KD EDUCATION ACADEMY [9582701165]

Time : 6 Hour | **Physics** | **Total Marks : 370**

kd 90+ questions ch-3 motion in a plane

*** Choose The Right Answer From The Given Options.[1 Marks Each] [35]**

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

   (A) 60m (B) 71m (C) 100m (D) 141m

2. From the top of a tower of height 40m, a ball is projected upwards with a speed of 20m/ s at an angle of elevation of 30°. The ratio of the total time taken by the ball to hit the ground to its time of flight time taken to come back to the same elevation) is (Take g = 10m/ s^2)

   (A) 2 : 1 (B) 3 : 1 (C) 3 : 2 (D) 1.5 : 1

3. A vector is of magnitude $10\sqrt{3}$ units and making equal angles with the positive direction of x, y and z axis is:

   (A) $10(\hat{i}+\hat{j}+\hat{k})$

   (B) $10(\hat{i}+2\hat{j}+3\hat{k})$

   (C) $10(-\hat{i}-\hat{j}-\hat{k})$

   (D) $10(\hat{i}-\hat{j}+\hat{k})$

4. The speed of a projectile at the maximum height is $\frac{1}{2}$ its initial speed. Find the ratio of range of projectile to the maximum height attained.

   (A) $4\sqrt{3}$ (B) $\frac{4}{\sqrt{3}}$ (C) $\frac{\sqrt{3}}{4}$ (D) 6

5. The sum of magnitudes of two forces acting at a point is 18 units and the magnitude oftheir resultant is 12 units. The resultant is at 90° with the force of the smaller magnitude. The magnitude of the individual forces is:

   (A) 5, 12 (B) 5, 13

   (C) 6, 14 (D) None of these.

6. The ceiling of a hall is 30m high. A ball is thrown with 60ms^{-1} at an angle θ, so that maximum horizontal distance may be covered. The angle of projection is given by,

   (A) $\sin\theta = \frac{1}{\sqrt{8}}$

   (B) $\sin\theta = \frac{1}{\sqrt{6}}$

   (C) $\sin\theta = \frac{1}{\sqrt{3}}$

   (D) None of these.

7. The displacement of a particle moving on a circular path of radius r when it makes 60° at the centre is:

   (A) 2r (B) r (C) $\sqrt{2}r$ (D) None of these.

8. A girl riding a bicycle with a speed of $5ms^{-1}$ towards North direction sees raindrops falling vertically downwards. On increasing the speed to 15ms rain appears to fall making an angle of 45° of the vertical. Find the magnitude of velocity of rain.

(A) $5ms^{-1}$ (B) $5\sqrt{5}\ ms^{-1}$ (C) $25ms^{-1}$ (D) $10ms^{-1}$

9. A body is projected horizontally with a velocity of $4ms^{-1}$. The velocity of the body after 0.7s is nearly (take g = 10 ms^{-2})

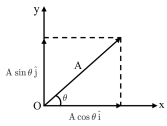
(A) $10ms^{-1}$ (B) $8ms^{-1}$ (C) $19.2ms^{-1}$ (D) $11ms^{-1}$

10. A boy aims a gun at a target from a point, at a horizontal distance of 100m. If the gun can impart a horizontal velocity of $500ms^{-1}$ to the bullet, the height above the target where he must aim his gun, in order to hit it is (Take g = $10ms^{-2}$)

(A) 20cm (B) 10cm (C) 50cm (D) 100cm

11. . The quantities A_x and A_y are called x and y-components of the vector A. Note that A_x is itself not a vector, but $A_x\hat{i}$ is a vector, and so is $A_y\hat{j}$. Using simple trigonometry, we can express A_x and A_y in terms of the magnitude of A and the angle it makes with the x-axis $A_x = A\cos\theta\ A_y = A\sin\theta$ Choose the correct figure on the basis of given description.

(A)



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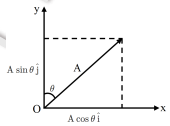

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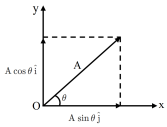


(D) None of these.

12. Two projectiles A and B thrown with speeds in the ratio $1:\sqrt{2}$ acquired the same height. If A is thrown at an angle of 45° with the horizontal, then angle of projection of B will be:

(A) 0° (B) 60° (C) 30° (D) 45°

13. Given, |A + B| = P, |A - B| = Q. The value of $P^2 + Q^2$ is:

(A) $2(A^2 + B^2)$ (B) $A^2 - B^2$ (C) $A^2 + B^2$ (D) $2(A^2 - B^2)$

14. A body is thrown with a velocity of $10ms^{-1}$ at an angle of 60° with the horizontal. Its velocity at the highest point is:

(A) zero (B) $5ms^{-1}$

(C) $10ms^{-1}$ (D) $8.66ms^{-1}$

15. During projectile motion the quantities that remain unchanged are:

(A) Force and vertical velocity.

(B) Acceleration and horizontal velocity.

(C) Kinetic energy and acceleration.

(D) Acceleration and momentum.

