PHYSICS

BOOKS - NCERT PHYSICS (ENGLISH)

MOTION IN A PLANE

Multiple Choice Questions

1. The angle between $A = \hat{i} + \hat{j}$ and $B = \hat{i} - \hat{j}$ is

A. 45°

B. 90°

C. -45°

D. 180°

Answer: B

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2. Which one of the following statements is true?

A. A scalar quantity is the one that is conserved in a process

B. A scalar quantity is the one that can never take negative values

C. A scalar quantity is the one that does not vary from one point to another in space

D. A scalar quantity has the same value for observers with different orientation of the axes

Answer: D

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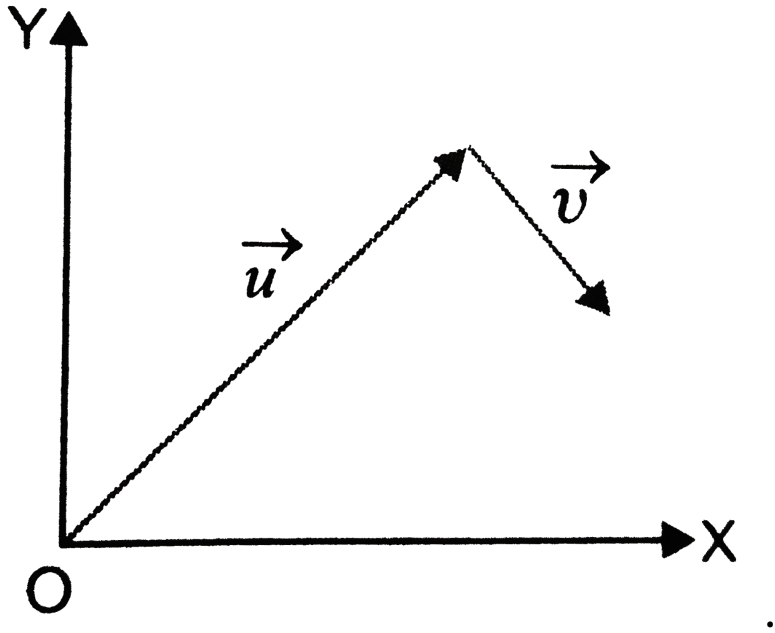
3. Figure shows the orientation of two vectors $\vec{u}$ and $\vec{v}$ in the (XY) plane.

If $\vec{u} = a\hat{i} + b\hat{j}$ and $\vec{v} = p\hat{i} + q\hat{j}$ which of the following is correct ?



Option 1 a and p are positive while b and q are negative

Option 2 a,p and b are positive while q is negative

Option 3 a, q and b are positive while p is negative

Option 4 a, b, p and q are all positive

A. a and p are positive while b and q are negative

B. a,p and b are positive while q is negative

C. a, q and b are positive while p is negative

D. a, b, p and q are all positive

Answer: B

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4. The component of a vector r along X-axis will have maximum value if

Option 1 r is along positive Y-axis

Option 2 r is along positive X-axis

Option 3 r makes an angle of 45° with the X-

axis

Option 4 r is along negative Y-axis

A. r is along positive Y-axis

B. r is along positive X-axis

C. r makes an angle of 45° with the X-axis

D. r is along negative Y-axis

Answer: B

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5. The range of a projectile fired at an angle of 15° is 50 m. If it is fired with the same speed at an angle of 45° its range will be

A. 60 m

B. 71 m

C. 100 m

D. 141 m

Answer: C

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6. Consider the quantities , pressure, power, energy impulse, gravitational potential, electrical charge , temperature, area,Out of these, the only vector quantities are .

A. impulse, pressure and area

B. impulse and area

C. area and gravitational potential

D. impulse and pressure

Answer: B

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7. In a two dimensional motion,instantaneous speed v_0 is a positive constant.Then which of the following are necessarily true?

