Chapter 3

Terms

Be able to define or discuss the following terms and ideas, with their SI units if appropriate.

1. vector
2. vector components
3. magnitude (of a vector)
4. angle (of a vector) with respect to the x-axis
5. how to add vectors algebraically
6. how to subtract vectors algebraically
7. how to add vectors pictorially
8. how to subtract vectors pictorially
9. resultant (of vector addition or vector subtraction)
10. position (in 2-D)
11. displacement (in 2-D)
12. distance
13. average velocity
14. instantaneous velocity
15. speed
16. change in velocity
17. average acceleration
18. instantaneous acceleration
19. projectile motion
20. acceleration due to gravity
21. direction of motion

Equations

Understand the meaning and know the SI units of all symbols in these equations; know how to perform each mathematical operation, such as trig functions; know how to solve for any unknown quantity; understand how changing one quantity affects another quantity (if all other quantities remain constant); be able to apply one or more equations to solve a problem.

- $\cos(\theta) = \frac{adjacent}{hypotenuse}$
- $\sin(\theta) = \frac{adjacent}{hypotenuse}$
- $\tan(\theta) = \frac{adjacent}{hypotenuse}$

- displacement

$$\Delta\vec{r} =< \Delta x, \Delta y > \tag{1}$$

- distance (between two positions)

$$|\Delta\vec{r}| = \sqrt{(\Delta x)^2 + (\Delta y)^2} \tag{2}$$

- average velocity

$$\vec{\bar{v}} = \frac{\Delta\vec{r}}{\Delta t} \tag{3}$$

$$\bar{v}_x = \frac{\Delta x}{\Delta t} \text{ and } \bar{v} = \frac{\Delta y}{\Delta t} \tag{4}$$

- speed

$$|\vec{v}| = \sqrt{v_x^2 + v_y^2} \tag{5}$$

- average acceleration

$$\vec{a} =< a_x, a_y > \text{ where } a_x = \frac{\Delta v_x}{\Delta t} \text{ and } a_y = \frac{\Delta v_y}{\Delta t} \tag{6}$$

- useful equations for ideal projectile motion (no air resistance):

$$x - x_0 = v_{0x}t \tag{7}$$

$$\tag{8}$$

$$y - y_0 = v_{0y}t - \frac{1}{2}gt^2 \tag{9}$$

$$y - y_0 = \left(\frac{v_y + v_{0y}}{2}\right)t \tag{10}$$

$$v_y = v_{0y} - gt \tag{11}$$

$$v_y^2 = v_{0y}^2 - 2g(y - y_0) \tag{12}$$

Skills

1. given the components, sketch the vector.
2. for an object shown on a Cartesian coordinate system, sketch the position vector, calculate the x-position and y-position, calculate the distance of the object's position from the origin, and calculate the angle of the object's position with respect to the +x axis.
3. for an object that moves across a Cartesian coordinate system, sketch the displacement vector, calculate the x and y components of the object's displacement, and calculate the magnitude of the displacement and angle it makes with respect to the +x axis.
4. calculate the average velocity of an object.
5. calculate the speed (magnitude) and direction of motion (angle) of an object.
6. sketch velocity vector for an object at a given instant, if given its path.
7. sketch the sum of two vectors.

8. sketch the change in two vectors (final – initial).
9. given final and initial position vectors, calculate displacement.
10. given final and initial position vectors, sketch displacement.
11. given multiple displacements, find the total displacement of an object.
12. given final and initial velocity vectors, calculate change in velocity and acceleration
13. given final and initial velocity vectors, sketch the change in velocity and acceleration vectors
14. sketch and/or interpret a x-position vs. time graph for projectile motion.
15. sketch and/or interpret a x-velocity vs. time graph for projectile motion.
16. sketch and/or interpret a y-position vs. time graph for projectile motion.
17. sketch and/or interpret a y-velocity vs. time graph for projectile motion.
18. solve problems dealing with projectile motion.

Lab Skills

1. use video analysis software to measure x-position and y-position vs. time graphs and x-velocity vs. y-velocity graphs for projectile motion; from the graphs, determine y-acceleration and x-velocity for a projectile