ⓒ **Problem 4** **Factoring a Polynomial Model**

Helipads A helicopter landing pad, or helipad, is sometimes marked with a circle inside a square so that it is visible from the air. What is the area of the shaded region of the helipad at the right? Write your answer in factored form.

Plan

How can you find the shaded region's area?
The shaded region is the entire square except for the circular portion. So, subtract the area of the circle from the area of the square.

Step 1 Find the area of the shaded region.

$$A_1 = s^2 \qquad \text{Area of a square}$$
$$= (2x)^2 \qquad \text{Substitute } 2x \text{ for } s.$$
$$= 4x^2 \qquad \text{Simplify.}$$
$$A_2 = \pi r^2 \qquad \text{Area of a circle}$$
$$= \pi x^2 \qquad \text{Substitute } x \text{ for } r.$$

The area of the shaded region is $A_1 - A_2$, or $4x^2 - \pi x^2$.

Step 2 Factor the expression.

First find the GCF.

$$4x^2 = 2 \cdot 2 \cdot x \cdot x$$

$$\pi x^2 = \pi \cdot x \cdot x$$

The GCF is $x \cdot x$, or x^2.

Step 3 Factor out the GCF.

$$4x^2 - \pi x^2 = x^2(4) + x^2(-\pi)$$
$$= x^2(4 - \pi)$$

The factored form of the area of the shaded region is $x^2(4 - \pi)$.

✓ **Got It?** **4.** In Problem 4, suppose the side length of the square is $6x$ and the radius of the circle is $3x$. What is the factored form of the area of the shaded region?

✓ **Lesson Check**

Do you know HOW?

1. What is a simpler form of $6x(2x^3 + 7x)$?

2. What is the GCF of the terms in $4a^4 + 6a^2$?

Factor each polynomial.

3. $6m^2 - 15m$

4. $4x^3 + 8x^2 + 12x$

Do you UNDERSTAND? ⓒ **MATHEMATICAL PRACTICES**

Match each pair of monomials with its GCF.

5. $14n^2, 35n^4$ **A.** 1

6. $21n^3, 18n^2$ **B.** $7n^2$

7. $7n^2, 9$ **C.** $3n^2$

ⓒ **8. Reasoning** Write a binomial with $9x^2$ as the GCF of its terms.

A Practice Simplify each product. ◀ See Problem 1.

9. $7x(x + 4)$

10. $(b + 11)2b$

11. $3m^2(10 + m)$

12. $-w^2(w - 15)$

13. $4x(2x^3 - 7x^2 + x)$

14. $-8y^3(7y^2 - 4y - 1)$

Find the GCF of the terms of each polynomial. ◀ See Problem 2.

15. $12x + 20$

16. $8w^2 - 18w$

17. $45b + 27$

18. $a^3 + 6a^2 - 11a$

19. $4x^3 + 12x - 28$

20. $14z^4 - 42z^3 + 21z^2$

Factor each polynomial. ◀ See Problem 3.

21. $9x - 6$

22. $t^2 + 8t$

23. $14n^3 - 35n^2 + 28$

24. $5k^3 + 20k^2 - 15$

25. $14x^3 - 2x^2 + 8x$

26. $g^4 + 24g^3 + 12g^2 + 4g$

27. Art A circular mirror is surrounded by a square metal frame. The radius of the ◀ See Problem 4.
mirror is $5x$. The side length of the metal frame is $15x$. What is the area of the metal
frame? Write your answer in factored form.

28. Design A circular table is painted yellow with a red square in the middle. The
radius of the tabletop is $6x$. The side length of the red square is $3x$. What is the
area of the yellow part of the tabletop? Write your answer in factored form.
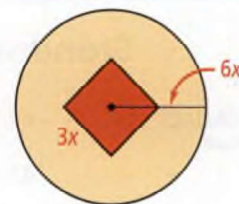
B Apply Simplify. Write in standard form.

29. $-2x(5x^2 - 4x + 13)$

30. $-5y^2(-3y^3 + 8y)$

31. $10a(-6a^2 + 2a - 7)$

32. $p(p + 2) - 3p(p - 5)$

33. $t^2(t + 1) - t(2t^2 - 1)$

34. $3c(4c^2 - 5) - c(9c)$

© 35. Think About a Plan A rectangular wooden frame has side lengths $5x$ and $7x + 1$.
The rectangular opening for a picture has side lengths $3x$ and $5x$. What is the area of
the wooden part of the frame? Write your answer in factored form.
- How can drawing a diagram help you solve the problem?
- How can you express the area of the wooden part of the frame as a difference
  of areas?

© 36. Error Analysis Describe and correct the error made
in multiplying.

$$-3x(2x - 5) = -3x(2x) - 3x(5)$$
$$= -6x^2 - 15x$$

Factor each polynomial.

37. $17xy^4 + 51x^2y^3$

38. $9m^4n^5 - 27m^2n^3$

39. $31a^6b^3 + 63a^5$

© 40. a. Factor $n^2 + n$.
  b. Writing Suppose n is an integer. Is $n^2 + n$ *always*, *sometimes*, or *never* an even
  integer? Justify your answer.