



MATHS

BOOKS - RS AGGARWAL MATHS (HINGLISH)

CONTINUITY AND DIFFERENTIABILITY

Solved Examples

1. Draw the graph of each of the following constant functions:

(i) $f(x)=2$ for all $x \in R$

(ii) $f(x)=0$ for all $x \in R$

(iii) $f(x)=-2$ for all $x \in R$



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2. Draw the graphs of the linear functions (i) $f(x) = 1 - x$ (ii) $f(x) = 2x + 1$



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3. Draw the graph of the identity function $f: \mathbb{R} \rightarrow \mathbb{R}: f(x) = x$ for all $x \in \mathbb{R}$.



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4. Draw the graphs of the polynomial functions

(i) $f(x) = x^2$ (ii) $f(x) = 1 - x^2$

(iii) $f(x) = x^3 - x$



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5. Draw the graph of the modulus function, defined by

$$f: \mathbb{R} \rightarrow \mathbb{R}: f(x) = |x| = \begin{cases} x, & \text{when } x \geq 0 \\ -x, & \text{when } x < 0 \end{cases}$$



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6. Draw the graph of the reciprocal function $f(x) = \frac{1}{x}$



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7. Explain square root function with graph



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8. Draw the graph of the rational function $f(x) = \frac{x^2 - 1}{x - 1}$



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9. Draw the graph of the step function $f(x) = [x]$.



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10. Draw the graph of the step function $f(x) = [x]$.



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11. Draw the graph of the signum function

$$f(x) = \begin{cases} \frac{|x|}{x} & \text{when } x \neq 0 \\ 0 & \text{when } x = 0 \end{cases}$$



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12. Draw the graph of the function

$$f(x) = \begin{cases} x^2, & \text{when } x < 0 \\ x, & \text{when } 0 \leq x \leq 1 \\ 1/x, & \text{when } 1 \leq x < \infty. \end{cases}$$



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13. Draw the graph of the function $f(x) = |x| + |x - 1|$



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14. Draw the graph of the exponential function.

(i) $f(x) = 2^x$ (ii) $f(x) = \left(\frac{1}{3}\right)^x$

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15. Draw the graphs of the logarithmic functions.

(i) $\log_a x$, when $a > 1$ (ii) $\log_a x$, when $0 < a < 1$

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16. On the same draw the graphs of e^x and $\log_e x$.

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17. show that $f(x) = x^3$ is continuous at $x=2$

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18. Show that $f(x) = [x]$, is not continuous at $x = n$, where n is an integer

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19. Show that the function $f(x) = \begin{cases} x, & \text{if } x \text{ is an integer} \\ 0, & \text{if } x \text{ is not an integer} \end{cases}$

is discontinuous at each integral value of x .

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20. Discuss the continuity of $f(x) = \begin{cases} 2x - 1 & x < 0 \\ 2x + 1 & x \geq 0 \end{cases}$ at $x = 0$

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21. Show that the function $f(x) = \begin{cases} 3x - 2, & \text{when } x \leq 0 \\ x + 1, & \text{when } x > 0 \end{cases}$

is discontinuous at $x = 0$

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22. Show that the function $f(x) = \begin{cases} \frac{x}{|x|}, & \text{when } x \neq 0 \\ 1, & \text{when } x = 0 \end{cases}$

is discontinuous at $x=0$

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23. Examine the continuity of the function

$$f(x) = \begin{cases} \frac{|\sin x|}{x}, & x \neq 0 \\ 1, & x = 0 \end{cases}$$

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24. Show that the function $f(x) = 2x - |x|$ is continuous at $x = 0$.

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25. Prove that $f(x) = \begin{cases} |x| + 3 & ; x \leq -3 \\ -2x & ; -3 < x < 3 \\ 6x + 2 & ; x \geq 3 \end{cases}$ is continuous at

$x = -3$ and $x = 3$.



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26. If the function $f(x) = \begin{cases} kx + 5, & \text{when } x \leq 2 \\ x - 1, & \text{when } x > 2 \end{cases}$ is continuous at $x = 2$

then $k = ?$

A. $k = -1$

B. $k = -2$

C. $k = -3$

D. $k = -4$

Answer: B



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27. Find the value of the constant k so that the function given below is

continuous at $x = 0$. $f(x) = \begin{cases} \frac{1 - \cos 2x}{2x^2}, & x \neq 0 \\ k, & x = 0 \end{cases}$



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28. Find the values of k for which $f(x) = \begin{cases} \frac{1 - \cos 4x}{8x^2} & \text{when } x \neq 0 \\ k & \text{when } x = 0 \end{cases}$ is continuous at $x = 0$.

