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***University Physics* (Pearson)**
Topic 2 Vectors

2.1 Conceptual Questions

2.1.1 Addition and Subtraction

1) Addition and subtraction: If $\vec{A} - \vec{B} = 0$, then the vectors $\vec{A}$ and $\vec{B}$ have equal magnitudes and are directed in the opposite directions from each other.
A) True
B) False
Answer: B
Var: 1
Topic: Addition and subtraction

2) Addition and subtraction: Under what condition is $|\vec{A} - \vec{B}| = A + B$?
A) The magnitude of vector $\vec{B}$ is zero.
B) Vectors $\vec{A}$ and $\vec{B}$ are in opposite directions.
C) Vectors $\vec{A}$ and $\vec{B}$ are in the same direction.
D) Vectors $\vec{A}$ and $\vec{B}$ are in perpendicular directions.
E) The statement is never true.
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Answer: B
Var: 1
Topic: Addition and subtraction

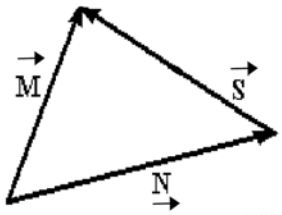
3) Addition and subtraction: If $A > B$, under what condition is $|\vec{A} - \vec{B}| = A - B$?
A) The statement is never true.
B) Vectors $\vec{A}$ and $\vec{B}$ are in opposite directions.
C) Vectors $\vec{A}$ and $\vec{B}$ are in the same direction.
D) Vectors $\vec{A}$ and $\vec{B}$ re in perpendicular directions.
E) The statement is always true.
Answer: C
Var: 1
Topic: Addition and subtraction

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4) Addition and subtraction: For the vectors shown in the figure, express vector $\vec{S}$ in terms of vectors $\vec{M}$ and $\vec{N}$.



Answer: $\vec{S} = \vec{M} - \vec{N}$
Var: 1
Topic: Addition and subtraction

2.1.2 Components

1) Components: Which of the following is an accurate statement?
A) The magnitude of a vector can be zero even though one of its components is not zero.
B) It is possible to add a scalar quantity to a vector.
C) Even though two vectors have unequal magnitudes, it is possible that their vector sum is zero.
D) Rotating a vector about an axis passing through the tip of the vector does not change the vector.
E) The magnitude of a vector is independent of the coordinate system used.
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Answer: E
Var: 1
Topic: Components

2) Components: The magnitude of a vector can never be less than the magnitude of one of its components.
A) True
B) False
Answer: A
Var: 1
Topic: Components

3) Components: If the magnitude of vector $\vec{A}$ is less than the magnitude of vector $\vec{B}$, then the x component of $\vec{A}$ is less than the x component of $\vec{B}$.
A) True
B) False
Answer: B
Var: 1
Topic: Components

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4) Components: If the eastward component of vector $\vec{A}$ is equal to the westward component of vector $\vec{B}$ and their northward components are equal. Which one of the following statements about these two vectors is correct?
A) Vector $\vec{A}$ is parallel to vector $\vec{B}$.
B) Vectors $\vec{A}$ and $\vec{B}$ point in opposite directions.
C) Vector $\vec{A}$ is perpendicular to vector $\vec{B}$.
D) The magnitude of vector $\vec{A}$ is equal to the magnitude of vector $\vec{B}$.
E) The magnitude of vector $\vec{A}$ is twice the magnitude of vector $\vec{B}$.
Answer: D
Var: 1
Topic: Components

2.1.3 Unit Vectors

1) Unit vectors: If all the components of a vector are equal to 1, then that vector is a unit vector.
A) True
B) False
Answer: B
Var: 1
Topic: Unit vectors

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2.1.4 Scalar (dot) Product

1) Scalar (dot) product: If the dot product of two nonzero vectors is zero, the vectors must be perpendicular to each other.
A) True
B) False
Answer: A
Var: 1
Topic: Scalar (dot) product

2) Scalar (dot) product: If two nonzero vectors point in the same direction, their dot product must be zero.
A) True
B) False
Answer: B
Var: 1
Topic: Scalar (dot) product

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3) Scalar (dot) product: The value of the dot product of two vectors depends on the particular coordinate system being used.
A) True
B) False
Answer: B
Var: 1
Topic: Scalar (dot) product