Option 1 The average velocity is not zero at any time

Option 2 Average acceleration must always vanish

Option 3 Displacements in equal time intervals are equal

Option 4 Equal path lengths are traversed in equal intervals

A. The average velocity is not zero at any time

B. Average acceleration must always vanish

C. Displacements in equal time intervals are equal

D. Equal path lengths are traversed in equal intervals

Answer: D

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8. In a two dimensional motion, instantaneous speed v_0 is a positive constant. Then which of the following are neccessarily true?

A. The acceleration of the particle is zero

B. The acceleration of the particle is bounded

C. The acceleration of the particle is necessarily in the plane of motion

D. The particle must be undergoing a uniform circular motion

Answer: C

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9. Three vectors $\vec{A}, \vec{B}$ and $\vec{C}$ add up to zero.Find which is false.

A. $(A \times B) \times C$ is not zero unless B, C are parallel

B. $(A \times B).C$ is not zero unless B, C are parallel

C. If A, B, C define a plane, $(A \times B) \times C$ is

in that plane

D.

$$(A \times B).C = |A||B||C| \rightarrow C^2 = A^2 + B^2$$

Answer: B::D

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10. It is found that $|A + B| = |A|$,This necessarily implies.

A. B=0

B. A, B are antiparallel

C. A, B are perpendicular

D. $A.\ B \leq 0$

Answer: A::B

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11. Two particles are projected in air with speed v_0 at angles θ_1 and θ_2 (both acute) to the horizontal,respectively.If the height reached by

the first particle greater than that of the second,then thick the right choices

A. Angle of projection $q_1 > q_2$

B. Time of flight $T_1 > T_2$

C. Horizontal range $R_1 > R_2$

D. Total energy $U_1 > U_2$

Answer: A::B::C

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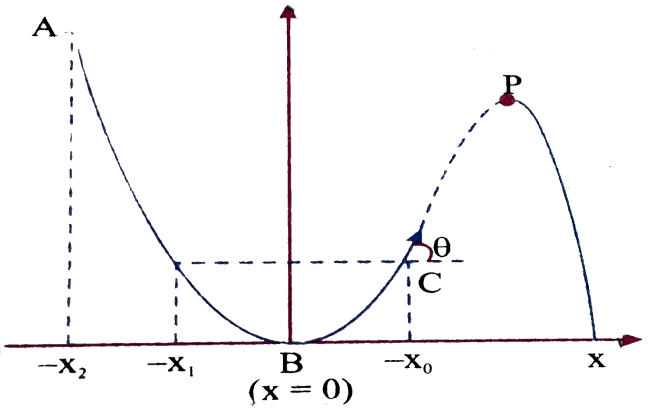
12. A particle slides down a frictionless paraboli $(y = x^2)$ track $(A - B - C)$ starting from rest at point A.Point B is at the vertex of parabola and point C is at a height less than that of point A.After C,the particle moves freely in air as a projectile. If the particle reaches highest point at P,then



A. KE at P = KE at B

B. height at P=height at A

C. total energy at P= total energy at A

D. time of travel from A to B = time of travel from B to P

Answer: C

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13. Following are four different relations about displacement, velocity and acceleration for the

motion of a particle in general. Choose the incorrect one (s)

A. $v_{\text{av}} = \frac{1}{2}[v(t_1) + v(t_2)]$

B. $v_{\text{av}} = \frac{r(t_2) - r(t_1)}{t_2 - t_1}$

C. $r = \frac{1}{2}(v(t_2) - v(t_1))(t_2 - t_1)$

D. $a_{\text{av}} = \frac{v(t_2) - v(t_1)}{t_2 - t_1}$

Answer: A::C

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14. For a particle performing uniform circular motion, choose the correct statement (s) from the following.

A. Magnitude of particle velocity (speed) remains constant

B. Particle velocity remains directed perpendicular to radius vector

C. Direction of acceleration keeps changing as particle moves

D. Angular momentum is constant in magnitude but direction keeps changing

Answer: A::B::C

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15. For two vectors $\vec{A}$ and $\vec{B}$ $\left|\vec{A}+\vec{B}\right| = \left|\vec{A}-\vec{B}\right|$ is always true when.

