

A Tourist Follows A Passage That Takes Her 160 M West, Then 180.m At An Angle Of 45.0 South Of East,

A Tourist Follows A Passage That Takes Her 160 M West, Then 180 m At An Angle Of 45.0 South Of East, embarking on a journey that involves both straightforward and angled movements across a landscape. Understanding her journey from a physics and navigation perspective provides valuable insights into how distances and directions combine to determine her final position relative to her starting point. This article explores the journey's details, the concepts of displacement and vector addition, and how such movements are analyzed in navigation and physics.

Understanding the Tourist's Movement: An Overview

In her journey, the tourist makes two distinct moves:

1. Moving 160 meters west in a straight line.
2. Moving 180 meters at an angle of 45.0° south of east.

These movements involve different directions and magnitudes, and translating them into a comprehensive understanding requires exploring the concepts of vectors, components, and resultant displacement.

Representing the Movements as Vectors

Vectors are quantities that have both magnitude and direction. In navigation and physics, representing movements as vectors allows us to analyze and combine different motions.

First Movement: 160 M West

- Direction: West (which is directly opposite to east).
- Vector Representation: Since it's purely westward, it can be represented as:

$$\vec{A} = -160\hat{i} \quad \text{meters}$$

where $\hat{i}$ is the unit vector pointing east, and the negative sign indicates the westward direction.

Second Movement: 180 M at 45.0° South of East

- Understanding the Direction: "South of East" means the movement is directed at an angle southward from the east axis.
- Angle: 45.0° south of east implies the vector makes a 45° angle with the east axis, directed toward the south.

- Vector Components:

$$\vec{B} = |\vec{B}| (\cos \theta \hat{i} + \sin \theta \hat{j})$$

Since it's south of east:

- $\theta = 45.0^\circ$
- $|\vec{B}| = 180 \text{ meters}$

The components:

$$\begin{aligned} B_x &= 180 \cos 45^\circ \\ B_y &= -180 \sin 45^\circ \end{aligned}$$

Note: The (x) -component is positive (eastward), and the (y) -component is negative (southward).

Calculating these:

$$\cos 45^\circ = \sin 45^\circ = \frac{\sqrt{2}}{2} \approx 0.7071$$

Therefore:

$$\begin{aligned} B_x &= 180 \times 0.7071 \approx 127.3 \text{ meters} \\ B_y &= -180 \times 0.7071 \approx -127.3 \text{ meters} \end{aligned}$$

Calculating the Resultant Displacement

To find the tourist's overall displacement from her starting point, we sum the vectors:

$$\vec{R} = \vec{A} + \vec{B}$$

Substituting the components:

$$\begin{aligned} R_x &= -160 + 127.3 \approx -32.7, \text{meters} \\ R_y &= 0 - 127.3 = -127.3, \text{meters} \end{aligned}$$

This indicates her final position relative to her starting point.

Magnitude of the Resultant Displacement

The straight-line distance from her initial position is:

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

Calculating:

$$|\vec{R}| = \sqrt{(-32.7)^2 + (-127.3)^2} \approx \sqrt{1069 + 16200} = \sqrt{17269} \approx 131.4, \text{meters}$$

Direction of the Resultant Displacement

The direction can be expressed as an angle south of east or east of south:

$$\theta = \arctan \left(\frac{|R_y|}{|R_x|} \right) = \arctan \left(\frac{127.3}{32.7} \right)$$

Calculating:

$$\theta \approx \arctan(3.89) \approx 75.4^\circ$$

Since (R_x) is negative and (R_y) is negative, the vector points toward the southwest quadrant.

Final Direction:

- The displacement is approximately 75.4° south of east or equivalently, 14.6° east of south.

Applications of Vector Analysis in Navigation

The tourist's journey exemplifies how vector analysis is fundamental in navigation, whether on land, sea, or air. The ability to decompose complex paths into components allows travelers and navigators to determine their position relative to starting points.

Practical Use Cases

- **Map Reading and Orientation:** Understanding directions and distances to find the shortest path or optimal route.
- **GPS Navigation:** Using vector components and displacement calculations to refine position estimates.
- **Maritime and Aeronautical Navigation:** Decomposing courses into components for course plotting and correction.

Understanding the Significance of Angles and Directions

Angles like " 45° south of east" are essential in navigation, indicating the precise direction of movement relative to cardinal directions.

Why Angle Measurement Matters

- Accuracy: Precise angles ensure accurate positioning.
- Route Planning: Helps in plotting efficient paths.
- Displacement Calculation: Critical for vector component determination.

