

1 Simplify each expression. Under what conditions is this expression undefined?

13. $\frac{x(x-3)(x+6)}{x^2+x-12} = \frac{x(x+6)}{x+4}$
 $x \neq -4, 3$

15. $\frac{(x^2-9)(x^2-z^2)}{4(x+z)(x-3)} = \frac{(x-3)(x+3)(x-z)(x+z)}{4(x+z)(x-3)} = \frac{(x+3)(x-z)}{4}$
 $x \neq -3, z$

17. $\frac{x^2(x+2)(x-4)}{6x(x^2+x-20)} = \frac{x(x+2)}{6(x+5)}$
 $x \neq 0, -5, 4$

14. $\frac{y^2(y^2+3y+2)}{2y(y-4)(y+2)}$

16. $\frac{(x^2-16x+64)(x+2)}{(x^2-64)(x^2-6x-16)}$

18. $\frac{3y(y-8)(y^2+2y-24)}{15y^2(y^2-12y+32)}$

2 19. MULTIPLE CHOICE Identify all values of x for which $\frac{(x-3)(x+6)}{(x^2-7x+12)(x^2-36)}$ is undefined.

A 3, -6

B 4, 6

C -6, 6

D -6, 3, 4, 6

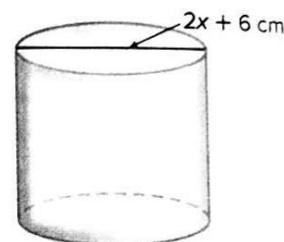
3 Simplify each expression.

20. $\frac{x^2-5x-14}{28+3x-x^2} = \frac{(x-7)(x+2)}{-(x^2-3x-28)} = \frac{(x-7)(x+2)}{-1(x-7)(x+4)} = \frac{x+2}{-1(x+4)}$
 $x \neq -4, -7$

22. $\frac{(x-4)(x^2+2x-48)}{(36-x^2)(x^2+4x-32)}$

23. $\frac{16-c^2}{c^2+c-20}$

24. GEOMETRY The cylinder at the right has a volume of $(x+3)(x^2-3x-18)\pi$ cubic centimeters. Find the height of the cylinder.



s 4-6 Simplify each expression.

25. $\frac{3ac^3f^3}{8a^2bcf^4} \cdot \frac{12ab^2c}{18ab^3c^2f} = \frac{3(12)a^2b^2c^4f^3}{8(18)a^3b^4c^3f^5} = \frac{1b^2}{4a^1f^2}$

27. $\frac{64a^2b^5}{35b^2c^3f^4} \div \frac{12a^4b^3c}{70abcf^2} = \frac{64a^2b^5}{35b^2c^3f^4} \cdot \frac{70abcf^2}{12a^4b^3c} = \frac{32a^2}{3b^2c^2f^2}$

29. $\frac{15a^2b^2}{21ac} \cdot \frac{14a^4c^2}{6ab^3} = \frac{(y+5)(y+3)(y-6)(y-3)}{(y-6)(y-3)(y+3)} = y+5$
 $y \neq 6, 3, -3$

31. $\frac{y^2+8y+15}{y-6} \cdot \frac{y^2-9y+18}{y^2-9} = \frac{y+5}{y+6, 3, -3}$

33. $\frac{x^2+9x+20}{8x+16} \cdot \frac{4x^2+16x+16}{x^2-25}$

26. $\frac{14xy^2z^3}{21w^4x^2yz} \cdot \frac{7wxyz}{12w^2y^3z}$

28. $\frac{9x^2yz}{5z^4} \div \frac{12x^4y^2}{50xy^4z^2}$

30. $\frac{14c^2f^5}{9a^2} \div \frac{35cf^4}{18ab^3}$

32. $\frac{c^2-6c-16}{c^2-d^2} \div \frac{c^2-8c}{c+d}$

34. $\frac{3a^2+6a+3}{a^2-3a-10} \div \frac{12a^2-12}{a^2-4} = \frac{3(a^2+2a+1)}{(a-5)(a+2)} \cdot \frac{(a-2)(a+2)}{12(a^2-1)} = \frac{3(a+1)(a+1)(a-2)(a+2)}{12(a-5)(a+2)(a-1)(a+1)} = \frac{1(a+1)(a-2)}{4(a-5)(a-1)}$
 $a \neq 5, -2, \pm 1$

