1-3 Study Guide and Intervention Continuity, End Behavior, and Limits

Continuity A function f(x) is continuous at x = c if it satisfies the following conditions.

(1) f(x) is defined at c; in other words, f(c) exists.

(2) f(x) approaches the same function value to the left and right of c; in other words, lim f(x) exists.

(3) The function value that f(x) approaches from each side of c is f(c); in other words, lim f(x) = f(c).

Functions that are not continuous are discontinuous. Graphs that are discontinuous can exhibit infinite discontinuity, jump discontinuity, or removable discontinuity (also called point discontinuity).

Example: Determine whether each function is continuous at the given x-value. Justify using the continuity test. If discontinuous, identify the type of discontinuity as infinite, jump, or removable.

 $a_{-}f(x) = 2|x| + 3; x = 2$

- (1) f(2) = 7, so f(2) exists.
- (2) Construct a table that shows values for f(x) for x-values approaching 2 from the left and from the right.

ar .	y = f(x)
1.9	6.8
1.99	6.98
1.999	6.998

×	y = I(x)
2.1	7.2
2.01	7.02
2.001	7.002

The tables show that y approaches 7 as x approaches 2 from both sides.

It appears that $\lim_{x \to \infty} f(x) = 7$.

(3) $\lim_{x \to 2} f(x) = 7$ and f(2) = 7.

The function is continuous at x = 2.

a decision		2.0		ă.			
$\mathbf{b}_{\mathbf{r}}f(\mathbf{x})$:	=	47 - 7		÷	x	-	

The function is not defined at x = 1 because it results in a denominator of 0.

The tables show that for values of x approaching 1 from the left, f(x) becomes increasingly more negative.

For values approaching 1 from the right, f(x) becomes increasingly more positive.

×	y = f(x)
0.9	- 9.5
0.99	- 99.5
0.999	- 999.5

.00	y = f(x)
1.1	10.5
1.03	100.5
1.001	1000.5

The function has infinite discontinuity at x = 1.

Exercises

Determine whether each function is continuous at the given x-value.

Justify your answer using the continuity test. If discontinuous, identify the type of discontinuity as infinite, jump, or removable.

1.
$$f(x) = \begin{cases} 2x + 1 & \text{if } x > 2 \\ x - 1 & \text{if } x \le 2 \end{cases}$$
; $x = 2$

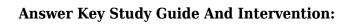
 $\lim_{x \to 2^-} f(x) = 1$ and $\lim_{x \to 2^+} f(x) = 5$, so the function is not continuous; it has jump discontinuity.

2.
$$f(x) = x^2 + 5x + 3$$
; $x = 4$

 $\lim_{x\to 0^+} f(x) = 39 \text{ and } \lim_{x\to 0^+} f(x) = 39,$ so the function is continuous.

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