2.1.5 Vector (cross) Product

1) Vector (cross) product: If two vectors are perpendicular to each other, their cross product must be zero.
A) True
B) False
Answer: B
Var: 1
Topic: Vector (cross) product

2) Vector (cross) product: If two vectors point in opposite directions, their cross product must be zero.
A) True
B) False
Answer: A
Var: 1
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Topic: Vector (cross) product

3) Vector (cross) product: If $\vec{A}$ and $\vec{B}$ are nonzero vectors for which $\vec{A} \cdot \vec{B} = 0$, it must follow that
A) $\vec{A} \times \vec{B} = 0$.
B) $\vec{A}$ is parallel to $\vec{B}$.
C) $|\vec{A} \times \vec{B}| = AB$.
D) $|\vec{A} \times \vec{B}| = 1$.
Answer: C
Var: 1
Topic: Vector (cross) product

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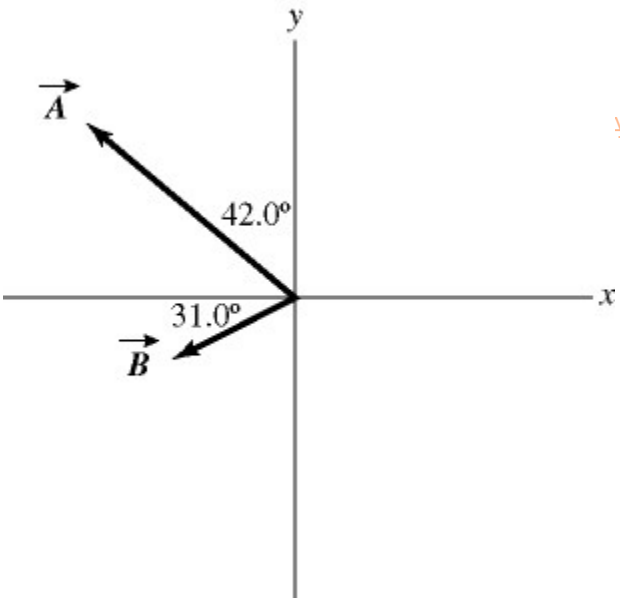
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2.2 Problems

2.2.1 Addition and Subtraction

1) Addition and subtraction: You walk 55 m to the north, then turn 60° to your right and walk another 45 m. How far are you from where you originally started?
A) 87 m
B) 50 m
C) 94 m
D) 46 m
Answer: A
Var: 31
Topic: Addition and subtraction

2) Addition and subtraction: Vectors $\vec{A}$ and $\vec{B}$ are shown in the figure. Vector $\vec{C}$ is given by $\vec{C} = \vec{B} - \vec{A}$. The magnitude of vector $\vec{A}$ is 16.0 units, and the magnitude of vector $\vec{B}$ is 7.00 units. What is the magnitude of vector $\vec{C}$?

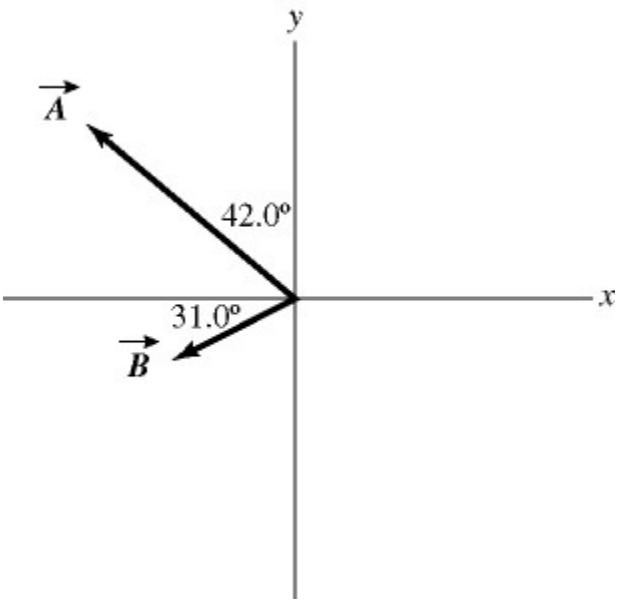


A) 9.00
B) 9.53
C) 15.5
D) 16.2
E) 17.5
Answer: D
Var: 1
Topic: Addition and subtraction

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3) Addition and subtraction: Vectors $\vec{A}$ and $\vec{B}$ are shown in the figure. Vector $\vec{C}$ is given by $\vec{C} = \vec{B} - \vec{A}$. The magnitude of vector $\vec{A}$ is 16.0 units, and the magnitude of vector $\vec{B}$ is 7.00 units. What is the angle of vector $\vec{C}$, measured counterclockwise from the +*x*-axis?