A. $|A| = |B| \neq 0$

B. $A \perp B$

C. $|A| = |B| \neq 0$ and A and B are parallel or anti-parallel

D. when either |A| or |B| is zero

Answer: B::D

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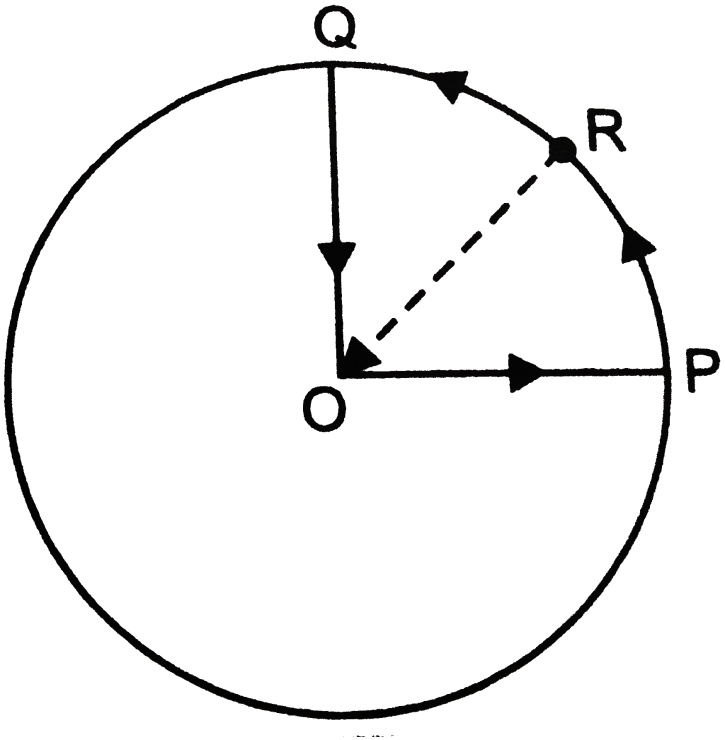
16. A cyclist starts form centre O of a circular park of radius $1km$ and moves along the path $OPRQO$ as shown in the figure . If he maintains constant speed of $10ms^{-1}$, what is

his acceleration at point (R)in magnitude and direction ?



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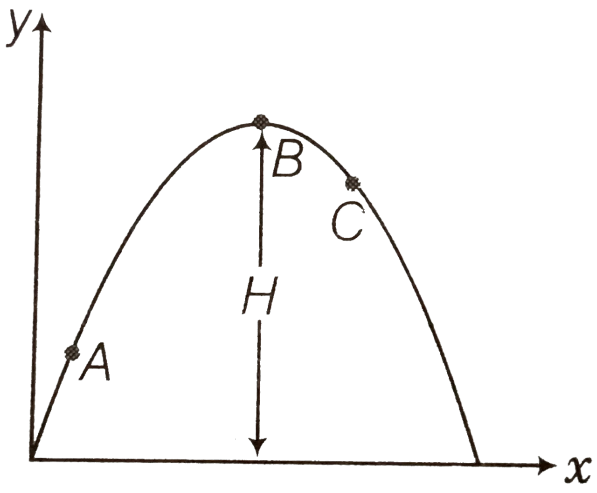
17. A particle is projected in air at some angle to the horizontal, moves along parabola as shown in figure where x and y indicate horizontal and vertical directions, respectively . Shown in the diagram, direction of velocity and acceleration at points A, B and C.



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18. A ball is thrown from a roof top at angle of 40° above the horizontal. It hits the ground a few seconds later. At what point during its motion. Does the ball have

(a) greatest speed (b) smallest speed (c) greatest acceleration ? Explain.

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19. A football is kicked into the air vertically upwards. What is its (a) acceleration, and (b) velocity at the highest point ?

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20. $\vec{A}$, $\vec{B}$ and $\vec{C}$ are three non-collinear, non co-planar vectors. What can you say about direction of $\vec{A} \times \overrightarrow{B \times \vec{C}}$) ?

