Name ______________________ Date ______________ Class ______________

LESSON 13-1

Reteach

Complex Numbers and Roots

An **imaginary number** is the square root of a negative number.
Use the definition $\sqrt{-1} = i$ to simplify square roots.

Simplify.

$\sqrt{-25}$

$\sqrt{(25)(-1)}$ *Factor out –1.*

$\sqrt{(25)}\,\sqrt{-1}$ *Separate roots.*

$5\sqrt{-1}$ *Simplify.*

$5i$ *Express in terms of i.*

$-\sqrt{-48}$

$-\sqrt{(48)(-1)}$ *Factor out –1.*

$-\sqrt{(48)}\,\sqrt{-1}$ *Separate roots.*

$-\sqrt{16}\,\sqrt{3}\,\sqrt{-1}$ *Factor the perfect square.*

$-4\sqrt{3}\,\sqrt{-1}$ *Simplify.*

$-4i\sqrt{3}$ *Express in terms of i.*

Real Imaginary

Complex numbers are numbers that can be written in the form $a + bi$.

The **complex conjugate** of $a + bi$ is $a - bi$.

The complex conjugate of $5i$ is $-5i$.

Write as $a + bi$
Find $0 - 5i = -5i$

Express each number in terms of *i*.

1. $\sqrt{-72}$
   $\sqrt{(36)(2)(-1)}$
   ____

2. $4\sqrt{-45}$
   $4\sqrt{(9)(5)(-1)}$
   ____

3. $\sqrt{-100}$
   ____

4. $5\sqrt{-54}$
   ____

5. $2\sqrt{-64}$
   ____

6. $-\sqrt{-98}$
   ____

Find each complex conjugate.

7. $-9i$
   ____

8. $1 + 4i$
   ____

9. $12 - i$
   ____

© Houghton Mifflin Harcourt Publishing Company

Name ______________________________ Date ______________ Class______________

LESSON 13-1

Reteach

Complex Numbers and Roots (continued)

You can use the square root property and $\sqrt{-1} = i$ to solve quadratic equations with imaginary solutions.

Solve $x^2 = -64$.

$\sqrt{x^2} = \pm\sqrt{-64}$ *Take the square root of both sides.*

$x = \pm 8i$ *Express in terms of i.*

Check each root: $(8i)^2 = 64i^2 = 64(-1) = -64$

$(-8i)^2 = 64i^2 = 64(-1) = -64$

Remember: $\left(\sqrt{-1}\right)^2 = i^2 = -1$

Solve $5x^2 + 80 = 0$.

$5x^2 = -80$ *Subtract 80 from both sides.*

$x^2 = -16$ *Divide both sides by 5.*

$\sqrt{x^2} = \pm\sqrt{-16}$ *Take the square root of both sides.*

$x = \pm 4i$ *Express in terms of i.*

Check each root:

$5(4i)^2 + 80$	$5(-4i)^2 + 80$
$5(16)i^2 + 80$	$5(16)i^2 + 80$
$80(-1) + 80$	$80(-1) + 80$
0	0

Solve each equation.

10. $x^2 + 18 = 0$

$x^2 = -18$

$x = \pm\sqrt{(9)(2)(-1)}$

____

11. $6x^2 + 24 = 0$

$6x^2 = -24$

____

____

12. $x^2 + 49 = 0$

____

____

____

13. $x^2 + 100 = 0$

____

____

____

14. $3x^2 + 108 = 0$

____

____

____

15. $x^2 + 12 = 0$

____

____

____

© Houghton Mifflin Harcourt Publishing Company

13. a. The beginning and end of the flight when the speed of the rocket is 0

b. $t = -3 \pm 5i$

c. No; possible answer: the zeros are imaginary because the graph never crosses the *x*-axis so the function never equals 0. The speed of the rocket must be 0 before takeoff and after landing.

Reteach

1. $6i\sqrt{2}$
2. $12i\sqrt{2}$
3. $10i$
4. $15i\sqrt{6}$
5. $16i$
6. $-7i\sqrt{2}$
7. $9i$
8. $1 - 4i$
9. $12 + i$
10. $x = \pm 3i\sqrt{2}$
11. $x = \pm\sqrt{-4}$

    $x = \pm 2i$
12. $x^2 = -49$

    $x = \pm\sqrt{-49}$

    $x = \pm 7i$
13. $x^2 = -100$

    $x = \pm\sqrt{-100}$

    $x = \pm 10i$
14. $x^2 = -36$

    $x = \pm\sqrt{-36}$

    $x = \pm 6i$
15. $x^2 = -12$

    $x = \pm\sqrt{(4)(3)(-1)}$

    $x = \pm 2i\sqrt{3}$

Challenge

1. $2i, -7i$
2. $-6i, -8i$
3. $9i, -12i$
4. $5i, 49i$
5. $-16i, -36i$
6. $-\frac{4}{3}i, -i$
7. $\frac{1}{5}i, 2i$
8. $-3i, -5i$
9. $-\frac{13}{4}i, 5i$
10. $\frac{5}{6}i, \frac{3}{2}i$

Problem Solving

1. a. $t = 1 \pm \frac{i}{2}$

   b. No; possible answer: the roots are imaginary numbers.

2. a.

b	Function	Roots
24	$d(t) = 16t^2 - 24t + 20$	$\frac{1}{4}\left(3 \pm i\sqrt{11}\right)$
32	$d(t) = 16t^2 - \_\_t + 20$	$1 \pm \frac{i}{2}$
40	$d(t) = 16t^2 - \_\_t + 20$	$\frac{1}{4}\left(5 \pm \sqrt{5}\right)$
48	$d(t) = 16t^2 - \_\_t + 20$	$\frac{3}{2} \pm \sqrt{1}$

   b. $b = 40$ and 48

   c. Possible answer: Real roots mean that ringing the bell is possible.

3. About 36 feet per second
4. C
5. D

Reading Strategies

1. $i\sqrt{9}$; $3i$; $\sqrt{-8}$
2. $3i$ or $-3i$
3. a. $x^2 = -1$, so $x = \pm\sqrt{-1}$, $x = i$ and $-i$

   b. Because the square of a real number cannot be a negative number
4. $\left(\sqrt{5}i\right)^2 = \left(\sqrt{5}\right)^2 (i)^2 = 5(-1) = -5; \left(-\sqrt{5}i\right)^2$

   $= \left(-\sqrt{5}\right)^2 (i)^2 = 5(-1) = -5$
5. Real number; $(3i)(5i) = 15i^2 = 15(-1)$
   $= -15$

© Houghton Mifflin Harcourt Publishing Company