

4.4 Practice A

In Exercises 1–6, factor the polynomial completely.

- $x^3 - x^2 - 12x$
- $9p^7 - 36p^5$
- $3n^6 - 33n^5 + 72n^4$
- $2k^4 - 242k^2$
- $2w^4 - 7w^3 - 15w^2$
- $3q^6 - 17q^5 - 28q^4$
- $x^3 + 27$
- $y^3 + 1000$
- $w^3 - 125$

In Exercises 7–9, factor the polynomial completely.

- $3x^6 - 33x^5 + 72x^4$

In Exercises 10–13, factor the polynomial completely.

- $y^3 - 3y^2 + 4y - 12$
- $q^3 - 2q^2 + 9q - 18$
- $2d^3 + 10d^2 + 3d + 15$
- $x^3 - 6x^2 - 9x + 54$

In Exercises 14–16, factor the polynomial completely.

- $36p^4 - 25$
- $n^4 + 11n^2 + 28$
- $y^4 - 16$

In Exercises 17–20, determine whether the binomial is a factor of the polynomial function.

- $f(x) = 3x^3 + 7x^2 - 8x - 5$; $x + 5$
- $f(x) = 2x^3 + 15x^2 - 23x + 36$; $x + 9$
- $f(x) = 6x^5 - 8x^4 - 6x^3 - 4x^2$; $x - 2$
- $f(x) = 12x^3 - 69x^2 + 39x + 30$; $x - 6$

21. Fill in the blank of the divisor so that the remainder is 0. Justify your answer.

$$f(x) = x^3 + 5x^2 - 6x; (x - \text{_____})$$

22. What is the value of k such that $x - 6$ is a factor of

$$f(x) = 3x^3 - 17x - kx + 18? \text{ Justify your answer.}$$

23. Factor each polynomial completely.

- $5a^2c - 3a^2d + 5b^2c - 3b^2d$

$$x^{2n} + 6x^n + 9$$

4.4 Practice B

In Exercises 1–6, factor the polynomial completely.

- $5t^5 - 320t^3$
- $2p^6 - 26p^5 + 84p^4$
- $3x^4 - 432x^2$
- $5a^6 - 16a^5 - 45a^4$
- $12j^9 - 28j^8 + 15j^7$
- $15q^{10} + 38q^9 + 24q^8$
- $2p^9 - 16p^6$
- $25k^8 + 1600k^5$
- $54w^7 - 16w^4$

In Exercises 7–9, factor the polynomial completely.

- $25k^8 + 1600k^5$

In Exercises 10–13, factor the polynomial completely.

- $x^3 - 7x^2 + 5x - 35$
- $m^3 - 2m^2 - 16m + 32$
- $9w^3 - 27w^2 - 4w + 12$
- $25s^3 + 100s^2 - s - 4$

In Exercises 14–16, factor the polynomial completely.

- $81g^4 - 625$
- $2t^8 + 6t^4 - 20t^2$
- $5y^{10} - 25y^6 + 30y^2$

In Exercises 17–20, determine whether the binomial is a factor of the polynomial function.

- $f(x) = 4x^3 - 15x^2 - 30x + 25$; $x - 5$
- $f(x) = 2x^3 + 16x^2 - 4x - 50$; $x + 7$
- $f(x) = 8x^5 + 43x^4 - 58x^3 + 60x^2 - 70$; $x - 4$
- $f(x) = 42x^4 + 143x^3 + 37x^2 - 27x + 45$; $x - 2$

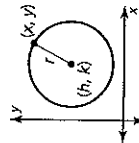
21. Fill in the blank of the divisor so that the remainder is 0. Justify your answer.

$$f(x) = 2x^3 + 7x^2 - 4x; (x + \text{_____})$$

The standard equation of a circle with radius r and center (h, k) is

$$(x - h)^2 + (y - k)^2 = r^2.$$

Rewrite the equation of each circle in standard form. Identify the center and radius of the circle. Then graph the circle.



- $x^2 + 8x + 16 + y^2 = 9$
- $x^2 - 10x + 25 + y^2 = 4$

- $x^2 - 4x + 4 + y^2 + 6y + 9 = 16$

Factoring & Solving

Name _____

Date _____

4.5 Practice A

In Exercises 1–6, solve the equation.

- $g^3 - g^2 - 30g = 0$
- $k^3 + 6k^2 + 9k = 0$
- $3y^4 - 6y^3 = -3y^2$
- $n^3 + 2n^2 - 9n - 18 = 0$
- $3p^3 = 21p$
- $8t^6 = 16t^4$

In Exercises 7–10, find the zeros of the function. Then sketch a graph of the function.

