PHYS 101 Previous Exam Problems

CHAPTER 3 Vectors

1. Vectors ***A***, ***B***, and ***C*** are related through equations ***A*** **+** ***B*** **=** ***C*** and ***A*** **–** ***B*** = 5.0 ***C***. If ***C*** = 3.0 **î** + 4.0 **ĵ**, what is the magnitude of vector ***A***? (Ans: 15)

2. Three vectors $\vec{F}$, $\vec{v}$ and $\vec{B}$ are related through $\vec{F} = 5.0(\vec{v} \times \vec{B})$. If vector $\vec{v} = 3.0\hat{i} - 5.0\hat{j}$ and $\vec{B} = -2.0\hat{k}$, what is vector $\vec{F}$? (Ans: $50\hat{i} + 30\hat{j}$)

3. Vectors $\vec{F}$ and $\vec{G}$ are defined as $\vec{F} = 3.0\hat{i} + 4.0\hat{j}$ and $\vec{G} = -\hat{i} + \hat{j}$. Find the component (projection) of vector $\vec{G}$ along the direction of vector $\vec{F}$. (Ans: 0.20)

4. In figure 1, what is the unknown vector $\vec{C}$? (Ans: $\vec{B} - \vec{A}$)

5. Two vectors are given by: $\vec{P} = -1.5\hat{i} + 2.0\hat{j}$, $\vec{Q} = 1.0\hat{j}$. What is the angle that the vector $2\vec{P} - \vec{Q}$ makes with the positive *x*-axis? (A: 135°)

6. A man walks 5.0 km due North, then 13 km 22.6° South of East, and then 12 km due West. What is the final location of the man? (Ans: where he started)

7. What is the angle between vector ***A*** = 3.00 **î** + 4.00 **ĵ** and the negative *y* axis? (Ans: 143°)

8. Three vectors are: ***A*** = –*3.0* **î** ; ***B*** = –5.0 **k̂** *and* ***C*** = 2.0 **ĵ**. What is the value of ***A.(B×C)***? (Ans: –30)

9. A vector in the *xy* plane has a magnitude of 25 m, an *x* component of +12 m, and a positive *y* component. What angle does it make with the positive *y* axis? (Ans: 29°)

10. If ***A*** = (2.0 **î** –3.0 **ĵ**) m and ***B*** = (1.0 **î** –2.0 **ĵ**) m , what is **A**–**2B**? (Ans: 1.0 **ĵ** m)

11. If ***A*** = **î** + **ĵ** and ***B*** = **î** – **ĵ**, what is the angle between **A** and **B**? (Ans: 90°)

12. Let **A** = 2.0 **î** + 3.0 **k̂** and ***B*** = 2.0 **î** + **k̂** . What is the vector ***D*** **=** ***(A–B)×A***? (Ans: 4.0 **ĵ**)

13. In figure 2, **A** = (12m, 60°) and **B** = (8m, 300°). What is the *x* component of ***(A–B)***? (Ans: 2 m)

14. Three vectors ***A***, ***B***, and ***C*** are such that: ***C*** **=** ***A+B***, ***B*** = 5 **î** and ***C*** = 5 **ĵ**. Find the angle between ***A*** and **B**. (Ans: 135°)

15. Two vectors ***A*** and ***B*** are shown in figure 3. Each vector has a magnitude of 5.0 m. Find the magnitude of the resultant vector ***R*** **=** ***A*** **+** ***B*** and the angle between *R* and the positive *x* axis. (Ans: 7.1 m, $\theta = 90°$)

16. Two displacement vectors **A** and **B** have equal magnitudes of 10 m. Vector **A** is along the + *y* axis and vector **B** makes 45° counterclockwise with + *x* axis. Find the vector **C** such that **B + C = 2A**.
(Ans: **C** = –7 **î** + 13 **ĵ**)

17. As shown in figure 4, a block moves down on a 45° inclined plane of 2.5 m length, then horizontally for another 2.5 m, and then falls down vertically a height of 2.5 m. Find the magnitude and direction of the resultant displacement vector of the block. (Ans: 6.0 m and 45° below horizontal axis)

18. Which of the following is NOT a unit vector? $(\hat{\mathbf{i}}+\hat{\mathbf{j}})/2$; $\vec{\mathbf{a}}/|\vec{\mathbf{a}}|$; $\hat{\mathbf{j}}\times\hat{\mathbf{i}}$; $(1/\sqrt{3})(\hat{\mathbf{i}}+\hat{\mathbf{j}}+\hat{\mathbf{k}})$; $0.6\hat{\mathbf{j}} + 0.8\hat{\mathbf{k}}$.

