Chapter 1
Due: 11:59pm on Sunday, September 4, 2016
To understand how points are awarded, read the Grading Policy for this assignment.

Exercise 1.10
Description: The following conversions occur frequently in physics and are very useful. (a) Use 1 (mi)=5280 (ft) and 1 h = 3600 s to convert 60 mph to units of ft/s. (b) The acceleration of a freely falling object is 32 (ft)/s^2. Use 1 (ft) = 30.48 (cm).

The following conversions occur frequently in physics and are very useful.

Part A

Use 1 mi = 5280 ft and 1 h = 3600 s to convert 60 mph to units of ft/s.

Express your answer using two significant figures.

ANSWER:

88 ft/s

Part B

The acceleration of a freely falling object is 32 ft/s^2. Use 1 ft = 30.48 cm to express this acceleration in units of m/s^2.

Express your answer using two significant figures.

ANSWER:

9.8 m/s^2

Part C

The density of water is 1.0 g/cm^3. Convert this density to units of kg/m^3.

Express your answer using two significant figures.

ANSWER:

1000 kg/m^3

Exercise 1.34
Description: (a) Find the magnitude of the vector A\_1\_vec represented by the pair of components A\_x\_1= A\_x\_1, A\_y\_1= A\_y\_1. (b) Let the direction of a vector be the angle that the vector makes with the +x-axis, measured counterclockwise from that axis...
Part A
Find the magnitude of the vector $\vec{A}_1$ represented by the pair of components $A_{x_1} = -7.60 \text{ cm}$, $A_{y_1} = 3.90 \text{ cm}$.

ANSWER:
$$\sqrt{A_{x_1}^2 + A_{y_1}^2} = 8.54 \text{ cm}$$

Part B

Let the direction of a vector be the angle that the vector makes with the $+x$-axis, measured counterclockwise from that axis. Find the direction of the vector $\vec{A}_1$.

ANSWER:
$$\arccos\left(\frac{A_{x_1}}{\sqrt{A_{x_1}^2 + A_{y_1}^2}}\right) \cdot \frac{180}{\pi} = 153^\circ$$

Part C

Find the magnitude of the vector $\vec{A}_2$ represented by the pair of components $A_{x_2} = -6.50 \text{ m}$, $A_{y_2} = -1.50 \text{ m}$.

ANSWER:
$$\sqrt{A_{x_2}^2 + A_{y_2}^2} = 6.67 \text{ m}$$

Part D

Find the direction of the vector $\vec{A}_2$. Let the direction of a vector be the angle that the vector makes with the $+x$-axis, measured counterclockwise from that axis.

ANSWER:
$$\frac{360 - \arccos\left(\frac{A_{x_2}}{\sqrt{A_{x_2}^2 + A_{y_2}^2}}\right) \cdot 180}{\pi} = 193^\circ$$

Part E

Find the magnitude of the vector $\vec{A}_3$ represented by the pair of components $A_{x_3} = 7.00 \text{ km}$, $A_{y_3} = -3.20 \text{ km}$.
Part F

Find the direction of the vector $\vec{A}_3$. Let the direction of a vector be the angle that the vector makes with the $+x$-axis, measured counterclockwise from that axis.

ANSWER:

$$\theta = \cos^{-1}\left(\frac{A_{x3}}{\sqrt{A_{x3}^2 + A_{y3}^2}}\right) \cdot 180 \div \pi = 335^\circ.$$

Exercise 1.24

Description: (a) For the vectors $\vec{A}_{\text{vec}}$ and $\vec{B}_{\text{vec}}$ in the figure, use a scale drawing to find the magnitude of the vector sum $\vec{A}_{\text{vec}} + \vec{B}_{\text{vec}}$. (b) Find the direction of the vector sum $\vec{A}_{\text{vec}} + \vec{B}_{\text{vec}}$. (c) Find the magnitude of the vector difference $\vec{A}_{\text{vec}} - ...$

Part A

For the vectors $\vec{A}$ and $\vec{B}$ in the figure, use a scale drawing to find the magnitude of the vector sum $\vec{A} + \vec{B}$.

Express your answer using two significant figures.

ANSWER:

$$9.0 \text{ m}$$

Part B

Find the direction of the vector sum $\vec{A} + \vec{B}$.
Express your answer using two significant figures.

**ANSWER:**

34 ° counterclockwise from +x-axis

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**Part C**

Find the magnitude of the vector difference $\vec{A} - \vec{B}$.

Express your answer using two significant figures.

**ANSWER:**

22 m

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**Part D**

Find the direction of the vector difference $\vec{A} - \vec{B}$.

Express your answer using three significant figures.

**ANSWER:**

250 ° counterclockwise from +x-axis

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**Part E**

Use your answers to find the magnitude of $-\vec{A} - \vec{B}$.

Express your answer using two significant figures.

**ANSWER:**

9.0 m

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**Part F**

Find the direction of $-\vec{A} - \vec{B}$.

Express your answer using three significant figures.

**ANSWER:**

214 ° counterclockwise from +x-axis

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**Part G**

Find the magnitude of $\vec{B} - \vec{A}$.