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21. A boy travelling in an open car moving on a levelled road with constant speed tosses a ball vetically up in the air and catches it back. Shetch the motion of the ball as observed by a boy stanceing on the footpath. Give explanation to support your diagram.

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22. A boy throws a ball in air at 60° to the horizontal along a road with a speed of $10m/s$. Another boy sitting in a car passing by

observes the ball. Sketch the motion of the ball as observed by the boy in the car, If car has a speed of $(18km/h)$. Give explanation to support your diagram.

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23. In dealing with motion of projectile in air, we ignore effect of air resistance on motion. This gives trajectory as a parabola as you have studied. What would the trajectory look like it air resistance is included . Sketch such a

trajectory and explain why you have drawn it that way.

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24. A fighter plane is flying horizontally at an altitude of 1.5 km with speed $720kmh^{-1}$. At what angle of sight (w.r.t horizontal) when the target is seen, should the pilot drop the bomb in order to attack the target? $(Takeg = 10ms^{-2})$

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25. (a) Earth can be thought of as a sphere of radius $6400km$. Any object (or a person) is performing circular motion around the axis on earth due to earth's rotation (period 1 day). What is acceleration of object on the surface of the earth (at equator) towards its centre ? What is its latitude θ ? How does these accelerations compare with $g = 9.8m/s^2$?

(b) Earth also moves in circular orbit around sun every year with an orbital radius of $1.5 \times 10^{11}m$. What is the acceleration of earth

(or any object on the surface of the earth) towards the centre of the sun ? How does this acceleration compare with $g = 9.8ms^2$?

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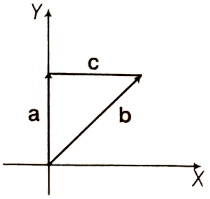
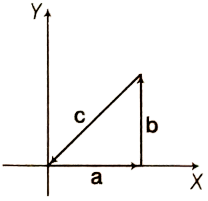
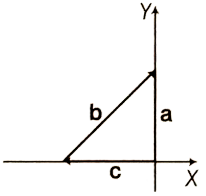
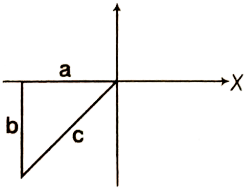
26. Given below in Column I are the relations between vectors a,b and c and in Column II are the orientations of a, b and c in the XY - plane . Match the relation in Column I to correct

orientations in Column II.

Column I	Column II
(a) $\mathbf{a}+\mathbf{b}=\mathbf{c}$	(i) 
(b) $\mathbf{a}-\mathbf{c}=\mathbf{b}$	(ii) 
(c) $\mathbf{b}-\mathbf{a}=\mathbf{c}$	(iii) 
(d) $\mathbf{a}+\mathbf{b}+\mathbf{c}=0$	(iv) 

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27. If $|A|=2$ and $|B| = 4$, then match the relation in Column I with the angle θ between A and B in Column II.

	Column I		Column II
(a)	$A \cdot B = 0$	(i)	$\theta = 0$
(b)	$A \cdot B = +8$	(ii)	$\theta = 90°$
(c)	$A \cdot B = 4$	(iii)	$\theta = 180°$
(d)	$A \cdot B = -8$	(iv)	$\theta = 60°$

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28. If $\left|\overrightarrow{A}\right| = 2$ and $\left|\overrightarrow{B}\right| = 4$, then match the relations in column I with the angleθ between

$\vec{A}$ and $\vec{B}$ in column II.

Column I, Column II

(a) $\left|\vec{A} \times \vec{B}\right| = 0$, (i) $\theta = 30^\circ$

(b) $\left|\vec{A} \times \vec{B}\right| = 0$, (ii) $\theta = 45^\circ$

(c) $\vec{A} \times \vec{B} \mid = 4$, (iii) $\theta = 90^\circ$

(d) $\left|\vec{A} \times x\vec{B}\right| = 4\sqrt{2}$, (iv) $\theta = 0^\circ$.