16. If $\vec{a}_1$ and $\vec{a}_2$ are two non collinear unit vectors and $|\vec{a}_1 + \vec{a}_2| = \sqrt{3}$, then the value of $(\vec{a}_1 - \vec{a}_2).(2\vec{a}_1 + \vec{a}_2)$ is:

(A) 2 (B) $\frac{3}{2}$

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

17. Two cars A and B move along a concentric circular path of radius r_A and r_B with velocities v_A and v_B maintaining constant distance, then $\frac{v_A}{v_B}$ is equal to:

(A) $\frac{r_B}{r_A}$ (B) $\frac{r_A}{r_B}$

(C) $\frac{r_A^2}{r_B^2}$ (D) $\frac{r_B^2}{r_A^2}$

18. A plane is inclined at an angle of 30° with horizontal. The magnitude of component of a vector $\vec{A} = -10\hat{k}$ perpendicular to this plane is (here z-direction is vertically upwards):

(A) $5\sqrt{2}$

(B) $5\sqrt{3}$

(C) 5

(D) 2.5

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

(A) 45° (B) 90° (C) -45° (D) 180°

20. A man standing on a road has to hold his umbrella at 30° with the vertical to keep the rain away. He throws the umbrella and starts running at 10kmh^{-1}. He finds that raindrops are hitting his head vertically. The actual speed of raindrops is:

(A) 20kmh^{-1} (B) $10\sqrt{3}\text{kmh}^{-1}$

(C) $20\sqrt{3}\text{kmh}^{-1}$ (D) 10kmh^{-1}

21. A particle starts from origin at t = 0 with a velocity $5.0\hat{i}\ \text{ms}^{-1}$ and moves in XY-plane under action of force which produces a constant acceleration of $(3.0\hat{i} + 2.0\hat{j})\ \text{ms}^{-2}$. What is the y-coordinate of the particle at the instant when its x-coordinate is 84m?

(A) 36m (B) 24m

(C) 39m (D) 18m

22. What is the position vector of a point mass moving on a circular path of radius of 10m with angular frequency of 2 rads^{-1} after $\frac{\pi}{8}$s? Initially the point was on Y-axis.

(A) $5.(\hat{i} + \hat{j})$ (B) $5\sqrt{2}(\hat{i} + \hat{j})$

(C) $\hat{i} + \hat{j}$ (D) $\frac{1}{\sqrt{2}}(\hat{i} + \hat{j})$

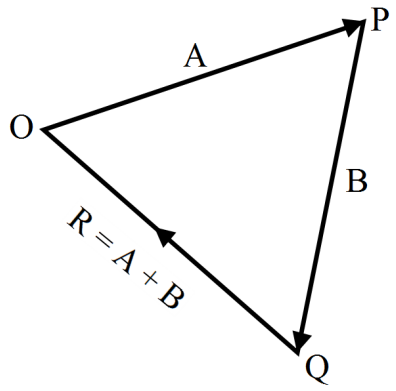
23. The length of seconds hand of a watch is 1cm. The change in velocity of its tip in 15 seconds in cm/ s is:

(A) zero (B) $\frac{x}{(30\sqrt{2})}$

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

24. A and B are two inclined vectors. R is their sum. Choose the correct figure for the given description.

(A)



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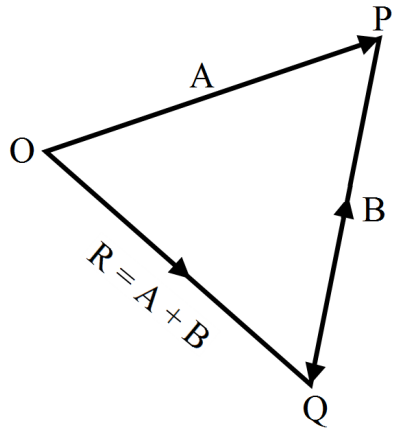

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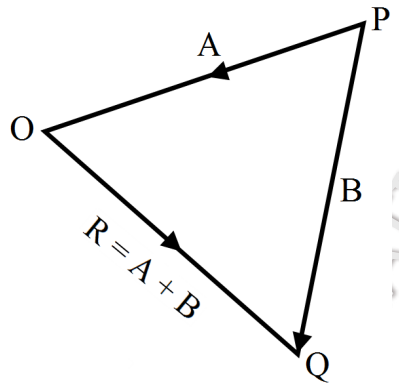

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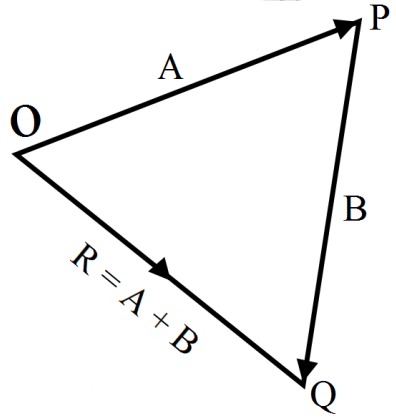


25. If the resultant of three forces $\vec{F}_1 = p\hat{i} + 3\hat{j} - \hat{k}$, $\vec{F}_2 = -5\hat{i} + 2\hat{k}$, and $\vec{F}_3 = 6\hat{i} - \hat{k}$ acting on a particle has a magnitude equal to 5 units, then the value of p is:

(A) -6 (B) -4

(C) 3 (D) 4

26. The simple sum of two forces acting at a point is 16N and their sum is 8N and its direction is perpendicular to the smaller force, then the forces are:

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

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

27. A person moves 30m North, then 20m East then $30\sqrt{2}$ South-West. His displacement from the original position is:

(A) 14m South-West.

