# A Plane Flies 35 Km In The Direction N 30 W, Then Flies 60 Km In The Direction N 60 E. How Far Is The

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Understanding the movement of a plane in different directions and calculating the resultant displacement is a common problem in vector mathematics and physics. This scenario involves analyzing the journey of an airplane that first travels in one direction and then in another, ultimately asking: How far is the plane from its starting point after completing both legs of its journey? To answer this, we will delve into the principles of vectors, coordinate systems, and trigonometry, providing a comprehensive guide to solving such problems.

## Understanding the Problem Statement

Before diving into calculations, it is essential to interpret the problem correctly:

- The plane first travels 35 km in the direction N 30 W.
- Then, it travels 60 km in the direction N 60 E.
- The question is: What is the straight-line distance from the starting point to the final position?

Key points to note:

- Directions are given relative to the cardinal points (North, South, East, West).
- The problem involves two vector movements at specific angles.
- The resultant displacement vector is the vector sum of these two movements.

## Converting Directions into Vectors

To analyze the movements, it is helpful to represent each leg of the journey as a vector in a coordinate system, typically with:

- The positive x-axis pointing East.
- The positive y-axis pointing North.

This coordinate system simplifies calculations, especially when applying vector addition and trigonometry.

### Interpreting Directions

- N 30 W: Means the direction is 30 degrees west of due North.
- N 60 E: Means the direction is 60 degrees east of due North.

Visualizing these directions:

- N 30 W is 30° west of the North axis, i.e., at an angle of 30° west from the vertical North line.
- N 60 E is 60° east of the North axis, i.e., at an angle of 60° east from the North line.

## Converting to Standard Angles

To facilitate calculations, convert these directions into standard angles measured from the positive x-axis (East), moving counter-clockwise:

- For N 30 W:
- Starting from North (which is 90° from East), moving 30° west of North, the angle from East is:
- 90° (North) + 30° (west) = 120°.
- Alternatively, considering the standard position:
- From East (0°), the vector points at 180° - 30° = 150°, but because of the direction, it's clearer to use the initial approach.

- For N 60 E:
- Starting from North (90°), moving 60° east of North:
- 90° - 60° = 30°.

In summary:

| Direction | Standard angle from East (counter-clockwise) | Description |
|-------------|---------------------------------------------|---------------------------------------------------------|
| N 30 W | 150° | 30° west of North, i.e., 150° from East |
| N 60 E | 30° | 60° east of North, i.e., 30° from East |

Note: It's often easier to work with angles from the positive x-axis (East), measured counter-clockwise.

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# Representing Movements as Vectors

Now, express each movement as a vector with magnitude and direction:

- The vector magnitude is the distance traveled.
- The direction is given by the angle from the positive x-axis.

First Leg: 35 km in N 30 W

- Distance: 35 km
- Direction angle: 150° from East

Using basic trigonometry:

- Components:

$$
\begin{cases}
x_1 = 35 \times \cos(150^\circ) \\
y_1 = 35 \times \sin(150^\circ)
\end{cases}
$$

Calculations:

$$
\cos(150^\circ) = -\frac{\sqrt{3}}{2} \approx -0.8660
$$
$$
\sin(150^\circ) = \frac{1}{2} = 0.5
$$

Therefore:

$$
x_1 = 35 \times (-0.8660) \approx -30.31\, \text{km}
$$
$$
y_1 = 35 \times 0.5 = 17.5\, \text{km}
$$

Second Leg: 60 km in N 60 E

- Distance: 60 km
- Direction angle: 30° from East

Components:

$$
x_2 = 60 \times \cos(30^\circ)
$$
$$
y_2 = 60 \times \sin(30^\circ)
$$

Calculations:

$$
\cos(30^\circ) = \frac{\sqrt{3}}{2} \approx 0.8660
$$
$$
\sin(30^\circ) = 0.5
$$

Thus:

$$
x_2 = 60 \times 0.8660 \approx 51.96\, \text{km}
$$

$$
y_2 = 60 \times 0.5 = 30\, \text{km}
$$

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# Calculating the Resultant Displacement

The total displacement vector $\vec{R}$ is the sum of the individual vectors:

$$
\vec{R} = \vec{V}_1 + \vec{V}_2
$$

Components:

$$
x_{total} = x_1 + x_2 \approx -30.31 + 51.96 = 21.65\, \text{km}
$$

$$
y_{total} = y_1 + y_2 = 17.5 + 30 = 47.5\, \text{km}
$$

The magnitude of the resultant displacement:

$$
D = \sqrt{(x_{total})^2 + (y_{total})^2}
$$

Calculations:

$$
D = \sqrt{(21.65)^2 + (47.5)^2} \approx \sqrt{468.4 + 2256.25} = \sqrt{2724.65} \approx 52.19\, \text{km}
$$

Answer: The plane is approximately 52.19 km from its starting point after completing both legs of the journey.

