MATHS

BOOKS - SURA MATHS (TAMIL ENGLISH)

DIFFERENTIAL CALCULUS - LIMITS AND CONTINUITY

Exercise 9 1

1. $\lim_{x \to 2} \frac{x - 2}{x^2 - x - 2}$

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2. $\lim_{x \to 2} \frac{x - 2}{x^2 - 4}$

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3. $\lim_{x \to 0} \frac{\sqrt{x+3} - \sqrt{3}}{x}$

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4. $\lim_{x \to -3} \frac{\sqrt{1-x} - 2}{x+3}$

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5. $\lim_{x \to 0} \frac{\sin x}{x}$

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6. $\lim_{x \to 0} \frac{\cos x - 1}{x}$

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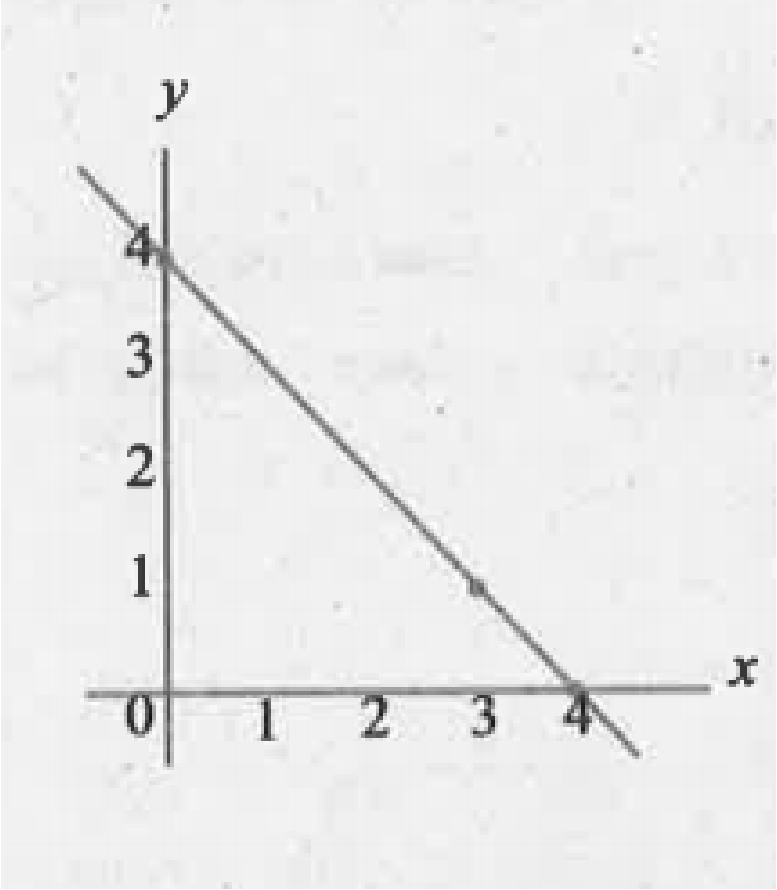
7. $\lim_{x \to 3} 4 - x.$



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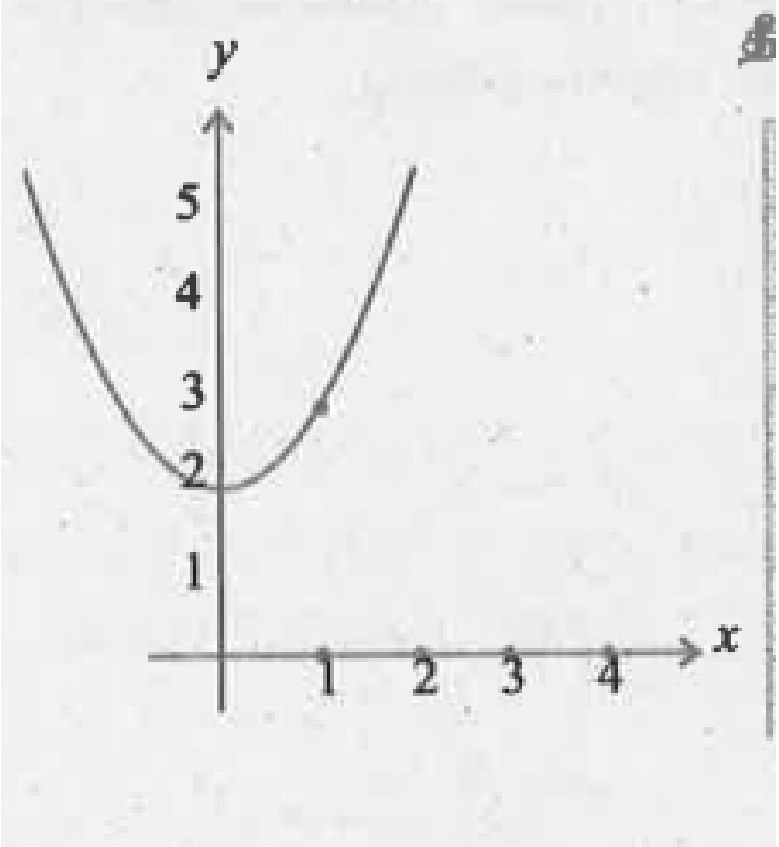
8. $\lim_{x \to 1} \left(x^2 + 2\right)$