(B) 28m South.

(C) 10m West.

(D) 15m East.

28. 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) $\sqrt{0.39}$

29. Angle that the vector $\vec{A} = 2\hat{i} + 2\hat{j}$ makes with y-axis is:

(A) $\tan^{-1}\left(\frac{3}{2}\right)$ (B) $\tan^{-1}\left(\frac{2}{3}\right)$

(C) $\sin^{-1}\left(\frac{2}{3}\right)$ (D) $\cos^{-1}\left(\frac{3}{2}\right)$

30. The relation between the vectors A and -2A is that,

(A) Both have same magnitude.

(B) Both have same direction.

(C) They have opposite directions.

(D) None of the above.

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

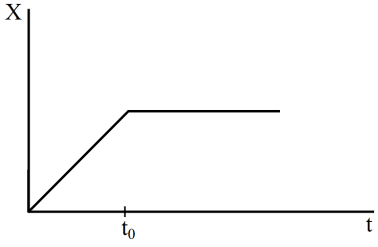
(A) Impulse, pressure and area.

(B) Impulse and area.

(C) Area and gravitational potential.

(D) Impulse and pressure.

32. Figure shows the displacement-time graph of a particle moving on the X-axis.



a. The particle is continuously going in positive x direction.
b. The particle is at rest.
c. The velocity increases up to a time to, and then becomes constant.
d. The particle moves at a constant velocity up to a time to, and then stops.

33. A particle moves along the X-axis as $x = u(t - 2s) + a(t - 2s)^2$.
a. The initial velocity of the particle is u.
b. The accelerati?n of the particle is a.
c. The acceleration of the particle is 2a.
d. At t = 2s particle is at the origin.

34. Two bullets are fired simultaneously, horizontally and with different speeds from the same place. Which bullet will hit the ground first?
a. The faster one.
b. The slower one.
c. Both will reach simultaneously.
d. Depends on the masses.

35. A person standing near the edge of the top of a building throws two balls A and B. The ball A is thrown vertically upward and B is thrown vertically downward with the same speed. The ball A hits the ground with a speed v_A and the ball B hits the ground with a speed v_B. We have:
a. $v_A > v_B$
b. $v_A < v_B$
c. $v_A = v_B$
d. The relation between v_A and v_B depends on height of the building above the ground.

*** Answer The Following Questions In One Sentence.[1 Marks Each] [2]**

36. 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 dimensions.
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.

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

*** Given Section consists of questions of 2 marks each. [36]**

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

should a boy waiting at a bus stop hold his umbrella?

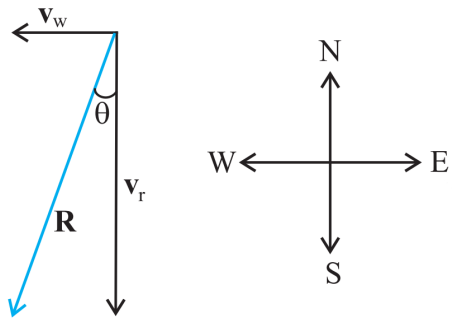


Fig. 3.7

39. A cricket ball is thrown at a speed of $28ms^{-1}$ in a direction 30 above the horizontal. Calculate (a) the maximum height, (b) the time taken by the ball to return to the same level, and (c) the distance from the thrower to the point where the ball returns to the same level.

40. An insect trapped in a circular groove of radius $12cm$ moves along the groove steadily and completes 7 revolutions in $100s$. (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?

41. Find the angle of projection for a projectile motion whose range R is n times the maximum height H.

42. A football is kicked 20m/ s at a projection angle of 45°. A receiver on the goal line 25m away in the direction of the kick runs the same instant to meet the ball. What must be his speed, if he has to catch the ball before it hits the ground?

43. An aeroplane travelling at a speed of 5000km/ hr tilts at an angle of 30° as it makes a turn. What is the radius of the curve?

44. Calculate the area of a parallelogram whose adjacent sides are given by the vectors. $\vec{A} = \hat{i} + 2\hat{j} + 3\hat{k};\ \vec{B} = 2\hat{i} - 3\hat{j} + \hat{k}.$

45. Two forces whose magnitudes are in the ratio 3 : 5 give a resultant of 28N. If the angle of their inclination is 60^o. Find the magnitude of each force.

46. A cyclist has to bend a little inwards from his vertical position while turning. Why?

47. Two bodies are thrown with same velocities at angles α and $(90^\circ - \alpha)$ with the horizontal. What will be the ratio of (i) maximum heights attained by them (ii) their horizontal ranges?

