PHYSICS

NCERT - NCERT PHYSICS(GUJRATI)

MOTION IN A PLANE

Example

1. Rain is falling vertically with a speed of $35ms^{-1}$. Winds starts blowing after sometime with a speed of 12 ms in east to

west direction . In which direction should a boy waiting at a bus stop hold his umbrella ?

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2. Find the magnitude and direction of the resultant of two vectors A and B in terms of their magnitudes and angle θ between them .

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3. A motorboay is racing towards north at 25 km/h and the water current in that region is 10km/h in the direction of 60° east of south . Find the resultant velocity of the boat.

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4. The position of a particle is given by

$r = 3.0t\hat{i} + 2.0t^2\hat{j} + 5, 0\hat{k}$

where t is in seconds and the coefficients have the proper units for r to be in matres. (a) Find

v (t) and a(t) of the particle . (b) Find the magnitude and direction of v (t) at t=1.0 s.

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5. A particle stars from origin at t=0 with a velocity $5.0\hat{i}m/s$ and moves in x-y plane under action of a force which produces a constant acceleration of $\left(3.0\hat{i}+2.0\hat{j}\right)m/s^2$. (a) What is the y- coordinate of the particle at the instant its x - coordinate is 84 m ? (b) What is the speed of the particle at this time ?

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6. Rain is fallinf vertically with a speed of 35 ms^{-1} . A women rides a bicycle with a speed of $12ms^{-1}$ in east to west dicrection . What is the direction in which she should hold her umbrella ?

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7. Galileo , in his book Two new sciences , stated that for elevations which exceed or fall

short of 45° by equal amounts , the ranges are equal . Prove this statement.

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8. A hiker stands on the edge of cliff 490 m above the ground and throws a stone horizontally with an initial speed of $15 \quad \mathrm{m\,s}^{-1}$ Neglecting air resistance , find the time taken by the stone to reach the ground , and the speed with which it hits the ground . (Take $g = 9.8 \quad \mathrm{m\,s}^{2}$).

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9. A cricket ball is thrown at a speed of ms^{-1} in a direction 30° above the horizontal . Calculate (a) the maximum height , (b) the time taken by the ball to return to the same thrower to the point where the ball returns to the same level.

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10. An insect trapped in a circular groove of radius 12 cm moves along the groov steadily and completes 7 revolutions in 100 s . (a) What is the angular speed , and the linear speed of the motion ? (b) Is the acceleration vector a constant vector ? What is its magnitude ?

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Excercises

1. State , for each of the following physical quantities , if it is a scalar or a vector : volume , mass , speed , acceleration , density , number of moles , velocity , angular frequency , displacement , angular velocity .

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2. Pick out the two scalar quantities in the following list : force , angular momentum , work current , linear momentum , electric field

, average velocity , magnetic moment , relative velocity.

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3. Pick out the only vector quantity in the following list : Temperature , pressure impulse , time , power , total path length , energy , gravitational potential , coefficient of friction , charge .

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4. State with reasons , whether the following algebraic operations with scalar and vector physical quantities are meaningful :

(a) adding any two scalars , (b) adding a scalar to a vector of the same dimesions , (c) multiplying any vector by any scalar , (d) multiplying any two scalars , (e) adding any two vectors , (f) adding a component of a vector to the same vector .

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5. Read each statement below carefully and state with reasons , if it is true of false :

(a) The magnitude of a vector is always a scalar , (b) each component of a vector is always a scalar , (c) the total path length is always equal to the magnitude of the displacement vector of a particle . (d) the average speed of a either greater or equal to the magnitude of average velocity of the particle over the same interval of time , (e) Three vectors not lying in a plane can never add up to give a null vector .

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6. Establish the following vector inequalities geometrically or otherwise :

(a) $|a+b| \leq |a| + |b|$

(b) $|a+b| \geq ||a| - |b||$

(c) $|a-b| \leq |a| + |b|$

(d) $|a-b| \geq ||a| - |b||$

When does the equality sign above apply ?

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7. Given $a+b+c+d=0$, which of the following statements are correct

(a) a,b,c and d must each be null vector ,

(b) The magnitude of (a+c) equals the magnitude of (b+d),

(c) The magnitude of a can never be greater than the sum of the magnitudes of b ,c and d,

(d) b+c must lie in the plane of and d if a and d are not collinear , and in the line of a and d , if they are collimear ?

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8. On an open ground , a motorist follows a track that turns to his left by an angle of 60° after every 500 m. Starting from a given turn , specify the displacement of of the motorist at the third , sixth and eighth turn . Compare the magnitude of the displacement with the total path length covered by the motorist in each case.

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9. A passenger arriving in a new town wishes to go from the station to a hotel located 10 km away on a straight road from the station . A dishonest cabman takes him along a circuitous path 23 km long and reaches the hotel in 28 min . What is (a) the average speed of the taxt , (b) the magnitude of average velocity ? Are the two equal ?

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10. Rain is falling vertically with a speed of $30ms^{-1}$. A woman rides a bicycle with a speed of $10ms^{-1}$ in the north to south direction . What is the direction in which she should hold her umbrella ?

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11. A man can swim with a speed of 4.0 km/h in still water . How long does he take to cross a river 1.0 km wide if the river flows steadily at

3.0 km/h and he makes his strokes normal to the river current ? How far down the river does he go when he reaches the other bank ?