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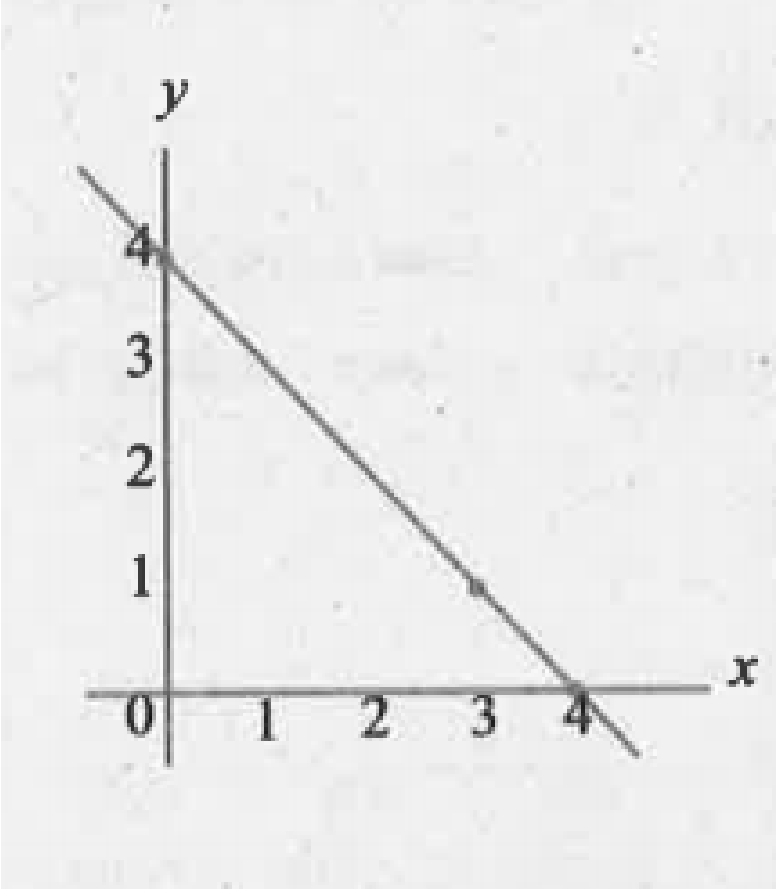
9. $\lim_{x \to 3} 4 - x.$



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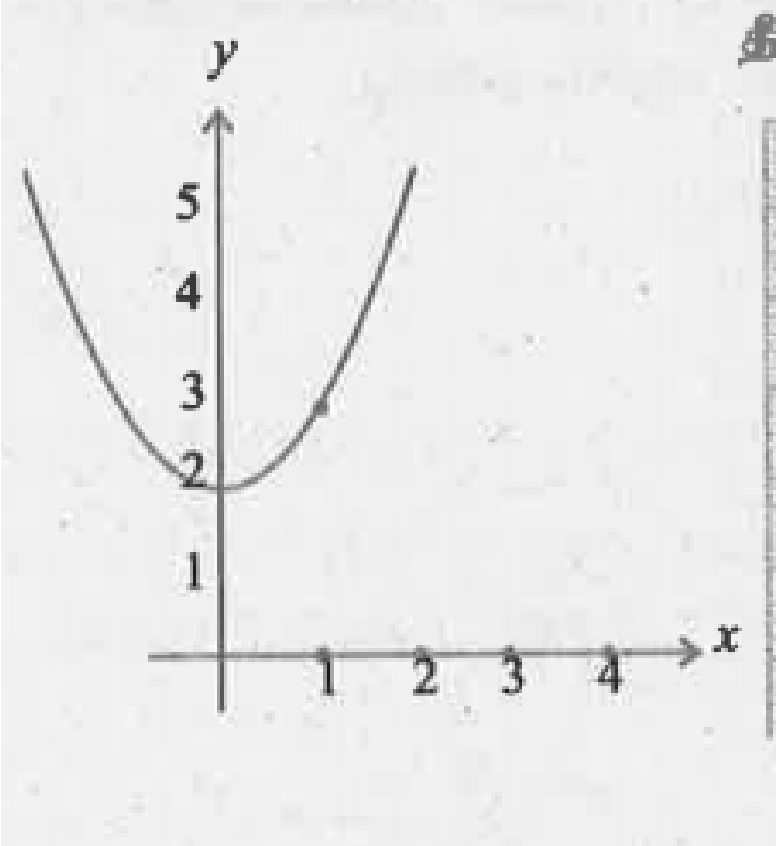
10. $\lim_{x \to 1} \left(x^2 + 2\right)$