- $f(x) = x^4 + x^3 - 12x^2$
- $g(x) = x^4 - 8x^2 + 16$
- $h(x) = x^5 - 2x^4 - 15x^3$
- $f(x) = -3x^3 - 15x^2 - 12x$

~~X~~ According to the Rational Root Theorem, which is *not* a possible solution of the equation $3x^4 - 6x^3 + 2x + 4 = 0$?

- A. 4 B. $\frac{1}{3}$ C. -3 D. $-\frac{2}{3}$

~~X~~ Describe and correct the error in listing the possible rational zeros of the function.

~~X~~ $f(x) = x^3 + 3x^2 - 8x - 18$
 Possible zeros: $\pm 2, \pm 3, \pm 6, \pm 9$

In Exercises 13 and 14, find all the real solutions of the equation.

- $x^4 - 8x^2 - 9 = 0$
- Write a third or fourth degree polynomial function that has zeros at $\pm \frac{3}{2}$. Justify your answer.
- Determine the value of k for each equation so that the given x -value is a solution.
 - $x^3 + 2x^2 - 9x + k = 0$; $x = 3$
 - $x^3 - 3x^2 + kx - 12 = 0$; $x = -4$

Name _____

Date _____

4.5 Practice B

In Exercises 1–6, solve the equation.

- $4x^4 + 12x^3 + 9x^2 = 0$
- $6t^5 = 12t^3$
- $16q^4 - 8q^2 + 1 = 0$
- $w^4 + 81 = 18w^2$
- $p^3 - 25p = 50 - 2p^2$
- $y^3 - 8y^2 = 9y - 72$

In Exercises 7–10, find the zeros of the function. Then sketch a graph of the function.

- $f(x) = -5x^4 + 20x^3 + 60x^2$
- $g(x) = -x^3 - x^2 + 30x$
- $h(x) = x^2 + x^2 - 4x - 4$
- $f(x) = x^3 - 4x^2 - 9x + 36$

~~X~~ According to the Rational Root Theorem, which is *not* a possible zero of the function $f(x) = 24x^4 - 16x^3 + 21x - 27$?

- A. $-\frac{3}{8}$ B. -2 C. $-\frac{1}{3}$ D. $-\frac{9}{4}$

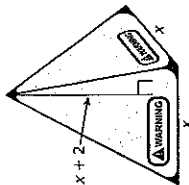
~~X~~ Describe and correct the error in listing the possible rational zeros of the function.

~~X~~ $f(x) = 2x^3 + 5x^2 - 2x - 6$
 Possible zeros: $\pm 1, \pm 2, \pm 3, \pm 6$

In Exercises 13 and 14, find all the real solutions of the equation.

- $2x^3 - 3x^2 + 18x - 27 = 0$
- Write a third or fourth degree polynomial function that has zeros at $\pm \frac{7}{2}$. Justify your answer.

~~X~~ The sidewalk hazard marker is shaped like a pyramid, with a height 2 centimeters greater than the length of each side of its square base. The volume of the marker is 297 cubic centimeters. What are the dimensions of the sidewalk hazard marker?



Answers

9. $x^2 - 4x^2 + 24x - 140 + \frac{820}{x+6}$

10. The powers in the quotient are too large by 1. The remainder (-2) was not divided by $(x+3)$:

$$\begin{array}{r} -3 \mid 1 \quad 2 \quad 0 \quad 7 \\ \underline{-3} \quad 3 \quad -9 \\ 1 \quad -1 \quad 3 \quad -2 \end{array}$$

$$\frac{x^3 + 2x^2 + 7}{x+3} = x^2 - x + 3 - \frac{2}{x+3}$$

11. 7 12. -10 13. 305

14. -95 15. $k = 4$

4.3 Enrichment and Extension

1. $y = -3x - 3$ 2. $y = x + 5$

3. $y = 2x + 1$ 4. $y = x + 6$

5. $y = -2x - 4$ 6. $y = ax + b - ad$

4.3 Puzzle Time

HE WAS ALWAYS WILLING TO LEND AN EAR

4.4 Start Thinking

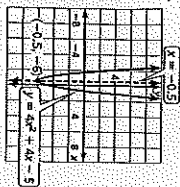
Yes, You can group the terms with coefficients of 3 and 21 together, or you can group the terms with coefficients of -5 and 40 together; yes, You can group $3x$ and $21xy$ together, and you can group -5 and $40y$ together.

