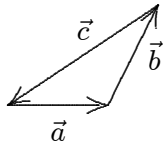


### Chapter 3: VECTORS

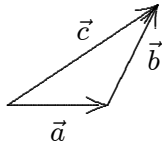
1. We say that the displacement of a particle is a vector quantity. Our best justification for this assertion is:
- A. displacement can be specified by a magnitude and a direction
  - B. operating with displacements according to the rules for manipulating vectors leads to results in agreement with experiments
  - C. a displacement is obviously not a scalar
  - D. displacement can be specified by three numbers
  - E. displacement is associated with motion

ans: B

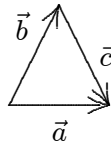
2. The vectors  $\vec{a}$ ,  $\vec{b}$ , and  $\vec{c}$  are related by  $\vec{c} = \vec{b} - \vec{a}$ . Which diagram below illustrates this relationship?



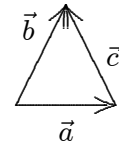
A



B



C



D

- E. None of these

ans: D

3. A vector of magnitude 3 CANNOT be added to a vector of magnitude 4 so that the magnitude of the resultant is:
- A. zero
  - B. 1
  - C. 3
  - D. 5
  - E. 7

ans: A

4. A vector of magnitude 20 is added to a vector of magnitude 25. The magnitude of this sum might be:
- A. zero
  - B. 3
  - C. 12
  - D. 47
  - E. 50

ans: C

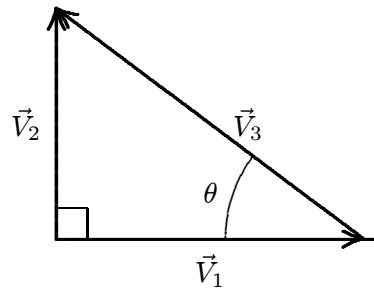
5. A vector  $\vec{S}$  of magnitude 6 and another vector  $\vec{T}$  have a sum of magnitude 12. The vector  $\vec{T}$ :
- must have a magnitude of at least 6 but no more than 18
  - may have a magnitude of 20
  - cannot have a magnitude greater than 12
  - must be perpendicular to  $\vec{S}$
  - must be perpendicular to the vector sum

ans: A

6. The vector  $-\vec{A}$  is:
- greater than  $\vec{A}$  in magnitude
  - less than  $\vec{A}$  in magnitude
  - in the same direction as  $\vec{A}$
  - in the direction opposite to  $\vec{A}$
  - perpendicular to  $\vec{A}$

ans: D

7. The vector  $\vec{V}_3$  in the diagram is equal to:



- $\vec{V}_1 - \vec{V}_2$
- $\vec{V}_1 + \vec{V}_2$
- $\vec{V}_2 - \vec{V}_1$
- $\vec{V}_1 \cos \theta$
- $\vec{V}_1 / (\cos \theta)$

ans: C

8. If  $|\vec{A} + \vec{B}|^2 = A^2 + B^2$ , then:
- $\vec{A}$  and  $\vec{B}$  must be parallel and in the same direction
  - $\vec{A}$  and  $\vec{B}$  must be parallel and in opposite directions
  - either  $\vec{A}$  or  $\vec{B}$  must be zero
  - the angle between  $\vec{A}$  and  $\vec{B}$  must be  $60^\circ$
  - none of the above is true

ans: E

9. If  $|\vec{A} + \vec{B}| = A + B$  and neither  $\vec{A}$  nor  $\vec{B}$  vanish, then:

- A.  $\vec{A}$  and  $\vec{B}$  are parallel and in the same direction
- B.  $\vec{A}$  and  $\vec{B}$  are parallel and in opposite directions
- C. the angle between  $\vec{A}$  and  $\vec{B}$  is  $45^\circ$
- D. the angle between  $\vec{A}$  and  $\vec{B}$  is  $60^\circ$
- E.  $\vec{A}$  is perpendicular to  $\vec{B}$

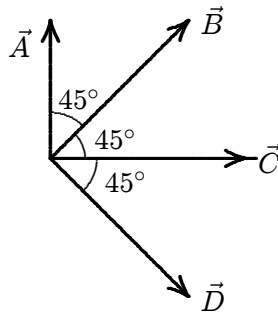
ans: A

10. If  $|\vec{A} - \vec{B}| = A + B$  and neither  $\vec{A}$  nor  $\vec{B}$  vanish, then:

- A.  $\vec{A}$  and  $\vec{B}$  are parallel and in the same direction
- B.  $\vec{A}$  and  $\vec{B}$  are parallel and in opposite directions
- C. the angle between  $\vec{A}$  and  $\vec{B}$  is  $45^\circ$
- D. the angle between  $\vec{A}$  and  $\vec{B}$  is  $60^\circ$
- E.  $\vec{A}$  is perpendicular to  $\vec{B}$

ans: B

11. Four vectors ( $\vec{A}$ ,  $\vec{B}$ ,  $\vec{C}$ ,  $\vec{D}$ ) all have the same magnitude. The angle  $\theta$  between adjacent vectors is  $45^\circ$  as shown. The correct vector equation is:



- A.  $\vec{A} - \vec{B} - \vec{C} + \vec{D} = 0$
- B.  $\vec{B} + \vec{D} - \sqrt{2}\vec{C} = 0$
- C.  $\vec{A} + \vec{B} = \vec{B} + \vec{D}$
- D.  $\vec{A} + \vec{B} + \vec{C} + \vec{D} = 0$
- E.  $(\vec{A} + \vec{C})/\sqrt{2} = -\vec{B}$

ans: B

12. Vectors  $\vec{A}$  and  $\vec{B}$  lie in the  $xy$  plane. We can deduce that  $\vec{A} = \vec{B}$  if:

- A.  $A_x^2 + A_y^2 = B_x^2 + B_y^2$
- B.  $A_x + A_y = B_x + B_y$
- C.  $A_x = B_x$  and  $A_y = B_y$
- D.  $A_y/A_x = B_y/B_x$
- E.  $A_x = A_y$  and  $B_x = B_y$

ans: C

13. A vector has a magnitude of 12. When its tail is at the origin it lies between the positive  $x$  axis and the negative  $y$  axis and makes an angle of  $30^\circ$  with the  $x$  axis. Its  $y$  component is:
- A.  $6/\sqrt{3}$
  - B.  $-6\sqrt{3}$
  - C. 6
  - D. -6
  - E. 12
- ans: D

14. If the  $x$  component of a vector  $\vec{A}$ , in the  $xy$  plane, is half as large as the magnitude of the vector, the tangent of the angle between the vector and the  $x$  axis is:
- A.  $\sqrt{3}$
  - B.  $1/2$
  - C.  $\sqrt{3}/2$
  - D.  $3/2$
  - E. 3
- ans: D

15. If  $\vec{A} = (6\text{ m})\hat{i} - (8\text{ m})\hat{j}$  then  $4\vec{A}$  has magnitude:
- A. 10 m
  - B. 20 m
  - C. 30 m
  - D. 40 m
  - E. 50 m
- ans: D

16. A vector has a component of 10 m in the  $+x$  direction, a component of 10 m in the  $+y$  direction, and a component of 5 m in the  $+z$  direction. The magnitude of this vector is:
- A. zero
  - B. 15 m
  - C. 20 m
  - D. 25 m
  - E. 225 m
- ans: B

17. Let  $\vec{V} = (2.00\text{ m})\hat{i} + (6.00\text{ m})\hat{j} - (3.00\text{ m})\hat{k}$ . The magnitude of  $\vec{V}$  is:
- A. 5.00 m
  - B. 5.57 m
  - C. 7.00 m
  - D. 7.42 m
  - E. 8.54 m
- ans: C

18. A vector in the  $xy$  plane has a magnitude of 25 m and an  $x$  component of 12 m. The angle it makes with the positive  $x$  axis is:
- A.  $26^\circ$
  - B.  $29^\circ$
  - C.  $61^\circ$
  - D.  $64^\circ$
  - E.  $241^\circ$
- ans: C

19. The angle between  $\vec{A} = (25 \text{ m})\hat{i} + (45 \text{ m})\hat{j}$  and the positive  $x$  axis is:
- A.  $29^\circ$
  - B.  $61^\circ$
  - C.  $151^\circ$
  - D.  $209^\circ$
  - E.  $241^\circ$
- ans: B

20. The angle between  $\vec{A} = (-25 \text{ m})\hat{i} + (45 \text{ m})\hat{j}$  and the positive  $x$  axis is:
- A.  $29^\circ$
  - B.  $61^\circ$
  - C.  $119^\circ$
  - D.  $151^\circ$
  - E.  $209^\circ$
- ans: C