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# Understanding the Significance of the Result

This calculation demonstrates how vector addition and trigonometry allow us to determine the straight-line distance between two points after a series of movements in different directions. The key steps involved:

- Converting directions into standard angles.
- Breaking down movements into x and y components using sine and cosine.
- Summing components to find the resultant vector.
- Calculating the magnitude of the resultant vector.

This method is applicable in various fields, including navigation, physics, engineering, and even gaming.

# Additional Considerations and Variations

Handling Different Direction Notations

Sometimes, directions are given in more complex formats, such as degrees, minutes, and seconds, or with different references. Always convert to a standard coordinate system for consistency.

Dealing with Negative Components

If components are negative, they indicate movement in the opposite direction along that axis. For example, a negative x-component indicates movement westward.

Incorporating Wind or External Factors

In real-world navigation, external factors like wind can affect the actual path. In such cases, the vector approach can be extended to include these influences.

Using Graphical Methods

For visual learners, plotting vectors on graph paper or using software can help better understand the problem and verify calculations.

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# Summary

- The journey involves two vectors: one 35 km in N 30 W and another 60 km in N 60 E.
- Converting directions into standard angles simplifies calculations.
- Breaking down each movement into x and y components allows for vector addition.
- The resultant displacement is approximately 52.19 km from the starting point.
- This approach demonstrates the practical application of trigonometry and vector analysis in

navigation problems.

By mastering these techniques, students and professionals can accurately determine distances and directions in complex movement scenarios, enhancing their spatial reasoning and problem-solving skills.

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# Practical Applications and Real-World Relevance

Understanding how to compute displacement after movements in different directions has numerous applications:

- Aviation and Navigation: Pilots and navigators rely on vector calculations to determine their position relative to their starting point, especially when dealing with wind drift.
- Maritime Navigation: Ships often travel in courses that require vector addition to account for currents and wind.
- Robotics: Programming autonomous robots for movement involves similar vector calculations to ensure accurate positioning.
- Sports and Athletics: Analyzing trajectories and displacements in sports like football or track events.
- Physics Education: Teaching students about vectors, trigonometry, and real-world problem-solving.

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# Conclusion

Calculating the straight-line distance from a starting point after traveling in different directions involves understanding vector components, trigonometry, and coordinate systems. In this scenario, the plane's final displacement from its starting point is approximately 52.

# Frequently Asked Questions

## What is the overall displacement of the plane after flying 35 km N 30 W and then 60 km N 60 E?

The overall displacement can be found using vector addition, considering the directions and distances traveled.

## How do I convert the given directions N 30 W and N 60 E into standard coordinate vectors?

N 30 W means 30° west of due north, which corresponds to a vector with a north component and a west component. N 60 E is 60° east of due north, with north and east components.

## What is the resultant vector magnitude after the plane's two flights?

Calculate the components of each flight, sum them to get the resultant vector, then find its magnitude using the Pythagorean theorem.

## Can trigonometry help determine the distance from the starting point to the ending point?

Yes, by resolving each flight into components and then applying the Law of Cosines or Law of Sines, or directly computing the resultant vector's magnitude.

## What are the steps to solve for the straight-line distance from the initial point to the final position?

Step 1: Resolve each flight into its components. Step 2: Add components to find total displacement. Step 3: Calculate the magnitude of the resultant vector.

## Is it necessary to use coordinate geometry or vectors to solve this problem?

Yes, using vector components simplifies the process of determining the overall displacement after multiple directional flights.

## How do I interpret the directions N 30 W and N 60 E in terms of angles for calculations?

N 30 W is 30° west of north (i.e., 360° - 30° = 330° from the positive x-axis), and N 60 E is 60° east of north (i.e., 60° from the positive y-axis).

## What is the approximate straight-line distance from the starting point to the final position?

By calculating the vector components and their resultant, the approximate straight-line distance is around 60 km, depending on the precise addition of components.

# Additional Resources

A Plane Flies 35 Km In The Direction N 30 W, Then Flies 60 Km In The Direction N 60 E: An In-Depth Analysis of Its Path and Displacement

Understanding the trajectory and displacement of a plane based on its directional movements is a classic problem in vector mathematics and physics. In this comprehensive review, we will explore the problem of a plane that first flies 35 km in the direction N 30° W, then proceeds to travel 60 km in the direction N 60° E. Our goal is to determine how far the plane is from its starting point after these two legs of the journey. We will analyze the problem step-by-step, breaking down the directions, calculating the resultant vectors, and applying the principles of vector addition and trigonometry to arrive at a precise solution.

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# Understanding the Directions and Coordinate System

Before delving into calculations, it’s essential to interpret the given directions properly and establish a consistent coordinate system.

## Interpreting the Directions

- N 30° W: This indicates a direction 30 degrees west of due north. Imagine standing at the origin, facing north; then turn 30 degrees toward the west.
- N 60° E: This indicates a direction 60 degrees east of due north. Starting from north, turn 60 degrees toward the east.

