This key should allow you to understand why you choose the option you did (beyond just getting a question right or wrong). More instructions on how to use this key can be found here.

If you have a suggestion to make the keys better, please fill out the short survey here.

Note: This key is auto-generated and may contain issues and/or errors. The keys are reviewed after each exam to ensure grading is done accurately. If there are issues (like duplicate options), they are noted in the offline gradebook. The keys are a work-in-progress to give students as many resources to improve as possible.

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1. Simplify the expression below into the form $a + bi$. Then, choose the intervals that a and b belong to.

$$\frac{9 - 77i}{4 + 3i}$$

The solution is $-7.80 - 13.40i$, which is option D.

A. $a \in [-195.5, -194.5]$ and $b \in [-14.5, -12.5]$ $-195.00 - 13.40i$, which corresponds to forgetting to multiply the conjugate by the numerator and using a plus instead of a minus in the denominator.

B. $a \in [-9.5, -7]$ and $b \in [-335.5, -334]$ $-7.80 - 335.00i$, which corresponds to forgetting to multiply the conjugate by the numerator.

C. $a \in [10, 11]$ and $b \in [-12.5, -10.5]$ $10.68 - 11.24i$, which corresponds to forgetting to multiply the conjugate by the numerator and not computing the conjugate correctly.

D. $a \in [-9.5, -7]$ and $b \in [-14.5, -12.5]$ * $-7.80 - 13.40i$, which is the correct option.

E. $a \in [1.5, 3]$ and $b \in [-26.5, -24.5]$ $2.25 - 25.67i$, which corresponds to just dividing the first term by the first term and the second by the second.

General Comment: Multiply the numerator and denominator by the *conjugate* of the denominator, then simplify. For example, if we have $2 + 3i$, the conjugate is $2 - 3i$.

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2. Simplify the expression below into the form $a + bi$. Then, choose the intervals that a and b belong to.

$$(-10 - 8i)(-6 - 7i)$$

The solution is $4 + 118i$, which is option E.

A. $a \in [113, 118]$ and $b \in [-26, -18]$ $116 - 22i$, which corresponds to adding a minus sign in the second term.

B. $a \in [0, 7]$ and $b \in [-122, -115]$ $4 - 118i$, which corresponds to adding a minus sign in both terms.

C. $a \in [58, 69]$ and $b \in [54, 62]$ $60 + 56i$, which corresponds to just multiplying the real terms to get the real part of the solution and the coefficients in the complex terms to get the complex part.

D. $a \in [113, 118]$ and $b \in [18, 27]$ $116 + 22i$, which corresponds to adding a minus sign in the first term.

E. $a \in [0, 7]$ and $b \in [113, 124]$ * $4 + 118i$, which is the correct option.

General Comment: You can treat i as a variable and distribute. Just remember that $i^2 = -1$, so you can continue to reduce after you distribute.

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3. Simplify the expression below and choose the interval the simplification is contained within.

$$19 - 3 \div 2 * 8 - (18 * 13)$$

The solution is -227.000, which is option C.

A. $[252.81, 255.81]$ 252.812, which corresponds to not distributing addition and subtraction correctly.

B. $[-146, -139]$ -143.000, which corresponds to not distributing a negative correctly.

C. $[-231, -219]$ * -227.000, which is the correct option.

D. $[-221.19, -212.19]$ -215.188, which corresponds to an Order of Operations error: not reading left-to-right for multiplication/division.

E. None of the above You may have gotten this by making an unanticipated error. If you got a value that is not any of the others, please let the coordinator know so they can help you figure out what happened.

General Comment: While you may remember (or were taught) PEMDAS is done in order, it is actually done as P/E/MD/AS. When we are at MD or AS, we read left to right.

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4. Choose the **smallest** set of Complex numbers that the number below belongs to.

$$\sqrt{\frac{64}{169}} + 49i^2$$

The solution is Rational, which is option A.

A. Rational * This is the correct option!

B. Nonreal Complex This is a Complex number $(a+bi)$ that is not Real (has i as part of the number).

C. Irrational These cannot be written as a fraction of Integers. Remember: π is not an Integer!

D. Pure Imaginary This is a Complex number $(a + bi)$ that **only** has an imaginary part like $2i$.

E. Not a Complex Number This is not a number. The only non-Complex number we know is dividing by 0 as this is not a number!

General Comment: Be sure to simplify $i^2 = -1$. This may remove the imaginary portion for your number. If you are having trouble, you may want to look at the *Subgroups of the Real Numbers* section.

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5. Choose the **smallest** set of Real numbers that the number below belongs to.

$$\sqrt{\frac{529}{25}}$$

The solution is Rational, which is option B.

A. Irrational These cannot be written as a fraction of Integers.

B. Rational * This is the correct option!

C. Integer These are the negative and positive counting numbers (..., -3, -2, -1, 0, 1, 2, 3, ...)

D. Whole These are the counting numbers with 0 (0, 1, 2, 3, ...)

E. Not a Real number These are Nonreal Complex numbers **OR** things that are not numbers (e.g., dividing by 0).

General Comment: First, you **NEED** to simplify the expression. This question simplifies to $\frac{23}{5}$.

Be sure you look at the simplified fraction and not just the decimal expansion. Numbers such as 13, 17, and 19 provide **long but repeating/terminating decimal expansions!**

The only ways to *not* be a Real number are: dividing by 0 or taking the square root of a negative number.