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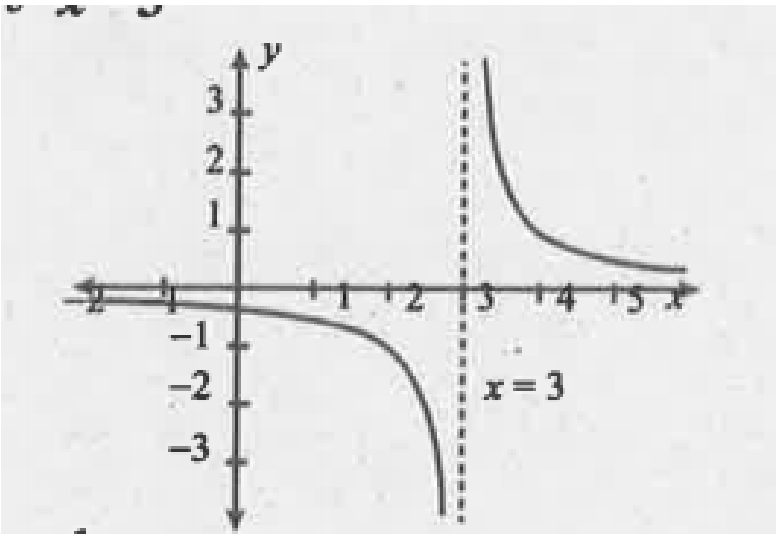
11. $\lim_{x \to 3} \frac{1}{x - 3}$



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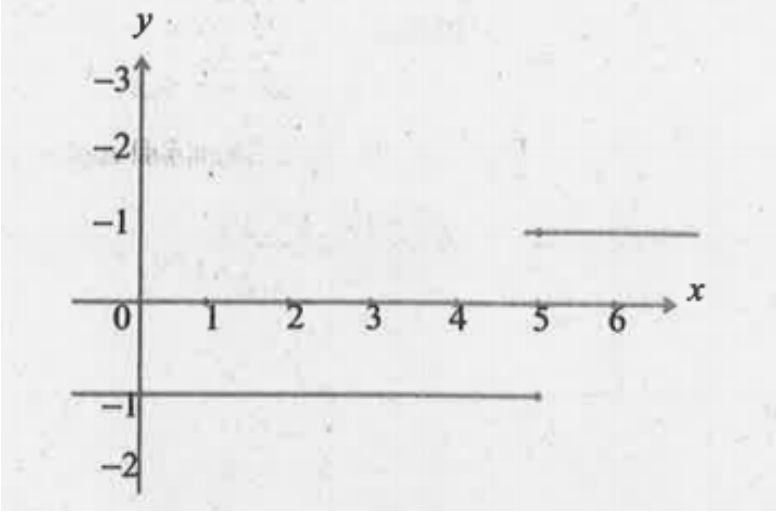
12. $\lim_{x \to 5} \frac{|x-5|}{x-5}$



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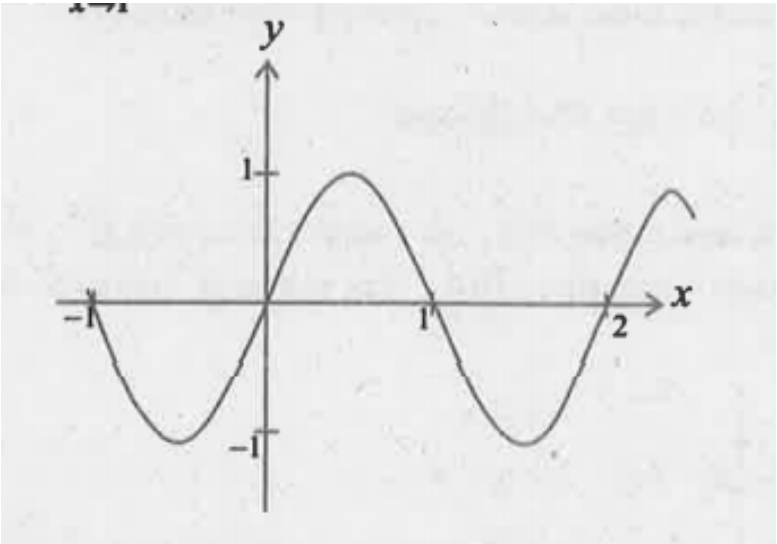
13. $\lim_{x \to 1} \sin \pi x$



