NCERT Solutions Class 12 Maths
Chapter 6: Application of Derivatives
Exercise 6.2

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Quick Summary: In NCERT Solutions Class 12 Maths Chapter 6 Exercise 6.2, students learn to determine intervals where functions are increasing or decreasing using derivatives. This exercise covers critical concepts of monotonicity, finding critical points, and analyzing function behavior which are essential for CBSE board exams and competitive entrance tests.

Key Takeaways:

- A function f(x) is increasing if f'(x) > 0 and decreasing if f'(x) < 0 in the given interval
- Critical points occur where f'(x) = 0 or f'(x) is undefined, helping identify potential maxima and minima
- Master techniques for polynomial, exponential, and trigonometric functions like f(x) = 2x^3 - 3x^2 - 36x + 7
- Use sign analysis of derivatives to determine monotonic intervals for complex functions

Complete Solutions

Question 1

QUESTION

Show that the function given by f(x) = 3x + 17 is increasing on \mathbbR.

SOLUTION

We need to show that the function is increasing on the set of real numbers, .

Step 1: Find the derivative of the function

To determine if a function is increasing, we need to find its derivative, . If for all in the domain, then the function is increasing.

Given , we differentiate with respect to :

Using the power rule and the constant rule for differentiation:

Step 2: Analyze the derivative

We found that . Since 3 is a positive number, for all in .

Step 3: Conclude

Since the derivative is positive for all real numbers, the function is increasing on .

Question 2

QUESTION

Show that the function given by f(x) = e^2x is increasing on \mathbbR.

SOLUTION

We need to show that the function is increasing on the set of all real numbers, .

Step 1: Find the derivative of the function

To determine if a function is increasing, we need to find its derivative and check its sign. The derivative of with respect to is:

Using the chain rule, we have:

Step 2: Analyze the sign of the derivative

Now we need to determine the sign of for all . We know that the exponential function is always positive for any real number . Therefore, for all .

Since , it follows that for all . Thus, for all .

Step 3: Conclude whether the function is increasing

Since the derivative is positive for all in , the function is increasing on .

Final Answer: The function is increasing on because its derivative is always positive.

Question 3

QUESTION

Show that the function given by f(x) = \sin x is

(a) increasing in (0, (π)/(2))

(b) decreasing in ((π)/(2), π)

(c) neither increasing nor decreasing in (0, π).

SOLUTION

We need to show that the function is increasing in , decreasing in , and neither increasing nor decreasing in .

Step 1: Find the derivative of

The derivative of is:

Step 2: Analyze the sign of in the interval

In the interval , lies in the first quadrant. In the first quadrant, is positive.

Therefore, for all .

Since the derivative is positive, the function is increasing in this interval.

(a) Conclusion: is increasing in .

Step 3: Analyze the sign of in the interval

In the interval , lies in the second quadrant. In the second quadrant, is negative.

Therefore, for all .

Since the derivative is negative, the function is decreasing in this interval.

(b) Conclusion: is decreasing in .

Step 4: Analyze the behavior of in the interval

In the interval , the function is increasing in the first part and decreasing in the second part .

Since the function both increases and decreases in the interval , it is neither increasing nor decreasing in the entire interval.

(c) Conclusion: is neither increasing nor decreasing in .

Question 4

QUESTION

Find the intervals in which the function f given by f(x) = 2x^2 - 3x is

(a) increasing

(b) decreasing.

SOLUTION

We are asked to find the intervals where the function is increasing and decreasing. This involves finding the derivative of the function and analyzing its sign.

Step 1: Find the derivative of the function

We need to find . Using the power rule, we have:

Step 2: Find the critical points

To find the critical points, we set :

So, is the only critical point.

Step 3: Determine the intervals of increasing and decreasing behavior

We analyze the sign of in the intervals and .

(a) Interval

Choose a test point in this interval, say . Then:

Since , the function is decreasing in the interval .

(b) Interval

Choose a test point in this interval, say . Then:

Since , the function is increasing in the interval .

Final Answer:

(a) Increasing:

(b) Decreasing:

ANSWER

(a) ((3)/(4), ∞)

(b) (-∞, (3)/(4))

Question 5

QUESTION

Find the intervals in which the function f given by f(x) = 2x^3 - 3x^2 - 36x + 7 is

(a) increasing

(b) decreasing.

