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Understanding the properties of trigonometric functions, particularly the cosine function, is essential for solving various mathematical problems involving wave patterns, oscillations, and periodic phenomena. When working with equations such as $Y = -4\cos(6x + 15) + 7$, it's crucial to analyze their components to determine key characteristics like amplitude, phase shift, vertical shift, and period. This article provides a comprehensive guide to interpreting this specific equation, focusing on how to find the amplitude and the phase shift step-by-step, using clear explanations and organized methods suitable for students and enthusiasts alike.

Understanding the General Form of Cosine Functions

Before diving into the specifics of the given equation, it's important to understand the general form of a cosine function:

```plaintext
Y = A cos(B(x - C)) + D
```

Where:
- A = Amplitude (the peak value from the middle of the wave)
- B = Determines the period of the function
- C = Phase shift (horizontal shift)
- D = Vertical shift (midline of the wave)

In the context of the given equation, the form slightly differs but can be adapted to match the standard form for easier analysis.

Analyzing the Given Equation

The equation provided is:

```plaintext
Y = -4cos(6x + 15) + 7
```

Let's dissect this step-by-step:

- Coefficient of cosine: -4
- Inside the cosine: 6x + 15
- Vertical shift: +7

The primary goals are:
1. Find the amplitude
2. Find the phase shift

Step 1: Find the Amplitude

The amplitude of a cosine function is the absolute value of the coefficient A in front of the cosine.

In the given equation:

```plaintext
Y = -4cos(6x + 15) + 7
```

- The coefficient A is -4.

Calculating amplitude:

```plaintext
Amplitude = |A| = |-4| = 4
```

Key Point:

- The amplitude is always positive, representing the maximum deviation from the midline.
- The negative sign indicates the cosine wave is reflected across the horizontal axis, flipping its peaks and troughs, but does not affect the amplitude.

Summary:

Parameter	Value	Explanation
Amplitude	4	The height from the midline to the maximum or minimum point of the wave

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Step 2: Find the Phase Shift

The phase shift determines how far the graph is horizontally shifted from the standard cosine graph. To find it, we need to analyze the inner function.

Standard form:

```plaintext
Y = A cos(B(x - C)) + D
```

In our equation:

```plaintext
Y = -4cos(6x + 15) + 7
```

The inner function is 6x + 15. To express this in the form B(x - C), we factor out B:

```plaintext
6x + 15 = 6(x + 15/6) = 6(x + 2.5)
```

Thus, the equivalent form is:

```plaintext
Y = -4cos(6(x + 2.5)) + 7
```

Note: The standard form involves (x - C), so to match it, consider:

```plaintext
6(x + 2.5) = 6(x - (-2.5))
```

Therefore, the phase shift C is -2.5.

Calculating Phase Shift:

```plaintext
C = - (constant added inside the parentheses) / B
```

Since the expression inside the cosine is 6x + 15, the phase shift C is:

```plaintext
C = - (15 / 6) = -2.5
```

Interpretation:

- The negative value indicates a shift to the left by 2.5 units.
- If the phase shift were positive, it would shift to the right.

Summary:

Parameter	Value	Explanation
Phase Shift	-2.5	Shifted 2.5 units to the left

Additional Key Characteristics of the Equation

While the question focuses on amplitude and phase shift, understanding other aspects can provide a more comprehensive view of the graph.

1. Vertical Shift (Midline)

- The D in the standard form is +7, which shifts the entire graph upward by 7 units.
- The midline of the wave is at y = 7.

2. Period of the Function

- The period determines how long it takes for the wave to complete one full cycle.
- Calculated as:

```plaintext
Period = (2π) / B
```

- Given B = 6, the period is:

```plaintext
Period = (2π) / 6 = π / 3
```

- This means the wave repeats every π/3 units along the x-axis.

Summary of Key Features of the Given Equation

| Feature | Value | Explanation |

Amplitude	4	The maximum displacement from the midline
Period	π/3	The length of one cycle along the x-axis
Phase Shift	-2.5	Shifted 2.5 units to the left
Vertical Shift	7	Wave is centered at y = 7

Visualizing the Graph of the Equation

Understanding the graph's behavior can solidify comprehension:

- The graph oscillates between y = 7 + 4 = 11 (maximum) and y = 7 - 4 = 3 (minimum).
- The midline is at y = 7.
- Starting point (phase shift): at x = -2.5, the cosine function begins its cycle, shifted leftward.
- The wave repeats every π/3 units, creating a rapid oscillation due to the high value of B.

