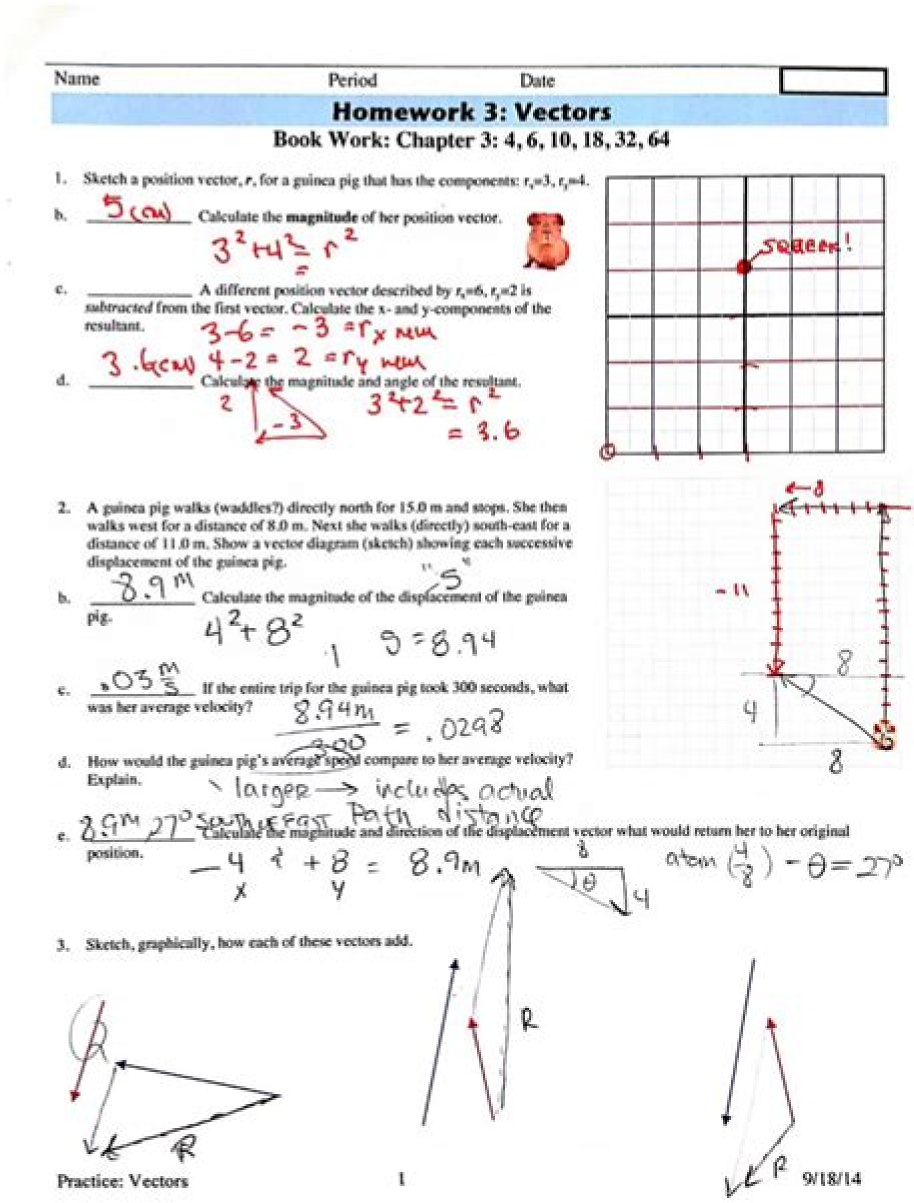
Study Guide Vector Addition Answer Key



Name Period Date

Homework 3: Vectors

Book Work: Chapter 3: 4, 6, 10, 18, 32, 64

1. Sketch a position vector, *r*, for a guinea pig that has the components: r_x=3, r_y=4.

b. 5(cm) Calculate the **magnitude** of her position vector.

$3^2+4^2=r^2$

c. ______ A different position vector described by r_x=6, r_y=2 is *subtracted* from the first vector. Calculate the x- and y-components of the resultant.

3-6 = -3 = r_x new

3.6(cm) 4-2 = 2 = r_y new

d. Calculate the magnitude and angle of the resultant.