SOLUTION

We are asked to find the intervals where the given function is increasing and decreasing. This involves finding the derivative of the function and analyzing its sign.

Step 1: Find the derivative of the function

We need to find . Using the power rule for differentiation:

Step 2: Find the critical points

To find the critical points, we set :

Divide by 6:

Factor the quadratic:

So, the critical points are and .

Step 3: Determine the intervals of increasing and decreasing

We use the critical points to divide the real number line into three intervals: , , and .

Step 4: Test the sign of in each interval

(a) Interval

Choose a test point, say . Then:

Since in this interval, is increasing on .

(b) Interval

Choose a test point, say . Then:

Since in this interval, is decreasing on .

(c) Interval

Choose a test point, say . Then:

Since in this interval, is increasing on .

Final Answer:

(a) Increasing on and

(b) Decreasing on

ANSWER

(a) (-∞, -2) and (3, ∞)

(b) (-2, 3)

Question 6

QUESTION

Find the intervals in which the following functions are strictly increasing or decreasing:

(a) x^2 + 2x - 5

(b) 10 - 6x - 2x^2

(c) -2x^3 - 9x^2 - 12x + 1

(d) 6 - 9x - x^2

(e) (x + 1)^3 (x - 3)^3

SOLUTION

We need to find the intervals where the given functions are strictly increasing or decreasing. This involves finding the first derivative and analyzing its sign.

(a)

Step 1: Find the first derivative

Step 2: Find critical points by setting

Step 3: Analyze the sign of in the intervals and

For , let . Then . So, is decreasing for .

For , let . Then . So, is increasing for .

Answer: decreasing for and increasing for

(b)

Step 1: Find the first derivative

Step 2: Find critical points by setting

Step 3: Analyze the sign of in the intervals and

For , let . Then . So, is increasing for .

For , let . Then . So, is decreasing for .

Answer: decreasing for and increasing for

(c)

Step 1: Find the first derivative

Step 2: Find critical points by setting

Step 3: Analyze the sign of in the intervals , and

For , let . Then . So, is decreasing for .

For , let . Then . So, is increasing for .

For , let . Then . So, is decreasing for .

Answer: increasing for and decreasing for and

(d)

Step 1: Find the first derivative

Step 2: Find critical points by setting

Step 3: Analyze the sign of in the intervals and

For , let . Then . So, is increasing for .

For , let . Then . So, is decreasing for .

Answer: increasing for and decreasing for

(e)

Step 1: Find the first derivative

Step 2: Find critical points by setting

Step 3: Analyze the sign of in the intervals , , and

For , let . Then . So, is decreasing for .

For , let . Then . So, is decreasing for .

For , let . Then . So, is increasing for .

For , let . Then . So, is increasing for .

Answer: increasing in and , decreasing in and

ANSWER

(a) decreasing for x < -1 and increasing for x > -1

(b) decreasing for x > -(3)/(2) and increasing for x < -(3)/(2)

(c) increasing for -2 < x < -1 and decreasing for x < -2 and x > -1

(d) increasing for x < -(9)/(2) and decreasing for x > -(9)/(2)

(e) increasing in (1, 3) and (3, ∞), decreasing in (-∞, -1) and (-1, 1)

Question 7

QUESTION

Show that y = \log(1 + x) - (2x)/(2 + x), x > -1, is an increasing function of x throughout its domain.

SOLUTION

We need to show that the function , where , is an increasing function throughout its domain. To do this, we will find the derivative of with respect to and show that it is always positive for .

Step 1: Find the derivative of with respect to

We have . We will differentiate each term separately.

The derivative of with respect to is .

The derivative of with respect to can be found using the quotient rule: . Here, and .

So, and .

Therefore, the derivative of is .

Thus, .

Step 2: Simplify the derivative

We need to simplify to determine its sign. We find a common denominator:

Step 3: Analyze the sign of the derivative

We have . Since , we know that and . Also, for all .

Therefore, for . Specifically, for , and only at .

Step 4: Conclude that the function is increasing

Since for all , the function is an increasing function of throughout its domain. Note that even though the derivative is zero at , the function is still increasing because the derivative is non-negative.

Question 8

QUESTION

Find the values of x for which y = [x(x - 2)]^2 is an increasing function.