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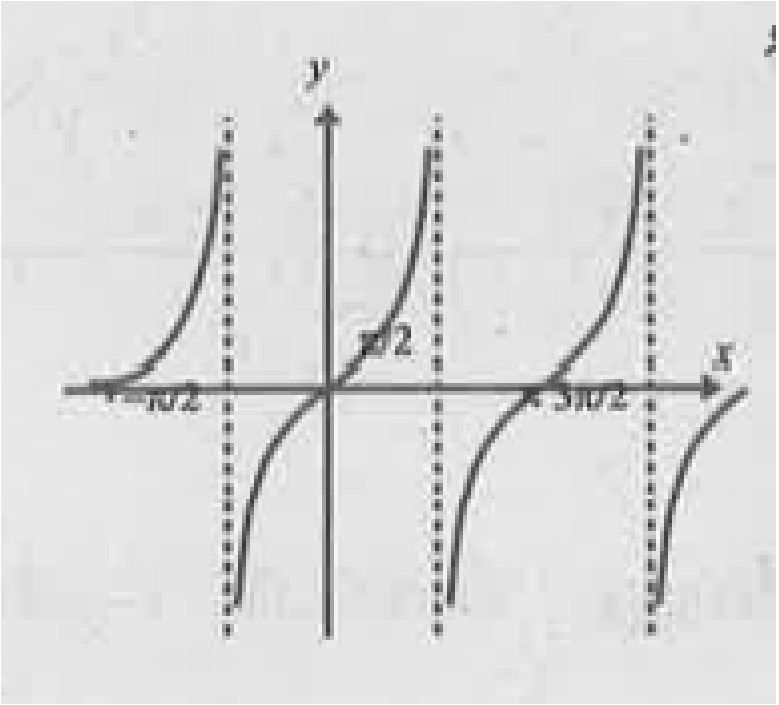
14. $\lim_{x \to \frac{\pi}{2}} \tan x$



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15. $f(x) = \begin{cases} x^2, & x \leq 2 \\ 8 - 2x, & 2 < x < 4 \\ 4, & x \geq 4 \end{cases}$

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16. $f(x) = \begin{cases} \sin x, & x < 0 \\ 1 - \cos x, & 0 \leq x \leq \pi \\ \cos x, & x > \pi \end{cases}$

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17. Sketch the graph of a function f that satisfies the given values:

f(0) is underfined $\lim_{x \to 0} f(x) = 4$,

f(2) = 6, $\lim_{x \to 2} f(x) = 3$

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18. Sketch the graph of a function f that satisfies the given values:

f(-2) = 0 , f(2) = 0 , $\lim_{x \to -2} f(x) = 0$

$\lim_{x \to 2} f(x)$ does not exist.

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19. Write a brief description of the meaning of the notation $\lim_{x \to 8} f(x) = 25$

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20. If f(2) = 4, can you conclude anything about the limit of f(x) as x approaches 2 ?

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21. If the limit of f(x) as x approaches 2 is 4, can you conclude anything about f(2)? Explain reasoning.

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22. Evaluate : $\lim_{x \to 3} \frac{x^2 - 9}{x - 3}$ if it exists by finding $f(3^-)$ and $f(3^+)$.

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23. Verify the existence of $\lim_{x \to 1} f(x)$, where

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

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Exercise 9 2

1. Solve : $\lim_{x \to 2} \frac{x^4 - 16}{x - 2}$

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2. $\lim_{x \to 1} \frac{x^m - 1}{x^n - 1}$ is

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3. Evaluate the limits :

$$\lim_{h \to 0} \frac{\sqrt{x+h} - \sqrt{x}}{h}, x > 0$$

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4. $\lim_{x \to 5} \frac{\sqrt{x+4} - 3}{x - 5}$

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5. $\lim_{x \to 2} \frac{\frac{1}{x} - \frac{1}{2}}{x - 2}$

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6. $\lim_{x \to 1} \frac{\sqrt{x} - x^2}{1 - \sqrt{x}}$

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7. $\lim_{x \to 0} \frac{\sqrt{x^2 + 1} - 1}{\sqrt{x^2 + 16} - 4}$

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8. $\lim_{x \to 0} \frac{\sqrt{1+x}-1}{x}$

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9. Evaluate $\lim_{x \to 1} \frac{\sqrt[3]{7+x^3}-\sqrt{3+x^2}}{x-1}$

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10. $\lim_{x \to 2} \frac{2-\sqrt{x+2}}{\sqrt[3]{2}-\sqrt[3]{4-x}}$

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11. $\lim_{x \to 0} \frac{\sqrt{1+x^2}-1}{x}$

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12. $\lim_{x \to 0} \frac{\sqrt{1-x}-1}{x^2}$

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13. $\lim_{x \to 5} \frac{\sqrt{x-1}-2}{x-5}$

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14. $\lim_{x \to a} \frac{\sqrt{x-b} - \sqrt{a-b}}{x^2 - a^2} (a > b)$

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Exercise 9 3

1. Find the left and right limits of

$f(x) = \frac{x^2 - 4}{(x^2 + 4x + 4)(x + 3)}$ at x = -2

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2. $f(x) = \tan x \quad \text{at} \quad x = \frac{\pi}{2}$

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3. $\lim_{x \to 3} \frac{x^2 - 9}{x^2(x^2 - 6x + 9)}$

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4.