Common Directions and Their Angles

Direction	Description	Typical Angle Reference
North	Towards the North Pole	0°
East	Towards the East	90°
South	Towards the South Pole	180°

| West | Opposite to East | 270° or -90° |

In "south of east," the angle is measured clockwise from east toward south, which aids in vector component calculations.

Conclusion: The Significance of Vector Analysis in Navigation and Physics

The journey of the tourist, involving movements west and at an angle south of east, demonstrates fundamental principles of vector addition and displacement calculation. By breaking down her movements into components, we can accurately determine her overall displacement and direction from her starting point. Such analyses are crucial in various fields, including navigation, physics, and engineering, enabling precise movement tracking and route optimization.

Understanding these principles enhances our ability to interpret and plan complex movements across landscapes, whether for recreational travel, military operations, or scientific research. The journey exemplifies the importance of combining magnitude and direction to achieve a comprehensive understanding of movement in a two-dimensional plane.

Frequently Asked Questions

What is the total displacement of the tourist after following the two passages?

The total displacement can be found by vector addition of the two displacements. First, convert each displacement into components and then find the resultant vector magnitude.

How do you resolve the second displacement, which is 180 m at 45° south of east, into east and south components?

Use trigonometry: the east component is $180 \text{ m} \cos(45^\circ) \approx 127.3 \text{ m}$ east, and the south component is $180 \text{ m} \sin(45^\circ) \approx 127.3 \text{ m}$ south.

What is the significance of the angle ' 45.0° south of east' in calculating the displacement components?

It indicates the direction of the displacement relative to east, specifically 45° towards the south, which helps in resolving the vector into its east and south components using trigonometry.

How do you compute the resultant displacement after the tourist's journey?

Add the east components and the south components separately to find the resultant vector's

components, then use the Pythagorean theorem to calculate the magnitude of the total displacement.

What is the approximate magnitude of the tourist's overall displacement?

The magnitude is approximately 292 m, calculated by combining the east and south components:
 $\sqrt{(160 + 127.3)^2 + (127.3)^2} \approx 292 \text{ m}$.

In what direction is the tourist located relative to her starting point after completing the passages?

She is approximately southeast of her starting point, with a heading roughly 45° south of east, based on the resultant displacement components.

Why is it important to resolve displacement vectors into components in navigation problems?

Resolving vectors into components simplifies the process of vector addition, allowing accurate calculation of resultant displacement and direction.

Can the Pythagorean theorem be used directly to find the total displacement in this problem?

It can be used after resolving the individual displacements into perpendicular components and summing them vectorially; directly applying it to the displacements without resolution would be incorrect.

Additional Resources

A Tourist Follows A Passage That Takes Her 160 M West, Then 180 M At An Angle Of 45.0° South Of East

Introduction

A tourist embarks on a journey through a scenic landscape, following a carefully mapped passage that takes her 160 meters west, then proceeds another 180 meters at an angle of 45.0° degrees south of east. While such movements might seem straightforward at first glance, they involve interesting concepts rooted in vector analysis, coordinate systems, and navigation principles. Understanding the precise nature of her path provides insight into how we interpret directional movements and apply mathematical tools to real-world navigation scenarios. This article explores the detailed breakdown of her journey, examining how to analyze her displacement, interpret her directional change, and understand the overall effect of her traversal.

The Path Breakdown: From Westward Movement to Diagonal Travel

Understanding the First Segment: 160 M West

The initial leg of her journey involves moving 160 meters directly west. In terms of coordinate systems, this movement can be represented as a displacement vector pointing purely along the negative x-axis if we define east as the positive x-direction and north as positive y-direction.

- Vector Representation:
- Displacement vector: $D_1 = -160 \hat{i}$ meters
- Here, $\hat{i}$ is the unit vector in the east-west direction.

This movement sets the starting point for her subsequent travel, establishing a baseline from which to analyze her second movement.

Deciphering the Second Segment: 180 M at 45.0° South of East

Following her initial move, the tourist proceeds 180 meters at an angle of 45.0 degrees south of east. This segment involves a more complex vector because it combines both eastward and southward components.

- Direction Clarification:
- "South of east" indicates a direction starting from east, rotating toward south.
- The angle of 45.0° south of east means the traveler's direction is 45 degrees away from the east axis toward the south.