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A) 16.9°
B) 22.4°
C) 73.1°
D) 287°
E) 292°
Answer: D
Var: 1
Topic: Addition and subtraction

4) Addition and subtraction: A rabbit trying to escape a fox runs north for 8.0 m, darts northwest for 1.0 m, then drops 1.0 m down a hole into its burrow. What is the magnitude of the net displacement of the rabbit?
A) 8.8 m
B) 8.1 m
C) 66 m
D) 10 m
Answer: A
Var: 50+
Topic: Addition and subtraction

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5) Addition and subtraction: You walk 53 m to the north, then turn 60° to your right and walk another 45 m. Determine the direction of your displacement vector. Express your answer as an angle relative to east.
A) 63° N of E
B) 50° N of E
C) 57° N of E
D) 69° N of E
Answer: A
Var: 50+
Topic: Addition and subtraction

2.2.2 Components

1) Components: Vector $\vec{A}$ has a magnitude 5.00 and points in a direction 40.0° clockwise from the negative *y* axis. What are the *x* and *y* components of vector $\vec{A}$.
A) A_X = 3.83 and A_Y = 3.21
B) A_X = 3.83 and A_Y = -3.21
C) A_X = -3.21 and A_Y = -3.83
D) A_X = -3.21 and A_Y = 3.83
E) A_X = 4.29 and A_Y = 2.16
Answer: C
Var: 5
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Topic: Components

2) Components: The components of vector $\vec{A}$ are A_x = + 3.90 and A_y = -4.00. What is the angle measured counterclockwise from the +x-axis to vector $\vec{A}$?
A) 314°
B) 134°
C) 224°
D) 136°
E) 46.0°
Answer: A
Var: 1
Topic: Components

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3) Components: Vector $\vec{A}$ has a magnitude of 5.5 cm and points along the *x*-axis. Vector $\vec{B}$ has a magnitude of 7.5 cm and points at +30° above the negative *x*-axis.
(a) Determine the *x* and *y* components of Vector $\vec{A}$.
(b) Determine the *x* and *y* components of Vector $\vec{B}$.
(c) Determine *x* and *y* components of the sum of these two vectors.
(d) Determine the magnitude and direction of the sum of these two vectors.
Answer: (a) A_x = 5.5 cm, A_y = 0
(b) B_x = -6.5 cm, B_y = 3.8 cm
(c) R_x = -1.0 cm, R_y = 3.8 cm
(d) 3.9 cm at 75° above -*x*-axis
Var: 1
Topic: Components

4) Components: Vector $\vec{A}$ has a magnitude of 75.0 cm and points at 30° above the positive *x*-axis. Vector $\vec{C}$ has a magnitude of 25.0 cm and points along the negative *x*-axis. Vector $\vec{C}$ has a magnitude of 40.0 cm and points at 45° below the negative *x*-axis.
(a) Determine the *x* and *y* components of Vector $\vec{A}$.
(b) Determine the *x* and *y* components of Vector $\vec{B}$.
(c) Determine the *x* and *y* components of Vector $\vec{C}$.
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(d) Determine *x* and *y* components of the sum of these three vectors.
(e) Determine the magnitude and direction of the sum of these three vectors.
Answer: (a) A_x = 65 cm, A_y = 38 cm
(b) B_x = -25 cm, B_y = 0
(c) C_x = -28 cm, C_y = -28 cm
(d) R_x = 12 cm, R_y = 9.2 cm
(e) 15 cm at 38° above +*x*-axis
Var: 1
Topic: Components

5) Components: A helicopter is flying horizontally with a speed of 444 m/s over a hill that slopes upward with a 2% grade (that is, the "rise" is 2% of the "run"). What is the component of the helicopter's velocity perpendicular to the sloping surface of the hill?
A) 8.9 m/s
B) 220 m/s
C) 435 m/s
D) 444 m/s
Answer: A
Var: 50+
Topic: Components