19. Two vectors ***A*** and ***B*** have the components in meters, A_x = -4.0, A_y = 3.0, and B_x = 5.0, B_y = 12. Find the angle between the directions of ***A*** and ***B***. (Ans: 76°)

20. Starting from the origin, a boy walks 3.5 m South, then 10 m at 30° North of East, and finally 10 m West. Find the resultant displacement vector. Take East along the positive x-axis and North along the positive *y* axis. (Ans: $-1.34\,\hat{\mathbf{i}} + 1.5\,\hat{\mathbf{j}}$ m)

21. In the cross product $\boldsymbol{F} = \boldsymbol{v} \times \boldsymbol{B}$, take $\boldsymbol{v} = 2.0\,\hat{\mathbf{i}}$, $\boldsymbol{F} = 6.0\,\hat{\mathbf{j}}$, and the *x* component of vector ***B*** equals zero. What then is ***B*** in unit-vector notation? (Ans: $-3.0\,\hat{\mathbf{k}}$)

22. If vector ***A*** has a magnitude of 3.0, and makes an angle of 30° with the + *x* axis, what is the vector $\boldsymbol{B} = -2\boldsymbol{A}$? (Ans: $-5.2\,\hat{\mathbf{i}} - 3.0\,\hat{\mathbf{j}}$)

23. Two vectors, ***A*** and ***B***, have magnitudes of 10 m and 15 m respectively. The angle between them is 65°. What is the component (projection) of ***B*** along ***A***? (Ans: 6.3 m)

24. If vector ***A*** is added to vector ***B***, the result is $(6\,\hat{\mathbf{i}} + \hat{\mathbf{j}})$ m. If ***A*** is subtracted from ***B***, the result is $(-4\,\hat{\mathbf{i}} + 7\,\hat{\mathbf{j}})$ m. Find the magnitude of ***B***. (Ans: 4m)

25. A car travels 30 km due south and then *D* km in an unknown direction. The magnitude of the resultant displacement is 50 km and its direction is 53° west of south. Find the magnitude and direction of the unknown displacement *D*. (Ans: 40 km due west)

26. A vector is defined by $\boldsymbol{A} = 1.50\,\hat{\mathbf{i}} + 1.50\,\hat{\mathbf{j}}$. Find a vector ***B*** that makes an angle of 60.0° with ***A*** in the counterclockwise direction and has a magnitude of 4 units. (Ans: $-1.04\,\hat{\mathbf{i}} + 3.86\,\hat{\mathbf{j}}$)

27. In figure 7, vector ***A*** has a magnitude of 12 m, and vector ***B*** has a magnitude of 8 m. What is $\boldsymbol{A} - \boldsymbol{B}$? (Ans: $4.49\,\hat{\mathbf{i}} + 15.4\,\hat{\mathbf{j}}$ m)

28. Two points *A* and *B* are in the *xy* plane. *A* has coordinates (0 m, 3 m), and *B* has coordinates (4 m, 0 m). What is the displacement vector that goes from *A* to *B*? (Ans: $4\,\hat{\mathbf{i}} - 3\,\hat{\mathbf{j}}$)

29. If vector ***B*** is added to vector $\boldsymbol{C} = (30\,\hat{\mathbf{i}} + 40\,\hat{\mathbf{j}})$ m, the resultant vector is directed along the positive *x* direction, with a magnitude equal to that of vector ***C***. What is the magnitude of ***B***? (Ans: 45 m)

30. Six vectors ($\vec{A}$, $\vec{B}$, $\vec{C}$, $\vec{D}$, $\vec{E}$ and $\vec{F}$) of magnitude 10.0 each are shown in figure 8. Find the resultant of these vectors in unit vector notations. (Ans: $7.07\,\hat{\mathbf{i}} + 2.93\,\hat{\mathbf{j}}$)