Practical Applications of Finding Amplitude and Phase Shift

Understanding how to determine these parameters is essential in various fields:

- Physics: Analyzing wave motion, sound vibrations, and electromagnetic waves.
- Engineering: Signal processing, oscillations, and control systems.
- Mathematics: Solving trigonometric equations, modeling periodic phenomena.
- Data Science: Analyzing cyclical patterns in data over time.

Being able to interpret and manipulate the parameters of a cosine function allows professionals and students to model real-world phenomena accurately.

Summary and Final Thoughts

In conclusion, analyzing the given cosine equation:

```plaintext
Y = -4cos(6x + 15) + 7
```

leads to the following key points:

- Amplitude: The absolute value of -4 is 4, indicating the wave's maximum height above or below the midline.
- Phase Shift: Calculated by rewriting the inner function to find C, resulting in -2.5, which signifies a shift 2.5 units to the left.
- Additional features include the period π/3, vertical shift 7, and reflection due to the negative amplitude.

Mastering these calculations enhances understanding of trigonometric functions and their applications across various scientific and engineering disciplines.

Note: Practice with different equations by identifying their parameters and plotting their graphs to improve proficiency in analyzing trigonometric functions.

Frequently Asked Questions

What is the amplitude of the function y = -4cos(6x + 15) + 7?

The amplitude is 4, which is the absolute value of the coefficient of the cosine function.

How do you determine the amplitude from the equation y = -4cos(6x + 15) + 7?

The amplitude is the absolute value of the coefficient of cosine, so it is | -4 | = 4.

What is the phase shift of y = -4cos(6x + 15) + 7?

The phase shift is found by rewriting the inside as 6(x + 15/6). Thus, the phase shift is -15/6 = -2.5 units.

How do you calculate the phase shift for the function y = -4cos(6x + 15) + 7?

Identify the horizontal shift as -C/B, where C is 15 and B is 6, so phase shift = -15/6 = -2.5 units.

What does a negative phase shift indicate in the function y = -4cos(6x + 15) + 7?

A negative phase shift indicates the graph shifts to the left by 2.5 units along the x-axis.

Additional Resources

Given The Equation: A. Find The Amplitude, (point Each) Y = -4cos(6x +15) + 7 C. Find The Phase Shift is a common problem in trigonometry, especially when analyzing sinusoidal functions. These types of questions are fundamental for understanding how the properties of a cosine or sine function—such as amplitude, phase shift, and vertical shift—affect the graph's shape and position. Whether you're a student preparing for an exam, a teacher designing lesson plans, or a professional needing to interpret sinusoidal data, mastering how to extract these parameters from a given equation is essential. This comprehensive guide will walk you through the steps to find the amplitude and phase shift of the given cosine function with detailed explanations, examples, and useful tips.

Understanding the Basic Form of a Cosine Function

Before diving into the specifics of the problem, it's essential to understand the general form of a cosine function:

y = A cos(B(x - C)) + D

Where:

- A (Amplitude): The maximum absolute value of the function from its midline.
- B (Frequency/Angular Frequency): Affects the period of the wave.
- C (Phase Shift): Horizontal shift of the graph.
- D (Vertical Shift): Vertical translation of the graph.

In the given function:

Y = -4cos(6x + 15) + 7

we can analyze each component to find the amplitude and phase shift.

Step 1: Identify the Amplitude

What is Amplitude?

The amplitude of a sinusoidal function represents the distance from its midline to its maximum or minimum point. It indicates how "tall" the wave is.

How to Find the Amplitude

In the standard form, the amplitude is the absolute value of the coefficient A multiplying the cosine function.

For the given equation:

Y = -4cos(6x + 15) + 7

- The coefficient A is -4.

Therefore:

Amplitude = |A| = |-4| = 4

Important Notes:

- The negative sign indicates reflection across the midline, but it does not affect the amplitude.
- The amplitude is always a positive value.