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6) Components: An apple falls from an apple tree growing on a 20° slope. The apple hits the ground with an impact velocity of 16.2 m/s straight downward. What is the component of the apple's impact velocity parallel to the surface of the slope?
A) 5.5 m/s
B) 8.7 m/s
C) 12 m/s
D) 15 m/s
Answer: A
Var: 50+
Topic: Components

7) Components: The components of vector $\vec{A}$ are $A_x = +2.2$ and $A_y = -6.9$, and the components of vector $\vec{B}$ are given are $B_x = -6.1$ and $B_y = -2.2$. What is the magnitude of the vector $\vec{B} - \vec{A}$?
A) 9.5
B) 6.1
C) 9.9
D) 91
E) 0.76
Answer: A
Var: 50+
Topic: Components

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8) Components: The components of vector $\vec{B}$ are $B_x = -3.5$ and $B_y = -9.7$, and the components of vector $\vec{C}$ are $C_x = -6$ and $C_y = +8.1$. What is the angle (less than 180 degrees) between vectors $\vec{B}$ and $\vec{C}$?
A) 124°
B) 56°
C) 17°
D) 163°
E) 106°
Answer: A
Var: 50+
Topic: Components

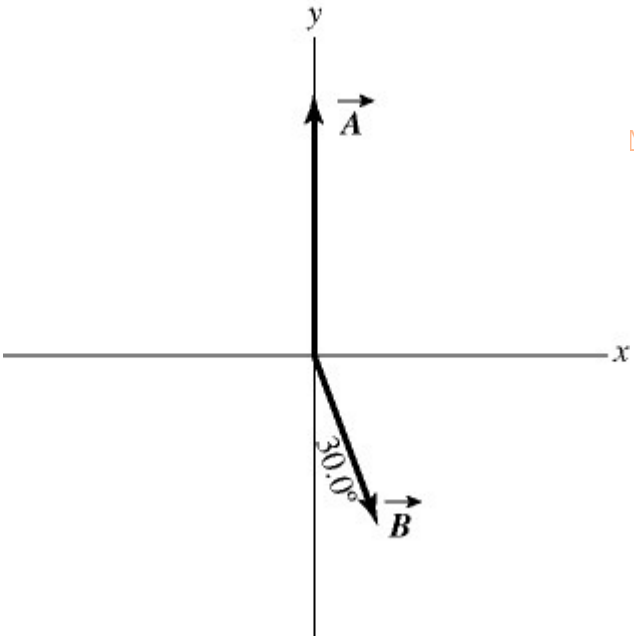
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9) Components: An airplane undergoes the following displacements: First, it flies 66 km in a direction 30° east of north. Next, it flies 49 km due south. Finally, it flies 100 km 30° north of west. Using vector components, determine how far the airplane ends up from its starting point.
A) 79 km
B) 81 km
C) 82 km
D) 78 km
E) 76 km
Answer: A
Var: 1
Topic: Components

10) Components: In the figure, the magnitude of vector $\vec{A}$ is 18.0 units, and the magnitude of vector $\vec{B}$ is 12.0 units. What vector $\vec{C}$ must be added to the vectors $\vec{A}$ and $\vec{B}$ so that the resultant of these three vectors points in the -x direction and has a magnitude of 7.50 units? Use vector components to find your answer, and express vector $\vec{C}$ by giving its magnitude and the angle it makes with the +x-axis taking counterclockwise to be positive.

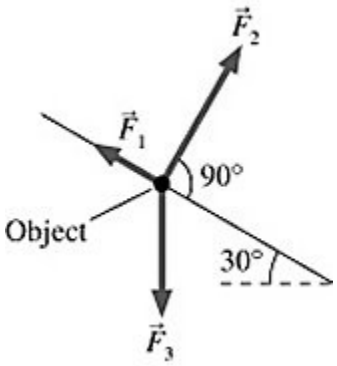


Answer: 15.5, 209°
Var: 1
Topic: Components

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11) Components: Three forces are exerted on an object placed on a tilted floor. Forces are vectors. The three forces are directed as shown in the figure. If the forces have magnitudes F_1 = 1.0 N, F_2 = 8.0 N and F_3 = 7.0 N, where N is the standard unit of force, what is the component of the *net force* $\vec{F}_{\text{net}} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3$ parallel to the floor?