4.4 Warm Up

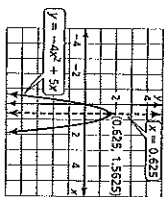
1. $3y$ 2. $2x$ 3. $3x$

4. yz 5. ab 6. xy

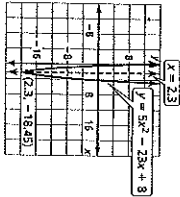
4.4 Cumulative Review Warm Up



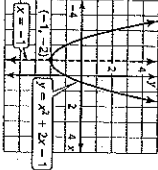
2.



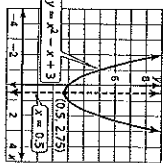
3.



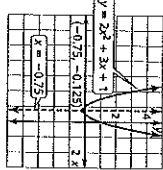
4.



5.



6.



4.4 Practice A

1. $x(x-4)(x+3)$ 2. $9p^3(p+2)(p-2)$

3. $3n^2(n-8)(n-3)$ 4. $2k^2(k+11)(k-11)$

5. $w^2(2w+3)(w-5)$ 6. $q^4(3q+4)(q-7)$

Answers

7. $(x+3)(x^2-3x+9)$

8. $(y+10)(y^2-10y+100)$

9. $(w-5)(w^2+5w+25)$

10. $(y-3)(y^2+4)$ 11. $(q-2)(q^2+9)$

12. $(d+5)(2d^2+3)$ 13. $(x-6)(x-3)(x+3)$

14. $(6p^2-5)(6p^2+5)$ 15. $(r^2+4)(r^2+7)$

16. $(y^2+4)(y+2)(y-2)$

17. no 18. yes 19. yes 20. no

21. Sample answer: $f(x) = x^3 + 5x^2 - 6x; (x-1); x(x-1)(x+6) = x^3 + 5x^2 - 6x$

22. $k = -9; f(x) = 3x^2 - 17x - 9x + 18;$

$3x^2 - 17x - 9x + 18 = (x-6)(3x^2+x-3)$

23. a. $(a^2 + b^2)(5c - 3d)$

b. $(x^2 + 3)^2$

4.4 Practice B

1. $5t^4(t+8)(t-8)$ 2. $2p^4(p-7)(p-6)$

3. $3x^2(x+12)(x-12)$ 4. $d^4(5d+9)(d-5)$

5. $j^7(2j-3)(6j-5)$ 6. $q^8(3q+4)(5q+6)$

7. $2p^6(p-2)(p^2+2p+4)$

8. $25k^2(k+4)(k^2-4k+16)$

9. $2w^4(3w-2)(9w^2+6w+4)$

10. $(x-7)(x^2+5)$

11. $(m-2)(m+4)(m-4)$

12. $(w-3)(3w+2)(3w-2)$

13. $(s+4)(5s+1)(5s-1)$

14. $(9g^2+25)(3g+5)(3g-5)$

15. $2x^2(x^2+5)(x^2-2)$ 16. $5x^2(x^4-3)(x^4-2)$

17. yes 18. no

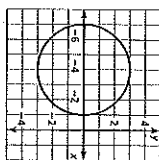
19. no 20. no

21. Sample answer: $f(x) = 2x^3 + 7x^2 - 4x;$

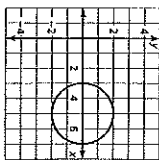
$(x+4); x(x+4)(2x-1) = 2x^3 + 7x^2 - 4x$

22. a. $(x-(-4))^2 + y^2 = 3^2; (h,k) = (-4,0);$

$r = 3$

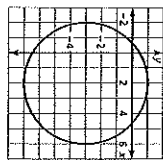


b. $(x-5)^2 + y^2 = 2^2; (h,k) = (5,0); r = 2$



c. $(x-2)^2 + (y-(-3))^2 = 4^2;$

$(h,k) = (2,-3); r = 4$



4.4 Enrichment and Extension

1. 27 2. -18 3. 3

4. -4 5. -1 6. 6

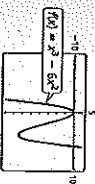
7. $(x^2 - y^2) = (x-y)(x^2 + x^2y + x^2y^2 + xy^2 + y^4)$

Answers

8. $(a^2 + b^2) = (a + b)(a^6 - a^3b + a^2b^2 - ab^3 + a^2b^4 - ab^5 + b^6)$
9. $(a^4 - b^4) = (a^2 + b^2)(a^2 - b^2) = (a + b)(a - b)(a^2 - a^2b + a^2b^2 - a^2b^3 + a^2b^4 - ab^5 + b^6)(a^2 + a^2b + a^2b^2 + a^2b^3 + a^2b^4 + ab^5 + b^6)$
10. $(y^0 - y^0) = (x^2 + y^2)(x^2 - y^2) = (x + y)(x - y)(x^2 - x^2y + x^2y^2 - xy^2 + y^4)$

4.4 Puzzle Time QUARTERBACK

4.5 Start Thinking



(0, 0) and (6, 0): The function simplifies to $0 = 0$. These points have x -values which yield a y -value of zero, meaning the graph crosses the x -axis. These are the only points that can be inserted into the function $f(x) = x^2 - 6x^2$ to get this result.

