5) A Bird Is Flying At A Velocity Of 20 M/s In A Direction Of 60 North Of East. Calculate: A) The Velocity

5) A Bird Is Flying At A Velocity Of 20 M/s In A Direction Of 60° North Of East. Calculate: A) The Velocity

Understanding the velocity of a bird in motion is a fundamental concept in physics, especially in the study of vectors and relative motion. In this problem, a bird is flying at a speed of 20 meters per second in a specific direction—60° North of East. Our goal is to analyze and calculate the velocity vector of the bird, breaking it down into its components and understanding the significance of direction and magnitude. This detailed explanation will guide you through the process of calculating the bird's velocity, providing insight into vector resolution, trigonometry, and how to interpret motion in a two-dimensional plane.

Understanding the Given Data

Before performing any calculations, it's essential to understand the provided information:

1. The speed of the bird is 20 m/s, which is the magnitude of the velocity vector.
2. The direction is given as 60° North of East. This indicates the angle the velocity vector makes with the eastward axis, measured towards the north.

Key points to note:

- The velocity vector is in a two-dimensional plane, with components along the east (x-axis) and north (y-axis).
- The angle of 60° North of East means the vector is rotated 60° from the east axis towards the north.

Understanding Direction: 60° North of East

To accurately analyze the velocity, we need to interpret what "60° North of East" means:

Interpreting the Direction

- East direction: Along the positive x-axis.
- North direction: Along the positive y-axis.
- 60° North of East: The velocity vector makes an angle of 60° with the east axis, measured towards the north.

This means:

- The angle between the velocity vector and the east axis is 60°.

- The vector's components will be calculated using basic trigonometry, considering this angle.

Resolving the Velocity Into Components

The velocity vector, $\vec{v}$, can be broken down into two perpendicular components:

- v_x: The eastward component.
- v_y: The northward component.

Given the magnitude of the velocity and the angle, these components can be calculated using sine and cosine functions:

$$
v_x = v \cos \theta
$$
$$
v_y = v \sin \theta
$$

where:

- $v = 20\, \text{m/s}$
- $\theta = 60^\circ$

Calculating the Velocity Components

Applying the formulas:

1. **Eastward component:**

   $$
   v_x = 20\, \text{m/s} \times \cos 60^\circ
   $$

   Since $\cos 60^\circ = 0.5$,

   $$
   v_x = 20 \times 0.5 = 10\, \text{m/s}
   $$

2. **Northward component:**

   $$
   v_y = 20\, \text{m/s} \times \sin 60^\circ
   $$

   Since $\sin 60^\circ \approx 0.866$,

$$
v_y = 20 \times 0.866 \approx 17.32\, \text{m/s}
$$

Summary of components:

- East component (v_x): 10 m/s
- North component (v_y): approximately 17.32 m/s

Expressing the Velocity as a Vector

The velocity vector $\vec{v}$ can now be written in component form:

$$
\vec{v} = v_x \hat{i} + v_y \hat{j} = 10\, \hat{i} + 17.32\, \hat{j}\, \text{m/s}
$$

where:

- $\hat{i}$ is the unit vector along the east direction.
- $\hat{j}$ is the unit vector along the north direction.

This vector provides both the magnitude and the direction of the bird's velocity.

Verifying the Magnitude of the Velocity

To confirm the calculations, we can verify that the magnitude of the velocity vector matches the given speed:

$$
|\vec{v}| = \sqrt{v_x^2 + v_y^2}
$$

Substituting the values:

$$
|\vec{v}| = \sqrt{(10)^2 + (17.32)^2} \approx \sqrt{100 + 299.99} \approx \sqrt{399.99} \approx 20\, \text{m/s}
$$

This confirms the correctness of the component calculations.

Understanding the Significance of the Velocity Components

The components of the velocity vector have practical implications:

- The eastward component (10 m/s) indicates the bird is moving eastward at this speed.
- The northward component (17.32 m/s) shows the bird is moving northward at a higher speed, reflecting the 60° angle.

This breakdown allows for precise predictions of the bird's position over time, understanding its flight path, or analyzing relative motion with other objects.