Step 2: Find the Phase Shift

What is Phase Shift?

The phase shift indicates how far the graph is shifted horizontally from its standard position. It is derived from the inside function of the cosine, specifically the argument (B(x - C)).

How to Extract the Phase Shift

The general form involving phase shift is:

cos(B(x - C))

or equivalently,

cos(Bx + D) which can be rewritten as:

cos(B(x - (-D/B)))

In the given function:

Y = -4cos(6x + 15) + 7

- The inside of the cosine is 6x + 15.

To find the phase shift, we need to express this in the form B(x - C).

Step 2.1: Rewrite the Inside of the Cosine

Given:

6x + 15

We can factor this as:

$6(x + 15/6) = 6(x + 2.5)$

Step 2.2: Identify the Phase Shift

In the form $\cos(B(x - C))$, the phase shift C is:

$C = - (\text{constant term}) / B$

From the rewritten form:

- $B = 6$
- Inside is $6(x + 2.5)$, which corresponds to:

$6[x - (-2.5)]$

Thus:

$C = -2.5$

Interpretation:

- The phase shift is -2.5 units along the x-axis.
- A negative phase shift indicates a shift to the left.

Summary of Findings

Parameter	Value	Explanation
Amplitude	4	Absolute value of the coefficient of cosine
Phase Shift	-2.5 units (to the left)	Derived from the inside argument of the cosine function

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Additional Insights: Understanding the Impact of the Coefficients

The Effect of the Amplitude

- The amplitude determines the height of the wave.
- For $A = -4$, the graph is reflected across the midline, but the amplitude remains positive at 4.
- The maximum value of the function is $D + |A| = 7 + 4 = 11$.
- The minimum value is $D - |A| = 7 - 4 = 3$.

The Effect of the Phase Shift

- The phase shift moves the entire graph horizontally.
- Since $C = -2.5$, the graph shifts 2.5 units to the left.
- This affects where the maximum and minimum points occur relative to the origin.

Visualizing the Graph

While this guide doesn't include visual charts, understanding how the equation transforms graphically is vital:

- The original cosine wave cos(x) oscillates between -1 and 1 with a period of 2π.
- In Y = -4cos(6x + 15) + 7, the period is affected by B = 6:

Period = (2π) / B = (2π) / 6 = π / 3

- The graph completes one full cycle every π/3 units along the x-axis.
- The phase shift of -2.5 shifts the starting point of the wave to the left by 2.5 units.

Practical Applications and Examples

Example 1: Calculating the Maximum and Minimum Values

Given the amplitude 4 and vertical shift 7:

- Maximum value: 7 + 4 = 11
- Minimum value: 7 - 4 = 3

Example 2: Finding the Graph's Key Points

- At x = -2.5, the cosine argument becomes:

6(-2.5) + 15 = -15 + 15 = 0

- cos(0) = 1, so:

Y = -4(1) + 7 = -4 + 7 = 3

which is the minimum value.

- At x = 0, the argument is:

6(0) + 15 = 15

- cos(15) (in radians) can be computed or approximated for specific plotting.

Troubleshooting Common Pitfalls

- Confusing the sign of phase shift: Remember that C in (x - C) determines the direction. A negative C shifts left, positive shifts right.
- Misinterpreting the coefficient of cosine: Always take the absolute value for amplitude,

regardless of the sign in front.
- Forgetting to adjust the period: The value of B affects how "compressed" or "stretched" the graph is along the x-axis.

Final Thoughts

Mastering how to identify the amplitude and phase shift from a given sinusoidal equation is a crucial skill in trigonometry. Recognizing the standard form and carefully analyzing each component allows for accurate interpretation and graphing of the function. With practice, parsing complex equations like Y = -4cos(6x + 15) + 7 becomes more intuitive, enabling you to visualize and analyze sinusoidal behavior confidently.

Remember: The key steps are to:

1. Identify the coefficient A to find the amplitude.
2. Rewrite the inside of the cosine to extract the phase shift.
3. Understand how these parameters influence the graph's shape and position.

This approach applies broadly to all sinusoidal functions, making it an invaluable tool for studying periodic phenomena in mathematics, physics, engineering, and beyond.

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