A) 2.5 N
B) 5.1 N
C) 6.0 N
D) 7.8 N
Answer: A
Var: 29
Topic: Components

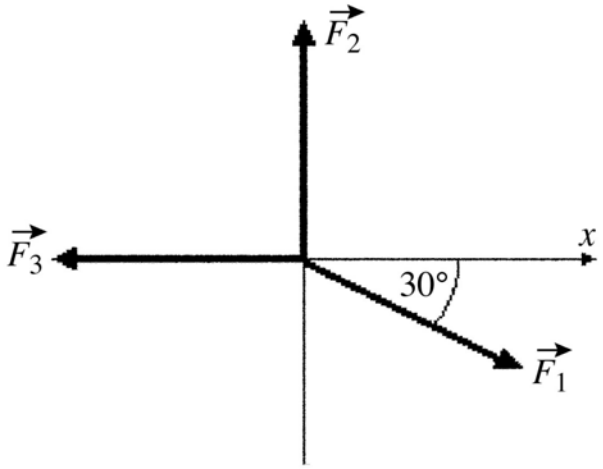
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12) Components: As shown in the figure, three force vectors act on an object. The magnitudes of the forces as shown in the figure are F_1 = 80.0 N, F_2 = 60.0 N, and F_3 = 40.0 N, where N is the standard SI unit of force. The resultant force acting on the object is given by



A) 180 N at an angle 60.0° with respect to +*x*-axis.
B) 60.0 N at an angle 90.0° with respect to +*x*-axis.
C) 20.0 N at an angle 34.3° with respect to +*x*-axis.
D) 35.5 N at an angle 34.3° with respect to +*x*-axis.
E) 40.0 N at an angle 60.0° with respect to +*x*-axis.
Answer: D
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Var: 1
Topic: Components

13) Components: A teacher sends her students on a treasure hunt. She gives the following instructions:
1. Walk 300 m north
2. Walk 400 m northwest
3. Walk 700 m east-southeast and the treasure is buried there.
As all the other students walk off following the instructions, Jane physics student quickly adds the displacements and walks in a straight line to find the treasure. How far and in what direction does Jane need to walk?
A) 187 m in a direction 67.3° north of east
B) 481 m in a direction 40.9° north of east
C) 399 m in a direction 52.5° north of east
D) 284 m in a direction 28.2° west of north
E) The treasure position cannot be reached in one straight walk.
Answer: B
Var: 1
Topic: Components

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2.2.3 Unit Vectors

1) Unit vectors: Vector $\vec{A}$ = -3.00 $\hat{i}$ + 3.00 $\hat{j}$ and vector $\vec{B}$ = 3.00 $\hat{i}$ + 4.00 $\hat{j}$. What is vector $\vec{C}$ = $\vec{A}$ + $\vec{B}$?

A) 0.00 $\hat{i}$ + 3.00 $\hat{j}$

B) 7.00 $\hat{i}$ + 7.00 $\hat{j}$

C) -3.00 $\hat{i}$ + 7.00 $\hat{j}$

D) 0.00 $\hat{i}$ + 7.00 $\hat{j}$

E) -3.00 $\hat{i}$ -3.00 $\hat{j}$

Answer: D
Var: 1
Topic: Unit vectors

2) Unit vectors: Vector $\vec{A}$ = 1.00 $\hat{i}$ + -2.00 $\hat{j}$ and vector $\vec{B}$= 3.00 $\hat{i}$ + 4.00 $\hat{j}$ What are the magnitude and direction of vector $\vec{C}$ = $\vec{A}$ + $\vec{B}$?

A) 7.21 in a direction 33.7° counterclockwise from the positive *x* axis
B) 6.00 in a direction 63.4° counterclockwise from the positive *x* axis
C) 4.47 in a direction 6.34° counterclockwise from the positive *x* axis
D) 4.47 in a direction 26.6° counterclockwise from the positive *x* axis
E) 7.21 in a direction 56.3° counterclockwise from the positive *x* axis

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Answer: D
Var: 1
Topic: Unit vectors

3) Unit vectors: What is the magnitude of $\vec{A}$ + $\vec{B}$ + $\vec{C}$, where $\vec{A}$ = 1.00 $\hat{i}$ + 4.00 $\hat{j}$ - 1.00 $\hat{k}$, $\vec{B}$ = 3.00 $\hat{i}$ - 1.00 $\hat{j}$ - 4.00 $\hat{k}$ and $\vec{C}$ = -1.00 $\hat{i}$ + 1.00 $\hat{j}$?