31. If $\vec{d}_1 = 3\hat{i} - 2\hat{j}$ and $\vec{d}_2 = -5\hat{i} + 2\hat{j}$, find $(\vec{d}_1 + \vec{d}_2)\cdot(\vec{d}_1 - \vec{d}_2)$. (Ans: -16)

32. A man leaves his house and makes **three** successive displacements. The first displacement is **D1** (10.0 km, 60.0°), the second displacement **D2** is unknown, and the third displacement **D3** is (10.0 km, 240°). Find the second displacement **D2** if his resultant displacement is (20.0 km, 90.0°). All angles are measured counter clockwise with respect to the positive x-axis. (Ans: (20.0 km, 90.0°))

33. You are given the two vectors ***A*** and ***B***. If $\vec{\mathbf{A}} \cdot \vec{\mathbf{B}} = 4.00$ and $|\vec{\mathbf{A}} \times \vec{\mathbf{B}}| = 3.00$, what is the angle between ***A*** and ***B***? (Ans: 36.9°)

34. Find the sum of the following two vectors: $\vec{A}$: 8.66 in +*x*-direction, $\vec{B}$: 10.0 , at 60° from +*y*-axis measured counterclockwise. (Ans: 5.00 $\hat{\mathbf{j}}$)

35. An airplane starting from airport **A** flies 500 km east, then 200 km 30° west of north, and then 127 km north to arrive at airport **B**. The next day, another plane flies directly from **A** to **B** in a straight line. In what direction should the pilot travel in this direct flight? Ignore the effects of air. (Ans: 37° north of east)

36. Three vectors are given by A = $1.0\hat{\mathbf{i}} + 1.0\hat{\mathbf{j}}$, B = $-1.0\hat{\mathbf{j}} + 1.0\hat{\mathbf{k}}$, and C = $-1.0\hat{\mathbf{i}} + 1.0\hat{\mathbf{k}}$. Find $\vec{\mathbf{A}} \cdot (\vec{\mathbf{B}} \times \vec{\mathbf{C}})$. (Ans: – 2.0)

37. If vector **A** = *b* ($3.0\hat{\mathbf{i}} + 4.0\hat{\mathbf{j}}$), where *b* is a constant. Find the value of *b* that makes vector **A** a unit vector. (Ans: 0.20)

38. Two vectors **A** and **B** have magnitudes 3.0 and 4.0 respectively. Find the angle between **A** and **B** if their vector product is **A x B** = $-5.0\hat{\mathbf{k}} + 2.0\hat{\mathbf{i}}$. (Ans: 27°)

39. What is the angle between the vector $2.50\hat{\mathbf{j}} + 4.33\hat{\mathbf{k}}$ and the *y* axis? (Ans: 60°)

40. You are given vectors **A** = $5.00\hat{\mathbf{i}} - 6.00\hat{\mathbf{j}}$ and **B** = $-3.00\hat{\mathbf{i}} + 7.00\hat{\mathbf{j}}$. A third vector **C** lies in the *xy*-plane. Vector **C** is perpendicular to vector **A**, and the scalar product of **C** with **B** is 15.0. Find the vector **C**. (Ans: $5.29\hat{\mathbf{i}} + 4.41\hat{\mathbf{j}}$)

41. The scalar product of vectors $\vec{A}$ and $\vec{B}$ is 6.00 and the magnitude of their vector product is 9.00. Find the angle between these two vectors. (Ans: 56.3°)

A B C D E Conceptual Problems ❶❷❸❹❺

1. Figure 5 shows four vectors **A**, **B**, **C**, **D**. Which of the following statements is correct:

A. **C = D + B – A**
B. **C = A + B + D**
C. **C = –D – B + A**
D. **C = A – B + D**
E. **C = –A – B – D**

2. Vector ***A*** of magnitude 20 is added to a vector ***B*** of magnitude 25. The magnitude of the vector ***A + B*** can be:

A. 12
B. zero
C. 3
D. 47
E. 50

3. Which one of the following statements concerning vectors and scalars is false?

A. A vector that has zero magnitude may have components other than zero.
B. A vector that has a negative component, has a positive magnitude.
C. A scalar component may be either positive or negative.
D. Two vectors are equal only if they have the same magnitude and same direction.
E. In calculations, the vector components of a vector may be used in place of the vector itself.

