

Rational Expressions and Functions: practice solutions, Grade 11 – download the PDF

Written solutions to the chapter problems. Check each step, then correct yourself.

1 Finding a domain



The denominator is zero when $x^2 - 25 = 0$, that is $(x - 5)(x + 5) = 0$, so $x = 5$ or $x = -5$.

The domain is all real numbers except -5 and 5 .

2 Simplifying a monomial quotient



Divide top and bottom by their common factor $6x^2$: $\frac{12x^3}{18x^2} = \frac{2x}{3}$.

The original denominator is zero when $x = 0$, so $x \neq 0$.

3 Factoring a common factor



Factor the numerator: $5x + 15 = 5(x + 3)$. So $\frac{5(x + 3)}{x + 3} = 5$ for $x \neq -3$.

The graph is the horizontal line $y = 5$ with a hole at $(-3, 5)$.

4 Multiplying two fractions



Multiply across: $\frac{12x}{72x^2}$. Divide top and bottom by $12x$: $\frac{1}{6x}$.

The result is $\frac{1}{6x}$, with $x \neq 0$.

5 Same denominator



The denominators match, so add the numerators: $\frac{(2x + 1) + (x + 7)}{x + 4} = \frac{3x + 8}{x + 4}$.

This does not simplify further, and $x \neq -4$.

6 Reading asymptotes from the form



The form is $\frac{a}{x - h} + k$ with $h = -3$ and $k = -2$.

The vertical asymptote is $x = -3$ and the horizontal asymptote is $y = -2$.

7 A cyclist at steady speed



Direct variation: $d = kt$. From $42 = k \cdot 3$ we get $k = 14$ miles per hour.

Then $d = 14 \cdot 5 = 70$. She rides **70 miles** (about 112.7 km).

8 A trinomial over a difference of squares



Factor: $x^2 - 6x + 8 = (x - 2)(x - 4)$ and $x^2 - 4 = (x - 2)(x + 2)$.

Restrictions: $x \neq 2$ and $x \neq -2$. Cancel $(x - 2)$: the result is $\frac{x - 4}{x + 2}$.

9 Dividing rational expressions



Multiply by the reciprocal: $\frac{(x-3)(x+3)}{x+2} \cdot \frac{(x-2)(x+2)}{x+3}$.

Cancel $(x+3)$ and $(x+2)$: the result is $(x-3)(x-2)$.

Restrictions: $x \neq -2$ (denominator $x+2$), $x \neq \pm 2$ from $x^2 - 4$, and $x \neq -3$ (the divisor would be 0). So $x \neq -3, -2, 2$.

10 Subtracting with different denominators



The LCD is $(x-2)(x+4)$.

$$\frac{5(x+4) - 3(x-2)}{(x-2)(x+4)} = \frac{5x+20-3x+6}{(x-2)(x+4)} = \frac{2x+26}{(x-2)(x+4)}.$$

Factoring the top gives $\frac{2(x+13)}{(x-2)(x+4)}$, which cannot be simplified further.

11 A first rational equation



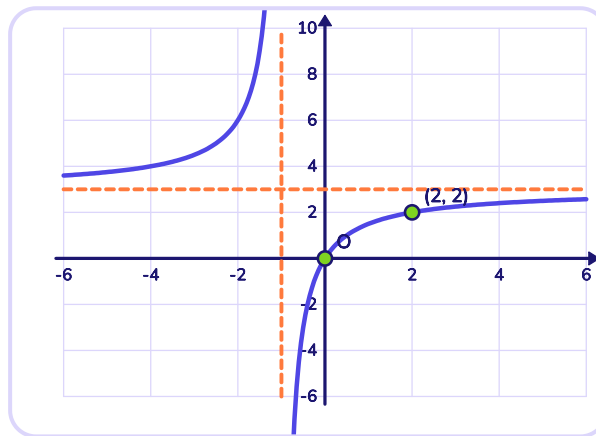
Multiply both sides by $x(x-4)$: $5(x-4) = 3x$, so $5x - 20 = 3x$ and $2x = 20$, $x = 10$.

Check: $\frac{5}{10} = \frac{1}{2}$ and $\frac{3}{6} = \frac{1}{2}$. The solution is $x = 10$.

12 Sketching a rational function



- a. The denominator is zero at $x = -1$: vertical asymptote $x = -1$. The degrees are equal and the leading coefficients are 3 and 1: horizontal asymptote $y = 3$.
- b. If $x = 0$, then $f(0) = 0$, so the only intercept is the origin $(0, 0)$.
- c. $f(2) = \frac{6}{3} = 2$ and $f(-3) = \frac{-9}{-2} = 4.5$. The right branch rises from the origin toward $y = 3$; the left branch lies above $y = 3$ and descends toward it as $x \rightarrow -\infty$.