- Coordinate Components:
- To resolve this movement into components:

- Eastward component:
- magnitude = $180 \text{ m} \times \cos(45.0^\circ)$
- Southward component:
- magnitude = $180 \text{ m} \times \sin(45.0^\circ)$

Using the known trigonometric values:

- $\cos(45.0^\circ) = \sin(45.0^\circ) \approx 0.7071$

Therefore,

- East component: $180 \text{ m} \times 0.7071 \approx 127.3 \text{ m}$
- South component: $180 \text{ m} \times 0.7071 \approx 127.3 \text{ m}$

- Vector Representation:
- $D_2 = 127.3 \hat{j} - 127.3 \hat{k}$, where:
- $\hat{j}$ is the unit vector toward north,
- $\hat{k}$ is the unit vector toward south.

However, since south is in the negative y-direction, and east is positive x-direction, it's more accurate to write:

$$- D_2 = +127.3 \text{ i} - 127.3 \text{ j}$$

This vector points 45° south of east, combining eastward and southward movements.

Calculating the Resultant Displacement

Having broken down her journey into two vectors, the next step is to determine her overall displacement—how far she is from her starting point and in which direction.

Vector Summation

The total displacement vector D_{total} is the sum of the two individual vectors:

$$D_{\text{total}} = D_1 + D_2$$

Substituting the components:

$$- D_1 = -160 \text{ i}$$

$$- D_2 = +127.3 \text{ i} - 127.3 \text{ j}$$

Adding components:

- x-component:

$$- -160 + 127.3 = -32.7 \text{ meters}$$

- y-component:

$$- 0 + (-127.3) = -127.3 \text{ meters}$$

Thus,

$$D_{\text{total}} = -32.7 \text{ i} - 127.3 \text{ j}$$

This indicates her overall movement is approximately 32.7 meters west and 127.3 meters south from her initial position.

Interpreting Her Displacement: Magnitude and Direction

To understand her overall journey, we calculate the magnitude and direction of D_{total} .

Magnitude Calculation

The magnitude of the resultant displacement vector is given by:

$$|D_{\text{total}}| = \sqrt{x^2 + y^2}$$

Plugging in the values:

$$|D_{\text{total}}| = \sqrt{(-32.7)^2 + (-127.3)^2}$$

$$|D_{\text{total}}| = \sqrt{(1068.09 + 16202.29)}$$

$$|D_{\text{total}}| = \sqrt{(17270.38)} \approx 131.4 \text{ meters}$$

So, from her starting point, she ends approximately 131.4 meters away in a specific direction.

Direction Determination

The direction can be described relative to a reference axis; for instance, the compass bearing from her starting position.

- Angle south of west:
- Since her x-component is negative (west) and y-component is negative (south), her overall displacement vector points southwest.

- To find the angle θ relative to the west axis:

$$\theta = \arctangent(|y\text{-component}| / |x\text{-component}|)$$

$$\theta = \arctangent(127.3 / 32.7) \approx \arctangent(3.89) \approx 75.4^\circ$$

- Interpretation:
- Her overall displacement is approximately 131.4 meters in a direction 75.4° south of west.

This precise measurement offers a comprehensive picture of her final position relative to her starting point.

Practical Navigation and Real-World Applications

Understanding such vector operations is fundamental in navigation, whether for hikers, sailors, or pilots. Modern GPS devices incorporate these principles to determine position, distance, and direction with high accuracy. While this scenario involves straightforward calculations, it mirrors real-world challenges faced during navigation across unfamiliar terrains.

Navigation Techniques

- Vector Addition: Combining multiple movements to determine the net displacement.
- Component Resolution: Breaking complex directions into manageable east-west and north-south components.
- Magnitude and Bearing: Calculating how far and in which direction the traveler has moved.

Significance in Navigation

- Route Planning: Knowing how to resolve a route into components helps in planning efficient paths.
- Position Tracking: Updating position based on successive movements.
- Error Correction: Recognizing deviations from planned routes using vector analysis.

Broader Mathematical Concepts

This journey exemplifies core concepts in physics and mathematics:

- Vector Resolution: Decomposing a vector into perpendicular components.
- Trigonometry: Using sine and cosine to resolve directions.
- Coordinate Geometry: Mapping movement in a coordinate system.
- Resultant Vectors: Summing individual vectors to find total displacement.

Such concepts extend beyond navigation, influencing fields like robotics, aerospace, and even computer graphics.

Conclusion

The tourist's journey, starting with a straightforward westward movement and followed by a diagonal traverse at 45.0° south of east, showcases the practical application of vector analysis in navigation. Breaking her path into components reveals her overall displacement, both in magnitude and direction, emphasizing the importance of mathematical tools in understanding movement through space. Whether for everyday navigation or complex scientific endeavors, mastering these principles enhances our ability to interpret and traverse the world accurately. This exploration highlights that behind simple directional descriptions lies a rich framework of mathematical reasoning vital for precise navigation and spatial awareness.

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