A) 7.07
B) 2.00
C) 10.76
D) 6.78
E) 8.12

Answer: A
Var: 9
Topic: Unit vectors

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4) Unit vectors: If $\vec{A} = +4\,\hat{i} - 2\,\hat{j} - 3\,\hat{k}$ and $\vec{C} = -4\,\hat{i} - 2\,\hat{j} - 3\,\hat{k}$, which of the following numbers is closest to the magnitude of $\vec{A} - \vec{C}$?
A) 8
B) 7
C) 9
D) 10
E) 11
Answer: A
Var: 50+
Topic: Unit vectors

5) Unit vectors: Vector $\vec{A} = -1.00\,\hat{i} + -2.00\,\hat{j}$ and vector $\vec{B} = 3.00\,\hat{i} + 4.00\,\hat{j}$ What are the magnitude and direction of vector $\vec{C} = 3.00\,\vec{A} + 2.00\,\vec{B}$?
A) 3.61 in a direction -56.3° counterclockwise from the positive *x*-axis
B) 3.61 in a direction 56.3° counterclockwise from the positive *x*-axis
C) 3.61 in a direction 33.7° counterclockwise from the positive *x*-axis
D) 5.00 in a direction 56.3° counterclockwise from the positive *x* axis
E) 6.72 in a direction 34.4° counterclockwise from the positive *x*-axis
Answer: C
Var: 1
Topic: Unit vectors

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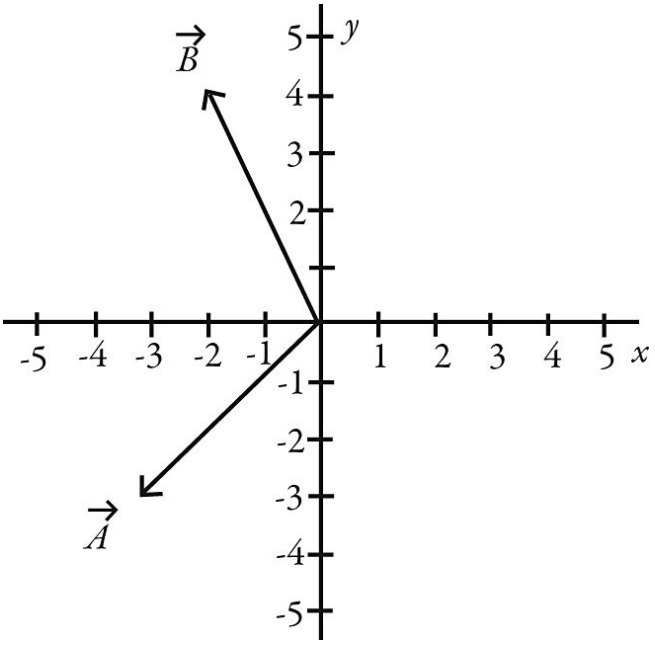
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6) Unit vectors: Vectors $\vec{A}$ and $\vec{B}$ are shown in the figure. What is $|-5.00\ \vec{A} + 4.00\ \vec{B}|$



A) 31.8
B) $-32.0\ \hat{i} - 2.00\ \hat{j}$
C) 1028
D) 34.0
E) $-2.00\ \hat{i} - 32.0\ \hat{j}$
Answer: A
Var: 1
Topic: Unit vectors

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2.2.4 Scalar (dot) Product

1) Scalar (dot) product: Determine the scalar product of $\vec{A} = 6.0\hat{i} + 4.0\hat{j} - 2.0\hat{k}$ and $\vec{B} = 5.0\hat{i} - 6.0\hat{j} - 3.0\hat{k}$.
A) $30\ \hat{i} + 24\hat{j} + 6\hat{k}$
B) $30\ \hat{i} - 24\hat{j} + 6\hat{k}$
C) 12
D) 60
E) undefined
Answer: C
Var: 5
Topic: Scalar (dot) product