$3^2+2^2=r^2$

= 3.6

2. A guinea pig walks (waddles?) directly north for 15.0 m and stops. She then walks west for a distance of 8.0 m. Next she walks (directly) south-east for a distance of 11.0 m. Show a vector diagram (sketch) showing each successive displacement of the guinea pig.

b. 8.9 m Calculate the magnitude of the displacement of the guinea pig.

4^2+8^2

9 = 8.94

c. .03 m/s If the entire trip for the guinea pig took 300 seconds, what was her average velocity?

$\frac{8.94m}{300}$ = .0298

d. How would the guinea pig's average speed compare to her average velocity? Explain.

larger → includes actual Path distance

e. 8.9m 27° southeast Calculate the magnitude and direction of the displacement vector what would return her to her original position.

$-4^2 + 8 = 8.9m$

x y

atan $(\frac{4}{8})$ - θ = 27°

3. Sketch, graphically, how each of these vectors add.

Practice: Vectors 1 9/18/14

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Vector addition is a fundamental concept in physics and mathematics, providing the basis for understanding various phenomena in fields such as mechanics, electromagnetism, and more. This study guide aims to clarify vector addition principles, techniques for solving vector problems, and provide an answer key to common vector addition exercises. Understanding these concepts is crucial for students and professionals alike, as vectors are essential in describing quantities that have both magnitude and direction.

Understanding Vectors

Vectors are mathematical entities that possess both a magnitude (size) and a direction. They can represent various physical quantities, such as displacement, velocity, acceleration, and force. Vectors are typically denoted by boldface letters (e.g., A) or with an arrow above the letter (e.g., \(\vec{A}\)).

Types of Vectors

1. Position Vectors: Represent the position of a point in space relative to an origin.
2. Displacement Vectors: Indicate the change in position from one point to another.
3. Velocity Vectors: Describe the rate of change of position with respect to time.
4. Force Vectors: Represent the influence that can change the motion of an object.

Vector Representation

Vectors can be represented in several ways, including graphical representation and algebraic notation.

Graphical Representation

Vectors can be drawn as arrows in a coordinate system, where:

- The length of the arrow corresponds to the vector's magnitude.
- The direction of the arrow indicates the vector's direction.

When adding vectors graphically, the following methods are commonly used:

1. Head-to-Tail Method: Place the tail of one vector at the head of another. The resultant vector is drawn from the tail of the first vector to the head of the last vector.
2. Parallelogram Method: Two vectors are drawn originating from the same point. A parallelogram is formed, and the resultant vector is the diagonal from the origin to the opposite corner of the parallelogram.

Algebraic Representation

Vectors can also be expressed in terms of their components along the axes of a coordinate system. For example, in a two-dimensional Cartesian coordinate system, a vector $\vec{A}$ can be represented as:

$$
\vec{A} = A_x \hat{i} + A_y \hat{j}
$$

Where:
- A_x is the component of vector A along the x-axis.
- A_y is the component of vector A along the y-axis.
- $\hat{i}$ and $\hat{j}$ are unit vectors in the x and y directions, respectively.

Adding Vectors Algebraically

When adding vectors algebraically, the following steps are usually followed:

1. Resolve each vector into its components: For each vector, determine the components along the x and y axes.
2. Sum the components: Add all the x-components together to find the resultant x-component, and do the same for the y-components.
3. Construct the resultant vector: Use the summed components to form the resultant vector in component form.

The resultant vector $\vec{R}$ can be expressed as:

$$
\vec{R} = R_x \hat{i} + R_y \hat{j}
$$

Where:
- $R_x = A_{1x} + A_{2x} + \ldots + A_{nx}$
- $R_y = A_{1y} + A_{2y} + \ldots + A_{ny}$

Magnitude and Direction of the Resultant Vector

The magnitude of the resultant vector can be calculated using the Pythagorean theorem:

$$
|\vec{R}| = \sqrt{R_x^2 + R_y^2}
$$

The direction (angle θ) of the vector can be found using:

\[

\theta = \tan^{-1}\left(\frac{R_y}{R_x}\right)
\]

Common Vector Addition Problems and Solutions

Here we provide a set of example problems regarding vector addition along with their solutions.