Express your answer using two significant figures.
Part H

Find the direction of \( \vec{B} - \vec{A} \).

Express your answer using two significant figures.

ANSWER:

\[ 70 \, ^\circ \text{ counterclockwise from } +x\text{-axis} \]

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Exercise 1.26

Description: A spelunker is surveying a cave. She follows a passage 160 m straight west, then 290 m in a direction 45 degree(s) east of south, and then 280 m at 30 degree(s) east of north. After a fourth unmeasured displacement, she finds herself back ...

A spelunker is surveying a cave. She follows a passage 160 m straight west, then 290 m in a direction 45° east of south, and then 280 m at 30° east of north. After a fourth unmeasured displacement, she finds herself back where she started.

Part A

Use a scale drawing to determine the magnitude of the fourth displacement.

Express your answer using two significant figures.

ANSWER:

\[
\sqrt{\left(140 - \frac{s_2}{\sqrt{2}}\right)^2 + \left(\frac{s_2}{\sqrt{2}} + 140 - s_1\right)^2} = 190 \, \text{m}
\]

Part B

Determine the direction of the fourth displacement.

Express your answer using two significant figures.

ANSWER:

\[
\left( \sin^{-1} \left( \frac{140 - \frac{s_2}{\sqrt{2}}}{\sqrt{\left(140 - \frac{s_2}{\sqrt{2}}\right)^2 + \left(\frac{s_2}{\sqrt{2}} + 140 - s_1\right)^2}} \right) \right) \cdot 180 \pi = 11 \, ^\circ \text{ South of West}
\]
Exercise 1.38

**Description:** (a) Given the vector \( \mathbf{A}_{\text{vec}} = 4.00 \hat{i} + 7.00 \hat{j} \), find the magnitude of the vector. (b) Given the vector \( \mathbf{B}_{\text{vec}} = 5.00 \hat{i} - 2.00 \hat{j} \), find the magnitude of the vector. (c) Write an expression for the vector difference...

**Part A**

Given the vector \( \mathbf{A} = 4.00 \hat{i} + 7.00 \hat{j} \), find the magnitude of the vector.

**ANSWER:**

8.06

**Part B**

Given the vector \( \mathbf{B} = 5.00 \hat{i} - 2.00 \hat{j} \), find the magnitude of the vector.

**ANSWER:**

5.39

**Part C**

Write an expression for the vector difference \( \mathbf{A} - \mathbf{B} \) using unit vectors.

**Express your answer in terms of unit vectors.**

**ANSWER:**

\[
\mathbf{A} - \mathbf{B} = -1.00\hat{i} + 9.00\hat{j}
\]

**Part D**

Find the magnitude of the vector difference \( \mathbf{A} - \mathbf{B} \).

**ANSWER:**

9.06

**Part E**

Find the direction of the vector difference \( \mathbf{A} - \mathbf{B} \).

**ANSWER:**

96.3° counterclockwise from +x direction
Part F

In a vector diagram show $\vec{A}$, $\vec{B}$, and $\vec{C} = \vec{A} - \vec{B}$.

Draw the vectors starting at the black dot. Both the orientation and length of your vectors will be graded. Use "vector info" button to see the angle and length of your vectors.

ANSWER:

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Exercise 1.45

**Description:** Find the angle between each of the following pairs of vectors $\vec{A}_{vec} = A_x \vec{i} + A_y \vec{j}$ and $\vec{B}_{vec} = B_x \vec{i} + B_y \vec{j}$.

(a) $A_x_1 = A_x_1$, $A_y_1 = A_y_1$; $B_x_1 = B_x_1$, $B_y_1 = B_y_1$.
(b) $A_x_2 = A_x_2$, $A_y_2 = A_y_2$; $B_x_2 = ...$

Find the angle between each of the following pairs of vectors $\vec{A} = A_x \hat{i} + A_y \hat{j}$ and $\vec{B} = B_x \hat{i} + B_y \hat{j}$.

**Part A**

$A_{x_1} = -2.40$, $A_{y_1} = 4.40$; $B_{x_1} = 1.20$, $B_{y_1} = -2.50$.

**ANSWER:**

$$\theta = \cos^{-1} \left( \frac{(A_{x_1})(B_{x_1}) + (A_{y_1})(B_{y_1})}{\sqrt{(A_{x_1})^2 + (A_{y_1})^2} \sqrt{(B_{x_1})^2 + (B_{y_1})^2}} \right) = 177^\circ$$
**Part B**

\[ A_{x_2} = 2.00, \; A_{y_2} = 5.00; \; B_{x_2} = 10.4, \; B_{y_2} = 5.60. \]

**ANSWER:**

\[
\cos \left( \frac{(A_{x_2})(B_{x_2}) + (A_{y_2})(B_{y_2})}{\sqrt{(A_{x_2})^2 + (A_{y_2})^2}(B_{x_2})^2 + (B_{y_2})^2}} \right) = 0.791 \\
\theta = 39.9^\circ
\]

**Part C**

\[ A_{x_3} = -4.00, \; A_{y_3} = 2.00; \; B_{x_3} = 7.00, \; B_{y_3} = 14.00. \]

**ANSWER:**

90°

**Exercise 1.46**

**Description:** (a) For the two vectors in the figure, find the magnitude of the vector product \( \vec{A} \times \vec{B} \). (b) Find the direction of the vector product \( \vec{A} \times \vec{B} \). (c) Find the magnitude of \( \vec{B} \times \vec{A} \). (d) Find the direction of \( \vec{B} \times \vec{A} \).

