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Rational Algebraic Expressions

Simplify each rational expression.

1. $\frac{5z^3 + z^2 - z}{3z}$ $\frac{5z^2+z-1}{3}$

2. $\frac{4a^2 - 9}{10a + 15}$ $\frac{2a-3}{5}$

3. $\frac{12b - 6}{6b^2 - b - 1}$ $\frac{6}{3b+1}$

4. $\frac{3x^2 + 3xy}{3x^2 - 3xy}$ $\frac{x+y}{x-y}$

5. $\frac{m^2 - 25}{m^2 + 5m}$ $\frac{m-5}{m}$

6. $\frac{3a^2 + 6a + 3}{3a^2 - 3}$ $\frac{a+1}{a-1}$

7. $\frac{e^2 + 10e + 25}{5e + e^2}$ $\frac{e+5}{e}$

8. $\frac{h^2 - 3(h + 6)}{18 + h(3 - h)}$ -1

9. $\frac{s^2 + 4(1 + s)}{s^2 - 4}$ $\frac{s+2}{s-2}$

10. $\frac{3a^3 + 3b^3}{5a^2 - 5ab + 5b^2}$ $\frac{3(a+b)}{5}$

11. $\frac{v^2 - u^2}{u^2 + 2uv + v^2}$ $\frac{v-u}{v+u}$

12. $\frac{cd - 2d^2 + c^2}{c^2 - 4cd + 3d^2}$ $\frac{c+2d}{c-3d}$

In Exercises 13–24 a rational function is defined. Determine the domain of the function. Find the zeros of the function. {domain}; zeros

13. $f(a) = \frac{a - 1}{a - 2}$ $\{a : a \neq 2\}$; 1

14. $k(x) = \frac{4 - x}{x^2 - 9}$ $\{x : x \neq \pm 3\}$; 4

15. $h(b) = \frac{3b - 9}{4b + 3}$ $\{b : b \neq -\frac{3}{4}\}$; 3

16. $F(c) = \frac{c^2 - c - 2}{c^2 - c}$ $\{c : c \neq 0, 1\}$; 2, −1

17. $G(x) = \frac{3x^2 - 11x + 6}{x^2 + x}$ $\{x : x \neq 0, -1\}$; $\frac{2}{3}$, 3

18. $E(y) = \frac{2y^2 - 13y - 15}{3y + 5}$ $\{y : y \neq -\frac{5}{3}\}$; −1, $\frac{15}{2}$

19. $z(e) = \frac{e^3 + 2e^2 + e}{3 + e^2}$ {real #s}; 0, −1

20. $c(j) = \frac{2j^2 - 5j + 2}{j^3 - 36j}$ $\{j : j \neq 0, -6, 6\}$; $\frac{1}{2}$, 2

21. $Q(n) = \frac{n^4 - 16}{n + 2n^2}$ $\{n : n \neq 0, -\frac{1}{2}\}$; 2, −2

22. $e(t) = \frac{t^4 - t^2 - 12}{t^3 - 16t}$ $\{t : t \neq 0, 4, -4\}$; 2, −2

23. $d(h) = \frac{h^4 + 6h^2 + 8}{h^4 - 5h^2 + 4}$ $\{h : h \neq \pm 1, \pm 2\}$; none

24. $H(d) = \frac{d^4 - 10d^2 + 9}{2d^3 - 32d}$ $\{d : d \neq 0, 4, -4\}$; $\pm 3, \pm 1$

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Products and Quotients; Sums and Differences

Simplify. Write answers without negative or zero exponents.

1. $\frac{10r^5}{21s^2} \cdot \frac{3s}{5r^3}$ $\frac{2r^2}{7s}$

2. $\frac{9a}{10b} \div \frac{3a^3}{20b}$ $\frac{6}{a^2}$

3. $\frac{4p^4q}{9r} \cdot \frac{9r^3}{10p^2q^2} \cdot \frac{15pq}{2r}$ $3p^3r$

4. $\frac{25u^6v}{4w^5} \cdot \frac{9v}{10u^2w} \div \frac{15u^3v}{2w^7}$ $\frac{3uvw}{4}$

5. $\frac{a^2 - 5a + 6}{a + 4} \cdot \frac{3a + 12}{a - 2}$ $3a - 9$

6. $\frac{6b^2 + 5b + 1}{3b - 6} \div \frac{4b^2 + 4b + 1}{2 - b}$ $-\frac{3b+1}{3(2b+1)}$

7. $\frac{6d - 9}{5d + 1} \div \frac{6 - 13d + 6d^2}{15d^2 - 7d - 2}$ 3

8. $\frac{25h^2 + 10h + 1}{12h - 18} \cdot \frac{10h - 15}{25h^2 - 1}$ $\frac{5(5h+1)}{6(5h-1)}$

9. $\frac{n^2 - 1}{n^2 - 3n - 10} \cdot \frac{n^2 + 5n + 6}{n^2 - 3n - 4} \cdot \frac{n^2 - n - 20}{n^2 + 2n - 3}$ $\frac{n+4}{n-4}$

10. $\frac{3z^2 + 6z - 45}{z^2 - 2z} \cdot \frac{10 - 7z + z^2}{6z^2 + 33z + 15} \div \frac{15 - 8z + z^2}{10z^2 + 5z}$ 5

Simplify.

11. $\frac{2x}{5} - \frac{x}{3}$ $\frac{x}{15}$

12. $\frac{b}{2a} - \frac{a}{b}$ $\frac{b^2 - 2a^2}{2ab}$

13. $\frac{4 + 3y}{3y} - \frac{1 + 2y}{2y}$ $\frac{5}{6y}$

14. $\frac{3}{2x} + \frac{5 - x}{x^2}$ $\frac{x+10}{2x^2}$

15. $\frac{b - a}{a^2b} + \frac{a + b}{ab^2}$ $\frac{a^2+b^2}{a^2b^2}$

16. $\frac{r - s}{rs} - \frac{r^2s + 1}{r^2s^2}$ $-\frac{rs^2+1}{r^2s^2}$

17. $\frac{2 - m}{3m} + \frac{m^2 - 2}{5m^2}$ $-\frac{2m^2-10m+6}{15m^2}$

18. $\frac{u + 2}{u - 1} - \frac{v + 2}{v + 1}$ $\frac{3v-u+4}{(u-1)(v+1)}$

19. $\frac{2 - a^2}{a^2 + a} + \frac{3a + 4}{3a + 3}$ $\frac{6+4a}{3a(a+1)}$

20. $\frac{3}{c^2 - 4} - \frac{2}{3c - 6}$ $\frac{5-2c}{3(c-2)(c+2)}$

21. $\frac{5}{2u^2 - u} + \frac{10}{2u + u^2}$ $\frac{25}{(2u-1)(u+2)}$

22. $\frac{2}{3z^2 + 2z} - \frac{6}{9z^2 + 12z + 4}$ $\frac{4}{z(3z+2)^2}$