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29. A hill is $500m$ high. Supplies are to be across the hill using a canon that can hurl packets at a speed of $125m/s$ over the hill .

The canon is located at a distance of $800m$ from the foot to hill and can be veoved on the ground at a speed of 2 m//s , so that its distance from the hill can be adjusted. What is the shortest time inwhich a pachet can reach on the ground across the hill ? Taje $g = 10m/s^2$.

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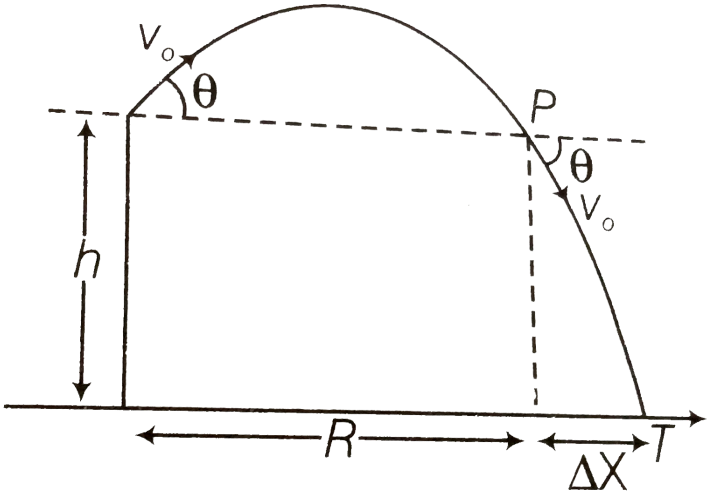
30. A gun can fire shells with maximum speed v_0 and the maximum horizontal range that can

be achieved is $R = \frac{v_0^2}{g}$. If a target farther away by distance Δx (beyond R) has to be hit with the same gun, show that it could that it could be achieved by raising the gun to a height at least $h = \Delta x\left[1 + \frac{\Delta x}{R}\right]$



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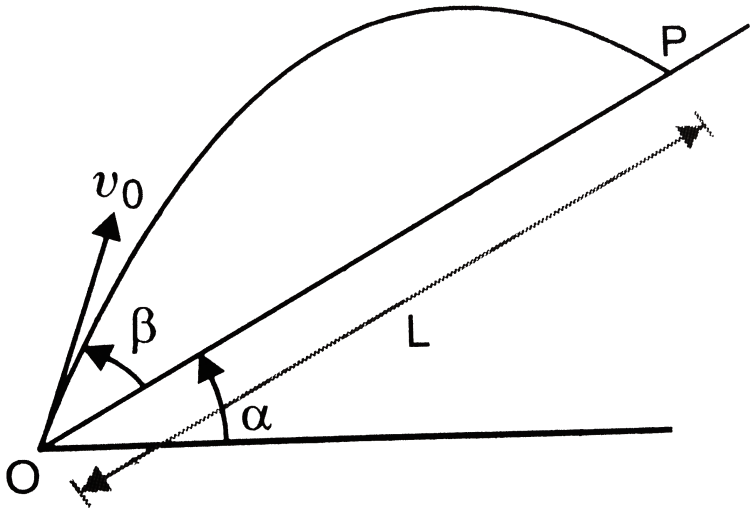
31. A particle is projected in air at an angle β to a surface which itself is inclined at an angle α to the horizontal (Fig. 2 (EP). 26)

(a) Find an expression for range on the plane surface (distance on the plane from the point of projection at which particle will hit the surface). (b) Time of flight. 9c) β at which

range will be maximum.