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29. Let $f(x) = \begin{cases} \frac{1 - \cos 4x}{x^2}, & \text{if } x < 0 \\ a, & \text{if } x = 0 \\ \frac{\sqrt{x}}{\sqrt{16 + \sqrt{x}} - 4}, & \text{if } x > 0 \end{cases}$ if

Determine the value of a so that $f(x)$ is continuous at $x = 0$.

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30. If the following function $f(x)$ is continuous at $x=0$, find the values of a , b and c .

$$f(x) = \begin{cases} \frac{\sqrt{x+bx^2} - \sqrt{x}}{bx^{\frac{3}{2}}} & \text{if } x > 0 \\ c & \text{if } x = 0 \\ \frac{\sin(a+1)x + \sin x}{x} & \text{if } x < 0 \end{cases}$$

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31. If the function $f(x)$ given by $f(x) = \begin{cases} 3ax + b & \text{if } x > 1 \\ 11 & \text{if } x = 1 \\ 5ax - 2b & \text{if } x < 1 \end{cases}$ is

continuous at $x = 1$ then find the values of a and b .

A. $a = 5, b = 2$

B. $a = 4, b = 3$

C. $a = 2, b = 1$

D. $a = 3, b = 2$

Answer: D



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32. for what value of k is the function .

$$f(x) = \begin{cases} k(x^2 - 2x), & \text{if } x \leq 0 \\ 4x + 1, & \text{if } x > 0 \end{cases}$$

(i) continuous at $x=0$? (ii) continuous at $x=1$?

(iii) continuous at $x = -1$?



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33. If the function $f(x) = \begin{cases} \frac{\sin^2 ax}{x^2}, & \text{when } x \neq 0 \\ k, & \text{when } x = 0 \end{cases}$ is continuous at $x = 0$ then $k = ?$



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34. If the function $f(x) = \frac{(3x + 4 \tan x)}{x}$ continuous at $x=0$? If not, how may the function be defined to make it continuous at this point ?



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35. Show that the function $f(x)$ given by $f(x) = \begin{cases} \frac{e^{1/x} - 1}{e^{1/x} + 1}, & \text{when } x \neq 0, \\ \end{cases}$ when $x = 0$ is discontinuous at $x = 0$.



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36. Let $f(x) = \begin{cases} x & \text{if } x \geq 1 \\ x^2 & \text{if } x < 1 \end{cases}$ is f a continuous function? Why?

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37. Prove that $f(x) = |x|$ is continuous at $x = 0$.

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38. Discuss the continuity of the function

$$f(x) = \begin{cases} 2x - 1, & \text{if } x < 0 \\ 2x + 1, & \text{if } x \geq 0 \end{cases}$$

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39. Discuss the continuity of the function

$$f(x) = \begin{cases} \frac{\sin x}{x}, & \text{if } x < 0 \\ (x + 1), & \text{if } x \geq 0 \end{cases}$$

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40. Find all points of discontinuity of f , where f is defined by

$$f(x) = \begin{cases} \frac{|x|}{x}, & \text{if } x \neq 0 \\ 0, & \text{if } x = 0 \end{cases}$$

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41. prove that $f(x)$ is a continuous function where

$$f(x) = \begin{cases} \frac{x^4 - 16}{x - 2}, & \text{if } x \neq 2 \\ 32, & \text{if } x = 2 \end{cases}$$

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42. Determine the value of the constant k so that the function

$$f(x) = \begin{cases} kx^2, & \text{if } x \leq 2 \\ 7, & \text{if } x > 2 \end{cases} \text{ is continuous.}$$

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43. If $f(x) = 1$ if $x < 3$; $ax + b$ if $3 < x < 5$ and 7 if $x > 5$ Then find the values of a and b for which $f(x)$ is continuous function



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44. Show that the function $f(x) = \sqrt{x^4 + 3}$ is continuous at each point.



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45. Show that the function $f(x) = |\sin x + \cos x|$ is continuous at $x = \pi$.



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46. Show that $f(x) = x^2$ is differentiable at $x = 1$ and find $f'(1)$.



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47. Show that $f(x) = [x]$ is not differentiable at $x = 1$.



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48. (i) Show that $f(x) = x^{4/3}$ is differentiable at $x = 0$, and hence find $f'(0)$.

(ii) Show that $g(x) = x^{3/2}$ is not differentiable at $x = 0$

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49. Show that the function $f(x) = \{(1 + x, \text{ if } x \leq 2), (5 - x, \text{ if } x > 2)\}$ is not differentiable at $x = 2$.

