$

or $\theta = 0, \pi, 2\pi.....$

$\therefore$ $\theta = \pi$.

5. **(c) :** Range is same for angles of projection θ and $(90° - \theta)$

$\therefore$ $T_1 = \dfrac{2u \sin\theta}{g}$ and $T_2 = \dfrac{2u \sin(90° - \theta)}{g}$

$\therefore$ $T_1 T_2 = \dfrac{4u^2 \sin\theta\cos\theta}{g^2} = \dfrac{2}{g} \times \left(\dfrac{u^2 \sin 2\theta}{g}\right) = \dfrac{2R}{g}$

$\therefore$ $T_1\ T_2$ is proportional to R.

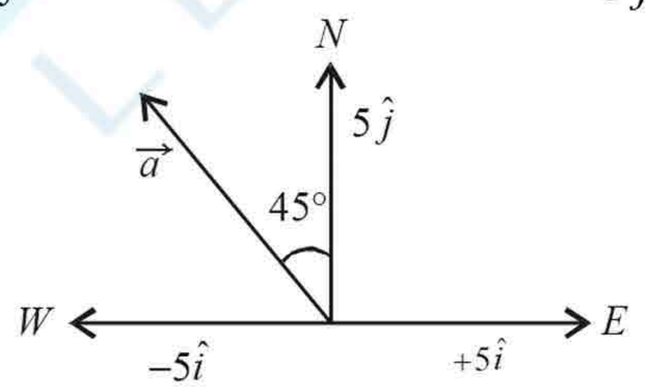
6. **(b) :** The acceleration vector acts along the radius of the circle. The given statement is false.

7. **(a) :** The person will catch the ball if his speed and horizontal speed of the ball are same

$= v_0 \cos\theta = \dfrac{v_0}{2} \Rightarrow \cos\theta = \dfrac{1}{2} = \cos 60°$ $\therefore$ $\theta = 60°$.

8. **(b) :** Velocity in eastward direction $= 5\hat{i}$

velocity in northward direction $= 5\hat{j}$



$\therefore$ Acceleration $\vec{a} = \dfrac{5\hat{j} - 5\hat{i}}{10}$

or $\vec{a} = \dfrac{1}{2}\hat{j} - \dfrac{1}{2}\hat{i}$ or $|\vec{a}| = \sqrt{\left(\dfrac{1}{2}\right)^2 + \left(-\dfrac{1}{2}\right)^2}$

or $|\vec{a}| = \dfrac{1}{\sqrt{2}}$ ms^{-2} towards north-west.

9. **(b) :** Range is same for angles of projection θ and $(90 - \theta)$

$\therefore$ $t_1 = \dfrac{2u \sin\theta}{g}$ and $t_2 = \dfrac{2u \sin(90 - \theta)}{g}$

$\therefore$ $t_1 t_2 = \dfrac{4u^2 \sin\theta\cos\theta}{g^2} = \dfrac{2}{g} \times \left(\dfrac{u^2 \sin 2\theta}{g}\right) = \dfrac{2R}{g}$

$\therefore$ $t_1\ t_2$ is proportional to R.