SOLUTION

We are asked to find the intervals where the function is increasing. This involves finding the derivative of the function and determining where it is positive.

Step 1: Rewrite the function

First, let's rewrite the function to make differentiation easier:

Step 2: Find the derivative

Using the chain rule:

Step 3: Determine when the derivative is positive

For the function to be increasing, we need . So we need to solve:

This inequality holds when . We analyze the sign of this expression by considering the intervals determined by the roots , , and .

Step 4: Analyze the intervals

We consider the following intervals:

- : is negative, is negative, is negative. The product is negative.
- : is positive, is negative, is negative. The product is positive.
- : is positive, is positive, is negative. The product is negative.
- : is positive, is positive, is positive. The product is positive.

Step 5: State the intervals where the function is increasing

The function is increasing when , which occurs when and .

Final Answer: The function is increasing for and .

ANSWER

0 < x < 1 and x > 2

Question 9

QUESTION

Prove that y = (4\sin θ)/(2 + \cos θ) - θ is an increasing function of θ in [0, (π)/(2)].

SOLUTION

We need to prove that the given function is an increasing function of in the interval . To do this, we will find the derivative of with respect to and show that it is non-negative in the given interval.

Step 1: Find the derivative

We have . We need to find . Using the quotient rule for the first term:

Simplifying the numerator:

Since :

Now, differentiating the entire function:

Step 2: Simplify

Expanding the numerator:

Step 3: Analyze the sign of in

In the interval , is non-negative, i.e., .

Also, is always positive since the maximum value of is 1.

The denominator is always positive.

Therefore, in the interval .

Step 4: Conclude

Since in , the function is an increasing function of in the given interval.

Question 10

QUESTION

Prove that the logarithmic function is increasing on (0, ∞).

SOLUTION

We need to prove that the logarithmic function is increasing on the interval . To do this, we will use the concept of the derivative of a function.

Step 1: Define the logarithmic function

Let be the logarithmic function, where the base of the logarithm is greater than 1. We will assume the natural logarithm, i.e., base , so .

Step 2: Find the derivative of the function

The derivative of with respect to is:

Step 3: Analyze the sign of the derivative on the given interval

We are given the interval . For any in this interval, . Therefore, for all in .

Step 4: Relate the sign of the derivative to the increasing/decreasing nature of the function

If on an interval, then the function is increasing on that interval. Since for all in , the logarithmic function is increasing on the interval .

Step 5: Conclusion

Therefore, the logarithmic function is increasing on .

Question 11

QUESTION

Prove that the function f given by f(x) = x^2 - x + 1 is neither strictly increasing nor decreasing on (-1, 1).

SOLUTION

We are asked to prove that the function is neither strictly increasing nor strictly decreasing on the interval .

Step 1: Find the derivative of the function

To determine whether a function is increasing or decreasing, we need to analyze its derivative. Let's find the derivative of with respect to :

Step 2: Analyze the sign of the derivative on the interval

We need to check if is always positive or always negative on the interval . If for all in , then is strictly increasing. If for all in , then is strictly decreasing.

Let's consider some values of in the interval :

- If , then
- If , then

Step 3: Show that the derivative changes sign within the interval

Since we found that and , this means that the derivative takes both negative and positive values on the interval . Specifically, for and for . Since lies within the interval , the derivative changes sign within the interval.

Step 4: Conclude that the function is neither strictly increasing nor strictly decreasing

Because is not always positive or always negative on the interval , we can conclude that the function is neither strictly increasing nor strictly decreasing on the interval .

Question 12

QUESTION

Which of the following functions are decreasing on (0, (π)/(2))?

(A) \cos x

(B) \cos 2x

(C) \cos 3x

(D) \tan x

SOLUTION

We need to determine which of the given functions are decreasing on the interval . A function is decreasing if its derivative is negative on the given interval.

Step 1: Analyze option (A)

The derivative of is . On the interval , is positive. Therefore, is negative on . Thus, is decreasing on .

Step 2: Analyze option (B)

The derivative of is . On the interval , ranges from to . is positive on . Therefore, is negative on . Thus, is decreasing on .

Step 3: Analyze option (C)

The derivative of is . On the interval , ranges from to . is positive on and negative on and positive again on . Therefore, changes sign on . Thus, is not decreasing on the entire interval .