48. A skilled gun man always keeps his gun slightly tilted above the line of sight while shooting. Why?

49. If $\vec{A} = (-2\hat{i} + 3\hat{j} - 4\hat{k})$ and $\vec{B} = (3\hat{i} - 4\hat{j} + 5\hat{k})$ find $\vec{A} \times \vec{B}$ and $\vec{A}.\vec{B}$

50. A swimmer can swim with velocity of 10 km/ h. w.r.t. the water flowing in a river with velocity of 5 km/ h. In what direction should he swim to reach the point on the other bank just opposite to his starting point?

51. A body is projected with a speed v at an angle θ with horizontal to have maximum range. What is the velocity at the highest point?

52. Two forces 5kg-wt. and 10kg-wt. are acting with an inclination of 120° between them. Find the angle when the resultant makes with 10kg-wt.

53. Two bombs of 20kg and 30kg are thrown from a cannon with the same velocity in the same direction. Which bomb will reach the ground first?

54. Determine that vector which when added to the resultant of $\mathrm{A} = 3\hat{\mathrm{i}} - 5\hat{\mathrm{j}} + 7\hat{\mathrm{k}}$ and $\mathrm{B} = 2\hat{\mathrm{i}} + 4\hat{\mathrm{j}} - 3\hat{\mathrm{k}}$ gives unit vector along y-direction.

55. Prove that the vectors $(\hat{\mathrm{i}} + 2\hat{\mathrm{j}} + 3\hat{\mathrm{k}})$ and $(2\hat{\mathrm{i}} - \hat{\mathrm{j}})$ are perpendicular to each other.

*** Given Section consists of questions of 3 marks each. [141]**

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

57. A motorboat is racing towards north at $25km/h$ 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.

58. A particle starts 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 $(3.0\hat{i} + 2.0\hat{j})m/s^2$. (a) What is the y-coordinate of the particle at the instant its x-coordinate is $84m$? (b) What is the speed of the particle at this time?

59. A man can swim with a speed of 4.0km/h in still water. How long does he take to cross a river 1.0km wide if the river flows steadily at 3.0km/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?

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

61. A boy stands at 78.4m from a building and throws a ball which just enters a window 39.2m above the ground. Calculate the velocity of projection of the ball.

62. An aeroplane is flying in a horizontal direction with a velocity of 600km/ hr and at a height of 1960m. When it is vertically above the point A on the ground, a body is dropped from it. The body strikes the ground at point B. Calculate the distance AB.

63. A person aims a gun at a bird from a point at a horizontal distance of 100m. If the gun can impart a speed of 500ms^{-1} to the bullet, at what height above the bird must he aim his gun in order to hit it?

64. A cyclist moving with a velocity of 7.5m s^{-1} approaches a U-turn of radius 80m. He applies brakes to slow down his speed at a rate of 0.5m s^{-2}. Calculate the acceleration of the cyclist on the turn.

65. From the top of a tower 100m in height, a ball is dropped and at the same time another ball is projected vertically upwards from the ground with a velocity of 25ms^{-1}. Find when

and where the two balls will meet? g = 9.8ms^{-2}?

66. A particle has a displacement of 12m towards east and 5m towards north and 6m vertically upwards. Find the magnitude of the sum of these displacements.

67. The range of a rifle bullet is 1000m, when e is the angle of projection. If the bullet is fired with the same angle from a car travelling at 36km/ h towards the target, show that the range will be increased by $142.9\sqrt{\tan\theta}\text{m}$.

68. A man runs across the roof-top of a tall building and jumps horizontally with the hope of landing on the roof of next building which is of lower height than the first. If his speed is 9m/ s, the (horizontal) distance between the two building is 10m and the height difference is 9m, will he able to land on the next building? Substantiate your answer. Take g = 10m/ s^2.

69. A shell bursts on contact with the ground and the fragments fly in all directions with speeds upto 39.2m/ s. Show that a man 78.4m away is in danger for $4\sqrt{2}$ seconds.

70. From the top of a tower 100m in height, a ball is dropped and at the same time another ball is projected vertically upwards from the ground with a velocity of 25ms^{-1}. Find when and where the two balls will meet? g = 9.8ms^{-2}?

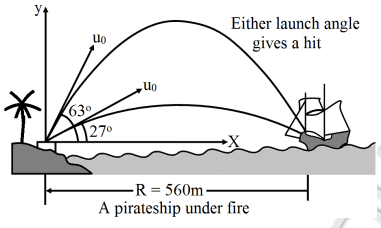
71. Find the angle between force $\vec{\text{F}} = (3\vec{\text{i}} + 4\vec{\text{j}} - 5\vec{\text{k}})$ unit and displacement $\vec{\text{d}} = (5\vec{\text{i}} + 4\vec{\text{j}} + 3\vec{\text{k}})$ unit. Also find the projection of $\vec{\text{F}}$ on $\vec{\text{d}}$.

72. Calculate the angular speed of the seconds hand of a clock. If the length of the seconds hand is 4cm, calculate the speed of the tip of the seconds hand.

73. Find a unit vector parallel to the vector $3\hat{\text{i}} + 7\hat{\text{j}} + 4\hat{\text{k}}$.

74. The maximum height attained by a projectile is increased by 10% by increasing its speed of projection, without changing the angle of projection. What will the percentage increase in the horizontal range?

