

Limits and Continuity: math practice, College – download the PDF

21 problems graded by difficulty (★ easy, ★★ medium, ★★★ hard). Try first, without looking at the solutions!

1 Guess a limit from a table

★ ★ ★

Let $f(x) = 2x + 1$. Compute $f(2.9)$, $f(2.99)$, $f(2.999)$, $f(3.1)$, $f(3.01)$, and $f(3.001)$. What limit do you suggest for $f(x)$ as $x \rightarrow 3$?

2 Direct substitution

★ ★ ★

Compute $\lim_{x \rightarrow -2} (x^2 + 3x - 1)$.

3 Applying the limit laws

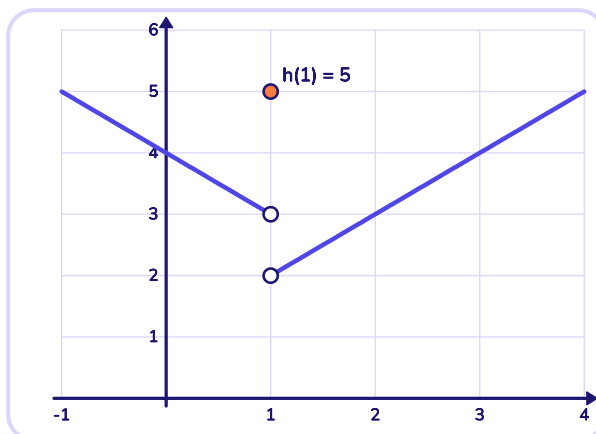
★ ★ ★

As $x \rightarrow a$, $f(x) \rightarrow 4$ and $g(x) \rightarrow -2$. Find the limit of: (a) $3f(x) + g(x)$; (b) $f(x)g(x)$; (c) $\frac{f(x)}{g(x)}$; (d) $(f(x))^2 - g(x)$.

4 Reading limits on a graph



The graph of h is shown below. Open circles are missing points.



- Find $\lim_{x \rightarrow 1^-} h(x)$ and $\lim_{x \rightarrow 1^+} h(x)$.
- Does $\lim_{x \rightarrow 1} h(x)$ exist?
- What is $h(1)$?

5 Two sides of the absolute value



Find (a) $\lim_{x \rightarrow 0^-} \frac{|x|}{x}$ and $\lim_{x \rightarrow 0^+} \frac{|x|}{x}$; (b) $\lim_{x \rightarrow 2^-} \frac{x-2}{|x-2|}$.

6 A simple limit at infinity



Compute $\lim_{x \rightarrow +\infty} \frac{4x+7}{2x-1}$.

7 True or false?



True or false: "If $f(2)$ is undefined, then $\lim_{x \rightarrow 2} f(x)$ does not exist." Justify with an example.

8 Cancel a common factor



Compute $\lim_{x \rightarrow -3} \frac{x^2 + 5x + 6}{x + 3}$.

9 Rationalize the numerator



Compute $\lim_{x \rightarrow 0} \frac{\sqrt{x+9} - 3}{x}$.

10 Find all asymptotes



Let $r(x) = \frac{6x^2 + 1}{3x^2 - x}$. Find its horizontal and vertical asymptotes.

11 Square roots at infinity



Compute $\lim_{x \rightarrow +\infty} \frac{\sqrt{4x^2 + 1}}{x + 3}$ and $\lim_{x \rightarrow -\infty} \frac{\sqrt{4x^2 + 1}}{x + 3}$.

12 Is it continuous at 2?



Let $f(x) = x^2 + 1$ for $x < 2$ and $f(x) = 3x - 1$ for $x \geq 2$. Is f continuous at $x = 2$?
Check the three conditions.

13 Repair a hole



Let $f(x) = \frac{x^2 - 16}{x - 4}$ for $x \neq 4$ and $f(4) = k$. Find k so that f is continuous at 4.

14 Parking garage fees

A garage charges 4 dollars for each hour or part of an hour, so the cost for parking t hours is $\lfloor 4t \rfloor$.

15 Squeeze with a cosine

Use the squeeze theorem to find $\lim_{x \rightarrow 0} x^2 \cos \frac{4}{x}$.

16 Squeeze at infinity

Find (a) $\lim_{x \rightarrow +\infty} \frac{\sin x}{x}$ and (b) $\lim_{x \rightarrow +\infty} \frac{2x + \cos x}{x}$.

17 Locate three roots

Let $f(x) = x^3 - 4x + 1$. Use the IVT to show that f has a root in each of $(-3, -2)$, $(0, 1)$, and $(1, 2)$. Why are there no other roots?

18 Classify the discontinuities

Let $f(x) = \frac{x^2 - 1}{x^2 - 3x + 2}$. Find where f is undefined and classify each discontinuity.

19 Make a piecewise function continuous

Find the constants a and b so that f is continuous everywhere, where $f(x) = x + 1$ for $x < 0$, $f(x) = ax + b$ for $0 \leq x \leq 3$, and $f(x) = 10 - x$ for $x > 3$.

20

Cooling coffee

★★★

A cup of coffee in a room at 72 degrees F cools according to $T(t) = 72 + 98e^{-0.1t}$, where t is in minutes. (a) Find $T(0)$ and $T(10)$ to the nearest tenth. (b) Find $\lim_{t \rightarrow +\infty} T(t)$ and the horizontal asymptote. Convert it to Celsius. (c) After how many minutes does the coffee reach 73 degrees F (nearest hundredth)?

21

When the MT applies

★★★

(a) f is continuous on $[0, 2]$ with $f(0) = -3$ and $f(2) = 5$. Must f take the value 4? The value 6? (b) Let $s(x) = -1$ for $x < 1$ and $s(x) = 1$ for $x \geq 1$. Show that $s(0) < 0$

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