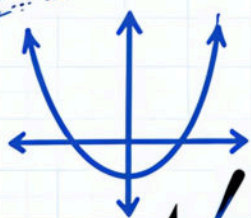


GRADES

10-11

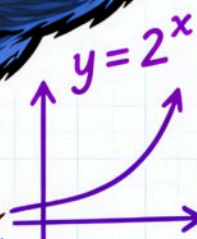


$$y = x^2 - 4$$

$$i^2 = -1$$

$$\log_2 8 = 3$$

BUILD  
CONFIDENCE.  
ONE REP  
AT A TIME.



# Muscle Math Mania

## ★ ALGEBRA 2 ★

STRONGER SKILLS. **EVERY SINGLE REP.**



MASTER  
ALGEBRA 2  
CONCEPTS



THINK  
CRITICALLY



BUILD  
CONFIDENCE



READY FOR  
PRE-CALCULUS



SOLVE  
STEP BY STEP

SKILLS YOU NEED.  
**REPS YOU  
CONTROL.**

# How to Use This Book

Every lesson has the same five parts, in the same order, on one page: a WARM-UP REP to wake up the skill, COACH NOTES that teach it, a CHECK YOUR FORM box with the mistake people actually make, a WORKED EXAMPLE done in full, and TRY IT for you.

After each lesson comes its worksheet. Every worksheet problem is different from every other one in the book — nothing is padded and nothing repeats.

Most of Algebra 2 is symbolic, but when a graph or diagram is there it is part of the problem, not decoration. The values shown on it are given to you; anything marked with a question mark is what you are being asked to find.

Every answer is in the back, grouped by unit. Check yourself after each block rather than at the end — a mistake caught early is one page of practice, and a mistake caught late is the whole unit.

## WHAT THIS BOOK ASSUMES YOU ALREADY HAVE

Comfort with Algebra 1: solving linear equations, factoring quadratics, the laws of exponents, and graphing lines. All of it is taught in earlier Muscle Math Mania books. This book uses those skills constantly and does not re-teach them.

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## UNIT 1

# Complex Numbers

*The Numbers That Let Every Equation Have an Answer*

For every quadratic you solved in Algebra 1, there was a quiet condition attached: the discriminant had to be zero or positive, or you wrote 'no real solution' and moved on. This unit removes the condition. Once you accept a single new number —  $i$ , whose square is  $-1$  — every polynomial equation has solutions, and the ones you used to throw away turn out to be the interesting half.

Complex numbers are not a trick or a loophole. They obey the same algebra you already know: you add like terms, you distribute, you factor. The only new rule is  $i^2 = -1$ , and almost every problem in this unit is that one rule applied carefully.

### BY THE END OF THIS UNIT YOU CAN

- Simplify the square root of a negative number using  $i$
- Add, subtract, and multiply complex numbers
- Simplify powers of  $i$
- Find the complex conjugate and use it to divide complex numbers
- Plot a complex number on the complex plane
- Use the discriminant to decide whether solutions are real or complex

## 1.1 The Imaginary Unit and Roots of Negatives

### WARM-UP REP

1. Simplify  $\sqrt{-64}$ .

2. Simplify  $\sqrt{-30}$ .

3. Simplify  $\sqrt{-28}$ .

### COACH NOTES

The imaginary unit  $i$  is DEFINED by  $i^2 = -1$ , which means  $i = \sqrt{-1}$ . That one definition is what lets you take the square root of any negative number: pull the  $-1$  out as  $i$  and simplify the positive part the way you always have.

So  $\sqrt{-49} = \sqrt{49} \cdot \sqrt{-1} = 7i$ , and  $\sqrt{-18} = \sqrt{9} \cdot \sqrt{2} \cdot \sqrt{-1} = 3i \cdot \sqrt{2}$ . Simplify the radical exactly as before; the  $i$  just comes along for the ride. A number like  $a + bi$ , with  $a$  and  $b$  real, is called a COMPLEX number, and it lives as a point on the complex plane — real part across, imaginary part up.

### CHECK YOUR FORM

Take the  $i$  out FIRST, then simplify the leftover radical. If you try to simplify  $\sqrt{-18}$  as though it were positive you will lose the  $i$  and answer a different question.