75. Figure shows a pirateship 560m from a fort defending a harbour entrance. A defence cannon, located at sea level, fires balls at initial speed, u_0 = 82m/ s.



i. At what angle, θ_0 from the horizontal must a ball be fired to hit the ship?
ii. What is the maximum range of the cannon balls?

76. An accelerating train is passing over a high bridge. A stone is dropped from the train at an instant when its speed is 10m/ s and acceleration is 1m/ s^2. Find the horizontal and vertical components of the velocity and acceleration of the stone one second after it is dropped. Take g = 10m/ s^2.

77. A man can jump on moon about six times as high as on the earth. Why?

78. Show that vectors $\text{A} = 2\hat{\text{i}} - 3\hat{\text{j}} - \hat{\text{k}}$ and $\text{B} = -6\hat{\text{i}} + 9\hat{\text{j}} + 3\hat{\text{k}}$ are parallel.

79. An aeroplane is flying in a horizontal direction with a velocity of 600km/ h and at a height of 1960m. When it is vertically above the point A on the ground, a body is dropped from it. The body strikes the ground at point B. Calculate the distance AB.

80. Prove that the path of a projectile is a parabola.

81. Show that the projection angle θ_0 for a projectile launched from the origin is given by, $\theta_0 = \tan^{-1}\left(\frac{4\mathrm{H}}{\mathrm{R}}\right)$ where, H is the maximum height attained by the projectile and R is the range of the projectile.

82. The position of a particle is given by: $\vec{\mathrm{r}} = 3.0\mathrm{t}\,\hat{\mathrm{i}} - 2.0\mathrm{t}^2\,\hat{\mathrm{j}} + 4\hat{\mathrm{k}}\ \mathrm{m}$ where t is in seconds, r is in metres and the coefficients have the proper units.
    a. Find the velocity v and acceleration a.
    b. What is the magnitude of velocity of the particle at t = 2s?

83. Determine a unit vector which is perpendicular to both $\vec{\mathrm{A}} = 2\hat{\mathrm{i}} + \hat{\mathrm{j}} + \hat{\mathrm{k}}$ and $\vec{\mathrm{B}} = \hat{\mathrm{i}} - \hat{\mathrm{j}} + 2\hat{\mathrm{k}}$.

84. A bullet fired at an angle of 30° with the horizontal hits the ground 3km away. By adjusting its angle of projection, can one hope to hit a target 5km away? Assume the muzzle speed to be fixed, and neglect air resistance. (Take g = 10ms^{-2})

85. The sum of the magnitude of two forces acting at a point is 18N and the magnitude of their resultant is 12N. If the resultant is at 90° with the force of smaller magnitude, what are the magnitude of forces?

86. A fighter jet makes a loop of 1000m with a speed of 250m s^{-1}. Compare its centripetal acceleration with the acceleration due to gravity.

87. A ball is thrown from a roof top at an angle of 45° above the horizontal. It hits the ground a few seconds later. At what point during its motion, does the ball have. Explain?
    a. greatest speed.
    b. smallest speed.
    c. greatest acceleration?

88. Earth also moves in circular orbit around sun once every year with on orbital radius of 1.5 × 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 = 9.8m/ s^2? $\left(\mathrm{Hint:\ acceleration}\frac{\mathrm{V}^2}{\mathrm{R}} = \frac{4\pi^2\mathrm{R}}{\mathrm{T}^2}\right)$

89. A ball is thrown from a roof top at an angle of 45° above the horizontal. It hits the ground a few seconds later. At what point during its motion, does the ball have. Explain?
    a. greatest speed.
    b. smallest speed.
    c. greatest acceleration?

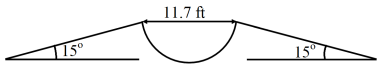
90. A boy throws a ball in air at 60° to the horizontal along a road with a speed of 10m/ s (36km/ h). Another boy sitting in a passing by car observes the ball. Sketch the motion of the ball as observed by the boy in the car, if car has a speed of (18km/ h). Give explanation to support your diagram.

91. A ball is projected vertically upward with a speed of 50m/s. Find:
    a. The maximum height.

b. The time to reach the maximum height.

c. The speed at half the maximum height. Take g = 10m/s^2.

92. Figure shows a 11.7ft wide ditch with the approach roads at an angle of 15° with the horizontal. With what minimum speed should a motorbike be moving on the road so that it safely crosses the ditch? Assume that the length of the bike is 5ft, and it leaves the road when the front part runs out of the approach road.



93. A ball is thrown at a speed of 40m/s at an angle of 60° with the horizontal. Find:

a. The maximum height reached.

b. The range of the ball. Take g = 10m/s^2.

94. Six particles situated at the corners of a regular hexagon of side a move at a constant speed v. Each particle maintains a direction towards the particle at the next corner. Calculate the time the particles will take to meet each other.

95. A river 400m wide is flowing at a rate of 2.0m/s. A boat is sailing at a velocity of 10m/s with respect to the water, in a direction perpendicular to the river.

a. Find the time taken by the boat to reach the opposite bank.

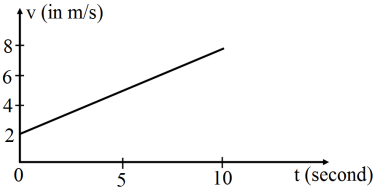
b. How far from the point directly opposite to the starting point does the boat reach the opposite bank?