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2) Scalar (dot) product: Determine the angle between the directions of vector $\vec{A} = 3.00\hat{i} + 1.00\hat{j}$ and vector $\vec{B} = -3.00\hat{i} + 3.00\hat{j}$.
A) 26.6°
B) 30.0°
C) 88.1°
D) 117°
E) 45.2°
Answer: D
Var: 5
Topic: Scalar (dot) product

3) Scalar (dot) product: The scalar product of vector $\vec{A} = 3.00\hat{i} + 2.00\hat{j}$ and vector $\vec{B}$ is 10.0. Which of the following vectors could be vector $\vec{B}$?
A) $2.00\hat{i} + 4.00\hat{j}$
B) $4.00\hat{i} + 6.00\hat{j}$
C) $5.00\hat{i} + 4.00\hat{j}$
D) $12.0\hat{i}$
E) $2.00\hat{i} + 2.00\hat{j}$
Answer: E
Var: 5
Topic: Scalar (dot) product

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4) Scalar (dot) product: The angle between vector $\vec{A} = 2.00\hat{i} + 3.00\hat{j}$ and vector $\vec{B}$ is 45.0°. The scalar product of vectors $\vec{A}$ and $\vec{B}$ is 3.00. If the *x* component of vector $\vec{B}$ is positive, what is vector $\vec{B}$.
A) $4.76\hat{i} + 0.952\hat{j}$
B) $1.15\hat{i} + 0.231\hat{j}$
C) $2.96\hat{i} + -0.973\hat{j}$
D) $0.871\hat{i} + 0.419\hat{j}$
E) $3.42\hat{i} + 0.684\hat{j}$
Answer: B
Var: 5
Topic: Scalar (dot) product

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5) Scalar (dot) product: What is the angle between the vector $\vec{A} = +3\hat{i} - 2\hat{j} - 3\hat{k}$ and the +*y*-axis?
A) 115°
B) 65°
C) 25°
D) 155°
E) 90°
Answer: A
Var: 16
Topic: Scalar (dot) product

6) Scalar (dot) product: If $\vec{A} = 3\hat{i} - \hat{j} + 4\hat{k}$ and $\vec{B} = x\hat{i} + \hat{j} - 5\hat{k}$, find *x* so $\vec{B}$ will be perpendicular to $\vec{A}$.
Answer: 7
Var: 1
Topic: Scalar (dot) product

7) Scalar (dot) product: Two boys searching for buried treasure are standing underneath the same tree. One boy walks 18 m east and then 18 m north. The other boy walks 16 m west and then 11 m north. Find the scalar product of their net displacements from the tree.
Answer: -90 m^2
Var: 50+
Topic: Scalar (dot) product

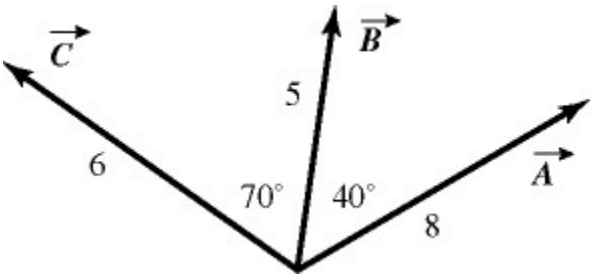
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8) Scalar (dot) product: A rectangular box is positioned with its vertices at the following points:
A = (0,0,0) *C* = (2,4,0) *E* = (0,0,3) *G* = (2,4,3)
B = (2,0,0) *D* = (0,4,0) *F* = (2,0,3) *H* = (0,4,3)
If the coordinates all have three significant figures, the angle between the line segments *AG* and *AH* is closest to:
A) 21.8°.
B) 22.5°.
C) 26.6°.
D) 36.9°.
E) 45.0°.
Answer: A
Var: 1
Topic: Scalar (dot) product

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9) Scalar (dot) product: For the vectors shown in the figure, assume numbers are accurate to two significant figures. The scalar product $\vec{A} \times \vec{C}$ is closest to



A) zero.
B) 16.
C) 45.
D) -16.
E) -45.
Answer: D
Var: 1
Topic: Scalar (dot) product

2.2.5 Vector (cross) Product

1) Vector (cross) product: What is the vector product of $\vec{A} = 2.00\,\hat{i} + 3.00\,\hat{j} + 1.00\hat{k}$ and $\vec{B} = 1.00\,\hat{i} - 3.00\,\hat{j} - 2.00\hat{k}$?