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5. $\lim_{x \to \infty} \frac{x^3 + x}{x^4 - 3x^2 + 1}$

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6. $\lim_{x \to \infty} \frac{x^4 - 5x}{x^2 - 3x + 1}$

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7. $\lim_{x \to \infty} \frac{1 + x - 3x^3}{1 + x^2 + 3x^3}$

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8. $\lim_{x \to \infty} \left(\frac{x^3}{2x^2 - 1} - \frac{x^2}{2x + 1} \right)$

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9. Show that

$$\lim_{x \to \infty} \frac{1 + 2 + 3 + \ldots + n}{3n^2 + 7n + 2} = \frac{1}{6}$$

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10. Show that

$$\lim_{x \to \infty} \frac{1^2 + 2^2 + \ldots + (3n)^2}{(1 + 2 + \ldots + 5n)(2n + 3)} = \frac{9}{25}$$

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11. Show that

$$\lim_{x \to \infty} \frac{1}{1.2} + \frac{1}{2.3} + \frac{1}{3.4} + \ldots + \frac{1}{n(n+1)} = 1$$

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12. An important problem in fishery science is to estimate the number of fish presently spawning in streams and use this information to predict the number of mature fish or

"recruits" that will return to the rivers during the reproductive period. If S is the number of spawners and R the number of recruits, "Beverton-Holt spawner recruit function" is R(S) = $\frac{S}{\alpha S + \beta}$ where α and β are positive constants.

Show that this function predicts approximately constant recruitment when the number of spawners is sufficiently large.

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Exercise 9 4

1. $\lim_{x \to \infty} \left(1 + \frac{1}{x}\right)^{7x}$

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2. $\lim_{x \to 0} (1 + x)^{\frac{1}{3x}}$

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3. $\lim_{x \to \infty} \left(1 + \frac{k}{x}\right)^{\frac{m}{x}}$

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4. $\lim_{x \to \infty} \left(\frac{2x^2 + 3}{2x^2 + 5} \right)^{8x^2 + 3}$

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5. $\lim_{x \to \infty} \left(1 + \frac{3}{x} \right)^{x + 2}$

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6. $\lim_{x \to 0} \frac{\sin^3 \left(\frac{x}{2} \right)}{x^3}$

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7. $\lim_{x \to 0} \frac{\sin \alpha x}{\sin \beta x}$

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8. $\lim_{x \to 0} \frac{\tan 2x}{\sin 5x}$

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9. $\lim_{\alpha \to 0} \frac{\sin(\alpha^n)}{(\sin \alpha)^m}$

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10. $\lim_{x \to 0} \frac{\sin(a+x) - \sin(a-x)}{x}$

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11. $\lim_{x \to 0} \frac{\sqrt{x^2 + a^2} - a}{\sqrt{x^2 + b^2} - b}$

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12. $\lim_{x \to 0} \frac{2\arcsin x}{3x}$

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13. $\lim_{x \to 0} \frac{1 - \cos x}{x^2}$

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14. $\lim_{x \to 0} \frac{\tan 2x}{x}$

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15. $\lim_{x \to 0} \frac{2^x - 3^x}{x}$

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16. $\lim_{x \to 0} \frac{3^x - 1}{\sqrt{x+1} - 1}$

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17. $\lim_{x \to 0} \frac{1 - \cos^2 x}{x \sin 2x}$

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18. $\lim_{x \to \infty} x\left[3^{\frac{1}{x}} + 1 - \cos\left(\frac{1}{x}\right) - e^{\frac{1}{x}}\right]$

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19. $\lim_{x \to \infty} \{x[\log(x+a) - \log(x)]\}$

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20. $\lim_{x \to \pi} \frac{\sin 3x}{\sin 2x}$

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21. $\lim_{x \to \frac{\pi}{2}} (1 + \sin x)^{2\operatorname{cosec} x}$

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22. $\lim_{x \to 0} \frac{\sqrt{2} - \sqrt{1 + \cos x}}{\sin^2 x}$

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23. $\lim_{x \to 0} \frac{\sqrt{1 + \sin x} - \sqrt{1 - \sin x}}{\tan x}$

