

# Applied Physics Assignment-1

## Vectors

1. A displacement vector in the  $xy$  plane is 7.3 m long and directed at angle of  $30^\circ$  in Fig.1. Determine (a) the  $x$  component and (b) the  $y$  component of the vector.

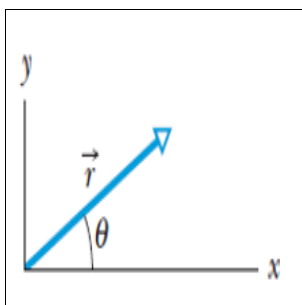


Fig-1

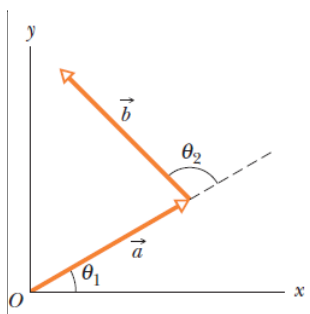


Fig-2

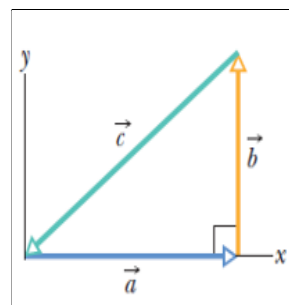


Fig-3

2. The two vectors  $\vec{a}$  and  $\vec{b}$  in Fig-2 have equal magnitudes of 10m and the angles are  $\theta_1 = 30^\circ$  and  $\theta_2 = 105^\circ$ . Find the (a)  $x$  and  $y$  components of their vector sum  $\vec{r}$  (b) the magnitude of  $\vec{r}$  and (c) the angle  $\vec{r}$  makes with the positive direction of the  $x$  axis
3. For the vectors in Fig. 3, with  $a = 4$ ,  $b = 3$ , and  $c = 5$ , what are (a) the magnitude and the direction of  $\vec{a} \times \vec{b}$ , (b) the magnitude and the direction of  $\vec{a} \times \vec{c}$ , and (c) the magnitude and the direction of  $\vec{b} \times \vec{c}$ ?
4. By Considering the above problem -2 find the (a)  $\vec{a} \cdot \vec{b}$  (b)  $\vec{a} \times \vec{b}$  (c) angle between  $\vec{a}$  and  $\vec{b}$
5. The  $x$  component of vector  $\vec{A}$  is 25.0 m and the  $y$  component is 40.0 m. (a) What is the magnitude of  $\vec{A}$  (b) What is the angle between the direction of and the positive direction of  $x$ ?
6. A ship sets out to sail to a point 120 km due north. An unexpected storm blows the ship to a point 100 km due east of its starting point. (a) How far and (b) in what direction must it now sail to reach its original destination?
7. Three vectors  $\vec{a}$ ,  $\vec{b}$  and  $\vec{c}$  each have a magnitude of 50 m and lie in an  $xy$  plane. Their directions relative to the positive direction of the  $x$  axis are  $30^\circ$ ,  $195^\circ$ , and  $315^\circ$ , respectively. What are (i) the magnitude and the angle of the vector  $\vec{a} + \vec{b} + \vec{c}$ , and (ii) the magnitude and the angle of  $\vec{a} - \vec{b} + \vec{c}$ ? What are the (iii) magnitude and angle of a fourth vector  $\vec{d}$  such that  $(\vec{a} + \vec{b}) - (\vec{c} + \vec{d}) = \vec{0}$ ?
8. Find the angle between the vector  $\vec{A} = 2\vec{i} - 3\vec{j} + 5\vec{k}$  and the  $x$ ,  $y$ , and  $z$  axes, respectively.
9. Calculate the angle between " $\vec{r}$ " and the positive  $z$ -axis. (c) Find the angle between " $\vec{a}$ " and " $\vec{b}$ ". where  $\vec{a} = 5\vec{i} + 4\vec{j} - 6\vec{k}$ ,  $\vec{b} = -2\vec{i} + 2\vec{j} + 3\vec{k}$  and  $\vec{c} = 4\vec{i} + 3\vec{j} + 2\vec{k}$ ,  $\vec{r} = \vec{a} + \vec{b} + \vec{c}$ .
10. Vector  $\vec{A}$  has a magnitude of 6 units, vector  $\vec{B}$  has a magnitude of 7 units, and  $\vec{A} \cdot \vec{B}$  has a value of 14. What is the angle between the direction of  $\vec{A}$  and  $\vec{B}$ ?

# Motion in 1D

1. The position of a particle moving in an XY direction is given by  

$$r = \{ (2)t^3 - (5)t \} i + \{ (6) - (7)t^4 \} j$$
 Calculate (a)  $r$  (b)  $v$  (c)  $a$  when  
 $t = 2 \text{ sec}$ . (Ans:  $r = 6i - 106j$ ,  $v = 19i - 224j$ ,  $a = 24i - 336j$ )
2. A particle had a velocity of 18 m/s in the +X direction and 2.4 sec later its velocity was 30m/s in the opposite direction. What was the average acceleration of the particle during this 2.4sec interval ? (Ans: -20m/s)
3. A rocket ship in free space moves with constant acceleration equal to 9.8 m/s<sup>2</sup>  
 (a) if it starts from rest, how long will it take to acquire a speed one – tenth that of light?  
 (b) How far will it travel in so doing? (The speed of light is  $3 \times 10^8 \text{ m/s}$ ).  
 (Ans:  $t = 3.1 \times 10^6 \text{ sec}$ ,  $s = 4.7 \times 10^{13} \text{ m}$ )
4. At a construction site a pipe wrench strikes the ground with a speed of 24m/s (a) From what height was it inadvertently dropped? (b) For how long was it falling?  
 (Ans:  $s = 29.38 \text{ m}$ ,  $t = 2.448 \text{ sec}$ )
5. A ball thrown straight up takes 2.25 sec to reach a height of 36.8m (a) What was its initial speed ? (b) What is its speed at this height? (c) How much higher will the ball go?(Ans: 27 m/s, 5.25 m/s, 1.45m)
6. A car travels up a hill at the constant speed of 40km/h and returns down the hill at the speed of 60km/h. Calculate the average speed for the round trip.(Ans: 48 km/h)
7. A balloon is ascending at 12.4 m/s at a height of 81.3m above the ground when a package is dropped. (a) With what speed does the package hit the ground? (b) How long did it take to reach the ground?(Ans: +41.8 or - 41.8 m/s,  $t = 5.53 \text{ sec}$ )
8. A jumbo jet needs to reach a speed of 360km/h on the runway for takeoff. Assuming a constant acceleration and a runway 1.8km long, what minimum acceleration from rest is required?(Ans: 2.8 m/s)
9. On a dry road a car with good tires may be able to brake with a deceleration of 4.92m/s<sup>2</sup> (a) how long does such a car, initially traveling at 24.6m/s take to come to rest ? (b) How far does it travel in this time? (Ans:  $t = 5 \text{ sec}$ ,  $s = 61.5 \text{ m}$ )
10. A particle moves along the x axis according to the equation  

$$x = 50 t + 10 t^2,$$
 where  $x$  is in meters and  $t$  is in seconds. Calculate  
 (a) the average velocity of the particle during the first 3 sec of its motion,

- (b) the instantaneous velocity of the particle at  $t = 3$  sec, and  
(c) the instantaneous acceleration of the particle at  $t = 3$  sec.  
(Ans: 80 m/s , 110 m/s , 20m/s<sup>2</sup>)