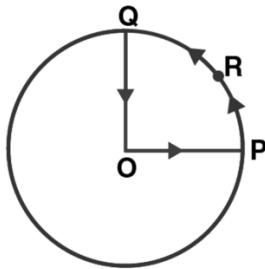


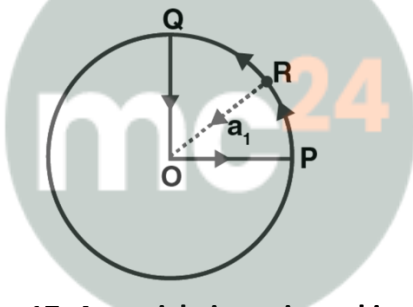
Exemplar Solutions for Class 11 Physics Chapter 4 - Motion In A Plane

Very Short Answers

16. A cyclist starts from centre O of a circular park of radius 1 km and moves along the path OPRQO as shown in the figure. If he maintains constant speed of 10 m/s, what is his acceleration at point R in magnitude and direction?

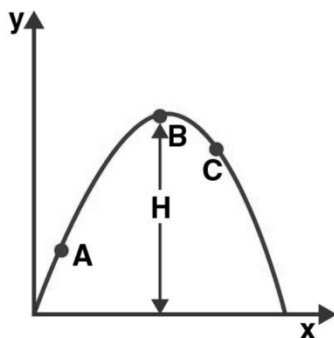


Answer: The radius of the circular path is 1 km with O as the centre and at distance R. Speed with which the cyclist is moving is 10 m/s. Therefore, it can be said that the motion is uniform circular motion at R. Therefore, $R = 1000$ m, $v = 10$ m/s Therefore, acceleration, $a_o = v^2/R = 0.1$ m/s² along RO.



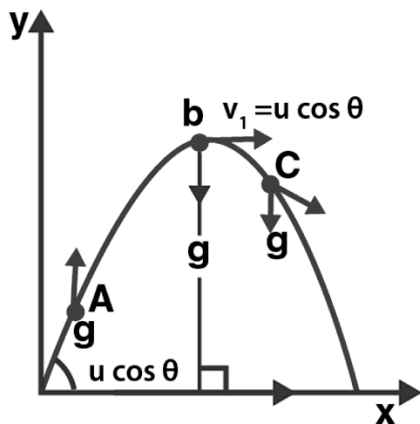
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17. A particle is projected in air at some angle to the horizontal, moves along parabola as shown in the figure, where x and y indicate horizontal and vertical directions respectively. Show in the diagram, direction of velocity and acceleration at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



Answer: The projectile motion is either parabolic or part of it. The velocity is always tangential to the direction of velocities of A, B and C. At point B, the maximum height is reached by the trajectory. Therefore, the vertical component $Bv_y = 0$ and horizontal component is $u \cos \theta$.

We know that the direction of acceleration is in the direction of force acting on the body. Therefore, here the direction of acceleration is in the direction of gravitational force and is always vertically downward which is equal to the acceleration due to gravity.

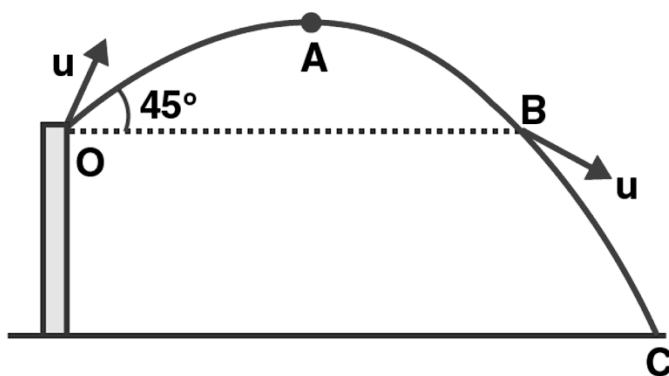


18. A ball is thrown from a roof top at an angle of 45° above the horizontal. It hits the ground a few seconds later. At what point during its motion, does the ball have a) greatest speed b) smallest speed c) greatest acceleration? Explain

Answer: a) Let us assume that the ball is projected from the point O at an angle 45° . From O to A there is an increase in the height of the ball such that the KE of the ball decreases. The height from point A to B decreases making the speed increase and now it is equal to the initial speed when the ball was at point O. This is because O and B are in the same horizontal line. From point B to C, again the speed increases as the height has reduced. Therefore, the greatest speed is at C as v_y maximum and $v_x = u/\sqrt{2}$.

b) The smallest speed will be at point A as the height at this point is the highest and $v_y = 0$ as the horizontal speed is the only constant value i.e; $u/\sqrt{2}$

c) The greatest acceleration is acceleration due to gravity as only gravitational force is acting on the ball and in downward direction.