Step 4: Analyze option (D)

The derivative of is . Since , is always positive where is defined. On the interval , is positive. Thus, is increasing on .

Final Answer: The functions that are decreasing on are (A) and (B) .

ANSWER

A, B

Question 13

QUESTION

On which of the following intervals is the function f given by f(x) = x^100 + \sin x - 1 decreasing?

(A) (0, 1)

(B) ((π)/(2), π)

(C) (0, (π)/(2))

(D) None of these

SOLUTION

We need to determine the interval on which the function is decreasing. A function is decreasing when its derivative is negative.

Step 1: Find the derivative of

We differentiate with respect to :

Using the power rule and the derivative of , we get:

Step 2: Analyze the sign of on the given intervals

(A) Interval

On this interval, is positive and less than 1, so is also positive. Thus, is positive. Also, is positive on , and since , is positive on . Therefore, is positive on , so the function is increasing.

(B) Interval

On this interval, is between and , so is positive. Thus, is positive. However, is negative on . We need to determine if on this interval. Since , will be a large positive number, making significantly larger than the absolute value of , which is at most 1. Thus, is positive, and the function is increasing.

(C) Interval

On this interval, is positive and less than , so is also positive. Thus, is positive. Also, is positive on . Therefore, is positive on , so the function is increasing.

Step 3: Conclusion

Since is positive on all the given intervals, the function is increasing on these intervals. Therefore, the function is not decreasing on any of these intervals.

Final Answer: D

ANSWER

D

Question 14

QUESTION

For what values of a the function f given by f(x) = x^2 + ax + 1 is increasing on [1, 2]?

SOLUTION

We are given a quadratic function and asked to find the values of for which the function is increasing on the interval .

Step 1: Find the derivative of the function

To determine where a function is increasing, we need to find its derivative and analyze its sign.

The derivative of is:

Step 2: Determine the condition for increasing function

For to be increasing on the interval , we must have for all in .

So, we need to ensure that for all in .

Step 3: Find the minimum value of on the interval [1, 2]

Since is an increasing function, the minimum value of on the interval occurs at .

Therefore, we need to ensure that .

Step 4: Solve the inequality

We have the inequality:

Subtracting 2 from both sides, we get:

Step 5: State the final answer

Therefore, the function is increasing on for .

ANSWER

a > -2

Question 15

QUESTION

Let I be any interval disjoint from [-1, 1]. Prove that the function f given by f(x) = x + (1)/(x) is increasing on I.

SOLUTION

We need to prove that the function is increasing on any interval disjoint from . This involves finding the derivative of the function and showing that it is positive on the given interval.

Step 1: Find the derivative of

Given , we differentiate with respect to :

Using the power rule, we get:

Step 2: Determine when

For to be increasing, we need . So,

Step 3: Solve the inequality

The inequality holds when or . This means the interval where is increasing is .

Step 4: Relate to the given interval

The interval is disjoint from , which means is contained in . Therefore, for any in , we have or , which implies .

Step 5: Conclude

Since for all in , the function is increasing on .

Question 16

QUESTION

Prove that the function f given by f(x) = \log \sin x is increasing on (0, (π)/(2)) and decreasing on ((π)/(2), π).

SOLUTION

We need to prove that the function is increasing on the interval and decreasing on the interval .

Step 1: Find the derivative of the function

To determine where a function is increasing or decreasing, we need to find its derivative, .

Given , we use the chain rule to find the derivative:

So, .

Step 2: Analyze the sign of the derivative on the interval

On the interval , is in the first quadrant. In the first quadrant, both sine and cosine are positive. Therefore, is positive.

Since on , the function is increasing on this interval.

Step 3: Analyze the sign of the derivative on the interval

On the interval , is in the second quadrant. In the second quadrant, sine is positive, but cosine is negative. Therefore, is negative.

Since on , the function is decreasing on this interval.

Step 4: Conclusion

We have shown that on and on . Therefore, the function is increasing on and decreasing on .

Question 17

QUESTION

Prove that the function given by f(x) = \log |\cos x| is decreasing on (0, (π)/(2)) and increasing on ((3π)/(2), 2π).

SOLUTION

We need to prove that the function is decreasing on the interval and increasing on the interval . To do this, we will analyze the sign of the derivative of the function in these intervals.

