

Assignment – I

Date of Submission : 22 February, 2018

Vectors, Motion in One-dimension and Two-dimensions

1. The components of a vector are given by **(a)** $A_x = +3$, $A_y = +5$, **(b)** $A_x = -3$, $A_y = -5$ **(c)** $A_x = -3$, $A_y = +5$ and **(d)** $A_x = +3$, $A_y = -5$; Construct the vectors, find their magnitude & directions and show them in figure.
2. Given that $\mathbf{A} = \mathbf{i} + 3\mathbf{j} + 5\mathbf{k}$ and $\mathbf{B} = 2\mathbf{i} - 2\mathbf{j} - 3\mathbf{k}$, Find **(a)** the Dot product between \mathbf{A} & \mathbf{B} and find the angle between them **(b)** the cross product between \mathbf{A} & \mathbf{B} and prove that $\mathbf{A} \times \mathbf{B} = -(\mathbf{B} \times \mathbf{A})$ **(c)** the value of $\mathbf{A} \cdot (\mathbf{B} \times \mathbf{A})$.
3. Check whether the vectors $\mathbf{A} = -\mathbf{i} + \mathbf{j} + 4\mathbf{k}$ and $\mathbf{B} = -3\mathbf{i} + \mathbf{j} + 4\mathbf{k}$ are parallel or perpendicular to each other. If none of them, find the angle between them.
4. Find the angles made by the vectors $\mathbf{A} = 2\mathbf{i} - 5\mathbf{j} + 3\mathbf{k}$ with the axes.
5. A train starts from rest at a station and accelerate at a rate of 2 m/s^2 for 10 s. It then runs at constant speed for 30 s, and slows down at -4 m/s^2 until it stops at the next station. Find the total distance covered. [Ans : 750m]
6. An airplane taking off from a landing field has a run of 500m. If it starts from rest, moves with constant acceleration and makes the run in 30 sec, with what velocity did it take off? [Ans : 33.3m/s]
7. A spaceship takes a straight line path from the earth to the moon, a distance of about 400000 km. Suppose it accelerates at 10 m/s^2 for the first 10 min of the trip, then travels at constant speed until the last 10 min, when it accelerates at -10 m/s^2 , just coming to rest as it reaches the moon (a) What is the maximum speed attained? (b) What total time required for the trip? [Ans : 6000m/s, 18hrs 20min]
8. A ball is thrown vertically upward from the ground with a velocity of 30m/s (a) How long will it take to rise to its highest point? (b) How high does the ball rise? (a) How long after projection will the ball have a velocity of 10 m/s upward? [Ans : 3.06 sec, 45.9 m, 2.04s]
9. A ball rolls off the edge of a tabletop 1m above the floor and strikes the floor at a point 1.5m horizontally from the edge of the table. (a) Find the time of flight (b) Find the initial velocity (c) Find the magnitude and direction of the velocity of the ball just before it strikes the floor. [Ans : 0.452 sec; 3.32 m/s; 5.53m/s]
10. A ball is projected with an initial upward velocity component of 20m/s and a horizontal velocity component of 25m/s. (a) Find the position and velocity of the ball after 4s (b) How much time is required to reach the highest point? (c) How high is this point ? (d) How much time is required for the ball to return to its original level? (e) How far has it traveled horizontally during this time? [Ans : (a) 100m, 1.8m, 25m/s, -19.2m/s (b) 2.04sec (c) 21.2 m (d) 4.12 sec (e) 103 m]
11. A batted baseball leaves the bat at an angle of 30° above the horizontal and is caught by an outfielder 400 ft from the plate. (a) What was the initial speed of the ball? (b) How high did it rise? (c) How long was it in air? [Ans :121.6 ft/s ; 57.7 m ; 3.8 sec.]

Newton's Law, Impulse & Momentum, Rotation

12. A 4-kg block is accelerated upward by a cord whose breaking strength is 60 N. Find the maximum acceleration that could be given to the block without breaking the cord.

13. A force of magnitude 5 N acts on a 2-kg body moving initially in the direction of the force with a speed of 4 m/s. Over what distance must the force act in order to change the body's speed to 6 m/s?

14. The moon is $0.38 \times 10^9 \text{ m}$ from the earth and has a mass of $7.36 \times 10^{22} \text{ kg}$. Find the gravitational force it exerts on a 1 kg body on earth; express your result also as a fraction of body's weight.

15. The mass of the moon is about one eighty-first, and its radius one-fourth, that of the earth. What is the acceleration due to gravity on the surface of the moon?

16. A bullet having a mass of 0.05-kg, moving with a velocity of 400 m/s, penetrates a distance of 0.1 m in to a wooden block firmly attached to the earth. Compute (a) the acceleration of the bullet (b) the force (c) the time of acceleration (d) the impulse of the collision.

17. A baseball has a mass of about 0.2-kg. (a) If the velocity of a pitched ball is 30 m/s, and after being batted it is 50 m/s in the opposite direction find the change in the momentum of the ball and impulse of the blow. (b) If the ball remains in contact with the bat for 0.002 s, find the average force of the blow.

18. A wheel 0.6m in diameter starts from rest and accelerates to an angular velocity 100 rad/s in 20-s. Find the angular acceleration and the angle turned through.

19. The angular velocity of a flywheel decreases uniformly from 1000rev/min to 400rev/min in 5-s. Find the angular acceleration and number of revolutions made by the wheel in 5-s interval. How many more seconds are required for the wheel to come to rest?

20. A wheel 1.0m in diameter is rotating about a fixed axis with an initial angular velocity of 2 rev/s. The angular acceleration is 3 rev/s^2 . (a) Compute the angular velocity after 6s. (b) Through what angle has the wheel turned in this time interval? (c) what is the tangential velocity of a point on the rim of the wheel at $t = 6\text{s}$? (d) what is the resultant acceleration of a point on the rim of the wheel at $t = 6\text{s}$?

21. A flywheel of radius 30 cm starts from rest and accelerates with 0.5 rad/s^2 . Compute the tangential acceleration, the radial acceleration and the resultant acceleration after it has turned through 120° .

22. A wheel starts from rest and accelerates with constant angular acceleration to an angular velocity of 900 rev min^{-1} in 20s. At the end of 1s, find the angle through which the wheel has rotated.