### WORKED EXAMPLE

**Simplify  $\sqrt{-166}$ .**

Step 1: The square root of a negative number carries a factor of  $i$ :  $\sqrt{-n} = i \cdot \sqrt{n}$ .

Step 2: 166 has no perfect-square factor, so  $\sqrt{166}$  stays as  $\sqrt{166}$ .

Step 3:  $\sqrt{-166} = i\sqrt{166}$ .

**Answer:  $i\sqrt{166}$**

### TRY IT

1. Simplify  $\sqrt{-114}$ .

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2. Simplify  $\sqrt{-178}$ .

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**Worksheet 1.1: The Imaginary Unit and Roots of Negatives**

Part 1 of 2

**1.** Simplify  $\sqrt{-111}$ .

SET A

---

---

---

**2.** Simplify  $\sqrt{-158}$ .

SET A

---

---

---

**3.** Simplify  $\sqrt{-125}$ .

SET A

---

---

---

**4.** Simplify  $\sqrt{-192}$ .

SET A

---

---

---

**5.** Simplify  $\sqrt{-103}$ .

SET B

---

---

---

**6.** Simplify  $\sqrt{-161}$ .

SET B

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## Worksheet 1.1: The Imaginary Unit and Roots of Negatives

Part 2 of 2

**7.** Simplify  $\sqrt{-113}$ .

SET B

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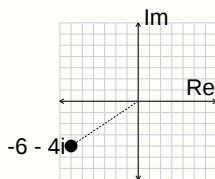
**8.** Simplify  $\sqrt{-52}$ .

SET B

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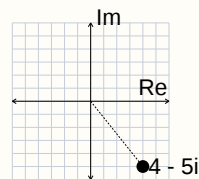
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**9.** In which quadrant of the complex plane does the number  
SET C  $-6 - 4i$  lie?

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**10.** In which quadrant of the complex plane does the number  
SET C  $4 - 5i$  lie?

---

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---

## 1.3 Multiplying Complex Numbers

### WARM-UP REP

1. Multiply:  $(-6 + i)(-7 + 8i)$ .

2. Multiply:  $(-6 - 5i)(7 - i)$ .

3. Multiply:  $(-6 - 3i)(4 + 9i)$ .

### COACH NOTES

Multiply complex numbers the way you multiply any two binomials — distribute every term across every term (FOIL). The only new step comes at the end: wherever an  $i^2$  appears, replace it with  $-1$ , which turns an imaginary term back into a real one.

That final substitution is where the real part of the answer usually comes from.  $(2 + 3i)(4 + i)$  has a  $-3$  hiding in it, because  $3i \cdot i = 3i^2 = -3$ . Miss the substitution and every product will be wrong in the real part.

### CHECK YOUR FORM

$i^2$  is  $-1$ , not  $1$  and not  $i$ . The single most common multiplication error in this unit is leaving an  $i^2$  in the answer or turning it into  $+1$ .

### WORKED EXAMPLE

**Multiply:  $(7 + 3i)(1 - 6i)$ .**

Step 1: Multiply as two binomials (FOIL), then replace  $i^2$  with  $-1$ .

Step 2: Real part:  $(7)(1) - (3)(-6) = 25$ .

Step 3: Imaginary part:  $(7)(-6) + (3)(1) = -39$ .

Step 4: Answer:  $25 - 39i$ .

**Answer:  $25 - 39i$**

### TRY IT

1. Multiply:  $(-3 - i)(-4i)$ .

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2. Multiply:  $(3 + 4i)(5 - 2i)$ .

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# Worksheet 1.3: Multiplying Complex Numbers

Part 1 of 2

**1.** Multiply:  $(-3 - 4i)(-7 + 6i)$ .

SET A

---

---

---

**2.** Multiply:  $(4 - 7i)(-1 + 4i)$ .

SET A

---

---

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**3.** Multiply:  $(9 - 7i)(6 - i)$ .