Problem 1: Two Vectors in the Same Direction

Given two vectors, \(\vec{A} = 5 \hat{i}\) and \(\vec{B} = 3 \hat{i}\). Find the resultant vector.

Solution:

\[
\vec{R} = \vec{A} + \vec{B} = (5 \hat{i} + 3 \hat{i}) = 8 \hat{i}
\]
Magnitude: \(|\vec{R}| = 8\)

Problem 2: Two Vectors at Right Angles

Given \(\vec{A} = 4 \hat{i}\) and \(\vec{B} = 3 \hat{j}\). Find the resultant vector.

Solution:

\[
R_x = 4, \quad R_y = 3
\]
\[
|\vec{R}| = \sqrt{4^2 + 3^2} = \sqrt{16 + 9} = 5
\]
\[
\theta = \tan^{-1}\left(\frac{3}{4}\right) \approx 36.87^\circ
\]

Resultant vector: \(\vec{R} = 5 \text{ at } 36.87^\circ\)

Problem 3: Adding Vectors with Negative Components

Given \(\vec{A} = 2 \hat{i} + 3 \hat{j}\) and \(\vec{B} = -1 \hat{i} + 4 \hat{j}\). Find the resultant vector.

Solution:

$$
R_x = 2 + (-1) = 1, \quad R_y = 3 + 4 = 7
$$

$$
|\vec{R}| = \sqrt{1^2 + 7^2} = \sqrt{1 + 49} = \sqrt{50} \approx 7.07
$$

$$
\theta = \tan^{-1}\left(\frac{7}{1}\right) \approx 82.87^\circ
$$

Resultant vector: $\vec{R} = 1 \hat{i} + 7 \hat{j}$

Conclusion

Understanding vector addition is crucial for various scientific applications. By mastering both graphical and algebraic methods of vector addition, students can approach complex problems with confidence. This study guide, along with the provided answer key, serves as a valuable resource for mastering the fundamentals of vector addition. Practice with a variety of problems is essential for developing proficiency in this critical area of study.

Frequently Asked Questions

What is vector addition and why is it important in physics?

Vector addition is the process of combining two or more vectors to determine their resultant vector. It is important in physics because it allows us to analyze forces, velocities, and other vector quantities in a coherent way.

How do you graphically add vectors using the head-to-tail method?

To add vectors graphically using the head-to-tail method, place the tail of the second vector at the head of the first vector. The resultant vector is drawn from the tail of the first vector to the head of the second vector.

What is the difference between vector addition and scalar addition?

Vector addition takes into account both the magnitude and direction of vectors, while scalar addition only considers magnitude. Vectors are added using specific rules based on their components, whereas scalars are simply summed.

Can you explain the concept of vector components in relation to vector addition?

Vector components are the projections of a vector along the coordinate axes (typically x and y axes). When adding vectors, you can add their components separately to find the resultant vector's components.

What is the formula for finding the resultant vector from two vectors A and B?

The resultant vector R can be found using the formula R = A + B, where R = (Ax + Bx, Ay + By) in component form, or using the law of cosines and sines for magnitude and direction.

What role does the angle between vectors play in vector addition?

The angle between vectors affects the magnitude of the resultant vector. If vectors are at an angle to each other, the resultant is less than the sum of their magnitudes, calculated using the cosine rule.

How do you handle vector addition in three dimensions?

In three dimensions, vector addition is performed by adding the corresponding components along the x, y, and z axes. The resultant vector R = (Ax + Bx, Ay + By, Az + Bz) is found similarly to two dimensions.

What is the significance of the parallelogram law in vector addition?

The parallelogram law states that if two vectors are represented as two adjacent sides of a parallelogram, their resultant vector is represented by the diagonal of the parallelogram. This law provides a geometric method for vector addition.

How can you verify the result of vector addition using a study guide answer key?

You can verify your result by comparing your computed resultant vector with the answer provided in the study guide answer key. Ensure you check both the magnitude and direction for accuracy.

What are common mistakes to avoid when performing

vector addition?

`Common mistakes include failing to consider the direction of vectors, miscalculating components, and mixing up the order of addition. Always double-check component-wise calculations and use the correct trigonometric functions for angles.`

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