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24. $\lim_{x \to \infty} \left(\frac{x^2 - 2x + 1}{x^2 - 4x + 2} \right)^x$

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25. $\lim_{x \to 0} \frac{e^x - e^{-x}}{\sin x}$

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26. $\lim_{x \to 0} \frac{e^{ax} - e^{bx}}{x}$

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27. $\lim_{x \to 0} \frac{\sin x(1 - \cos x)}{x^3}$

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28. $\lim_{x \to 0} \frac{\tan x - \sin x}{x^3}$

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Exercise 9 5

1. Prove that $f(x) = 2x^2 + 3x - 5$ is continuous at all points in $\mathbb{R}$.

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2. Examine the continuity of the following :

x + sinx

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3. Examine the continuity of the following :

$x^2 \cos x$

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4. Examine the continuity of the following :

$e^x \tan x$

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5. Examine the continuity of the following :

$e^{2x} + x^2$

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6. Examine the continuity of the following :

x.ln x

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7. Examine the continuity of the following :

$$\frac{\sin x}{x^2}$$

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8. Examine the continuity of the following :

$$\frac{x^2 - 16}{x + 4}$$

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9. Examine the continuity of the following :

$$|x + 2| + |x - 1|$$

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10. Examine the continuity of the following :

$$\frac{|x-2|}{|x+1|}$$

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11. Examine the continuity of the following :

$$\cot x + \tan x$$

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12. Find the points of discontinuity of the function f, where

$$f(x) = \begin{cases} 4x + 5, & \text{if } x \leq 3 \\ 4x - 5, & \text{if } x > 3 \end{cases}$$

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13. Find the points of discontinuity of the function f, where

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

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14. Find the points of discontinuity of the function f, where

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

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15. Find the points of discontinuity of the function f, where

$$f(x) = \begin{cases} \sin x, & 0 \leq x \leq \frac{\pi}{4} \\ \cos x, & \frac{\pi}{4} < x < \frac{\pi}{2} \end{cases}$$

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16. At the given point x_0 discover whether the given function is continuous or discontinuous citing the reasons for your answer:

$$x_0 = 1, f(x) = \begin{cases} \frac{x^2-1}{x-1}, & x \neq 1 \\ 2, & x = 1 \end{cases}$$

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17. At the given point x_0 discover whether the given function is continuous or discontinuous citing the reasons for your answer:

$$x_0 = 3, f(x) = \begin{cases} \frac{x^2-9}{x-3}, & \text{if } x \neq 3 \\ 5, & \text{if } x = 3 \end{cases}$$

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18. Show that the function $\begin{cases} \frac{x^3-1}{x-1}, & \text{if } x \neq 1 \\ 3, & \text{if } x = 1 \end{cases}$ is continuous on $(-\infty, \infty)$

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19. For what value of α is this function $f(x) = \begin{cases} \frac{x^4-1}{x-1}, & \text{if } x \neq 1 \\ \alpha, & \text{if } x = 1 \end{cases}$ continuous at x = 1?

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20. Let $f(x) = \begin{cases} 0, & \text{if } x < 0 \\ x^2, & \text{if } 0 \leq x < 2 \\ 4, & \text{if } x \geq 2 \end{cases}$. Graph the function. Show that f(x) continuous on $(-\infty, \infty)$.

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21. If f and g are continuous functions with f(3) = 5 and $\lim_{x \to 3} [2f(x) - g(x)] = 4$, find g(3).

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22. Find the points at which f is discontinuous. At which of these points f is continuous from the right, from the left, or neither? Sketch the graph of f.

$$f(x) = \begin{cases} 2x + 1, & \text{if } x \leq -1 \\ 3x, & \text{if } -1 < x < 1 \\ 2x - 1, & \text{if } x \geq 1 \end{cases}$$

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23. Find the points at which f is discontinuous. At which of these points f is continuous from the right, from the left, or neither? Sketch the graph of f.

$$f(x) = \begin{cases} (x-1)^3, & \text{if } x < 0 \\ (x+1)^3, & \text{if } x \geq 0 \end{cases}$$

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24. Which of the following functions f has a removable discontinuity at $x = x_0$? If the discontinuity is removable, find a function g

that agrees with f for $x \neq x_0$ and is continuous on $\mathbb{R}$.

$$f(x) = \frac{x^2 - 2x - 8}{x + 2}, x_0 = -2$$

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25. Which of the following functions f has a removable discontinuity at $x = x_0$? If the discontinuity is removable, find a function g that agrees with f for $x \neq x_0$ and is continuous on $\mathbb{R}$.

$$f(x) = \frac{x^3 + 64}{x + 4}, x_0 = -4$$

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26. Which of the following functions f has a removable discontinuity at $x = x_0$? If the discontinuity is removable, find a function g that agrees with f for $x \neq x_0$ and is continuous on $\mathbb{R}$.

$$f(x) = \frac{3 - \sqrt{x}}{9 - x}, x_0 = 9$$

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27. Find the constant b that makes g continuous on $(-\infty, \infty)$ $g(x) = \begin{cases} x^2 - b^2 & \text{if } x < 4 \\ bx + 20 & \text{if } x \geq 4 \end{cases}$

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28. Consider the function $f(x) = x\sin\frac{\pi}{x}$. What value must we give f(0) in order to make the function continuous everywhere?