4. The vectors ***X***, ***Y***, and ***Z*** are related by ***Z* = *Y* – *X***. Which diagram in figure 6 illustrates this relationship?

A. E
B. B
C. C
D. D
E. A

5. Consider two non-zero vectors $\vec{A}$ and $\vec{B}$. If $|\vec{A}+\vec{B}|^2 = |\vec{A}|^2 + |\vec{B}|^2$, then:

A) None of the other answers is true.
B) $\vec{A}$ and $\vec{B}$ must be parallel and in opposite directions.
C) The angle between $\vec{A}$ and $\vec{B}$ must be 45°.
D) The angle between $\vec{A}$ and $\vec{B}$ must be 60°.
E) $\vec{A}$ and $\vec{B}$ must be parallel and in the same direction.

6. A vector $\vec{B}$ is given by $\boldsymbol{B} = 2.0\,\hat{\mathbf{i}} + 2.0\,\hat{\mathbf{j}} + 2.0\,\hat{\mathbf{k}}$. Which one of the following represents a unit vector in the direction of ***B***?

A) $0.58\hat{i} + 0.58\hat{j} + 0.58\hat{k}$
B) $2.0\hat{i} + 2.0\hat{j} + 2.0\hat{k}$
C) $0.45\hat{i} + 0.56\hat{j} + 0.67\hat{k}$
D) $0.29\hat{i} + 0.32\hat{j} + 0.78\hat{k}$
E) $1.0\hat{i} + 1.0\hat{j} + 1.0\hat{k}$

7. Three vectors are given by $\vec{A} = 3.0\hat{i} + 3.0\hat{j}$, $\vec{B} = -1.0\hat{i} - 4.0\hat{j}$ and $\vec{C} = 2.0\hat{i} + 2.0\hat{j}$. Find $\vec{A} \cdot (\vec{B} \times \vec{C})$.

A. 0
B. -21
C. +26
D. -26
E. +5.0

8. If the magnitude of the sum of two vectors is less than the magnitude of either vector, then:

A. the scalar product of the vectors must be negative
B. the scalar product of the vectors must be positive
C. the vectors must be parallel and in opposite directions
D. the vectors must be parallel and in the same direction
E. the vectors must be perpendicular to each other.

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

A. -1
B. +1
C. zero
D. 3
E. i

10. Consider the vector $\vec{A} = 3.0\hat{\mathrm{i}} + 4.0\hat{\mathrm{j}}$. Which of the following vectors is perpendicular to vector $\vec{A}$:

A) $4.0\hat{\mathrm{i}} - 3.0\hat{\mathrm{j}}$
B) $3.0\hat{\mathrm{i}} - 4.0\hat{\mathrm{j}}$
C) $4.0\hat{\mathrm{i}} + 3.0\hat{\mathrm{j}}$
D) $-3.0\hat{\mathrm{i}} - 4.0\hat{\mathrm{j}}$
E) $3.0\hat{\mathrm{i}} + 4.0\hat{\mathrm{j}}$

11. Consider two vectors $\mathbf{v} = 3.0\ \hat{\mathbf{i}} + 3.0\,\hat{\mathbf{j}}$ and $\mathbf{w} = \cos\theta\,\hat{\mathbf{i}} + \sin\theta\,\hat{\mathbf{j}}$, where θ is measured counter clockwise with respect to the positive x axis. For what value of θ (in degrees) is the vector product $\mathbf{v} \times \mathbf{w} = 0$?

A. 45
B. 135
C. 90
D. 105
E. 0

12. The two vectors shown in figure 9 lie in the *xy* plane. Which of the following vectors has positive *x* and *y* components?

A) $\vec{\mathbf{B}} - \vec{\mathbf{A}}$
B) $\vec{\mathbf{A}} - \vec{\mathbf{B}}$
C) $\vec{\mathbf{B}} + \vec{\mathbf{A}}$
D) $\vec{\mathbf{A}} - 2\vec{\mathbf{B}}$
E) $2\vec{\mathbf{A}} - \vec{\mathbf{B}}$

13. If $\mathbf{A} = (-10\,\hat{\mathbf{i}} + 10\,\hat{\mathbf{j}})$ and $\mathbf{B} = (-10\,\hat{\mathbf{i}} - 10\,\hat{\mathbf{j}})$, which statement is correct?