96. Figure shows the graph of velocity versus time for a particle going along the X-axis. Find:

a. The acceleration.

b. The distance travelled in 0 to 10s.

c. The displacement in 0 to 10s.



97. A man is sitting on the shore of a river. He is in the line of a 1.0m long boat and is 5.5m away from the centre of the boat. He wishes to throw an apple into the boat. If he can throw the apple only with a speed of 10m/s, find the minimum and maximum angles of projection for successful shot. Assume that the point of projection and the edge of the boat are in the same horizontal level.

98. A person standing on the top of a cliff 171ft high has to throw a packet to his friend standing on the ground 228ft horizontally away. If he throws the packet directly aiming at the friend with a speed of 15.0ft/s, how short will the packet fall?

99. A person sitting on the top of a tall building is dropping balls at regular intervals of one second. Find the positions of the 3rd, 4th and 5th ball when the 6th ball is being dropped.

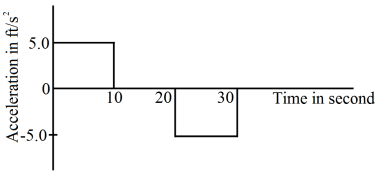
100. A ball is dropped from a height. If it takes 0.200s to cross the last 6.00m before hitting the ground, find the height from which it was dropped. Take g = 10m/s^2.

101. A man has to go 50m due north, 40m due east and 20m due south to reach a field.

a. What distance he has to walk to reach the field?

b. What is his displacement from his house to the field?

102. The acceleration of a cart started at t = 0, varies with time as shown in figure. Find the distance travelled in 30 seconds and draw the position-time graph.



*** Given Section consists of questions of 5 marks each. [140]**

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

104. A cricketer can throw a ball to a maximum horizontal distance of 100m. How much high above the ground can the cricketer throw the same ball?

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

106. A fighter plane flying horizontally at an altitude of 1.5km with speed 720km/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 600ms^{-1} to hit the plane? At what minimum altitude should the pilot fly the plane to avoid being hit? (Take g = 10ms^{-2}).

107. A particle starts from the origin at t = 0s with a velocity of $10.0\hat{\mathrm{j}}\,\mathrm{m/s}$ and moves in the x - y plane with a constant acceleration of $(8.0\hat{\mathrm{i}} + 2.0\hat{\mathrm{j}})\mathrm{ms}^{-2}$. (a) At what time is the x-coordinate of the particle 16m? What is the y-coordinate of the particle at that time? (b) What is the speed of the particle at the time?

108. The position of a particle is given by $\mathrm{r} = 3.0\mathrm{t}\hat{\mathrm{i}} - 2.0\mathrm{t}^2\hat{\mathrm{j}} + 4.0\hat{\mathrm{k}}\,\mathrm{m}$ Where t is in seconds and the coefficients have the 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?

109. A hill is 500m high. Supplies are to be sent 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 of hill and can be moved on the ground at a speed of 2m/ s; so that its distance from the hill can be adjusted. What is the shortest time in which a packet can reach on the ground across the hill? Take g =10m/ s^2.

110. A fighter plane flying horizontally at an altitude of 1.5km with speed 720km/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 600ms^{-1} to hit the plane? At what minimum altitude should the pilot fly the plane to avoid being hit? (Take g = 10ms^{-2}).

111. A girl riding a bicycle with a speed of 5m/ s towards north direction, observes rain falling vertically down. If she increases her speed to 10m/ s, rain appears to meet her at 45° to the vertical. What is the speed of the rain? In what direction does rain fall as observed by a ground based observer? (**Hint:** Assume north to be $\hat{\mathrm{i}}$ direction and vertically downward to be $-\hat{\mathrm{j}}$. Let the rain velocity $\mathrm{v_r}$ be $\mathrm{a}\hat{\mathrm{i}} + \mathrm{b}\hat{\mathrm{j}}$. The velocity of rain as observed by the girl is always V_r-V_{girl}. Draw the vector diagram/s for the information

given and find a and b. You may draw all vectors in the reference frame of ground based observer)

112. Define angular velocity and angular acceleration. The total speed V_1 of a projectile at its greatest height is $\sqrt{\frac{6}{7}}$ of its speed V_2 when it is at half its greatest height. Show that the angle of projection is 30°.

113. A man whirls a stone round his head on the end of a string 4m long. Can the string be in a horizontal plane? If the stone has a mass of 0.4kg, and the string will break if the tension in it exceed 8N, what is the smallest angle the string can make with the horizontal ? What is the speed of the stone? (take g = $10ms^{-2}$)

114. A cricket ball is thrown at a speed of 28m/ s in a direction 30° above the horizontal. Calculate:
   a. The maximum height.
   b. The time taken by the ball to return to the same level.
   c. The horizontal distance from the point of projection to the point where the ball returns to the same level.

115. A particle is thrown over a triangle from one end of a horizontal base that grazing the vertex falls on the other end of the base. If α and β be the base angles and θ the angle of projection; prove that: $\tan\theta = \tan\alpha + \tan\beta$.