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

Answer: a) The acceleration of the football will be downward when it is kicked upwards as only gravitational force is acting on it.

b) The football will have its highest velocity when $v_y = 0$.

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

Answer: The direction of product of vectors **B** and **C** is perpendicular to the plane that contains vector **B** and **C** which is based on the Right hand grip rule. The direction of vector $A(B \times C)$ is perpendicular to vector **A** and is in the plane which contains vectors **B** and **C** and is again based on the Right hand grip rule.

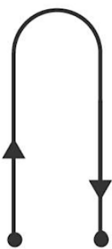
Short Answers

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

Answer: Given, v = vertical velocity of the ball that the boy has u = velocity of the car which is equal to the horizontal velocity of the ball

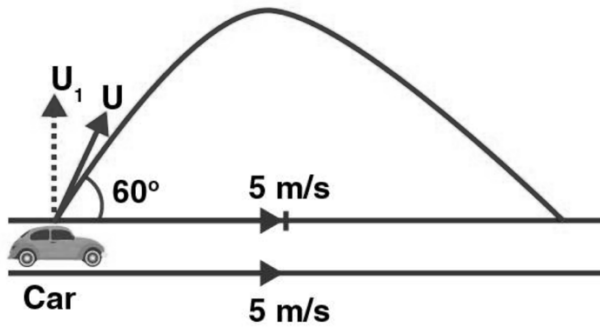


Above is the diagram which is viewed by the observer on the footpath. The diagram is parabolic as the vertical and horizontal components of the velocities are viewed by the observer.

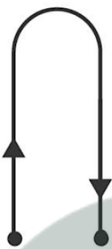


22. A boy throws a ball in air at 60° to the horizontal along a road with a speed of 10 m/s. Another boy sitting in a passing by car observes the ball. Sketch the motion of the ball as observed by the boy in the car, if car has a speed of 18 km/h. Give explanation to support your diagram.

Answer: Given, $u = 36 \text{ km/h} = 10 \text{ m/s}$ $u_x = u \cos 60^\circ = 5 \text{ m/s}$ Speed of the car in the direction of motion of ball = $(18)(5/18) = 5 \text{ m/s}$



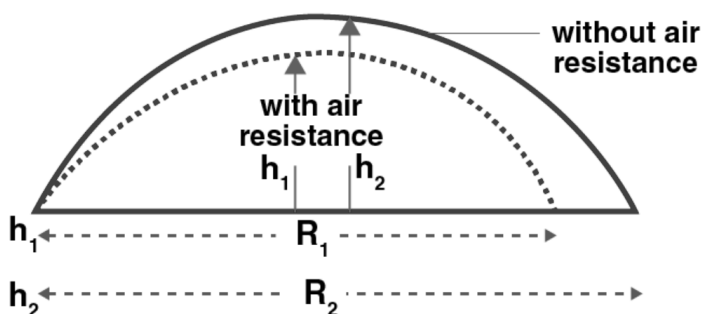
Following is the diagram of the ball thrown by the boy when the car passes him. Both, car as well as ball are in the horizontal distances and speeds that are equal to each other. But the vertical component of velocity is $u_v = u \cos 30^\circ = 5\sqrt{3}$ m/s. The motion of the ball according to the boy sitting in the car is in vertically up-down motion.



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 if air resistance is included? Sketch such a trajectory and explain why you have drawn it that way.

Answer: When the air resistance acting on the projectile motion is considered, the vertical and horizontal velocity decreases due to air resistance. Following is the formula which is responsible for reducing the height of the motion and this is smaller than the height which exists when there is no force of friction: $R = (u^2/g) \sin 2\theta$ $H_{\max} = u^2 \sin^2 \theta / 2g$

Following is the diagram which explains that the time of flight will remain constant with and without air resistance. Therefore, $h_1 < h_2$ and $R_1 < R_2$.