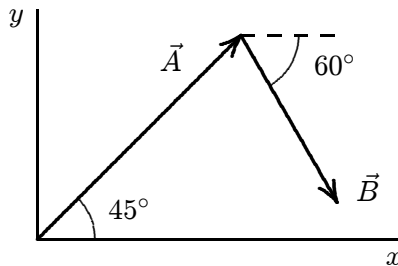
21. Let  $\vec{A} = (2 \text{ m})\hat{i} + (6 \text{ m})\hat{j} - (3 \text{ m})\hat{k}$  and  $\vec{B} = (4 \text{ m})\hat{i} + (2 \text{ m})\hat{j} + (1 \text{ m})\hat{k}$ . The vector sum  $\vec{S} = \vec{A} + \vec{B}$  is:
- A.  $(6 \text{ m})\hat{i} + (8 \text{ m})\hat{j} - (2 \text{ m})\hat{k}$
  - B.  $(-2 \text{ m})\hat{i} + (4 \text{ m})\hat{j} - (4 \text{ m})\hat{k}$
  - C.  $(2 \text{ m})\hat{i} - (4 \text{ m})\hat{j} + (4 \text{ m})\hat{k}$
  - D.  $(8 \text{ m})\hat{i} + (12 \text{ m})\hat{j} - (3 \text{ m})\hat{k}$
  - E. none of these
- ans: A

22. Let  $\vec{A} = (2 \text{ m})\hat{i} + (6 \text{ m})\hat{j} - (3 \text{ m})\hat{k}$  and  $\vec{B} = (4 \text{ m})\hat{i} + (2 \text{ m})\hat{j} + (1 \text{ m})\hat{k}$ . The vector difference  $\vec{D} = \vec{A} - \vec{B}$  is:
- A.  $(6 \text{ m})\hat{i} + (8 \text{ m})\hat{j} - (2 \text{ m})\hat{k}$
  - B.  $(-2 \text{ m})\hat{i} + (4 \text{ m})\hat{j} - (4 \text{ m})\hat{k}$
  - C.  $(2 \text{ m})\hat{i} - (4 \text{ m})\hat{j} + (4 \text{ m})\hat{k}$
  - D.  $(8 \text{ m})\hat{i} + (12 \text{ m})\hat{j} - (3 \text{ m})\hat{k}$
  - E. none of these
- ans: B

23. If  $\vec{A} = (2 \text{ m})\hat{i} - (3 \text{ m})\hat{j}$  and  $\vec{B} = (1 \text{ m})\hat{i} - (2 \text{ m})\hat{j}$ , then  $\vec{A} - 2\vec{B} =$
- A.  $(1 \text{ m})\hat{j}$
  - B.  $(-1 \text{ m})\hat{j}$
  - C.  $(4 \text{ m})\hat{i} - (7 \text{ m})\hat{j}$
  - D.  $(4 \text{ m})\hat{i} + (1 \text{ m})\hat{j}$
  - E.  $(-4 \text{ m})\hat{i} + (7 \text{ m})\hat{j}$

ans: A

24. In the diagram,  $\vec{A}$  has magnitude 12 m and  $\vec{B}$  has magnitude 8 m. The  $x$  component of  $\vec{A} + \vec{B}$  is about:



- A. 5.5 m
- B. 7.6 m
- C. 12 m
- D. 14 m
- E. 15 m

ans: C

25. A certain vector in the  $xy$  plane has an  $x$  component of 4 m and a  $y$  component of 10 m. It is then rotated in the  $xy$  plane so its  $x$  component is doubled. Its new  $y$  component is about:

- A. 20 m
- B. 7.2 m
- C. 5.0 m
- D. 4.5 m
- E. 2.2 m

ans: B

26. Vectors  $\vec{A}$  and  $\vec{B}$  each have magnitude  $L$ . When drawn with their tails at the same point, the angle between them is  $30^\circ$ . The value of  $\vec{A} \cdot \vec{B}$  is:

- A. zero
- B.  $L^2$
- C.  $\sqrt{3}L^2/2$
- D.  $2L^2$
- E. none of these

ans: C

27. Let  $\vec{A} = (2\text{ m})\hat{i} + (6\text{ m})\hat{j} - (3\text{ m})\hat{k}$  and  $\vec{B} = (4\text{ m})\hat{i} + (2\text{ m})\hat{j} + (1\text{ m})\hat{k}$ . Then  $\vec{A} \cdot \vec{B} =$
- $(8\text{ m})\hat{i} + (12\text{ m})\hat{j} - (3\text{ m})\hat{k}$
  - $(12\text{ m})\hat{i} - (14\text{ m})\hat{j} - (20\text{ m})\hat{k}$
  - $23\text{ m}^2$
  - $17\text{ m}^2$
  - none of these
- ans: D
28. Two vectors have magnitudes of 10 m and 15 m. The angle between them when they are drawn with their tails at the same point is  $65^\circ$ . The component of the longer vector along the line of the shorter is:
- 0
  - 4.2 m
  - 6.3 m
  - 9.1 m
  - 14 m
- ans: C
29. Let  $\vec{S} = (1\text{ m})\hat{i} + (2\text{ m})\hat{j} + (2\text{ m})\hat{k}$  and  $\vec{T} = (3\text{ m})\hat{i} + (4\text{ m})\hat{k}$ . The angle between these two vectors is given by:
- $\cos^{-1}(14/15)$
  - $\cos^{-1}(11/225)$
  - $\cos^{-1}(104/225)$
  - $\cos^{-1}(11/15)$
  - cannot be found since  $\vec{S}$  and  $\vec{T}$  do not lie in the same plane
- ans: D
30. Two vectors lie with their tails at the same point. When the angle between them is increased by  $20^\circ$  their scalar product has the same magnitude but changes from positive to negative. The original angle between them was:
- 0
  - $60^\circ$
  - $70^\circ$
  - $80^\circ$
  - $90^\circ$
- ans: D
31. If the magnitude of the sum of two vectors is less than the magnitude of either vector, then:
- the scalar product of the vectors must be negative
  - the scalar product of the vectors must be positive
  - the vectors must be parallel and in opposite directions
  - the vectors must be parallel and in the same direction
  - none of the above
- ans: A

32. If the magnitude of the sum of two vectors is greater than the magnitude of either vector, then:
- the scalar product of the vectors must be negative
  - the scalar product of the vectors must be positive
  - the vectors must be parallel and in opposite directions
  - the vectors must be parallel and in the same direction
  - none of the above
- ans: E
33. Vectors  $\vec{A}$  and  $\vec{B}$  each have magnitude  $L$ . When drawn with their tails at the same point, the angle between them is  $60^\circ$ . The magnitude of the vector product  $\vec{A} \times \vec{B}$  is:
- $L^2/2$
  - $L^2$
  - $\sqrt{3}L^2/2$
  - $2L^2$
  - none of these
- ans: C
34. Two vectors lie with their tails at the same point. When the angle between them is increased by  $20^\circ$  the magnitude of their vector product doubles. The original angle between them was about:
- 0
  - $18^\circ$
  - $25^\circ$
  - $45^\circ$
  - $90^\circ$
- ans: B
35. Two vectors have magnitudes of 10 m and 15 m. The angle between them when they are drawn with their tails at the same point is  $65^\circ$ . The component of the longer vector along the line perpendicular to the shorter vector, in the plane of the vectors, is:
- 0
  - 4.2 m
  - 6.3 m
  - 9.1 m
  - 14 m
- ans: E
36. The two vectors  $(3\text{ m})\hat{i} - (2\text{ m})\hat{j}$  and  $(2\text{ m})\hat{i} + (3\text{ m})\hat{j} - (2\text{ m})\hat{k}$  define a plane. It is the plane of the triangle with both tails at one vertex and each head at one of the other vertices. Which of the following vectors is perpendicular to the plane?
- $(4\text{ m})\hat{i} + (6\text{ m})\hat{j} + (13\text{ m})\hat{k}$
  - $(-4\text{ m})\hat{i} + (6\text{ m})\hat{j} + (13\text{ m})\hat{k}$
  - $(4\text{ m})\hat{i} - (6\text{ m})\hat{j} + (13\text{ m})\hat{k}$
  - $(4\text{ m})\hat{i} + (6\text{ m})\hat{j} - (13\text{ m})\hat{k}$
  - $(4\text{ m})\hat{i} + (6\text{ m})\hat{j}$
- ans: A



37. Let  $\vec{R} = \vec{S} \times \vec{T}$  and  $\theta \neq 90^\circ$ , where  $\theta$  is the angle between  $\vec{S}$  and  $\vec{T}$  when they are drawn with their tails at the same point. Which of the following is NOT true?

A.  $|\vec{R}| = |\vec{S}||\vec{T}|\sin\theta$

B.  $-\vec{R} = \vec{T} \times \vec{S}$

C.  $\vec{R} \cdot \vec{S} = 0$

D.  $\vec{R} \cdot \vec{T} = 0$

E.  $\vec{S} \cdot \vec{T} = 0$

ans: E

38. The value of  $\hat{i} \cdot (\hat{j} \times \hat{k})$  is:

A. zero

B. +1

C. -1

D. 3

E.  $\sqrt{3}$

ans: B

39. The value of  $\hat{k} \cdot (\hat{k} \times \hat{i})$  is:

A. zero

B. +1

C. -1

D. 3

E.  $\sqrt{3}$

ans: A