A. (**A**-**B**) is perpendicular to (A+B)
B. (**A**-**B**) is perpendicular to (B-A)
C. The magnitude of (**A**-**B**) is larger than the magnitude of (**A**+**B**)
D. The magnitude of (**A**-**B**) is smaller than the magnitude of (**A**+**B**)
E. (**A**-**B**) is parallel to (**A**+**B**)

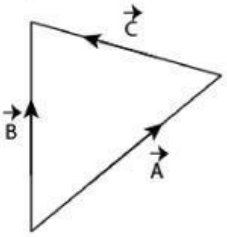
14. The two vectors shown in figure 10 lie in an *xy* plane. What are the signs of the *x* and *y* components, respectively, of the vector $\mathbf{d}_2 - \mathbf{d}_1$?

A) +,+
B) +, -
C) -, +
D) -, -
E) None of the other answers is correct.

15. Refer to figure 11. Express vector **A** in terms of vectors **B**, **C**, and **D**. Fig#

A) $\vec{A} = \vec{B} + \vec{C} - \vec{D}$
B) $\vec{A} = \vec{B} + \vec{C} + \vec{D}$
C) $\vec{A} = \vec{B} - \vec{C} - \vec{D}$
D) $\vec{A} = \vec{B} - \vec{C} + \vec{D}$
E) $\vec{A} = -\vec{B} + \vec{C} - \vec{D}$

Figure 1



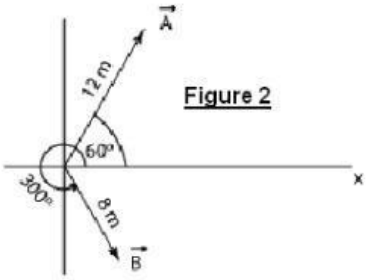


Figure 2

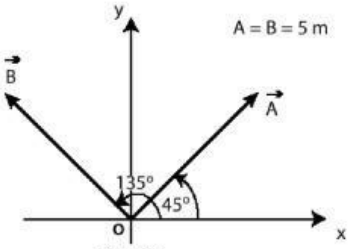


Figure 3

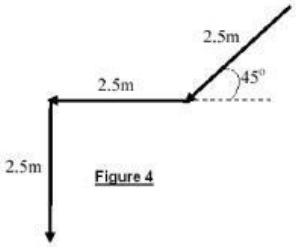


Figure 4

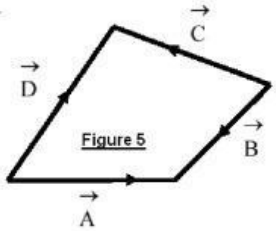


Figure 5

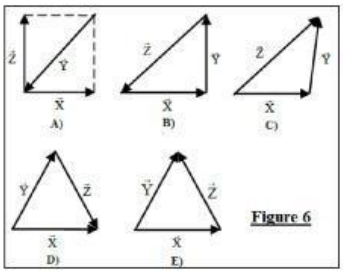


Figure 6

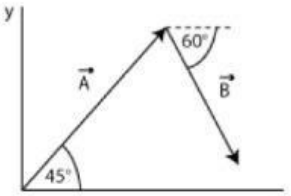


Figure 7

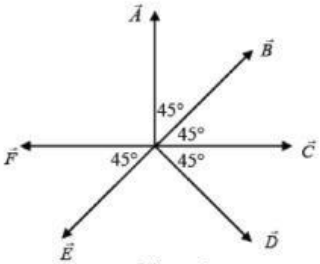


Figure 8

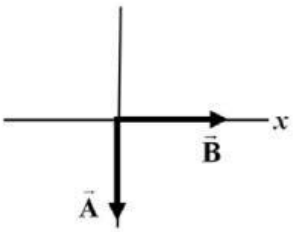


Figure 9

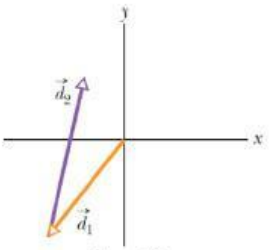


Figure 10

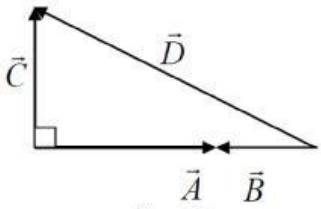


Figure 11