

Adding and Subtracting Complex Numbers

Name: _____

Date: _____

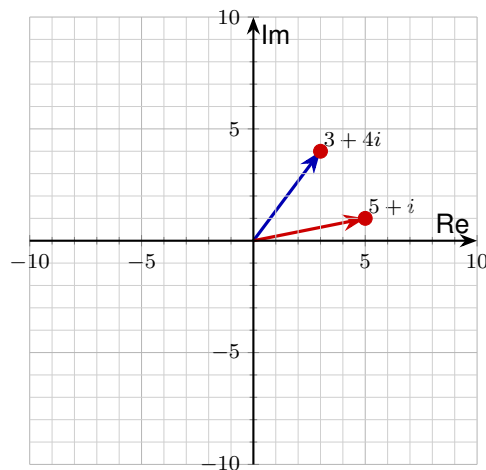
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Q Quick Review

A **complex number** looks like $a + bi$, where a is the *real part*, b is the *imaginary part*, and i is the imaginary unit with the defining property $i^2 = -1$. The trick to adding and subtracting complex numbers is to treat the real parts and imaginary parts as two separate families that never mix — much like combining x -terms with x -terms and constants with constants in a polynomial.

Addition: $(a + bi) + (c + di) = (a + c) + (b + d)i$. Add real to real, imaginary to imaginary. **Subtraction:** $(a + bi) - (c + di) = (a - c) + (b - d)i$. The most common trap is forgetting that the minus sign distributes to *both* parts of the second number — the imaginary part flips sign too. So $(7 + 3i) - (2 + 5i) = 5 - 2i$, not $5 + 8i$.

On the **Argand plane** (real axis horizontal, imaginary axis vertical), each complex number is a point, and addition acts like vector addition: stack the arrows tip-to-tail. The figure below shows $(3 + 4i) + (2 - 3i) = 5 + i$ as two displacement vectors that land at the sum.



The blue arrow shows $3 + 4i$. Stacking the second arrow $(2 - 3i)$ on its tip lands at $5 + i$ (the red arrow from the origin). Adding complex numbers is just adding displacements.

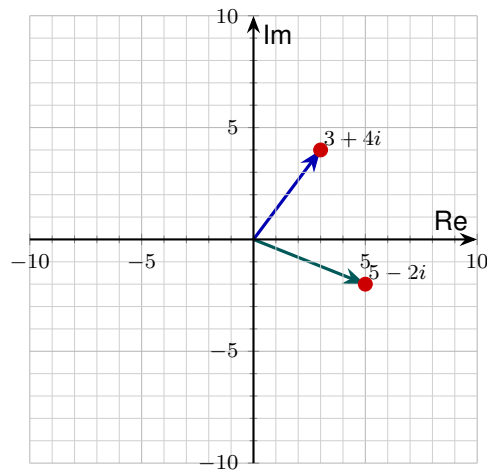
PRACTICE

Simplify each expression. Write the result in standard form $a + bi$.



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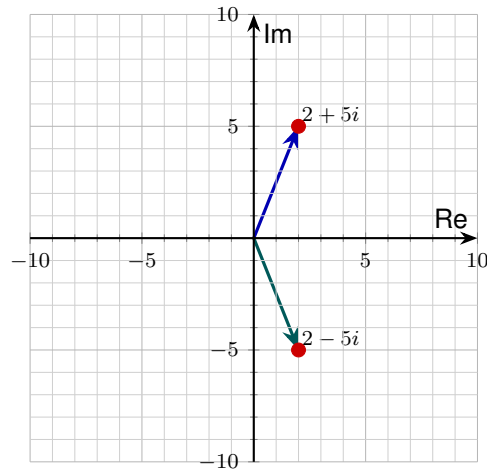
1. $(3 + 4i) + (5 - 2i)$. The two addends are drawn as vectors on the Argand plane below — add them tip-to-tail to land on the sum. _____