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50. Let $f(x) = \begin{cases} (1 + \sin x), & \text{when } 0 \leq x < \frac{\pi}{2} \\ 1, & \text{when } x < 0 \end{cases}$

Show that $f'(0)$ does not exist.

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51. Let $f(x) = mx + c$ and $f(0) = f'(0) = 1$. Find $f(2)$.

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52. Show that the function $f(x) = \begin{cases} x \frac{\sin 1}{x} & , \text{ when } x \neq 0 \\ \text{when } x = 0 \end{cases}$ is continuous but not differentiable at $x = 0$.

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53. Show that $f(x) = |x - 2|$ is continuous but not differentiable at $x = 2$.

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1. Show that $f(x) = x^2$ is continuous at $x=2$ It

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2. Show that $f(x) = (x^2 + 3x + 4)$ is continuous at $x=1$

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3. Prove that $f(x) = \begin{cases} \frac{x^2 - x - 6}{x - 3} & \text{when } x \neq 3; \\ 5 & \text{when } x = 3 \end{cases}$, is continuous at $x = 3$.

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4. $f(x) = \begin{cases} \frac{x^2 - 25}{x - 5}, & \text{when } x \neq 5 \\ 10, & \text{when } x = 5 \end{cases}$ is continuous at $x=5$

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5. $f(x) = \begin{cases} \frac{\sin 3x}{x}, & \text{when } x \neq 0 \\ 1, & \text{when } x = 0 \end{cases}$ is discontinuous at $x=0$.

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6. Let $f(x) = \begin{cases} \frac{1 - \cos x}{x^2} & 1 \end{cases}$. Show that $f(x)$ is discontinuous at $x = 0$.

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7. $f(x) = \begin{cases} 2 - x, & \text{when } x < 2 \\ 2 + x, & \text{when } x \geq 2 \end{cases}$ is discontinuous at $x=2$

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8. $f(x) = \begin{cases} (3 - x, & \text{when } x \leq 0, \\ x^2, & \text{when } x > 0 \end{cases}$ is discontinuous at $x=0$

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9. Show that $f(x) = \begin{cases} 5x - 4, & \text{when } x < 0 \\ \end{cases}$

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10. $f(x) = \begin{cases} x - 1, & \text{when } 1 \leq x < 2; \\ 2x - 3, & \text{when } 2 \leq x \leq 3 \end{cases}$ is continuous at $x = 2$.

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11. $f(x) = \begin{cases} \cos x, & \text{when } x \geq 0, \\ -\cos x, & \text{when } x < 0 \end{cases}$ is discontinuous at $x = 0$

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12. Show that $f(x) = \begin{cases} \frac{|x - a|}{x - a}, & \text{when } x \neq a \\ 1, & \text{when } x = a \end{cases}$ is discontinuous at $x = a$

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13.

$f(x) = \{(-x, \text{ when } x < 0), (1, \text{ when } x = 0), (x, \text{ when } x > 0)\}$ is discontinuous at $x = 0$

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14. If $f(x) = \begin{cases} \sin\left(\frac{1}{x}\right), & x \neq 0 \\ 0, & x = 0 \end{cases}$ then it is discontinuous at-

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15. $f(x) = \{(2x, \text{ when } x < 0), (2, \text{ when } x = 2), (x^2, \text{ when } x > 2)\}$ is discontinuous at $x=0$

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16.

$f(x) = \{(-x, \text{ when } x < 0), (1, \text{ when } x = 0), (x, \text{ when } x > 0)\}$ is discontinuous at $x = 0$



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17. Determine the value of the constant k so that the function

$$f(x) = \begin{cases} \frac{\sin 2x}{5x} & \text{if } x \neq 0 \\ k & \text{if } x = 0 \end{cases} \text{ is continuous at } x = 0.$$

A. $k = \frac{2}{5}$

B. $k = \frac{3}{5}$

C. $k = \frac{4}{5}$

D. $k = \frac{1}{5}$

Answer: A



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18. Find the value of k for which

$$f(x) = \left\{ \left(\frac{x^2 - 2x - 3}{x + 1} \right), \text{ when, } x \neq -1, \right\}, (\lambda, \text{ when, } x = -1)$$

is continuous at $x = -1$



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19. For what value of k is the following function continuous at $x = 2$?

$$f(x) = \{2x + 1; x < 2k; x = 23x - 1; x > 2\}$$



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20. Determine the value of k for which the following function is

continuous at $x = 3$. $f(x) = \left\{ \frac{x^2 - 9}{x - 3}, x \neq 3k, x = 3 \right\}$