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12. In a harbour , wind is blowing at the speed of 72 km/h and the flag on the mast of a boat anchored in the harbour flutters along the N-E direction . If the boat starts moving at a speed of 51 km/h to the north , what is the direction of the flag on the mast of the boat?

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13. The celling of a long hall is 25 m high What is the maximum horizontal distance that a ball thrown with a speed of $40\ \mathrm{ms}^{-1}$ can go without hitting the ceiling of the hall ?

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14. A cricketer can throw a ball to a maximum horizontal distance of 100 m. How much high

above the ground can the cricketer throw the same ball ?

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15. A stone tied to the end of astring 80 cm long is whirled in a horizontal circle with a constant speed . If the stone makes 14 revolutions in 25 s , what is the magnitude and direction of acceleration of the stone?

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16. An aircraft executes a horizontal loop of radius 1.00 km with a steady speed of 900km/h. Compare its centripetal acceleration with the acceleration due to gravity .

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17. Read each statement below carefully and state , with reasons , if it is true or false :

(a) The net acceleration of a particle in circular motion is always along the radius of the circle towards the centre

(b) The velocity vector of a particle at point is always along the tangent to the path of the particle at that point

(c) The acceleration vector of a particle in uniform circular motion averaged over one cycle is a nul vector

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18. The position of a particle is given by

$r = 3.0\hat{i} - 2.0t^2\hat{j} + 4.0\hat{k}m$

where t is in seconds and the coefficients have

proper units for r to be in metres .

(a) Find the v and a of the particle ? (b) What is the magnitude and direction of velocity of the particle at $t = 2.0s$?

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19. A particle starts from the origin at t=0 s with a velocity of $10.0\hat{j}m/s$ and moves in the x-y plane with a constant acceleration of $\left(8.0\hat{i} + 2.0\hat{j}\right)\ \mathrm{m\,s^{-2}}$ (a) At what time is the

x - coordinate of the speed of the particle at the time ?

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20. $\hat{i}$ and $\hat{j}$ are unit vectors along x - and y-axis respectively . What is the magnitude and direction of the vectors $\hat{i}+\hat{j}$ and $\hat{i}-\hat{j}$? What are the components of a vector $A=2\hat{i}+3\hat{j}$ along the directions of $\hat{i}+\hat{j}$ and $\hat{i}-\hat{j}$? [You may use graphical method]

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21. For any arbitrary motion in space , which of the following relations are true : (a) $V_{\text{average}} = (1/2)(v(t_1) + v(t_2))$

(b) $V_{\text{average}} = [r(t_2) - r(t_1)]/(t_2 - t_1)$

(c) $V(t) = V(0) + at$

(d) $r(t) = r(0) + v(0)T + (1/2)at^2$

(e) $a_{\text{average}} = [v(t_2) - v(t_1)]/(t_2 - t_1)$

(The average stands for average of the quantity over the time interval t_1 to t_2)

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22. Read each statement below acrefully and state , with reasons and examples , if it is true or false : A scalar quantity is one that

(a) is conserved in a process

(b) can never take negative values

(c) must be dimensionless

(d) does not very from one point to another in space

(e) has the same value for observers with different orientations of axes.

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23. An aircraft is flying at a height of 3400 m above the ground . If the angle subtended at aground observation point by the aircraft positions 10.0 s apart is 30° , what is the speed of the aircraft ?

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24. A very has magnitude and direction . Does it have a location in space ? Can it very with

time ? Will two equal vectors a and b at different locations in space necessarily have identical physical effects ? Give examples in support of your answer .

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25. A vector has both magnitude and direaction . Does it mean that anything that has magnitude and direction is necessarily a vector ? The rotation of a body can be specified by the direction of the axis of

rotation , and the angle of rotation about the axis . Does that make any rotation a vector ?

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26. Can you associate vectors with (a) the length of a wire bent into a loop , (b) a plane are a , (c) a sphere ? Explain .

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27. A bullet fired at an angle of 30° with the horizontal hits the ground 3.0 km away . By adjusting its angle of projection , can one hope to hit a target 5.0 km away ? Assume the muzzle speed to be fixed and neglect air resistance .

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28. A fighter plane flying horizontally at an altitude of 1.5 km with speed 720 km/h passes

directly overhead an anti - aircraft gun . At what angle from the vertical should the gun be fired for the shell with muzzle speed $600 \mathrm{ms}^{-1}$ to hit the plane ? At what minimum altitude should the pilot fly the plane to avoid being hit ? (Take g=10 ms^{-2}).

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29. A cyclist is riding with a speed of 27 km /h . As he approaches a circular turn on the road of radius 80 m , he applies brakes and reduces

his speed at the constant rate of $0.50 m / s$ every second . What is the magnitude and direction of the net acceleration of the cyclist on the circular turn ?

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30. (a) Show that for a projectile the angle between the velocity and the x - axis as a function of time is given by

$$\theta(t) = \tan^{-1}\left(\frac{v_{0y} - \mathrm{gt}}{v_{\circ} x}\right)$$

(b) Shows that the projection angle $\theta_{\circ}$ for a

projectile launched from the origin given by

$$\theta_0 = \tan^{-1}\left(\frac{4h_m}{R}\right)$$

where the symbols have their usual meaning.

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