35. $\frac{x^2-9}{6x-12} = \frac{(x-3)(x+3)}{6(x-2)} = \frac{(x-3)(x+3)(x-2)(x+1)}{6(x-2)(x+1)(x-2)} = \frac{(x-3)(x+1)}{6(x-2)}$
 $x \neq 2, -1$

36. $\frac{y-x}{z^3} \cdot \frac{x-y}{6z^2}$

37. $\frac{a^2-b^2}{b^3} \cdot \frac{b^2-ab}{a^2}$

38. $\frac{x-y}{a+b} \cdot \frac{x^2-y^2}{b^2-a^2}$

$$\frac{(3x+1)(x-6)}{4(x^2-5x-6)} \cdot \frac{(2x-3)(x+1)}{(3x+1)(2x-3)}$$

$$\frac{(3x+1)(x-6)}{4(x+1)(x-6)} \cdot \frac{(2x-3)(x+1)}{(3x+1)(2x-3)}$$

$$= \frac{1}{4} \quad x \neq -1, 6, \frac{3}{2}, -1$$

Simplify each expression.

42. $\frac{x^2 - 16}{3x^3 + 18x^2 + 24x} \cdot \frac{x^3 - 4x}{2x^2 - 7x - 4}$

43. $\frac{3x^2 - 17x - 6}{4x^2 - 20x - 24} \div \frac{6x^2 - 7x - 3}{2x^2 - x - 3} =$

44. $\frac{9 - x^2}{x^2 - 4x - 21} \cdot \left(\frac{2x^2 + 7x + 3}{2x^2 - 15x + 7} \right)^{-1}$

45. $\left(\frac{2x^2 + 2x - 12}{x^2 + 4x - 5} \right)^{-1} \cdot \frac{2x^3 - 8x}{x^2 - 2x - 35}$

46. $\left(\frac{3xy^3z}{2a^2bc^2} \right)^3 \cdot \frac{16a^4b^3c^5}{15x^7yz^3}$

47. $\frac{20x^2y^6z^{-2}}{3a^3c^2} \cdot \left(\frac{16x^3y^3}{9acz} \right)^{-1}$

48. $\left(\frac{2xy^3}{3abc} \right)^{-2} \div \frac{6a^2b}{x^2y^4}$

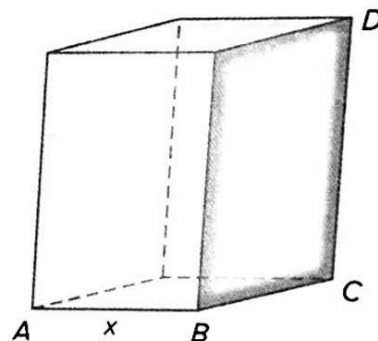
49. $\frac{\frac{8x^2 - 10x - 3}{10x^2 + 35x - 20}}{\frac{2x^2 + x - 6}{4x^2 + 18x + 8}}$

50. $\frac{\frac{2x^2 + 7x - 30}{-6x^2 + 13x + 5}}{\frac{4x^2 + 12x - 72}{3x^2 - 11x - 4}}$

51. $\frac{\frac{4x^2 - 1}{3x^3 - 6x^2 - 24x}}{\frac{12x^2 + 12x - 9}{-2x^2 + 5x + 12}}$

52. **GEOMETRY** The area of the base of the rectangular prism at the right is 20 square centimeters.

- Find the length of $\overline{BC}$ in terms of x .
- If $DC = 3BC$, determine the area of the shaded region in terms of x .
- Determine the volume of the prism in terms of x .



Simplify each expression.

53. $\frac{x^2 + 4x - 32}{2x^2 + 9x - 5} \cdot \frac{3x^2 - 75}{3x^2 - 11x - 4} \div \frac{6x^2 - 18x - 60}{x^3 - 4x}$

54. $\frac{8x^2 + 10x - 3}{3x^2 - 12x - 36} \div \frac{2x^2 - 5x - 12}{3x^2 - 17x - 6} \cdot \frac{4x^2 + 3x - 1}{4x^2 - 40x + 24}$

55. $\frac{4x^2 - 9x - 9}{3x^2 + 6x - 18} \div \frac{-2x^2 + 5x + 3}{x^2 - 4x - 32} \div \frac{8x^2 + 10x + 3}{6x^2 - 6x - 12}$