Additional Calculations and Applications

Understanding the velocity vector opens avenues for further analysis:

1. Time to Reach a Certain Point

If the bird maintains this velocity, you can calculate how long it takes to reach a specific position.

2. Relative Velocity

In situations involving other objects (like wind, predators, or prey), relative velocity calculations become vital.

3. Graphical Representation

Plotting the velocity vector on a coordinate plane illustrates the bird's direction and speed visually, aiding in motion analysis.

Conclusion

In summary, the velocity of a bird flying at 20 m/s in a direction of 60° North of East can be accurately represented by its components:

- East component: 10 m/s
- North component: approximately 17.32 m/s

The resulting velocity vector:

$$
\vec{v} = 10\, \hat{i} + 17.32\, \hat{j}\, \text{m/s}
$$

confirms the magnitude matches the initial speed, and the direction aligns with the given angle. This analysis demonstrates the power of vector resolution in understanding motion, essential for physics students, engineers, and anyone interested in motion analysis. Whether for academic purposes or real-world applications like navigation, aviation, or robotics, mastering the calculation of velocity components is crucial for precise motion understanding.

Keywords for SEO:

- Velocity calculation
- Vector resolution
- Bird velocity components
- Physics velocity analysis
- Direction of motion
- Trigonometry in physics
- 2D motion analysis
- Velocity components formula
- North of East direction
- Motion in physics

Frequently Asked Questions

What is the given velocity of the bird in the problem?

The bird's velocity is 20 m/s.

In which direction is the bird flying according to the problem statement?

The bird is flying in a direction of 60° North of East.

How do you resolve the velocity into its components?

You can resolve it into east and north components using trigonometry: $V_x = V \cos(\theta)$, $V_y = V \sin(\theta)$.

What is the east (horizontal) component of the bird's velocity?

$V_x = 20$ m/s $\cos(60°) = 20$ m/s $0.5 = 10$ m/s.

What is the north (vertical) component of the bird's velocity?

$V_y = 20$ m/s $\sin(60°) = 20$ m/s (3/2) ≈ 20 m/s $0.866 \approx 17.32$ m/s.

How can you express the velocity vector of the bird?

The velocity vector can be expressed as (10 m/s east, 17.32 m/s north).

What is the magnitude of the bird's velocity vector?

The magnitude is given as 20 m/s, which matches the initial velocity. Alternatively, it can be calculated as ($(10^2 + 17.32^2) \approx 20$ m/s.

Why is it important to resolve the velocity into components in this problem?

Resolving into components helps analyze the bird's motion in each direction separately and understand its overall velocity vector.

Additional Resources

Understanding the Velocity of a Bird Flying at 20 m/s in a Direction of 60° North of East

In the realm of physics, especially when analyzing motion, the concept of velocity plays a pivotal role. When a bird is flying at a speed of 20 meters per second in a direction described as 60° North of East, understanding how to quantify and analyze this velocity becomes essential. This scenario offers a great opportunity to delve into vector components, directional analysis, and the fundamental principles of kinematics. In this comprehensive guide, we will explore how to calculate the velocity components, interpret the given data, and understand the implications of the bird's motion.

Understanding the Problem

The problem states:

> A bird is flying at a velocity of 20 m/s in a direction of 60° North of East. Calculate:

> A) The velocity components

Before jumping into calculations, it's crucial to clarify what is meant by "60° North of East." This specifies the direction of the bird's velocity vector relative to the east axis, with the angle measured toward the north from east.

Setting up the Coordinate System

To analyze this problem effectively, we need to establish a coordinate system:

- East is taken as the positive x-axis.
- North is taken as the positive y-axis.

In this setup:

- The velocity vector makes an angle of 60° with the east axis.
- The angle is measured towards the north from east, meaning the vector points 60° away from the east axis towards the north.

Visualizing the Velocity Vector

Imagine the coordinate axes:

```
North (Y)
|
|\
| \
| \ 60° (direction of the velocity vector)
| \
|____\_____________ East (X)
```

The velocity vector forms a 60° angle with the east axis, pointing toward the northeast.