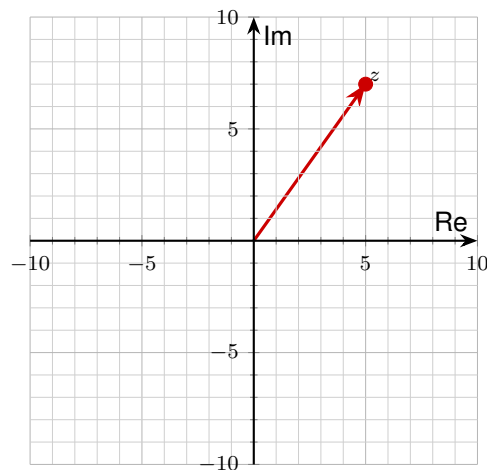
2. $(7 + 3i) - (2 + 5i)$ _____
3. $(4 - 6i) - (-1 + 2i)$ _____
4. $(2 + i) + (3 - 4i) + (-1 + 2i)$ _____
5. $(6 - 2i) - (3 + 5i) + (-4 + 7i)$ _____
6. $(8 + 5i) - (3 - 2i)$ _____
7. $(1 + 4i) - (-2 + 6i)$ _____
8. $-(2 - 3i) + (5 + i)$ _____
9. $(9 - i) - (9 - i)$ _____
10. $(-3 + 2i) + (3 - 2i)$ _____
11. $(0.5 + 0.3i) + (1.5 - 1.3i)$ _____
12. $(\frac{1}{2} + \frac{3}{4}i) + (\frac{1}{2} - \frac{1}{4}i)$ _____



13. $(2 + 5i) + (2 - 5i)$. The two addends, shown on the plane below, are reflections of each other across the real axis. Add them. _____



14. $(a + bi) + (c + di)$ _____
15. $[(8 + 5i) - (3 - 2i)] + [(1 + 4i) - (-2 + 6i)]$ _____
16. $(10 - 7i) + (-4 + 2i) - (3 - 5i)$ _____
17. $3(2 + i) + 2(1 - 3i)$ _____
18. $-(4 + i) - (1 - 2i)$ _____
19. $(2.5 + 1.5i) - (0.5 + 0.5i) + (-1 + 2i)$ _____
20. Find the complex number z if $z + (3 - 2i) = 8 + 5i$. Then plot z on the Argand plane below. _____



◆ Word Problems

21. In an AC circuit, two impedances connect in series: $Z_1 = 5 + 3i$ ohms and $Z_2 = 4 - 7i$ ohms. The total impedance is $Z_1 + Z_2$. Find the total impedance. _____
22. A point in the complex plane starts at $-2 + 5i$, moves by $4 - 3i$, then by $-1 - 6i$. What's its final position? _____
23. The voltage across two components in a series circuit is $V_1 = 12 + 5i$ volts and $V_2 = -3 + 8i$ volts. The total voltage is $V_1 + V_2$. Then a third reading $V_3 = 4 - 6i$ volts is added in series. What is the total voltage $V_1 + V_2 + V_3$? _____
24. On the Argand plane, point A is at $3 + 4i$ and point B is at $-2 + i$. Find the displacement vector from A to B (that is, $B - A$). _____

Additional Practice

25. Add $(3 + 2i) + (5 - i)$. _____
26. Subtract $(4 - i) - (1 + 6i)$. _____
27. Multiply $(2 + 3i)(1 - i)$. _____
28. Simplify i^{17} . _____
29. Simplify i^{22} . _____



Answer Keys

1. $8 + 2i$

2. $5 - 2i$

3. $5 - 8i$

4. $4 - i$

5. -1

6. $5 + 7i$

7. $3 - 2i$

8. $3 + 4i$

9. 0

10. 0

11. $2 - i$

12. $1 + \frac{1}{2}i$

Additional Practice Answers

25. $8 + i$

26. $3 - 7i$

27. $5 + i$

13. 4

14. $(a + c) + (b + d)i$

15. $8 + 5i$

16. 3

17. $8 - 3i$

18. $-5 + i$

19. $1 + 3i$

20. $z = 5 + 7i$

21. $9 - 4i$ ohms

22. $1 - 4i$

23. $13 + 7i$ volts

24. $-5 - 3i$

28. i

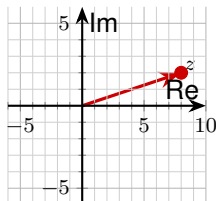
29. -1

Additional Practice: Answers for all numbered items, including the added practice, are shown in the grid above.