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29. The function $f(x) = \frac{x^2 - 1}{x^3 - 1}$ is not defined at x = 1. What value must we give f(1) in order to make f(x) continuous at x = 1?

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Exercise 9 6

1. $\lim_{x \to \infty} \frac{\sin x}{x}$

A. 1

B. 0

C. ∞

D. $-\infty$

Answer:

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2. $\lim_{x \to \frac{\pi}{2}} \frac{2x - \pi}{\cos x}$

A. 2

B. 1

C. -2

D. 0

Answer:

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3. $\lim_{x \to 0} \frac{\sqrt{1 - \cos 2x}}{x}$

A. 0

B. 1

C. $\sqrt{2}$

D. does not exist

Answer:

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4. $\lim_{\theta \to 0} \frac{\sin \sqrt{\theta}}{\sqrt{\sin \theta}}$

A. 1

B. -1

C. 0

D. 2

Answer:

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5. $\lim_{x \to \infty} \left(\frac{x^2 + 5x + 3}{x^2 + x + 3} \right)^x$ is

A. e^4

B. e^2

C. e^3

D. 1

Answer:

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6. $\lim_{x \to \infty} \frac{\sqrt{x^2 - 1}}{2x - 1} =$

A. 1

B. 0

C. -1

D. $\frac{1}{2}$

Answer:

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7. $\lim_{x \to \infty} \frac{a^x - b^x}{x} =$

A. $\log ab$

B. $\log\left(\frac{a}{b}\right)$

C. $\log\left(\frac{b}{a}\right)$

D. $\frac{a}{b}$

Answer:

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8. $\lim_{x \to 0} \frac{8^x - 4^x - 2^x + 1^x}{x^2} =$

A. $2 \log 2$

B. $2(\log 2)^2$

C. $\log 2$

D. $3 \log 2$

Answer:

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9. If $f(x) = x(-1)^{\frac{1}{x}} x \leq 0$, then the value of $\lim_{x \to 0} f(x)$ is equal to

A. -1

B. 0

C. 2

D. 4

Answer:

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10. If $f: R \to R$ is defined by $f(x) = |x-3| + |x-4|$ for $x \in R$ then $\lim_{x \to 3^-} f(x)$ is equal to ..... .

A. -2

B. -1

C. 0

D. 1

Answer:

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11. $\lim_{x \to 0} \frac{xe^x - \sin x}{x}$ is

A. 1

B. 2

C. 3

D. 0

Answer:

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12. If $\lim_{x \to 0} \frac{\sin px}{\tan 3x} = 4$, then the value of p is

A. 6

B. 9

C. 12

D. 4

Answer:

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13. $\lim_{\alpha \to \frac{\pi}{4}} \frac{\sin\alpha - \cos\alpha}{\alpha - \frac{\pi}{4}}$ is

A. $\sqrt{2}$

B. $\frac{1}{\sqrt{2}}$

C. 1

D. 2

Answer:

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14. $\lim_{n \to 0} \left(\frac{1}{n^2} + \frac{2}{n^2} + \frac{3}{n^2} + \ldots + \frac{n}{n^2} \right)$ is

A. $\frac{1}{2}$

B. 0

C. 1

D. ∞

Answer:

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15. $\lim_{x \to 0} \frac{e^{\sin x} - 1}{x} =$

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16. $\lim_{x \to 0} \frac{e^{\tan x} - e^{x}}{\tan x - x} =$

A. 1

B. e

C. $\frac{1}{2}$

D. 0

Answer:

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17. The value of $\lim_{x \to 0} \frac{\sin x}{\left(\sqrt{x}\right)^2}$ is

A. -1

B. 1

C. 0

D. limit does not exist

Answer:

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18. The value of $\lim_{x \to k^-} x - [x]$, where k is an integer

A. -1

B. 1

C. 0

D. 2

Answer:

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19. At $x = \frac{3}{2}$ the function $f(x) = \frac{|2x - 3|}{2x - 3}$ is

A. continuous

B. discontinuous

C. differentiable

D. non-zero

Answer:

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20. Let f : $\mathbb{R} \to \mathbb{R}$ be defined by $f(x) = \begin{cases} x & x \text{ is irrational} \\ 1 - x & x \text{ is rational} \end{cases}$ then f is

A. discontinuous at $x = \frac{1}{2}$

B. continuous at $x = \frac{1}{2}$

C. continuous everywhere

D. discontinuous everywhere

Answer:

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21. The function $f(x) = \begin{cases} \frac{x^2-1}{x^3+1} & x \neq 1 \\ P & x = -1 \end{cases}$ is not defined for x = -1.

