Adding and Subtracting Complex Numbers

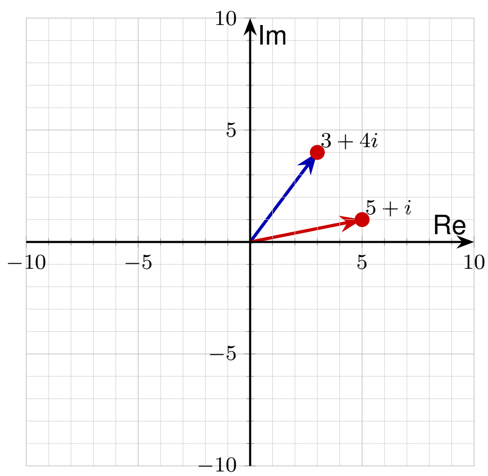
Name: ______________ Date: ______________ Score: ______ / 29

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.

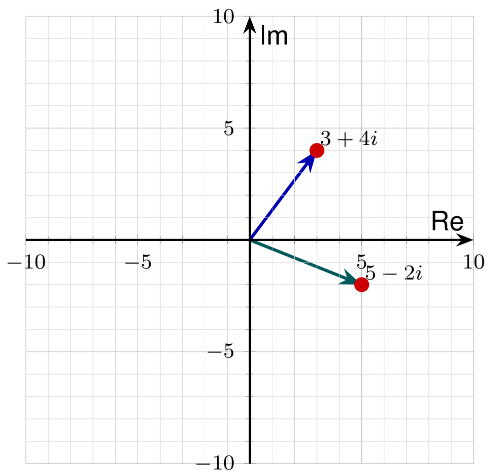


The blue arrow shows $3 + 4i$. Stacking the second arrow $(2 - 3i)$ on its tip lands at $5 + i$ (the red arrow from the origin). Adding complex numbers is just adding displacements.

PRACTICE

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

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. $-(2-3i)+(5+i)$ ________

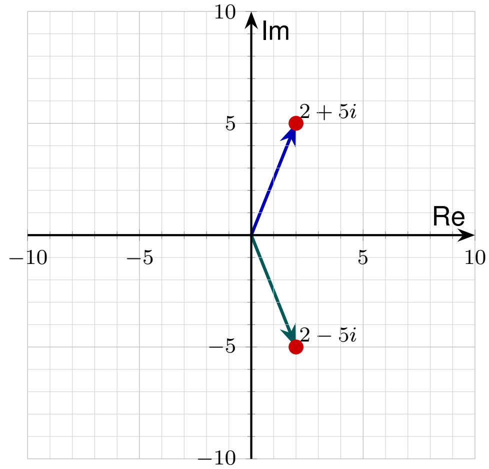
9. $(9-i)-(9-i)$ ________

10. $(-3+2i)+(3-2i)$ ________

11. $(0.5+0.3i)+(1.5-1.3i)$ ________

12. $\left(\frac{1}{2}+\frac{3}{4}i\right)+\left(\frac{1}{2}-\frac{1}{4}i\right)$ ________

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. $\left[(8+5i)-(3-2i)\right]+\left[(1+4i)-(-2+6i)\right]$ ________

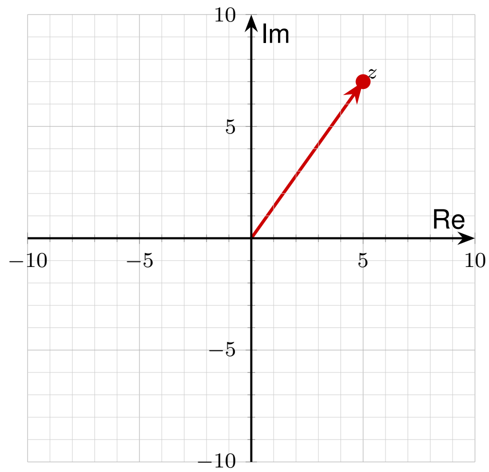
16. $(10-7i)+(-4+2i)-(3-5i)$ ________

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. ________



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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. $\boxed{8+2i}$	**13.** $\boxed{4}$
2. $\boxed{5-2i}$	**14.** $\boxed{(a+c)+(b+d)i}$
3. $\boxed{5-8i}$	**15.** $\boxed{8+5i}$
4. $\boxed{4-i}$	**16.** $\boxed{3}$
5. $\boxed{-1}$	**17.** $\boxed{8-3i}$
6. $\boxed{5+7i}$	**18.** $\boxed{-5+i}$
7. $\boxed{3-2i}$	**19.** $\boxed{1+3i}$
8. $\boxed{3+4i}$	**20.** $\boxed{z=5+7i}$
9. $\boxed{0}$	**21.** $\boxed{9-4i \text{ ohms}}$
10. $\boxed{0}$	**22.** $\boxed{1-4i}$
11. $\boxed{2-i}$	**23.** $\boxed{13+7i \text{ volts}}$
12. $\boxed{1+\frac{1}{2}i}$	**24.** $\boxed{-5-3i}$

Additional Practice Answers

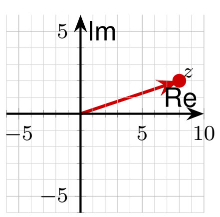
25. $\boxed{8+i}$	**28.** $\boxed{i}$
26. $\boxed{3-7i}$	**29.** $\boxed{-1}$
27. $\boxed{5+i}$	

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 $z+\overline{z}=2\,\mathrm{Re}(z)$ — 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.

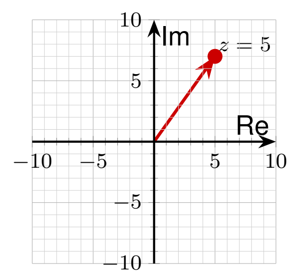
17. Distribute first: $3(2+i)=6+3i$ and $2(1-3i)=2-6i$. Add: $(6+2)+(3-6)i=8-3i$. A scalar multiplied through $a+bi$ just scales both parts.

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:

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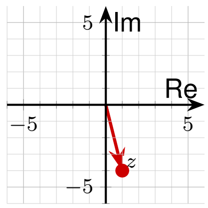
$3 + (-7) = -4$. So $Z = 9 - 4i$ ohms. (The negative imaginary part means the circuit is capacitive on net.)

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: $1 - 4i$.

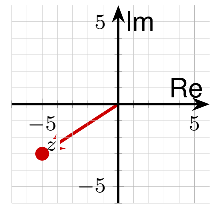
Answer graph



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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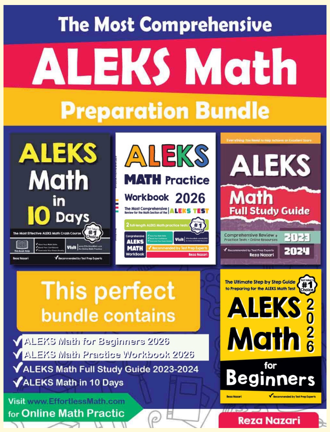

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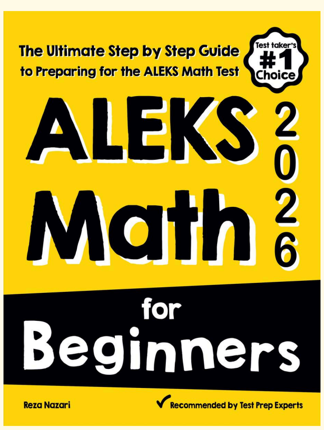

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