Step-by-Step Explanations

1. Real parts: $3 + 5 = 8$. Imaginary parts: $4 + (-2) = 2$. Stack the answer in standard form: $8 + 2i$. Geometrically, sliding the second arrow onto the tip of the first lands you at $(8, 2)$.

Answer graph



2. The minus has to reach both parts of the second number. Real: $7 - 2 = 5$. Imaginary: $3 - 5 = -2$. So $5 - 2i$ (a common slip is writing $5 + 8i$, forgetting that the minus flips the second imaginary part).

3. Distribute the negative: $(4 - 6i) + (1 - 2i) = 5 - 8i$. The minus in front of -1 becomes $+1$ — watch that step.

4. With three numbers, the safe move is to column-add. Reals: $2 + 3 + (-1) = 4$. Imaginaries: $1 + (-4) + 2 = -1$. So $4 - i$. Add the two columns separately and a stray sign can't sneak in.

5. The middle minus distributes to both of its parts, so the i -terms are $-2 - 5 + 7$. Reals: $6 - 3 - 4 = -1$. Imaginaries: $-2 - 5 + 7 = 0$. The imaginary part vanishes, leaving the real number -1 (which is $-1 + 0i$).

6. The minus reaches both parts of $3 - 2i$. Real side: $8 - 3 = 5$. Imaginary side: $5 - (-2) = 5 + 2 = 7$ — subtracting a negative adds. Result: $5 + 7i$ (writing $5 - 2i$ here is the classic sign slip).

7. Both pieces of $-2 + 6i$ get the minus. Real: $1 - (-2) = 1 + 2 = 3$. Imaginary: $4 - 6 = -2$. So $3 - 2i$. Watch the real part — the $-(-2)$ flips up to $+2$.

8. The leading minus flips both parts: $-(2 - 3i) = -2 + 3i$. Add $(5 + i)$: $-2 + 5 = 3$ and $3 + 1 = 4$. So $3 + 4i$.

9. Subtracting any number from itself gives 0 in both columns: $9 - 9 = 0$ and $-1 - (-1) = 0$. That's $0 + 0i$, which we just write as 0.

10. These are *additive inverses* (opposites in both parts), so their sum is 0. Verify: $-3 + 3 = 0$ and $2 + (-2) = 0$.

11. Decimals add by columns just like whole numbers. Reals: $0.5 + 1.5 = 2$. Imaginaries: $0.3 + (-1.3) = -1$. So $2 - i$ (the coefficient -1 is written as just $-i$).

12. Fractions follow the same column rule. Reals: $\frac{1}{2} + \frac{1}{2} = 1$. Imaginaries (same denominator, so just combine numerators): $\frac{3}{4} - \frac{1}{4} = \frac{2}{4} = \frac{1}{2}$. So $1 + \frac{1}{2}i$.

13. The imaginary parts are opposites, so they cancel. Reals: $2 + 2 = 4$. Result: 4 (which is $4 + 0i$). This is the pattern $z + \bar{z} = 2 \operatorname{Re}(z)$ — the two mirrored arrows add to a point on the real axis.

14. This is the general rule every other problem is built on: add real to real ($a + c$) and imaginary to imaginary ($b + d$), each staying in its own column. The two parts never mix because i can't combine with a plain number.

