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Lesson 5-6

Complex Numbers

Lesson Objectives	**NAEP 2005 Strand:** Algebra
1 Identifying and graphing complex numbers	**Topic:** Algebraic Representations
2 Adding, subtracting, and multiplying complex numbers	**Local Standards:** ____________________

Vocabulary and Key Concepts

Square Root of a Negative Real Number

For any positive real number a, $\sqrt{-a} = i\sqrt{a}$.

Example $\sqrt{-4} = i\sqrt{4} = i \cdot 2 = 2i$

Note that $(\sqrt{-4})^2 = (i\sqrt{4})^2 = i^2(\sqrt{4})^2 = -1 \cdot 4 = -4$ (not 4).

Complex Numbers

A complex number can be written in the form $a + bi$, where a and b are real numbers, including 0.

a (Real part) + bi (Imaginary part)

Complex Numbers

- **Real Numbers:** $-5,\ -\sqrt{3},\ 0,\ \sqrt{5},\ \frac{8}{3},\ 9$
  - ________ **Numbers:** $-5,\ 0,\ \frac{8}{3},\ 9$
    - **Integers:** $-5,\ 0,\ 9$
      - **Whole Numbers:** $0,\ 9$
        - **Natural Numbers:** 9
  - **Irrational Numbers:** $-\sqrt{3}$, $\sqrt{5}$
- ________ **Numbers:** $-4i$, $3 + 2i$, $2i\sqrt{2}$

The symbol i represents ____

____

An imaginary number is ____

____

The set of complex numbers is made up of ________________________________

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A complex number plane can be used to ______________________________

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The absolute value of a complex number is ______________________________

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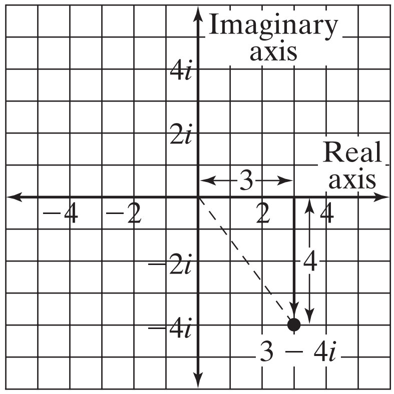

Examples

1 Simplifying Numbers Using *i* Simplify $\sqrt{-54}$ by using the imaginary number i.

$\sqrt{-54} = \sqrt{\square \cdot 54}$

$= \sqrt{\square} \cdot \sqrt{54}$

$= \square \cdot \sqrt{54}$

$= \square \cdot \square\sqrt{\square}$

$= \square$

2 Simplifying Imaginary Numbers Write the complex number $\sqrt{-121} - 7$ in the form $a + bi$.

$\sqrt{-121} - 7 = \square - 7$ **Simplify the radical expression.**

$= \square + \square$ **Write in the form *a* + *bi*.**

Quick Check

1. Simplify each number by using the imaginary number i.

a. $\sqrt{-2}$ **b.** $\sqrt{-12}$ **c.** $\sqrt{-36}$

2. Write the complex number $\sqrt{-18} + 7$ in the form $a + bi$.

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Examples

❸ Finding Absolute Value Find each absolute value.

a. $|-7i|$

$-7i$ is ☐ units from the origin on the imaginary axis.

So $|-7i| =$ ☐

b. $|10 + 24i|$

$|10 + 24i| = \sqrt{10^2 + 24^2}$ **Use the Pythagorean Theorem to find distance.**

$= \sqrt{\square + \square} = \square$ **Simplify.**

❹ Adding Complex Numbers Simplify the expression $(3 + 6i) - (4 - 8i)$.

$(3 + 6i) - (4 - 8i) = 3 + (-4) + \square + \square$ **Use commutative and associative properties.**

$= \square + \square$ **Simplify.**

❺ Multiplying Complex Numbers

a. Find $(3i)(8i)$.

$(3i)(8i) = \square i^2$ **Multiply the real numbers.**

$= \square(\square) = \square$ **Substitute -1 for i^2 and multiply.**

b. Find $(3 - 7i)(2 - 4i)$.

$(3 - 7i)(2 - 4i) = 6 - \square - \square + 28i^2$ **Multiply the binomials.**

$= 6 - \square + 28(\square)$ **Substitute -1 for i^2.**

$= \square - \square$ **Simplify.**

Quick Check

3. Find the absolute value of each complex number.

a. $|6 - 4i|$ **b.** $|-2 + 5i|$ **c.** $|4i|$

4. Simplify each expression.

a. $(8 + 3i) - (2 + 4i)$ **b.** $7 - (3 + 2i)$ **c.** $(4 - 6i) + 3i$

5. Simplify each expression.

a. $(12i)(7i)$ **b.** $(6 - 5i)(4 - 3i)$ **c.** $(4 - 9i)(4 + 3i)$

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Examples

❻ Finding Complex Solutions
Solve $9x^2 + 54 = 0$.

$9x^2 + 54 = 0$

$9x^2 = \square$ **Isolate x^2.**

$x^2 = \square$

$x = \pm \square$ **Find the square root of each side.**

❼ Output Values
Find the first three output values for $f(z) = z^2 - 4i$. Use $z = 0$ as the first input value.

$f(0) = \square^2 - 4i$

$= \square$

$f(-4i) = (-4i)^2 - 4i$ **First output becomes second input. Evaluate for $z = -4i$.**

$= \square - 4i$

$f(\square - \square) = (\square - \square)^2 - 4i$ **Second output becomes third input. Evaluate for $z = \square - \square$.**

$= [(\square)^2 + (-16)(-4i) + (-16)(-4i) + (\square)^2] - 4i$

$= (\square + \square - \square) - 4i$

$= \square + \square$

The first three output values are $\square$, $\square$, and $\square$.

Quick Check

6. Solve for x.
   a. $3x^2 + 48 = 0$
   b. $-5x^2 - 150 = 0$
   c. $8x^2 + 2 = 0$

7. Find the first three output values for $f(z) = z^2 - 1 + i$. Use $z = 0$ as the first input value.