4.5 Warm Up

- $r = \frac{1}{4}$
- $x = -5$
- $r = -60$
- $z = 20$
- $m = -2$
- $b = 20$

4.5 Cumulative Review Warm Up

- $x < -\sqrt{5}$ or $x > \sqrt{5}$
- $-9 \leq x \leq -3$
- $x < -5$ or $x > -1$
- $-\sqrt{5} < x < \sqrt{5}$
- $x < -3$ or $x > 1$
- $1 < x < 8$

4.5 Practice A

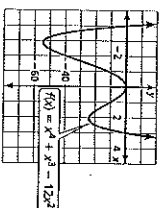
- $q = -5, q = 0, q = 6$

- $k = -3, k = 0$
- $y = 0, y = 1$

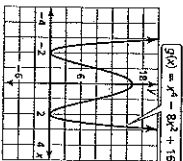
4. $n = -3, n = -2, n = 3$

5. $p = 0, p = \pm\sqrt{7}$

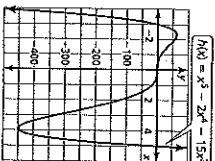
6. $u = 0, u = \pm\sqrt{2}$



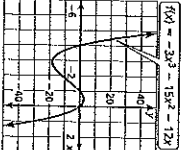
7. $x = -4, x = 0, x = 3$



8. $x = -2, x = 2$



9. $x = -3, x = 0, x = 5$



11. C

Answers

12. The factors of 18 include ± 1 and ± 18 .

$$f(x) = x^3 + 3x^2 - 8x - 18$$

Possible zeros: $\pm 1, \pm 2, \pm 3, \pm 6, \pm 9, \pm 18$

13. $x = 3, x = -3$

14. $x = -1, x = 2, x = -3$

15. Sample answer: $f(x) = 4x^3 + 4x^2 - 9x - 9$

$$f\left(\frac{3}{2}\right) = 0, f\left(-\frac{3}{2}\right) = 0$$

16. a. $k = -18$ b. $k = -31$

4.5 Practice B

1. $x = -\frac{3}{2}, x = 0$

2. $h = 0, h = \pm\sqrt{2}$

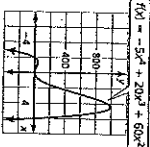
3. $q = \pm\frac{1}{2}$

4. $w = \pm 3$

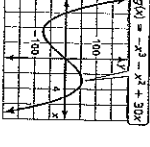
5. $p = -2, p = \pm 5$

6. $y = \pm 3, y = 8$

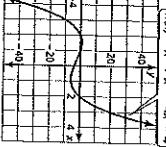
7. $x = -2, x = 0, x = 6$



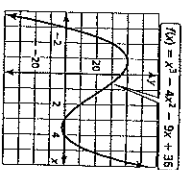
8. $x = -6, x = 0, x = 5$



9. $x = -2, x = -1, x = 2$



10. $x = -3, x = 3, x = 4$



11. B

12. The factors of 2 include ± 2 .

$$f(x) = 2x^3 + 5x^2 - 2x - 6$$

Possible zeros: $\pm 1, \pm 2, \pm 3, \pm 6, \pm \frac{1}{2}, \pm \frac{3}{2}$

13. $x = \frac{3}{2}$

14. $x = -2, x = 3, x = 4$

15. Sample answer:

$$f(x) = 25x^2 - 50x^2 - 49x + 98$$

$$f\left(\frac{7}{5}\right) = 0, f\left(-\frac{7}{5}\right) = 0$$

16. height is 11 cm, side length is 9 cm

4.5 Enrichment and Extension

1. $P(x) = -7x^2 - 7x + 14$

2. $P(x) = x^3 - 3x + 2$

3. $P(x) = a(x^4 - x^3 - 6x^2)$, a can be any real number

4. $P(x) = 3x^4 + 12x^3 - 3x^2 + 48x - 60$

5. $P(x) = -3x^3 - 3x^2 + 21x + 45$

4.5 Puzzle Time

IT WAS A BREEZE WITH ONLY A FEW FOGGY PATCHES