Step 1: Find the derivative of

We have . Using the chain rule, we find the derivative:

Step 2: Analyze the sign of on

In the interval , is in the first quadrant. In the first quadrant, is positive (since both and are positive). Therefore, is negative.

Since on , the function is decreasing on this interval.

Step 3: Analyze the sign of on

In the interval , is in the fourth quadrant. In the fourth quadrant, is negative (since is negative and is positive). Therefore, is positive.

Since on , the function is increasing on this interval.

Step 4: Conclusion

We have shown that on and on . Therefore, the function is decreasing on and increasing on .

Question 18

QUESTION

Prove that the function given by f(x) = x^3 - 3x^2 + 3x - 100 is increasing in \mathbbR.

SOLUTION

We need to prove that the function is increasing in .

Step 1: Find the derivative of the function

To determine if a function is increasing, we need to analyze its derivative. If the derivative is positive for all in the given interval, the function is increasing.

Given , we find its derivative with respect to :

Using the power rule for differentiation, we get:

Step 2: Analyze the derivative

Now we need to show that for all . We can rewrite as follows:

Step 3: Determine the sign of the derivative

Since is always non-negative for any real number , we have . Multiplying by 3, we get:

Thus, for all .

Step 4: Check for points where the derivative is zero

The derivative only when . However, at all other points, . A function is strictly increasing if its derivative is greater than or equal to zero, and it is not zero over an interval.

Step 5: Conclude

Since for all and is not zero over any interval, the function is increasing in .

Question 19

QUESTION

The interval in which y = x^2 e^-x is increasing is

(A) (-∞, ∞)

(B) (-2, 0)

(C) (2, ∞)

(D) (0, 2)

SOLUTION

We need to find the interval in which the function is increasing. This involves finding the derivative of the function and determining where it is positive.

Step 1: Find the derivative of with respect to

We use the product rule: . Here, and .

and

So,

We can factor out :

Step 2: Determine when for increasing function

For the function to be increasing, the derivative must be positive:

Since is always positive for any real number , we only need to consider the sign of .

So,

Step 3: Solve the inequality

We analyze the sign of . The critical points are and .

We test the intervals , , and .

- For , let . Then .
- For , let . Then .
- For , let . Then .

Thus, when .

Step 4: State the interval

The function is increasing in the interval .

Final Answer: The interval in which is increasing is .

Therefore, the correct option is (D).

ANSWER

D

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📐 Key Formulas

Important Formulas for Exercise 6.2

Formula / Concept	Description
Increasing Function	A function f is said to be increasing on an interval I if for any two numbers x_1 and x_2 in I such that $x_1 < x_2$, we have $f(x_1) \leq f(x_2)$.
Strictly Increasing Function	A function f is said to be strictly increasing on an interval I if for any two numbers x_1 and x_2 in I such that $x_1 < x_2$, we have $f(x_1) < f(x_2)$.
Decreasing Function	A function f is said to be decreasing on an interval I if for any two numbers x_1 and x_2 in I such that $x_1 < x_2$, we have $f(x_1) \geq f(x_2)$.
Strictly Decreasing Function	A function f is said to be strictly decreasing on an interval I if for any two numbers x_1 and x_2 in I such that $x_1 < x_2$, we have $f(x_1) > f(x_2)$.
Condition for Increasing Function using Derivative	Let f be a continuous function on [a, b] and differentiable on the open interval (a, b). Then f is increasing in [a, b] if $f'(x) \geq 0$ for each $x \in (a, b)$.
Condition for Strictly Increasing Function using Derivative	Let f be a continuous function on [a, b] and differentiable on the open interval (a, b). Then f is strictly increasing in [a, b] if $f'(x) > 0$ for each $x \in (a, b)$.

Formula / Concept	Description
Condition for Decreasing Function using Derivative	Let f be a continuous function on [a, b] and differentiable on the open interval (a, b). Then f is decreasing in [a, b] if f'(x) ≤ 0 for each x \in (a, b).
Condition for Strictly Decreasing Function using Derivative	Let f be a continuous function on [a, b] and differentiable on the open interval (a, b). Then f is strictly decreasing in [a, b] if f'(x) < 0 for each x \in (a, b).
Constant Function	A function f is constant on an interval I if f'(x) = 0 for all x in the interval.
Monotonic Function	A function is said to be monotonic on an interval if it is either increasing or decreasing on that interval.

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