13 Painters on a fence



Inverse variation: $t = \frac{k}{n}$, so $k = nt = 8 \cdot 9 = 72$.

With $n = 12$: $t = \frac{72}{12} = 6$. Twelve painters need **6 hours**.

14 True or false?



- a. **False.** For $x = 1$: $\frac{6}{8} = 0.75$ but $\frac{5}{7} \approx 0.714$. You cannot cancel terms.
- b. **True.** $x^2 - 1 = (x - 1)(x + 1)$, and the factor $x - 1$ cancels whenever $x \neq 1$.
- c. **False.** For $x = y = 1$: the left side is $1 + 1 = 2$ and the right side is $\frac{2}{2} = 1$.

15 A complex fraction

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Write each part over the LCD $3x$: the top is $\frac{3+x}{3x}$ and the bottom is $\frac{3-x}{3x}$.

Dividing: $\frac{3+x}{3x} \cdot \frac{3x}{3-x} = \frac{x+3}{3-x}$.

Restrictions: $x \neq 0$ (small denominators) and $x \neq 3$ (the bottom would be 0).

16 Spot the extraneous solution

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Multiply by $x - 4$: $x - 2(x - 4) = 4$, so $-x + 8 = 4$ and $x = 4$.

But $x = 4$ makes the denominator 0. It is extraneous, so the equation has **no solution**.

17 A rational equation that becomes a quadratic

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Multiply by $2x(x + 3)$: $2(x + 3) + 2x = x(x + 3)$, so $4x + 6 = x^2 + 3x$.

Then $x^2 - x - 6 = 0$, that is $(x - 3)(x + 2) = 0$, so $x = 3$ or $x = -2$.

Check: $\frac{1}{3} + \frac{1}{6} = \frac{1}{2}$ and $-\frac{1}{2} + 1 = \frac{1}{2}$. Both are valid.

18 Two hoses fill a pool

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In one hour, A fills $\frac{1}{t}$ of the pool and B fills $\frac{1}{t+6}$. Together: $\frac{1}{t} + \frac{1}{t+6} = \frac{1}{4}$.

Multiply by $4t(t + 6)$: $4(t + 6) + 4t = t(t + 6)$, so $8t + 24 = t^2 + 6t$ and $t^2 - 2t - 24 = 0$, that is $(t - 6)(t + 4) = 0$.

A time cannot be negative, so $t = 6$. Hose A needs **6 hours** and hose B needs **12 hours**.

Check: $\frac{1}{6} + \frac{1}{12} = \frac{1}{4}$.

19 Designing a function

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Use the denominator $x - 2$ for the asymptote $x = 2$, and the numerator $3(x + 1)$: the degrees are equal with leading-coefficient ratio 3, and the zero is at $x = -1$.

$$\text{So } f(x) = \frac{3(x + 1)}{x - 2} = \frac{3x + 3}{x - 2}.$$

$$\text{The } y\text{-intercept is } f(0) = \frac{3}{-2} = -1.5.$$

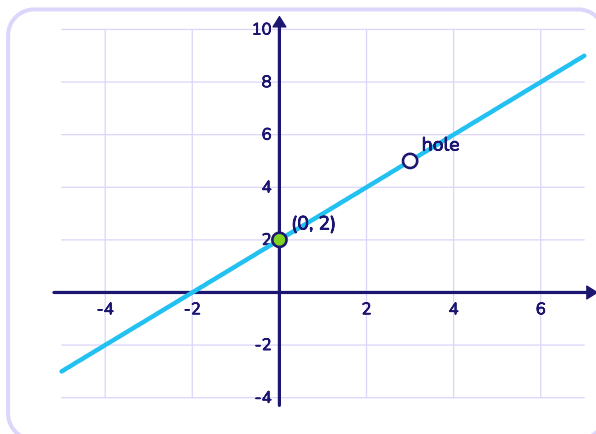
20 Hole or asymptote?

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a. $x^2 - x - 6 = (x - 3)(x + 2)$, so $g(x) = x + 2$ for $x \neq 3$. The hole is at $x = 3$, height $3 + 2 = 5$: the point $(3, 5)$.

b. No: the factor $x - 3$ cancels completely.

c. $g(0) = \frac{-6}{-3} = 2$, so the y -intercept is $(0, 2)$. The graph is the line $y = x + 2$ with an open circle at $(3, 5)$.



21 Combined variation

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The model is $y = \frac{kx}{z}$. From $6 = \frac{4k}{10}$ we get $k = 15$.

$$\text{Then } y = \frac{15 \cdot 7}{5} = 21.$$



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