The value of f(-1) so that the function extended by this value is continuous is

A. $\frac{2}{3}$

B. $-\frac{2}{3}$

C. 1

D. 0

Answer:

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22. Let f be a continuous function on [2, 5]. If f takes only rational values for all x and f(3) = 12, then f(4.5) is equal to

A. $\dfrac{f(3)+f(4.5)}{1.5}$

B. 12

C. 17.5

D. $\dfrac{f(4.5)-f(3)}{1.5}$

Answer:

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Additional Problems Section A

1. $\lim_{x \to 2} \frac{2x^2 + x + 1}{x + 2}$ is equal to

A. $\frac{1}{2}$

B. 2

C. $\frac{11}{4}$

D. 0

Answer:

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2. $\lim_{x \to 1} \frac{x^m - 1}{x^n - 1}$ is

A. mn

B. m + n

C. m - n

D. $\frac{m}{n}$

Answer:

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3. $\lim_{x \to \infty} \left(\frac{1}{x} + 2 \right)$

A. ∞

B. 0

C. 1

D. 2

Answer:

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4. $\lim_{x \to \frac{\pi}{2}} \frac{\sin x}{x} =$

A. π

B. $\frac{\pi}{2}$

C. $\frac{2}{\pi}$

D. 1

Answer:

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5. Find the odd one of the following

A. x^2

B. x^4

C. cos x

D. sin x

Answer:

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6. Find the odd one out of the following

A. $|x|$

B. sin x

C. cos x

D. $\frac{1}{x}$

Answer:

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7. Choose the incorrect pair

A. $\lim_{x \to \infty} \frac{\sin x}{x} = 0$

B. $\lim_{x \to \frac{\pi}{2}} \frac{2x - \pi}{\cos x} = -2$

C. $\lim_{x \to \infty} \frac{a^x - b^x}{x} = \log\left(\frac{a}{b}\right)$

D. $\lim_{x \to 0} \frac{a^x - 1}{x} = \log a > 0$

Answer:

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8. Choose the incorrect statement

A. log 1 to any base is zero.

B. $\frac{d}{dx}(e^x) = e^x$

C. Inverse function of log x is $\frac{1}{x}$

D. |x| is not differentiable at x = 0

Answer:

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9. Find the odd one of the following

A. tan x

B. $\frac{1}{x}$

C. $\frac{x^2 + 5x + 4}{x^2 + 4x + 4}$

D. cos x

Answer:

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Additional Problems Section B

1. Evaluate : $\lim_{x \to 0} \frac{e^{5x} - 1}{x}$.

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2. Evaluate $\lim_{x \to 1} \frac{1 + (x - 1)^2}{1 + x^2}$

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3. Evaluate $\lim_{x \to a} \frac{\sqrt{x} + \sqrt{a}}{x + a}$

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4. Evaluate $\lim_{x \to 0} \frac{\sqrt{1+x} + \sqrt{1-x}}{1+x}$

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5. Evaluate $\lim_{x \to 2} \frac{x^2 - 3x + 2}{x^2 - x - 2}$

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Additional Problems Section C

1. $\lim_{x \to 0} \frac{3^x - 1}{\sqrt{x+1} - 1}$

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2. Evaluate $\lim_{x \to 2} \frac{x^3 - 8}{x^2 - 4}$.

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3. Evaluate $\lim_{x \to 1} \frac{\sqrt{x^2 - 1} + \sqrt{x - 1}}{\sqrt{x^2 - 1}}$ if $x > 1$.

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Additional Problems Section D

1. Discuss continuity of $f(x) = \sqrt{1 - x^2}$, where $x \in [-1, 1]$.

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2. Evaluate $\lim_{x \to 0} \frac{4^x - 1}{\sqrt{1 + x} - 1}$

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3. Examine the continuity of f(x) at $x = \frac{1}{2}$

where

$$f(x) = \begin{cases} \frac{1}{2} - x, & 0 \leq x < \frac{1}{2} \\ 1, & x = \frac{1}{2} \\ \frac{3}{2} - x, & \frac{1}{2} < x \leq 1 \end{cases}$$

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4. If $f(x) = \begin{cases} 1, & x \leq 3 \\ ax + b, & 3 < x < 5 \\ 7, & 5 \leq x \end{cases}$ is

continuous, prove that a = 3 and b = -8.

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