15. Simplify each bracket first. Left bracket: $5 + 7i$ (as in problem 6). Right bracket: $1 - (-2) = 3$ and $4 - 6 = -2$, so $3 - 2i$. Add the two pieces: $(5 + 7i) + (3 - 2i) = 8 + 5i$.

16. The last term is subtracted, so flip both of its signs: $-(3 - 5i) = -3 + 5i$. Reals: $10 - 4 - 3 = 3$. Imaginaries: $-7 + 2 + 5 = 0$. The i -column vanishes, leaving 3.

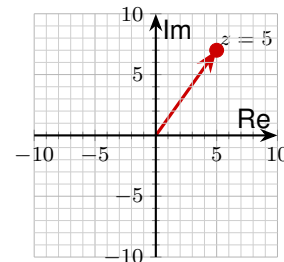
17. Distribute first: $3(2 + i) = 6 + 3i$ and $2(1 - 3i) = 2 - 6i$. Add: $(6 + 2) + (3 - 6)i = 8 - 3i$. A scalar multiplied through $a + bi$ just scales both parts.

18. Distribute both minus signs: $-4 - i - 1 + 2i$. Combine: $-5 + i$. Two leading negatives are where students lose track — write every term out before combining.

19. The middle term is subtracted, so both its parts lose their sign. Reals: $2.5 - 0.5 - 1 = 1$. Imaginaries: $1.5 - 0.5 + 2 = 3$. So $1 + 3i$.

20. Isolate z : $z = (8 + 5i) - (3 - 2i)$. Distribute the subtraction: $z = (8 - 3) + (5 - (-2))i = 5 + 7i$. Check: $(5 + 7i) + (3 - 2i) = 8 + 5i$ ✓. The point sits in the upper-right region of the Argand plane.

Answer graph



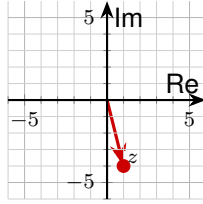
21. Series impedances add like complex numbers. Reals: $5 + 4 = 9$. Imaginaries:



$3 + (-7) = -4$. So $Z = 9 - 4i$ ohms. (The negative imaginary part means the circuit is capacitive on net.)

22. Each move is a displacement vector. Add them all to the starting point: $(-2 + 5i) + (4 - 3i) + (-1 - 6i)$. Reals: $-2 + 4 - 1 = 1$. Imaginaries: $5 - 3 - 6 = -4$. Final position: $1 - 4i$.

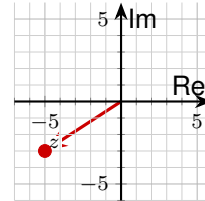
Answer graph



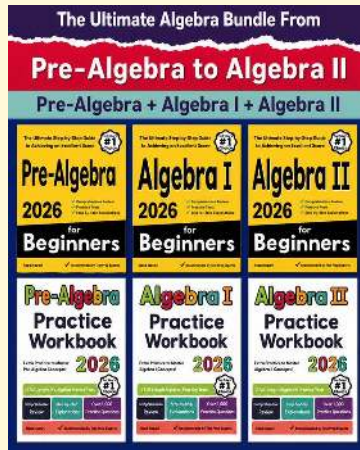
23. Add real parts: $12 + (-3) + 4 = 13$. Add imaginary parts: $5 + 8 + (-6) = 7$. Total: $13 + 7i$ volts. Series voltages combine by complex addition just like the impedances in problem 1.

24. The displacement from A to B is $B - A = (-2 + i) - (3 + 4i)$. Distribute the minus: $-2 - 3 + (1 - 4)i = -5 - 3i$. (Direction matters: $A - B$ would be $+5 + 3i$, the opposite vector.)

Answer graph



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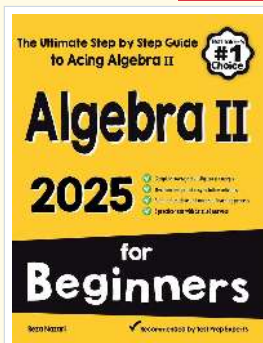
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