SET A

---

---

---

**4.** Multiply:  $(-4i)(1 - 7i)$ .

SET B

---

---

---

**5.** Multiply:  $(-3i)(5 - 8i)$ .

SET B

---

---

---

**6.** Multiply:  $(-2i)(-3i)$ .

SET B

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---

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## Worksheet 1.3: Multiplying Complex Numbers

Part 2 of 2

**7.** Expand and simplify:  $(-9 - 8i)^2$ .

SET C

---

---

---

**8.** Expand and simplify:  $(4 - i)^2$ .

SET C

---

---

---

# Answer Key — Unit 1: Complex Numbers

## Lesson 1.1 — Warm-Up

1.  $8i$
2.  $i\sqrt{30}$
3.  $2i\sqrt{7}$

## Lesson 1.1 — Try It

1.  $i\sqrt{114}$
2.  $i\sqrt{178}$

## Worksheet 1.1

1.  $i\sqrt{111}$
2.  $i\sqrt{158}$
3.  $5i\sqrt{5}$
4.  $8i\sqrt{3}$
5.  $i\sqrt{103}$
6.  $i\sqrt{161}$
7.  $i\sqrt{113}$
8.  $2i\sqrt{13}$
9. Quadrant III
10. Quadrant IV

## Lesson 1.2 — Warm-Up

1.  $2 - 5i$
2.  $2 + 2i$
3.  $2 - 2i$

## Lesson 1.2 — Try It

1.  $-3 - i$
2.  $2 + 4i$

## Worksheet 1.2

1.  $-11i$
2.  $15 + 15i$
3.  $2 + 6i$
4.  $-15 - 5i$
5.  $10 + 6i$
6.  $5 + 3i$
7.  $-8 + 15i$
8.  $-11 + i$

## Lesson 1.3 — Warm-Up

1.  $34 - 55i$
2.  $-47 - 29i$

3.  $3 - 66i$

## Lesson 1.3 — Try It

1.  $-4 + 12i$
2.  $23 + 14i$

## Worksheet 1.3

1.  $45 + 10i$
2.  $24 + 23i$
3.  $47 - 51i$
4.  $-28 - 4i$
5.  $-24 - 15i$
6.  $-6$
7.  $17 + 144i$
8.  $15 - 8i$

## Lesson 1.4 — Warm-Up

1.  $-i$
2.  $-i$
3.  $-1$

## Lesson 1.4 — Try It

1.  $-1$
2.  $-1$

## Worksheet 1.4

1.  $-1$
2.  $-1$
3.  $-i$
4.  $-i$
5.  $i$
6.  $i$
7.  $i$
8.  $-i$

## Lesson 1.5 — Warm-Up

1.  $1 + 9i$
2.  $-6 + 5i$
3.  $-9 + 4i$

## Lesson 1.5 — Try It

1.  $-7 - 2i$
2.  $2 - 3i$

## Worksheet 1.5

1.  $6 - 5i$
2.  $-6 + 3i$
3.  $5 + i$
4.  $1 + 8i$
5.  $-3 + 9i$
6.  $9 - 9i$
7.  $-2 + 2i$
8.  $-6i$

## Lesson 1.6 — Warm-Up

1. Two real, rational solutions
2. Two real, irrational solutions
3. One real, repeated solution

## Lesson 1.6 — Try It

1. Two real, rational solutions
2. Two real, irrational solutions

## Worksheet 1.6

1. Two real, irrational solutions
2. Two real, irrational solutions
3. Two real, irrational solutions
4. Two real, irrational solutions
5.  $x = \pm i\sqrt{38}$

$$6. x = \pm i\sqrt{6}$$

$$7. x = \pm 3i\sqrt{10}$$

$$8. x = \pm 5i$$

## Unit 1 Review

1.  $2i\sqrt{13}$
2. Quadrant IV
3.  $17 - i$
4.  $4 - 12i$
5.  $-44 - 27i$
6.  $-36 + 36i$
7.  $11 + 60i$
8.  $-i$
9.  $-5 - 9i$
10.  $-6 + 7i$
11. Two real, irrational solutions
12.  $x = \pm 8i$



THAT WAS THE WARM-UP.

# Ready for the full workout?

The Algebra 2 Workbook · Grades 10-11

## WHAT'S IN THE FULL BOOK

- 85 lessons across 15 units
- Complex numbers, polynomials, logarithms, series, conics, matrices
- Every lesson names the mistake people actually make
- Full answer key, grouped by unit

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