116. A projectile shot at an angle of 60° above the horizontal ground strikes a vertical wall 30m away at a point 15m above the ground. Find the speed with which the projectile was launched and the speed with which it strikes the wall.

117. A projectile is fired horizontally with a velocity of $98ms^{-1}$ from the hill 490m high. Find (i) time taken to reach the ground (ii) the distance of the target from the hill and (iii) the velocity with which the body strikes the ground.

118. On an open ground, a motorist follows a track that turns to his left by an angle of 60° after every 500m. Starting from a given turn, specify the displacement 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.

119. A fighter plane is flying horizontally at an altitude of 1.5km with speed 720km/ h. 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?

120. A ball is thrown vertically upwards with a velocity of 20m/ s from the top of a building of height 25m from the ground,
   a. How high will the ball reach?
   b. How long will it take for the ball to reach the ground?
   c. Trace the trajectory of motion of this ball.

121. A gun kept on a straight horizontal road is used to hit a car travelling along the same road away from the gun with a uniform speed of 72km/ h. The car is at a distance of 500m from the gun when the gun is fired at an angle of 45° to the horizontal. Find,
   i. The distance of the car from the gun when the shell hits it.
   ii. The speed of projection of the shell from the gun.

122. An airline passenger late for a flight walks on an airport moving sidewalk at a speed of 5.00km/ h relative to the sidewalk in the direction ofits motion. The sidewalkis moving at

3.00km/ h relative to the ground and has a total length of 135m.

i. What is the passenger's speed relative to the ground?
ii. How long does it take him to reach the end of the sidewalk?
iii. How much of the sidewalk has he covered by the time he reaches the end?

123. A train starts from rest and moves with a constant acceleration of 2.0m/s^2 for half a minute. The brakes are then applied and the train comes to rest in one minute. Find:

a. The total distance moved by the train.
b. The maximum speed attained by the train.
c. The position(s) of the train at half the maximum speed.

124. A person is standing on a truck moving with a constant velocity of 14.7m/s on a horizontal road. The man throws a ball in such a way that it returns to the truck after the truck has moved 58.8m. Find the speed and the angle of projection:

a. As seen from the truck.
b. As seen from the road.

125. A ball is thrown horizontally from a point 100m above the ground with a speed of 20m/s. Find:

a. The time it takes to reach the ground.
b. The horizontal distance it travels before reaching the ground.
c. The velocity (direction and magnitude) with which it strikes the ground.

126. It is 260km from Patna to Ranchi by air and 320km by road. An aeroplane takes 30 minutes to go from Patna to Ranchi whereas a delux bus takes 8 hours.

a. Find the average speed of the plane.
b. Find the average speed of the bus.
c. Find the average velocity of the plane.
d. Find the average velocity of the bus.

127. The benches of a gallery in a cricket stadium are 1m wide and 1m high. A batsman strikes the ball at a level one metre above the ground and hits a mammoth sixer. The ball starts at 35m/s at an angle of 53° with the horizontal. The benches are perpendicular to the plane of motion and the first bench is 110m from the batsman. On which bench will the ball hit?

128. A ball is dropped from a height of 5m onto a sandy floor and penetrates the sand up to 10cm before coming to rest. Find the retardation of the ball in sand assuming it to be uniform.

129. A car travelling at 60km/h overtakes another car travelling at 42km/h. Assuming each car to be 5.0m long, find the time taken during the overtake and the total road distance used for the overtake.

130. A stone is thrown vertically upward with a speed of 28m/s.

a. Find the maximum height reached by the stone.
b. Find its velocity one second before it reaches the maximum height.
c. Does the answer of part.
d. Change if the initial speed is more than 28m/s suchas 40m/s or 80m/s?

* Case study based questions [16]

131. Read the passage given below and answer the following questions from i to v. we consider the motion of a projectile. An object that is in flight after being thrown or

projected is called a projectile. Such a projectile might be a football, a cricket ball, a baseball or any other object. The motion of a projectile may be thought of as the result of two separate, simultaneously occurring components of motions. One component is along a horizontal direction without any acceleration and the other along the vertical direction with constant acceleration due to the force of gravity. It was Galileo who first stated this independency of the horizontal and the vertical components of projectile motion in his Dialogue on the great world systems. **Horizontal range of a projectile:** The horizontal distance travelled by a projectile from its initial position (x = y = 0) to the position where it passes y = 0 during its fall is called the horizontal range, R. It is the distance travelled during the time of flight T_f . Therefore, the range R is $\mathrm{R} = (\mathrm{v}_o \cos\theta_o(\mathrm{T_f})\ \mathrm{R} = \frac{(\mathrm{v_o}\cos\theta_\mathrm{o})(2\mathrm{v_o}\sin\theta_\mathrm{o})}{\mathrm{g}}\ \mathrm{R} = \frac{(\mathrm{v_o^2}\sin\theta_\mathrm{o})}{g}$ This shows that for a given projection velocity, R is maximum when $2\theta_\mathrm{o}$ is maximum, i.e., when $\theta_\mathrm{o} = 45^\circ$. The maximum horizontal range is, therefore $\mathrm{R} = \frac{\mathrm{v_o^2}}{g}$ **Maximum height of a projectile:** Maximum height that can be achieved during projectile and it is given by: $\mathrm{H_m} = \frac{(\mathrm{v_o}\sin\theta)^2}{2g}$

i. Range in projectile motion is maximum when θ° :
   a. 45^0
   b. 0^0
   c. 90^0
   d. None of these

ii. Who was first stated this independency of the horizontal and the vertical components of projectile motion in his Dialogue on the great world system?
   a. Galileo
   b. Newton
   c. Einstein
   d. None of these

iii. What is projectile motion?

