MATHEMATICS · GRADES 10-12

Rational functions

Difficulty level: Advanced

Mathematics: Grades 10-12

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Overview of the concept

This is how you describe things that level off or break suddenly, like the average cost per item dropping as you buy more, or a drug's concentration in the body over time. Buying in bulk drops the average cost per item, but it never drops to zero, it just levels off. A medicine rises in the blood after a dose and then falls away, and a tank filling up approaches full without ever quite passing it. These are all situations where the behaviour changes as the numbers grow, and a rational function is the shape that describes that.



Rule

The domain of a rational function is all real numbers except the values that make the denominator zero.

To find them, set the denominator equal to zero and solve.

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Worked examples

EXAMPLE 1

Q For $f(x) = \frac{(x + 1)}{(x - 2)}$, find the domain



SOLUTION

Set the denominator to zero: $x - 2 = 0$, so $x = 2$.

Exclude that value from the domain.

So the domain is all real numbers except 2.

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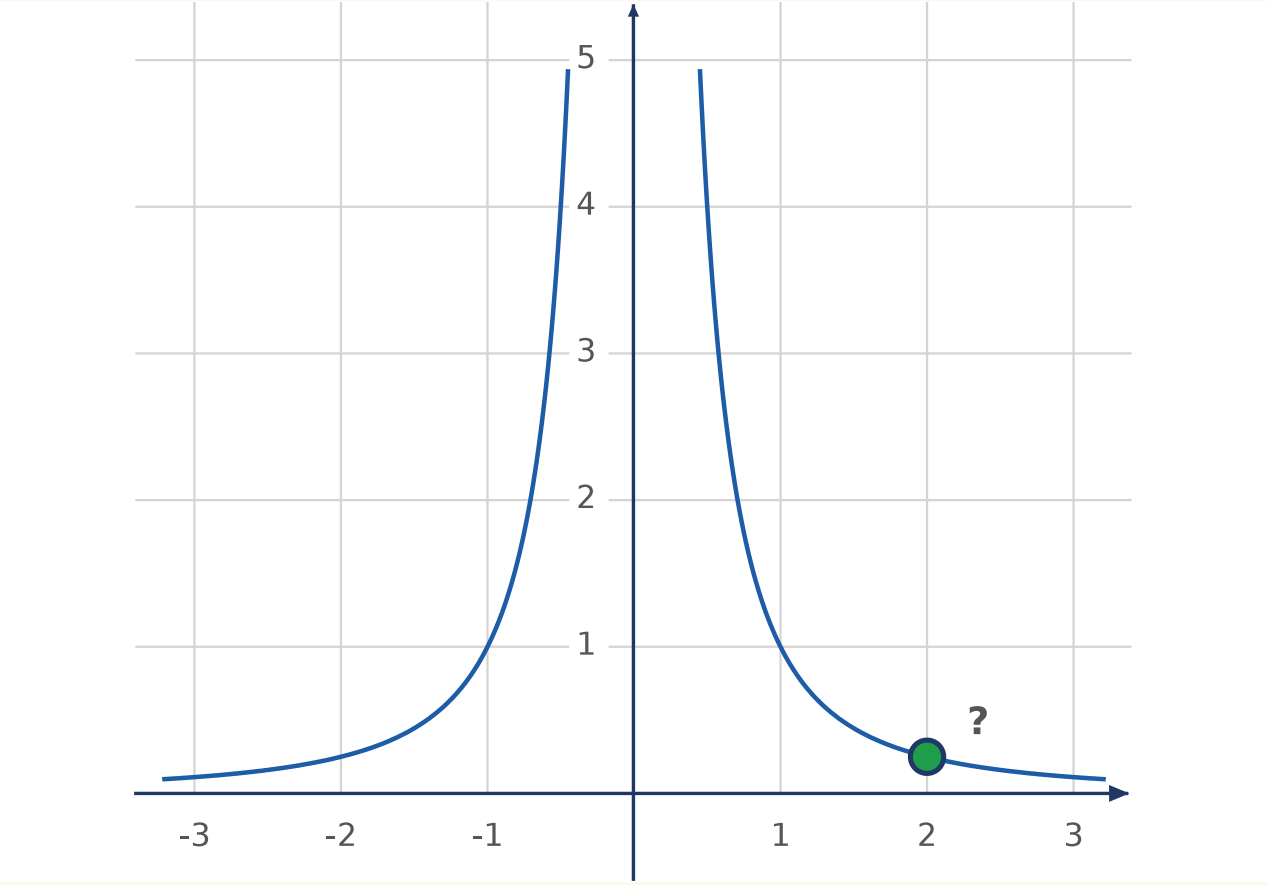
EXAMPLE 2