24. A fighter plane is flying horizontally at an altitude of 1.5 km with speed 720 km/h. At what angle of sight when the target is seen, should the pilot drop the bomb in order to attack the target?

Answer: Given, $u = 720 \text{ km/h} = 200 \text{ m/s}$ Let t be the time at which pilot drops the bomb, then Q will be the point vertically above the target T. We also know that the horizontal velocity of the bomb is equal to the velocity of the fighter plane. But the vertical component is zero. When the bomb reaches TQ, it is a free falling object with initial velocity equal to zero. $u = 0$ $H = 1.5 \text{ km} = 1500 \text{ m}$, $g = 10 \text{ m/s}^2$ $H = ut + \frac{1}{2}gt^2$ Substituting the values, we get $t = 10\sqrt{3}$ second. Let the distance between PQ be ut . Therefore, $PQ = 2000\sqrt{3} \text{ m}$ $\tan \theta = \frac{\sqrt{3}}{4}$ $\theta = \tan^{-1}23^\circ 42'$ $\theta = 23^\circ 42'$

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

b) Earth also moves in circular orbit around sun once every year with an orbital radius of $1.5 \times 10^{11} \text{ m}$. What is the acceleration of earth towards the centre of the sun? How does this acceleration compare with $g = 9.8 \text{ m/s}^2$?

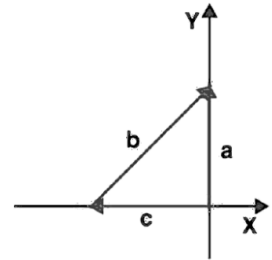
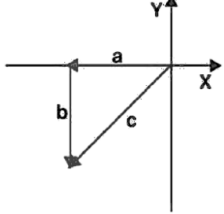
Answer: a) From the problem, Radius of the earth, $R = 6400 \text{ km} = 6.4 \times 10^6 \text{ m}$ Time period, $T = 1 \text{ day} = 24 \times 60 \times 60 = 86400 \text{ s}$ Centripetal acceleration, $a_o = \omega^2 R = \frac{4\pi^2 R}{T^2}$ Substituting the values, we get $a_o = 0.034 \text{ m/s}^2$ At equator, latitude $\theta = 0^\circ$ We know that, $a_o/g = 0.034/9.8 = 1/288$

b) Orbital radius of the earth around the sun, $R = 1.5 \times 10^{11} \text{ m}$ Time period = 1 year = 365 days = $3.15 \times 10^7 \text{ s}$ Centripetal acceleration, $a_o = \omega^2 R = \frac{4\pi^2 R}{T^2} = 5.97 \times 10^{-3} \text{ m/s}^2$ $a_o/g = 5.97 \times 10^{-3}/9.8 = 1/1642$

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) $a + b = c$	<p>i)</p>
b) $a - c = b$	<p>ii)</p>

Answer: a) matches with iv) b)

<p>c) $b - a = c$</p>	 <p>iii)</p>
<p>d) $a + b + c = 0$</p>	 <p>iv)</p>

matches with iii) c) matches with i) d) matches with ii)

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

Column I Column II

- a) $A \cdot B = 0$ i) $\theta = 0^\circ$
 b) $A \cdot B = +8$ ii) $\theta = 90^\circ$
 c) $A \cdot B = 4$ iii) $\theta = 180^\circ$
 d) $A \cdot B = -8$ iv) $\theta = 0^\circ$

Answer: a) matches with ii) b) matches with i) c) matches with iv) d) matches with iii)

28. If $|A| = 2$ and $|B| = 4$, then match the relations in column I with the angle θ between A and B in column II.

Column I

- a) $|\left| A \times B \right| = 0|$
 b) $|\left| A \times B \right| = 8|$
 c) $|\left| A \times B \right| = 4|$
 d) $|\left| A \times B \right| = 4\sqrt{2}|$

Column II

- i) $\theta = 30^\circ$
 ii) $\theta = 45^\circ$
 iii) $\theta = 90^\circ$
 iv) $\theta = 0^\circ$

Answer: a) matches with iv) b) matches with iii) c) matches with i) d) matches with ii)