Breaking Down the Velocity into Components

The key step is to decompose the velocity vector into its horizontal (x) and vertical (y) components:

- Vx: component along the east (x-axis)
- Vy: component along the north (y-axis)

Given:

- Magnitude of velocity (V) = 20 m/s
- Direction = 60° North of East

Using trigonometry:

$$
V_x = V \cos \theta
$$
$$
V_y = V \sin \theta
$$

where:

- $\theta = 60^\circ$

Calculating the Components

Step-by-step calculation:

1. Calculate Vx:

$$
V_x = 20\, \text{m/s} \times \cos 60^\circ
$$
$$
V_x = 20\, \text{m/s} \times 0.5
$$
$$
V_x = 10\, \text{m/s}
$$

2. Calculate Vy:

$$
V_y = 20\, \text{m/s} \times \sin 60^\circ
$$
$$
V_y = 20\, \text{m/s} \times \frac{\sqrt{3}}{2} \approx 20\, \text{m/s} \times 0.866
$$
$$
V_y \approx 17.32\, \text{m/s}
$$

Interpreting the Result

The velocity components tell us:

- The bird is flying 10 m/s toward the east.
- The bird is flying approximately 17.32 m/s toward the north.

Together, these components specify the bird's velocity vector fully in terms of magnitude and direction.

Calculating the Resultant Velocity (Optional)

While the problem specifies the initial velocity magnitude (20 m/s), if needed, one can verify the total velocity magnitude from components:

$$
V = \sqrt{V_x^2 + V_y^2}
$$
$$
V = \sqrt{(10)^2 + (17.32)^2} \approx \sqrt{100 + 299.99} \approx \sqrt{399.99} \approx 20\, \text{m/s}
$$

This confirms our initial magnitude, illustrating consistency.

Understanding the Direction

To find the precise direction of the velocity vector relative to east:

$$
\phi = \arctan \left(\frac{V_y}{V_x} \right)
$$
$$
\phi = \arctan \left(\frac{17.32}{10} \right) \approx \arctan (1.732) \approx 60^\circ
$$

which aligns with the given direction of 60° North of East.

Practical Applications and Broader Context

This analysis isn't just a mathematical exercise—understanding velocity components is vital in various real-world applications such as:

- Navigation and Flight Planning: Pilots and navigators decompose velocities to determine course corrections.
- Animal Movement Studies: Biologists analyze animal trajectories by breaking down movement vectors.
- Physics and Engineering: Engineers design systems accounting for directional velocities and resultant forces.

Additional Considerations

- Vector Addition: If the bird's velocity is combined with another vector (e.g., wind), the resultant velocity can be found by vector addition of components.
- Relative Velocity: In scenarios involving observers moving relative to the bird, the velocity components help determine relative motion.
- Graphical Representation: Plotting the velocity vector and components visually enhances understanding.

Summary of Key Steps

To sum up, the process to analyze the velocity of a bird flying at 20 m/s in a 60° North of East direction involves:

1. Establishing a coordinate system with east as x-axis and north as y-axis.
2. Recognizing the angle of the velocity vector relative to east.
3. Using trigonometric functions to resolve the velocity into components:

- $V_x = V \cos \theta$
- $V_y = V \sin \theta$

4. Calculating the components numerically:

- $V_x = 10\, \text{m/s}$
- $V_y \approx 17.32\, \text{m/s}$

5. Confirming the magnitude and direction consistency.

Final Thoughts

Understanding how to resolve a velocity vector into its components is fundamental in physics. It enables precise analysis of motion in multiple dimensions, crucial for navigation, physics experiments, and understanding natural phenomena. The scenario of a bird flying at 20 m/s in a specified direction beautifully illustrates the power of vector decomposition and the importance of clear coordinate systems and trigonometry in physics.

Whether you're a student tackling kinematics problems or a professional working on navigation systems, mastering these concepts ensures you can accurately interpret and manipulate motion data, leading to better insights and decision-making.

In conclusion, the velocity of the bird is characterized by:

- Horizontal component (eastward): 10 m/s
- Vertical component (northward): approximately 17.32 m/s

This comprehensive analysis underscores the elegance of vector mathematics in describing real-world motion, making it an invaluable tool in physics and engineering disciplines.

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