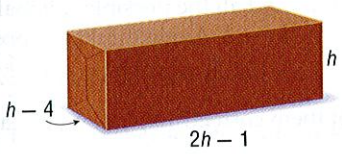
Exercises

= **Step-by-Step Solutions** begin on page R29.

List all possible rational zeros of each function. Then determine which, if any, are zeros. (Examples 1 and 2)

1. $g(x) = x^4 - 6x^3 - 31x^2 + 216x - 180$
2. $f(x) = 4x^3 - 24x^2 - x + 6$
3. $g(x) = x^4 - x^3 - 31x^2 + x + 30$
4. $g(x) = -4x^4 + 35x^3 - 87x^2 + 56x + 20$
5. $h(x) = 6x^4 + 13x^3 - 67x^2 - 156x - 60$
6. $f(x) = 18x^4 + 12x^3 + 56x^2 + 48x - 64$
7. $h(x) = x^5 - 11x^4 + 49x^3 - 147x^2 + 360x - 432$
8. $g(x) = 8x^5 + 18x^4 - 5x^3 - 72x^2 - 162x + 45$
9. **MANUFACTURING** The specifications for the dimensions of a new cardboard container are shown. If the volume of the container is modeled by $V(h) = 2h^3 - 9h^2 + 4h$ and it will hold 45 cubic inches of merchandise, what are the container's dimensions? (Example 3)



Solve each equation. (Example 3)

10. $x^4 + 2x^3 - 7x^2 - 20x - 12 = 0$
11. $x^4 + 9x^3 + 23x^2 + 3x - 36 = 0$
12. $x^4 - 2x^3 - 7x^2 + 8x + 12 = 0$
13. $x^4 - 3x^3 - 20x^2 + 84x - 80 = 0$
14. $x^4 + 34x = 6x^3 + 21x^2 - 48$
15. $6x^4 + 41x^3 + 42x^2 - 96x + 6 = -26$
16. $-12x^4 + 77x^3 = 136x^2 - 33x - 18$
17. **SALES** The sales $S(x)$ in thousands of dollars that a store makes during one month can be approximated by $S(x) = 2x^3 - 2x^2 + 4x$, where x is the number of days after the first day of the month. How many days will it take the store to make \$16,000? (Example 3)

Determine an interval in which all real zeros of each function must lie. Explain your reasoning using the upper and lower bound tests. Then find all the real zeros. (Example 4)

18. $f(x) = x^4 - 9x^3 + 12x^2 + 44x - 48$
19. $f(x) = 2x^4 - x^3 - 29x^2 + 34x + 24$
20. $g(x) = 2x^4 + 4x^3 - 18x^2 - 4x + 16$
21. $g(x) = 6x^4 - 33x^3 - 6x^2 + 123x - 90$
22. $f(x) = 2x^4 - 17x^3 + 39x^2 - 16x - 20$
23. $f(x) = 2x^4 - 13x^3 + 21x^2 + 9x - 27$
24. $h(x) = x^5 - x^4 - 9x^3 + 5x^2 + 16x - 12$
25. $h(x) = 4x^5 - 20x^4 + 5x^3 + 80x^2 - 75x + 18$

Describe the possible real zeros of each function. (Example 5)

26. $f(x) = -2x^3 - 3x^2 + 4x + 7$
27. $f(x) = 10x^4 - 3x^3 + 8x^2 - 4x - 8$
28. $f(x) = -3x^4 - 5x^3 + 4x^2 + 2x - 6$
29. $f(x) = 12x^4 + 6x^3 + 3x^2 - 2x + 12$
30. $g(x) = 4x^5 + 3x^4 + 9x^3 - 8x^2 + 16x - 24$
31. $h(x) = -4x^5 + x^4 - 8x^3 - 24x^2 + 64x - 124$

Write a polynomial function of least degree with real coefficients in standard form that has the given zeros. (Example 6)

32. $3, -4, 6, -1$
33. $-2, -4, -3, 5$
34. $-5, 3, 4 + i$
35. $-1, 8, 6 - i$
36. $2\sqrt{5}, -2\sqrt{5}, -3, 7$
37. $-5, 2, 4 - \sqrt{3}, 4 + \sqrt{3}$
38. $\sqrt{7}, -\sqrt{7}, 4i$
39. $\sqrt{6}, -\sqrt{6}, 3 - 4i$
40. $2 + \sqrt{3}, 2 - \sqrt{3}, 4 + 5i$
41. $6 - \sqrt{5}, 6 + \sqrt{5}, 8 - 3i$

Write each function as (a) the product of linear and irreducible quadratic factors and (b) the product of linear factors. Then (c) list all of its zeros. (Example 7)

42. $g(x) = x^4 - 3x^3 - 12x^2 + 20x + 48$
43. $g(x) = x^4 - 3x^3 - 12x^2 + 8$
44. $h(x) = x^4 + 2x^3 - 15x^2 + 18x - 216$
45. $f(x) = 4x^4 - 35x^3 + 140x^2 - 295x + 156$
46. $f(x) = 4x^4 - 15x^3 + 43x^2 + 577x + 615$
47. $h(x) = x^4 - 2x^3 - 17x^2 + 4x + 30$
48. $g(x) = x^4 + 31x^2 - 180$

Use the given zero to find all complex zeros of each function. Then write the linear factorization of the function. (Example 8)

49. $h(x) = 2x^5 + x^4 - 7x^3 + 21x^2 - 225x + 108; 3i$
50. $h(x) = 3x^5 - 5x^4 - 13x^3 - 65x^2 - 2200x + 1500; -5i$
51. $g(x) = x^5 - 2x^4 - 13x^3 + 28x^2 + 46x - 60; 3 - i$
52. $g(x) = 4x^5 - 57x^4 + 287x^3 - 547x^2 + 83x + 510; 4 + i$
53. $f(x) = x^5 - 3x^4 - 4x^3 + 12x^2 - 32x + 96; -2i$
54. $g(x) = x^4 - 10x^3 + 35x^2 - 46x + 10; 3 + i$
55. **ARCHITECTURE** An architect is constructing a scale model of a building that is in the shape of a pyramid.
    a. If the height of the scale model is 9 inches less than its length and its base is a square, write a polynomial function that describes the volume of the model in terms of its length.
    b. If the volume of the model is 6300 cubic inches, write an equation describing the situation.
    c. What are the dimensions of the scale model?