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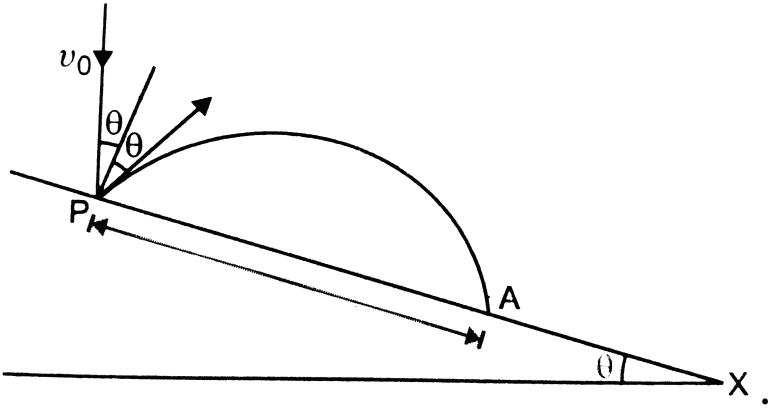
32. A particle falling vertically from a height hits a plane surface inclined to horizontal at an ange θ with speed v_0 and rebounds elastically

(Fig. 2 (RP). 28). Find the distance aling the plane where it will hit second time.



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33. A girl riding a bicycle with a speed of $5m/s$ to wards North direction, observes rain falling vertically down. If she increases her speed to

$10m/s$, rain appeared to meet her at 45° to the vertical . What is the speed of the rain ?

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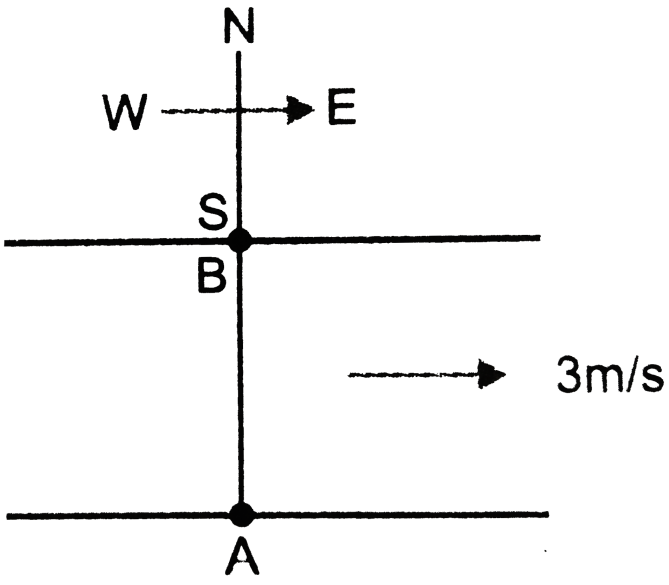
34. A river is flowing due east with a speed $3m/s$ (Fig. 2 (EP) .31).



. (a) If

swimmer starts swimming due north, what will be his resultant velocity (magnitude and direction) ? (b) If he wants to start from point (A) on South bank and reach opposite point (B) on North bank,

(i) Which direction should he swim? (ii) What will be his resultant speed ? (c) From two differenrent casses as mentioned in (a) and 9b) above, in which casse will he reach opposite bank in shorter time ?

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35. A cricket fielder can throw the cricket ball with a speed v_0. If he throws the ball while running with speed (u) at angle θ to the horizontal, find

(b) what will be time of flight ?

(c) what is the distance (horizontal range) form the point of projection at which the ball will land ?

(d) find θ at which he should throw the ball that would maxmise the horizontal range range as found in (c).

(e) how does θ for maximum range change if $u > v_0, u = v_0, \underline{t}v_0$?

(f) how does θ in (e) compare with that for ` u=0 (i.e., 45^@) ?

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36. Motion in two dimensions, in a plane can be studied by expressing position, velocity and acceleration as vectors in cartesian coordinates $A = A_x\hat{i} + A_y\hat{j}$, where $\hat{i}$ and $\hat{j}$ are unit vector along x and y-directions, respectively and A_x and A_y are corresponding components of A. Motion can also be studied

by expressing vectors in circular polar coordinates as $A = A_r\hat{r} + A_\theta\hat{\theta}$, where $\hat{r} = \frac{r}{r} = \cos\theta\hat{i} + \sin\theta\hat{j}$ and $\hat{\theta} = -\sin\theta\hat{i} + \cos\theta\hat{j}$ are unit vectors along direction in which r and θ are increasing.