Irrational numbers are more than just square root of 3: adding or subtracting values from square root of 3 is also irrational.

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6. Simplify the expression below into the form $a + bi$. Then, choose the intervals that a and b belong to.

$$\frac{72 - 11i}{3 + 6i}$$

The solution is $3.33 - 10.33i$, which is option D.

A. $a \in [149.5, 151]$ and $b \in [-11.5, -9.5]$ $150.00 - 10.33i$, which corresponds to forgetting to multiply the conjugate by the numerator and using a plus instead of a minus in the denominator.

B. $a \in [23, 25.5]$ and $b \in [-2.5, -1.5]$ $24.00 - 1.83i$, which corresponds to just dividing the first term by the first term and the second by the second.

C. $a \in [1.5, 4]$ and $b \in [-466, -464.5]$ $3.33 - 465.00i$, which corresponds to forgetting to multiply the conjugate by the numerator.

D. $a \in [1.5, 4]$ and $b \in [-11.5, -9.5]$ * $3.33 - 10.33i$, which is the correct option.

E. $a \in [5, 6.5]$ and $b \in [8.5, 10.5]$ $6.27 + 8.87i$, which corresponds to forgetting to multiply the conjugate by the numerator and not computing the conjugate correctly.

General Comment: Multiply the numerator and denominator by the *conjugate* of the denominator, then simplify. For example, if we have $2 + 3i$, the conjugate is $2 - 3i$.

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7. Simplify the expression below into the form $a + bi$. Then, choose the intervals that a and b belong to.

$$(-6 - 8i)(2 + 4i)$$

The solution is $20 - 40i$, which is option E.

A. $a \in [17, 23]$ and $b \in [35, 43]$ $20 + 40i$, which corresponds to adding a minus sign in both terms.

B. $a \in [-15, -10]$ and $b \in [-34, -30]$ $-12 - 32i$, which corresponds to just multiplying the real terms to get the real part of the solution and the coefficients in the complex terms to get the complex part.

C. $a \in [-45, -40]$ and $b \in [6, 9]$ $-44 + 8i$, which corresponds to adding a minus sign in the second term.

D. $a \in [-45, -40]$ and $b \in [-12, -5]$ $-44 - 8i$, which corresponds to adding a minus sign in the first term.

E. $a \in [17, 23]$ and $b \in [-41, -34]$ * $20 - 40i$, which is the correct option.

General Comment: You can treat i as a variable and distribute. Just remember that $i^2 = -1$, so you can continue to reduce after you distribute.

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8. Simplify the expression below and choose the interval the simplification is contained within.

$$3 - 6^2 + 10 \div 19 * 9 \div 8$$

The solution is -32.408, which is option A.

A. $[-32.78, -32.26]$ * -32.408, this is the correct option

B. $[-33.09, -32.91]$ -32.993, which corresponds to an Order of Operations error: not reading left-to-right for multiplication/division.

C. [39.55, 39.75] 39.592, which corresponds to an Order of Operations error: multiplying by negative before squaring. For example: $(-3)^2 \neq -3^2$

D. [38.63, 39.25] 39.007, which corresponds to two Order of Operations errors.

E. None of the above You may have gotten this by making an unanticipated error. If you got a value that is not any of the others, please let the coordinator know so they can help you figure out what happened.

General Comment: While you may remember (or were taught) PEMDAS is done in order, it is actually done as P/E/MD/AS. When we are at MD or AS, we read left to right.

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9. Choose the **smallest** set of Complex numbers that the number below belongs to.

$$\sqrt{\frac{576}{121}} + 9i^2$$

The solution is Rational, which is option A.

A. Rational * This is the correct option!

B. Nonreal Complex This is a Complex number $(a+bi)$ that is not Real (has i as part of the number).

C. Pure Imaginary This is a Complex number $(a + bi)$ that **only** has an imaginary part like $2i$.

D. Irrational These cannot be written as a fraction of Integers. Remember: π is not an Integer!

E. Not a Complex Number This is not a number. The only non-Complex number we know is dividing by 0 as this is not a number!

General Comment: Be sure to simplify $i^2 = -1$. This may remove the imaginary portion for your number. If you are having trouble, you may want to look at the *Subgroups of the Real Numbers* section.

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10. Choose the **smallest** set of Real numbers that the number below belongs to.

$$-\sqrt{\frac{529}{400}}$$

The solution is Rational, which is option B.

A. Integer These are the negative and positive counting numbers (..., -3, -2, -1, 0, 1, 2, 3, ...)

B. Rational * This is the correct option!

C. Not a Real number These are Nonreal Complex numbers **OR** things that are not numbers (e.g., dividing by 0).

D. Irrational These cannot be written as a fraction of Integers.

E. Whole These are the counting numbers with 0 (0, 1, 2, 3, ...)

General Comment: First, you **NEED** to simplify the expression. This question simplifies to $-\frac{23}{20}$.

Be sure you look at the simplified fraction and not just the decimal expansion. Numbers such as 13, 17, and 19 provide **long but repeating/terminating decimal expansions!**

The only ways to *not* be a Real number are: dividing by 0 or taking the square root of a negative number.

Irrational numbers are more than just square root of 3: adding or subtracting values from square root of 3 is also irrational.