A) $-3.00\,\hat{i} + 5.00\,\hat{j} - 9.00\hat{k}$
B) $-5.00\,\hat{i} + 2.00\,\hat{j} - 6.00\hat{k}$
C) $-9.00\,\hat{i} - 3.00\,\hat{j} - 3.00\hat{k}$
D) $-4.00\,\hat{i} + 3.00\,\hat{j} - 1.00\hat{k}$
E) $2.00\,\hat{i} - 9.00\,\hat{j} - 2.00\hat{k}$
Answer: A
Var: 1
Topic: Vector (cross) product

2) Vector (cross) product: What is the magnitude of the cross product of a vector of magnitude 2.00 m pointing east and a vector of magnitude 4.00 m pointing 30.0° west of north?
A) 6.93
B) -6.93
C) 4.00
D) -4.00
E) 8.00
Answer: A
Var: 1
Topic: Vector (cross) product

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3) Vector (cross) product: If the magnitude of the cross product of two vectors is one-half the dot product of the same vectors, what is the angle between the two vectors?
Answer: 26.6°
Var: 1
Topic: Vector (cross) product

4) Vector (cross) product: If $\vec{C} = -4\hat{i} - 2\hat{j} - 3\hat{k}$, what is $\vec{C} \times \hat{j}$?
A) $+3\hat{i} - 4\hat{k}$
B) $+3\hat{i} + 4\hat{k}$
C) $-3\hat{i} + 4\hat{k}$
D) $+3\hat{i} + 2\hat{j} - 4\hat{k}$
E) $-3\hat{i} - 2\hat{j} + 4\hat{k}$
Answer: A
Var: 50+
Topic: Vector (cross) product

5) Vector (cross) product: If $\vec{B} = -2\hat{i} - 6\hat{j} + 2\hat{k}$ and $\vec{C} = -2\hat{i} - 2\hat{j} - 3\hat{k}$, which of the following numbers is closest to the magnitude of $\vec{C} \times \vec{B}$?
A) 25
B) 21
C) 17
D) 13
E) 9
Answer: A
Var: 50+
Topic: Vector (cross) product

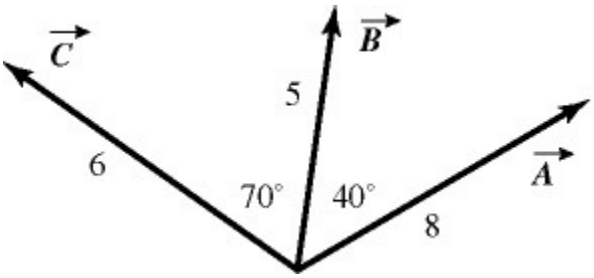
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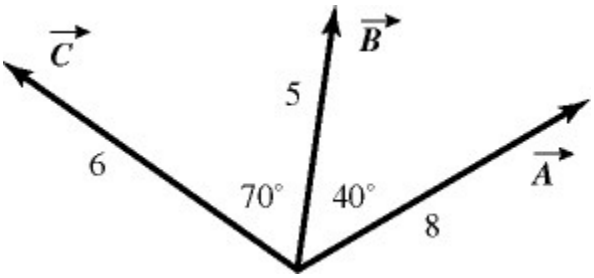
6) Vector (cross) product: For the vectors shown in the figure, find the magnitude and direction of $\vec{B} \times \vec{A}$, assuming that the quantities shown are accurate to two significant figures.



A) 26, directed into the plane
B) 26, directed out of the plane
C) 31, directed on the plane
D) 31, directed into the plane
E) 31, directed out of the plane
Answer: A
Var: 1
Topic: Vector (cross) product

7) Vector (cross) product: For the vectors shown in the figure, find the magnitude and direction of the vector product $\vec{A} \times \vec{C}$ that the quantities shown are accurate to two significant figures.

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A) 16, directed into the plane
B) 16, directed out of the plane
C) 45, directed on the plane
D) 45, directed into the plane
E) 45, directed out of the plane
Answer: E
Var: 1
Topic: Vector (cross) product

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