## Coordinate System Setup

- Use a standard Cartesian coordinate system where:
- The positive x-axis points east.
- The positive y-axis points north.
- Directions will be converted into vectors based on angles measured from the positive x-axis (east), moving counterclockwise.

Note: Since the directions are given relative to the north axis, we need to convert them into standard polar angles measured from the east (x-axis).

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# Converting Directions to Vectors

To determine the resultant displacement, we first convert each segment’s direction and distance into vector form.

## First Leg: N 30° W

- This direction is 30° west of north.
- Since north corresponds to 90° from east, moving 30° west of north corresponds to an angle of:

Angle from east (x-axis):
90° (north) - 30° (westward) = 60°
But note: moving "north 30° west" is equivalent to an angle of 120° measured from the positive x-axis (east), since:

- North is 90°, west is 180°, so "north 30° west" lies 30° west of north, i.e., at 120° from east.

Calculation:
- Distance: 35 km
- Angle from east: 120°
- Components:
- $x_1 = 35 \times \cos(120^\circ)$
- $y_1 = 35 \times \sin(120^\circ)$

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### Second Leg: N 60° E

- This direction is 60° east of north.
- Starting from north at 90°, moving 60° eastward:

Angle from east:
- North is 90°, east is 0°, so "north 60° east" is at 30° from east.

Calculation:
- Distance: 60 km
- Angle from east: 30°
- Components:
- $x_2 = 60 \times \cos(30^\circ)$
- $y_2 = 60 \times \sin(30^\circ)$

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## Calculating the Components

Let's compute each component explicitly.

### First Segment Components

- $\cos(120^\circ) = -0.5$
- $\sin(120^\circ) = \frac{\sqrt{3}}{2} \approx 0.8660$

Therefore:
- $x_1 = 35 \times -0.5 = -17.5$ km
- $y_1 = 35 \times 0.8660 \approx 30.31$ km

### Second Segment Components

- $\cos(30^\circ) = \frac{\sqrt{3}}{2} \approx 0.8660$
- $\sin(30^\circ) = 0.5$

Thus:
- $x_2 = 60 \times 0.8660 \approx 51.96$ km
- $y_2 = 60 \times 0.5 = 30$ km

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## Determining the Resultant Displacement

The total displacement vector is the sum of the two vectors:

$$
\vec{R} = \vec{r}_1 + \vec{r}_2
$$

Where:
- $\vec{r}_1 = (x_1, y_1)$
- $\vec{r}_2 = (x_2, y_2)$

Calculations:
- $R_x = x_1 + x_2 = -17.5 + 51.96 \approx 34.46$ km
- $R_y = y_1 + y_2 = 30.31 + 30 = 60.31$ km

The magnitude of the resultant displacement:
$$
|\vec{R}| = \sqrt{R_x^2 + R_y^2}
$$

Calculating:
$$
|\vec{R}| \approx \sqrt{(34.46)^2 + (60.31)^2} \approx \sqrt{1188.98 + 3637.56} \approx \sqrt{4826.54} \approx 69.49\, \text{km}
$$

Result:
The plane is approximately 69.5 km from its starting point after completing the two legs of its journey.

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## Visualizing the Path

Graphical representation helps in understanding the journey:
- Starting at the origin, the first vector points toward N 30° W with a length of 35 km.
- The second vector, from the endpoint of the first, points toward N 60° E with a length of 60 km.
- The resultant vector directly from the origin to the final position is roughly 69.5 km in a direction characterized by the components $R_x \approx 34.5$ km east and $R_y \approx 60.3$ km north.

This visualization confirms the calculation, showing the overall displacement's magnitude and approximate direction.

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# Additional Considerations and Variations

While the above calculations provide a clear answer, several factors can influence interpretations or lead to different results:

## Pros and Cons of the Approach

Pros:
- Uses straightforward vector addition and trigonometry.
- Can be generalized to any similar problem involving directions and distances.
- Provides precise numerical results.

Cons:
- Requires careful conversion of directions into standard angles.
- Assumes flat Earth approximation, which is valid for small distances.
- Slight variations in angle definitions or misinterpretation can lead to errors.

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# Summary and Final Remarks

To summarize, the plane's journey involves two segments with different directions, which can be effectively analyzed using vector components:

- The first segment (N 30° W, 35 km) translates to components approximately $-17.5$ km (west) and $30.31$ km (north).
- The second segment (N 60° E, 60 km) translates to approximately $51.96$ km (east) and $30$ km (north).
- Adding these yields a resultant displacement vector with components roughly $34.46$ km east and $60.31$ km north.
- The magnitude of the resultant displacement is approximately 69.5 km from the starting point.

This problem exemplifies how vector analysis and trigonometry come together to solve real-world navigation problems efficiently. Whether for pilot navigation, robotics, or physics problems, mastering these techniques is essential for accurate analysis of directional movements.

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Final note: Always double-check your angle conversions and signs to ensure accuracy. Small errors in interpretation can significantly affect the results in vector-based calculations.

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