Q For $f(x) = \frac{1}{x^2}$, find the domain and the value at $x = 2$



SOLUTION

Set the denominator to zero: $x^2 = 0$, so $x = 0$ is excluded.

The domain is all real numbers except 0.

At $x = 2$, $f(2) = \frac{1}{4}$

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Practice questions

1 $f(x) = \frac{(x - 1)}{(x - 7)}$. For which x values is it defined?

- **A** All real numbers except 1
- **B** All real numbers except 7
- **C** All real numbers except -7
- **D** All real numbers

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2 $f(x) = \frac{3}{(x - 2)^2}$. Find the domain and the value at $x = 1$.

- **A** All real numbers except 1; f(1) = 3
- **B** All real numbers except 2; f(1) = 3
- **C** All real numbers except 2; $f(1) = \frac{1}{3}$
- **D** All real numbers except 0; f(1) = 3

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3 $f(x) = \frac{1}{(x - 2)(x + 3)}$. Find the domain.

- **A** All real numbers except 2 and –3
- **B** All real numbers except 2
- **C** All real numbers except –3
- **D** All real numbers

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4 For $f(x) = \frac{1}{(x - 4)^2}$, what happens to f(x) as x gets closer and closer to 4?

- **A** f(x) grows without bound
- **B** f(x) approaches 0
- **C** f(x) becomes 0
- **D** f(x) approaches 1

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5 What is $f(5)$ for $f(x) = \frac{2}{(x - 5)}$?

- **A** Undefined
- **B** 2
- **C** 0
- **D** 5

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6 $f(x) = \frac{3}{x^2}$. Find the domain and the value at $x = 3$.

- **A** All real numbers except 3; $f(3) = \frac{1}{3}$
- **B** All real numbers except 0; $f(3) = 3$
- **C** All real numbers except 0; $f(3) = \frac{1}{3}$
- **D** All real numbers except 0; $f(3) = \frac{1}{9}$

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7 $f(x) = \frac{(x + 1)}{x^2 - 9}$. Find the domain.

- **A** All real numbers except 3 and –3
- **B** All real numbers except 3
- **C** All real numbers except 9
- **D** All real numbers except –9

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8 $f(x) = \frac{(x - 2)}{(x + 3)}$. What is f(2)?

- **A** 0
- **B** 1
- **C** Undefined
- **D** $\frac{2}{5}$

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9 $f(x) = \frac{(x + 4)}{(x - 1)}$. Find the domain and the value at $x = 3$.

- **A** All real numbers except -1; $f(3) = \frac{7}{2}$
- **B** All real numbers except 1; $f(3) = \frac{7}{4}$
- **C** All real numbers except 4; $f(3) = \frac{7}{2}$
- **D** All real numbers except 1; $f(3) = \frac{7}{2}$

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10 $f(x) = \frac{5}{(x + 8)}$. Find the domain and the value at $x = 2$.

- **A** All real numbers except -8; $f(2) = \frac{1}{2}$
- **B** All real numbers except 8; $f(2) = \frac{1}{2}$
- **C** All real numbers except -8; $f(2) = \frac{5}{2}$
- **D** All real numbers except -2; $f(2) = \frac{1}{2}$

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ANSWER KEY

1. All real numbers except 7

2. All real numbers except 2; f(1) = 3

3. All real numbers except 2 and –3

4. f(x) grows without bound

5. Undefined

6. All real numbers except 0; f(3) = $\frac{1}{3}$

7. All real numbers except 3 and –3

8. 0

9. All real numbers except 1; f(3) = $\frac{7}{2}$

10. All real numbers except -8; f(2) = $\frac{1}{2}$

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