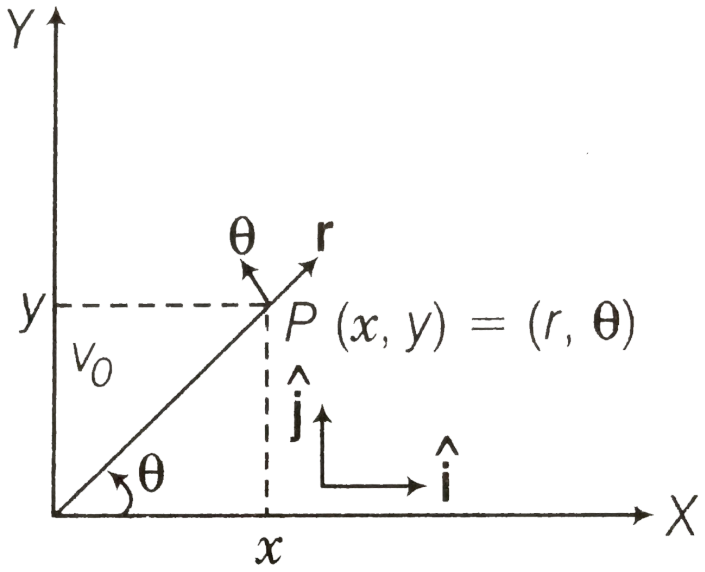
(a) Express $\hat{i}$ and $\hat{j}$ in terms of $\hat{r}$ and $\hat{\theta}$.

(b) Show that both $\hat{r}$ and $\hat{\theta}$ are unit vectors and are perpendicular to each other.

(c) Show that $\frac{d}{dt}(\hat{r}) = \omega\hat{\theta}$, where $\omega = \frac{d\theta}{dt}$ and $\frac{d}{dt}\left(\hat{\theta}\right) = -\theta\hat{r}$.

(d) For a particle moving along a spiral given by $r = a\theta\hat{r}$, where a = 1 (unit), find dimensions of a .

(e) Find velocity and acceleration in polar vector representation for particle moving along spiral described in (d) above.



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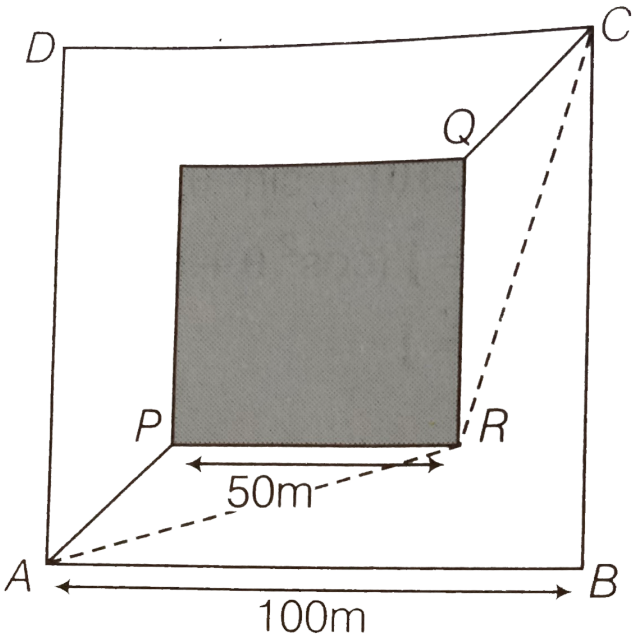
37. A man wants to reach from A to the opposite corner of the square C. The sides of the square are 100 m. A central square of $50m \times 50m$ is filled with sand. Outside this square, he can walk at a speed 1 m/s. In the central square , he can walk only at a speed of v m/s $(v < 1)$. What is smallest value of v for which he can reach faster via a straight path through the sand than any path in the square

outside the sand ?



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