**Part A**

For the two vectors in the figure, find the magnitude of the vector product \( \vec{A} \times \vec{B} \).

**ANSWER:**

4.61 cm²
Part B

Find the direction of the vector product $\mathbf{A} \times \mathbf{B}$.

ANSWER:
- $+z$-direction
- $-z$-direction

Part C

Find the magnitude of $\mathbf{B} \times \mathbf{A}$.

ANSWER:

4.61 cm$^2$

Part D

Find the direction of $\mathbf{B} \times \mathbf{A}$.

ANSWER:
- $+z$-direction
- $-z$-direction

Problem 1.66

Description: On a training flight, a student pilot flies from Lincoln, Nebraska to Clarinda, Iowa, then to St. Joseph, Missouri, and then to Manhattan, Kansas. The directions are shown relative to north: 0 degree(s) is north, 90 degree(s) is east, 180 degree(s) is...

On a training flight, a student pilot flies from Lincoln, Nebraska to Clarinda, Iowa, then to St. Joseph, Missouri, and then to Manhattan, Kansas. The directions are shown relative to north: 0° is north, 90° is east, 180° is south, and 270° is west.
Part A

Use the method of components to find the distance she has to fly from Manhattan to get back to Lincoln.

ANSWER:

189 km

Part B

Find the direction (relative to north) she must fly to get there.

ANSWER:

\[ \theta = 350^\circ \]

Also accepted: -10.5

Problem 1.68

Description: An explorer in Antarctica leaves his shelter during a whiteout. He takes \( n_1 \) steps northeast, then \( n_2 \) steps at an angle 60 degree(s) north of west, then \( n_3 \) steps due south. Assume his steps all have equal length. (a) Select the...

An explorer in Antarctica leaves his shelter during a whiteout. He takes 37 steps northeast, then 85 steps at an angle 60° north of west, then 43 steps due south. Assume his steps all have equal length.

Part A

Select the correct diagram, roughly to scale, of the three vectors and their resultant.

ANSWER:

![Diagram](image)
Part B

What is the magnitude of the displacement that will return the explorer to his shelter?

Express your answer using two significant figures.

ANSWER:

\[
R = \sqrt{(n_1 \cos(45) - n_2 \cos(60))^2 + (n_1 \sin(45) + n_2 \sin(60) - n_3)^2} = 59 \text{ steps}
\]

Also accepted: \[
\sqrt{(n_1 \cos(45) - n_2 \cos(60))^2 + (n_1 \sin(45) + n_2 \sin(60) - n_3)^2} = 59.1,
\]

\[
\sqrt{(n_1 \cos(45) - n_2 \cos(60))^2 + (n_1 \sin(45) + n_2 \sin(60) - n_3)^2} = 59
\]

Part C

What is the direction of the displacement that will return the explorer to his shelter?

Express your answer using two significant figures.

ANSWER:

\[
\theta = 90 - \tan \left( \frac{1}{-n_1 \cos(45) + n_2 \cos(60)} \right) = 16^\circ \text{ east of south}
\]

Also accepted: \[
90 - \tan \left( \frac{1}{-n_1 \cos(45) + n_2 \cos(60)} \right) = 16.1, 90 - \tan \left( \frac{1}{n_1 \sin(45) + n_2 \sin(60) - n_3} \right) = 16
\]

Problem 1.76

Description: Ricardo and Jane are standing under a tree in the middle of a pasture. An argument ensues, and they walk away in different directions. Ricardo walks \( l_1 \) in a direction 60.0 degree(s) west of north. Jane walks \( l_2 \) in a direction 30.0 degree(s) south of west.

Ricardo and Jane are standing under a tree in the middle of a pasture. An argument ensues, and they walk away in different directions. Ricardo walks 30.0 \( \text{m} \) in a direction 60.0 \( ^\circ \) west of north. Jane walks 12.0 \( \text{m} \) in a direction 30.0 \( ^\circ \) south of west. They then stop and turn to face each other.

Part A

What is the distance between them?

Express your answer with the appropriate units.

ANSWER:

\[
d = \sqrt{l_1^2 + l_2^2 - 2l_1l_2 \cos(120^\circ)} = 26.2 \text{m}
\]
Part B

In what direction should Ricardo walk to go directly toward Jane?

ANSWER:

\[
\frac{\text{atan} \left( \frac{14 - 12}{14 + 12} \sqrt{3} \right)}{\pi} \cdot 180 = 36.6 \text{ } \circ \text{ east of south}
\]