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.

$$\frac{18 - 44i}{-1 - 8i}$$

The solution is $5.14 + 2.89i$, which is option B.

A. $a \in [-18.5, -17.5]$ and $b \in [5, 6.5]$ $-18.00 + 5.50i$, which corresponds to just dividing the first term by the first term and the second by the second.

B. $a \in [4.5, 6.5]$ and $b \in [1.5, 3.5]$ * $5.14 + 2.89i$, which is the correct option.

C. $a \in [-6.5, -5]$ and $b \in [-2, -0.5]$ $-5.69 - 1.54i$, which corresponds to forgetting to multiply the conjugate by the numerator and not computing the conjugate correctly.

D. $a \in [333.5, 334.5]$ and $b \in [1.5, 3.5]$ $334.00 + 2.89i$, which corresponds to forgetting to multiply the conjugate by the numerator and using a plus instead of a minus in the denominator.

E. $a \in [4.5, 6.5]$ and $b \in [187.5, 189.5]$ $5.14 + 188.00i$, which corresponds to forgetting to multiply the conjugate by the numerator.

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.

$$(3 + 6i)(8 - 7i)$$

The solution is $66 + 27i$, which is option A.

A. $a \in [63, 70]$ and $b \in [19, 29]$ * $66 + 27i$, which is the correct option.

B. $a \in [63, 70]$ and $b \in [-27, -23]$ $66 - 27i$, which corresponds to adding a minus sign in both terms.

C. $a \in [-18, -15]$ and $b \in [-69, -68]$ $-18 - 69i$, which corresponds to adding a minus sign in the first term.

D. $a \in [-18, -15]$ and $b \in [68, 70]$ $-18 + 69i$, which corresponds to adding a minus sign in the second term.

E. $a \in [22, 28]$ and $b \in [-45, -41]$ $24 - 42i$, 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.

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.

$$4 - 7^2 + 8 \div 20 * 11 \div 13$$

The solution is -44.662, which is option A.

A. $[-44.79, -44.62]$ * -44.662, this is the correct option

B. $[52.89, 53.08]$ 53.003, which corresponds to two Order of Operations errors.

C. $[53.1, 53.74]$ 53.338, which corresponds to an Order of Operations error: multiplying by negative before squaring. For example: $(-3)^2 \neq -3^2$

D. $[-45.14, -44.87]$ -44.997, 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.

$$\sqrt{\frac{324}{0}} + \sqrt{165}i$$

The solution is Not a Complex Number, which is option C.

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

B. Rational These are numbers that can be written as fraction of Integers (e.g., -2/3 + 5)

C. Not a Complex Number * This is the correct option!

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

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

$$-\sqrt{\frac{6}{0}}$$

The solution is Not a Real number, which is option D.

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

B. Rational These are numbers that can be written as fraction of Integers (e.g., -2/3)

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

D. Not a Real number * This is the correct option!

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

General Comment: First, you **NEED** to simplify the expression. This question simplifies to $-\sqrt{\frac{6}{0}}$.

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.

$$\frac{63 + 11i}{-4 - 3i}$$

The solution is $-11.40 + 5.80i$, which is option E.

A. $a \in [-17, -14]$ and $b \in [-4.5, -3]$ $-15.75 - 3.67i$, which corresponds to just dividing the first term by the first term and the second by the second.

B. $a \in [-285.5, -284]$ and $b \in [5.5, 6.5]$ $-285.00 + 5.80i$, which corresponds to forgetting to multiply the conjugate by the numerator and using a plus instead of a minus in the denominator.

C. $a \in [-9.5, -8]$ and $b \in [-10.5, -8.5]$ $-8.76 - 9.32i$, which corresponds to forgetting to multiply the conjugate by the numerator and not computing the conjugate correctly.

D. $a \in [-12.5, -11]$ and $b \in [144.5, 146.5]$ $-11.40 + 145.00i$, which corresponds to forgetting to multiply the conjugate by the numerator.

E. $a \in [-12.5, -11]$ and $b \in [5.5, 6.5]$ * $-11.40 + 5.80i$, which is the correct option.

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.

$$(8 + 7i)(-3 - 9i)$$

The solution is $39 - 93i$, which is option B.

A. $a \in [-31, -21]$ and $b \in [-66, -56]$ $-24 - 63i$, 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.

B. $a \in [37, 42]$ and $b \in [-96, -91]$ * $39 - 93i$, which is the correct option.

C. $a \in [-93, -85]$ and $b \in [51, 52]$ $-87 + 51i$, which corresponds to adding a minus sign in the second term.

D. $a \in [37, 42]$ and $b \in [88, 97]$ $39 + 93i$, which corresponds to adding a minus sign in both terms.

E. $a \in [-93, -85]$ and $b \in [-56, -50]$ $-87 - 51i$, which corresponds to adding a minus sign in the first term.

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.

$$5 - 9 \div 10 * 3 - (7 * 19)$$

The solution is -130.700, which is option A.

A. $[-132, -129.9]$ * -130.700, which is the correct option.

B. $[-129.1, -127.2]$ -128.300, which corresponds to an Order of Operations error: not reading left-to-right for multiplication/division.

C. $[-89.6, -88.4]$ -89.300, which corresponds to not distributing a negative correctly.

D. $[136.5, 137.8]$ 137.700, which corresponds to not distributing addition and subtraction correctly.

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.

$$\frac{-5}{10} + \sqrt{90}i$$

The solution is Nonreal Complex, which is option D.

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

B. 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!

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

D. Nonreal Complex * This is the correct option!

E. Rational These are numbers that can be written as fraction of Integers (e.g., -2/3 + 5)

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.

$$-\sqrt{\frac{900}{10}}$$

The solution is Irrational, which is option D.

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

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

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

D. Irrational * This is the correct option!

E. Rational These are numbers that can be written as fraction of Integers (e.g., -2/3)

General Comment: First, you **NEED** to simplify the expression. This question simplifies to $-\sqrt{90}$.

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.