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21. Find the value of k so that the function f defined by

$$f(x) = \begin{cases} \frac{k \cos x}{\pi - 2x}, & \text{for } x \neq \frac{\pi}{2} \\ 3, & \text{for } x = \frac{\pi}{2} \end{cases} \text{ is continuous at } x = \frac{\pi}{2}$$

A. $k = 6$

B. $k = 5$

C. $k = 4$

D. $k = 3$

Answer: A



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22. If $f(x) = x^2 \sin' \frac{1}{x}$, where $x \neq 0$, then the value of the function f at $x = 0$, so that the function is continuous at $x = 0$ is



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23. Show that $f(x) = ((x + 1),, \text{ if } x \leq 2), (x^2 + 1),, \text{ if } x < 1) : \}$ is continuous at $x = 1$

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24. Show that $f(x) = \begin{cases} x^3 - 3, & \text{if } x \leq 2 \\ x^2 + 1, & \text{if } x > 2 \end{cases}$ is continuous at $x = 2$

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25. If the function $f(x) = \begin{cases} 5, & x \leq 2 \\ ax + b, & 2 < x \leq 10 \\ 21, & x > 10 \end{cases}$

continuous, find the values of a and b

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26. Find the value of ' a ' for which the function f defined as

$f(x) = \begin{cases} a \sin\left(\frac{\pi}{2}(x + 1)\right) & x \leq 0 \\ \frac{\tan x - \sin x}{x^3} & x > 0 \end{cases}$ is continuous at $x = 0$



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27. Show that the function $f(x) = |x - 3|$, $x \in \mathbb{R}$, is continuous but not differentiable at $x = 3$.



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Exercise 9 B

1. Show that the function $f(x) = \begin{cases} 7x + 5, & x \geq 0, \\ 5 - 3x, & x < 0 \end{cases}$ is a continuous function.



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2. Show that the function $f(x) = \begin{cases} \sin x, & \text{if } x < 0 \\ x \ln x, & \text{if } x \geq 0 \end{cases}$ is continuous.



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3. Show that the function $f(x) = \begin{cases} \frac{x^n - 1}{x - 1}, & \text{when } x \neq 1 \\ n, & \text{when } x = 1 \end{cases}$ is continuous.

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4. Show that the sec x is a continuous function.

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5. Show that cos x is a continuous function

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6. Show that the function $f(x) = \begin{cases} \frac{\sin x}{x} & \text{when } x \neq 0 \\ 1 & \text{when } x = 0 \end{cases}$ is continuous at each point except 0.

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7. Discuss the continuity of $f(x) = [x]$

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8. show that $f(x) = \begin{cases} (2x - 1), & \text{if } x < 2 \\ \frac{3x}{2} & \text{if } x \geq 2 \end{cases}$ is continuous

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9. Show that $f(x) = \begin{cases} x, & \text{if } x \neq 0 \\ 1, & \text{if } x = 0 \end{cases}$ is continuous at each point except 0.

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10. Locate the point of discontinuity of the function.

$f(x) = \begin{cases} (x^3 - x^2 + 2x - 2), & \text{if } x \neq 1 \\ 4, & \text{if } x = 1 \end{cases}$

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11. Discuss the continuity of the function $f(x) = |x| + |x - 1|$ in the interval $[-1, 2]$

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Exercise 9 C

1. Show that $f(x) = x^3$ is continuous as well as differentiable at $x=3$

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2. Show that $f(x) = (x - 1)^{\frac{1}{3}}$ is not differentiable at $x = 1$.

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3. show that a constant function is always differentiable.

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4. Show that $f(x) = |x - 5|$ is continuous but not differentiable at $x = 5$.

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5. Let $f(x) = \begin{cases} (2x - 1), & \text{when } x \geq 1 \\ x, & \text{when } 0 \leq x \leq 1 \end{cases}$

Show that $f(x)$ is continuous but not differentiable at $x=1$

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6. show that $f(x) = |x|$ is continuous but not differentiable at $x=0$

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7. Show that the function $f(x) = \begin{cases} 1 - x, & x < 1 \\ x^2 - 1, & x \geq 1 \end{cases}$ is continuous but not differentiable at $x=1$



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8. Let $f(x) = \begin{cases} (2 + x), & \text{if } x \geq 0 \\ (2 - x), & \text{if } x < 0 \end{cases}$ show that $f(x)$ not derivable at $x = 0$



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9. Find the values of a and b so that the function $f(x) = \begin{cases} x^2 + 3x + a, & \text{if } x \leq 1 \\ bx^2, & \text{if } x > 1 \end{cases}$ is differentiable at each $x \in \mathbb{R}$.



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