iv. What is horizontal range of projectile? Give its formula:

v. What is maximum height of projectile? Give its formula:

132. Read the passage given below and answer the following questions from 1 to 5. If A is vector given by A = Ax i + Ay j where The quantities A_x and A_y are called x, and y-components of the vector A. Note that Ax is itself not a vector, but A_x i is a vector, and so is A_y j. Using simple trigonometry, we can express A_x and A_y in terms of the magnitude of A and the angle θ it makes with the x-axis. $\mathrm{Ax} = \mathrm{A}\cos(\theta)$ $\mathrm{Ay} = \mathrm{A}\sin(\theta)$ If A and θ are given, Ax and Ay can be obtained using If Ax and Ay are given, A and θ can be obtained as follows – $\mathrm{A_x^2} + \mathrm{A_y^2} = (\mathrm{A}\cos\theta)^2 + (\mathrm{A}\sin\theta)^2$ $\mathrm{A_x^2} + \mathrm{A_y^2} = \mathrm{A}^2\cos^2\theta + \mathrm{A}^2\sin^2\theta \Rightarrow \mathrm{A_x^2} + \mathrm{A_y^2} = \mathrm{A}^2(\cos^2\theta + \sin^2\theta)$ $A_\mathrm{x}^2 + \mathrm{A_y^2} = \mathrm{A}^2(\because \sin^2\theta + \cos^2\theta = 1)\ \mathrm{A}^2 = \mathrm{A_y^2} + \mathrm{A_y^2} \Rightarrow \mathrm{A} = \sqrt{\mathrm{A_x^2} + \mathrm{A_y^2}} \ldots$ $\mathrm{Dividing\ A_y\ by\ A_y, we\ get}\ \frac{\mathrm{A_y}}{\mathrm{A_x}} = \frac{\mathrm{A}\sin\theta}{\mathrm{A}\cos\theta} \Rightarrow \frac{\mathrm{A_y}}{\mathrm{A_x}} = \tan\theta\ \tan\theta = \frac{\mathrm{A_y}}{\mathrm{A_x}}$ $\theta = \tan^{-1}\left[\frac{\mathrm{A_y}}{\mathrm{A_x}}\right]$ **Position vector**-The position vector r of a particle P located in a plane with reference to the origin of an x-y reference frame is given by r = x i + y j where x and y are components of r along x-, and y- axes or simply they are the

coordinates of the object. Suppose a particle moves along the Then, the displacement is: $\Delta r = r_2 - r_1$. We can write this in a component form: $\Delta r = (x' i + y' j) - (x i + y j) = i\Delta x - j\Delta y$ Where $\Delta x = x' - x$, $\Delta y = y' - y$. **The average velocity** (v) of an object is the ratio of the displacement and the corresponding time Interval. $V = \frac{\triangle r}{\triangle t} = \frac{i\triangle x - j\triangle y}{\triangle t}$ $= i \times \frac{\triangle x}{\triangle t} + j \times \frac{\triangle y}{\triangle t} = V_x i + V_y j$ So, if the expressions for the coordinates x and y are known as functions of time, we can use these equations to find vx and vy. The magnitude of v is then $V = (v_x^2 + v_y^2)$ and the direction of v is given by the angle q and given by $\tan(\theta) = \frac{vx}{vy}$

i. If A is vector given by A = Ax i + Ay j .if the magnitude of vector is A and the angle θ it makes with the x-axis Ax can be given by:
   a. Ax = A cos(q)
   b. Ax = A sin(q)
   c. Ax = A tan(q)
   d. None of the above

ii. If A is vector given by A = Ax i + Ay j .if the magnitude of vector is A and the angle θ it makes with the x-axis Ay can be given by:
   a. Ax = A cos(q)
   b. Ax = A sin(q)
   c. Ax = A tan(q)
   d. None of the above

iii. Write a note on position vector and displacement of object:

iv. Write a note on average velocity:

v. If A is vector given by A = Ax i + Ay j where obtain expression for resultant amplitude of vector and its angle with x axis:

133. A police jeep is chasing a culprit going on a motorbike. The motorbike crosses a turning at a speed of 72km/h. The jeep follows it at a speed of 90km/h, crossing the turning ten seconds later than the bike. Assuming that they travel at constant speeds, how far from the turning will the jeep catch up with the bike?

134. A player hits a baseball at some angle. The ball goes high up in space. The player runs and catches the ball before it hits the ground. Which of the two (the player or the ball) has greater displacement?

----- "जिस दिन एक सिग्नेचर ऑटोग्राफ में बदलजाए तब मान लीजिएगा कि आप कामयाब हो गए।" -----