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.

$$\frac{-54 - 11i}{5 + 3i}$$

The solution is $-8.91 + 3.15i$, which is option D.

A. $a \in [-12, -10.5]$ and $b \in [-4, -2]$ $-10.80 - 3.67i$, which corresponds to just dividing the first term by the first term and the second by the second.

B. $a \in [-303.5, -302.5]$ and $b \in [2, 4]$ $-303.00 + 3.15i$, which corresponds to forgetting to multiply the conjugate by the numerator and using a plus instead of a minus in the denominator.

C. $a \in [-7.5, -6.5]$ and $b \in [-7, -6]$ $-6.97 - 6.38i$, which corresponds to forgetting to multiply the conjugate by the numerator and not computing the conjugate correctly.

D. $a \in [-10, -8.5]$ and $b \in [2, 4]$ * $-8.91 + 3.15i$, which is the correct option.

E. $a \in [-10, -8.5]$ and $b \in [105.5, 108.5]$ $-8.91 + 107.00i$, 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.

$$(10 - 9i)(8 + 6i)$$

The solution is $134 - 12i$, which is option B.

A. $a \in [75, 81]$ and $b \in [-59, -49]$ $80 - 54i$, 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. $a \in [131, 140]$ and $b \in [-18, -2]$ * $134 - 12i$, which is the correct option.

C. $a \in [20, 28]$ and $b \in [-134, -130]$ $26 - 132i$, which corresponds to adding a minus sign in the second term.

D. $a \in [20, 28]$ and $b \in [131, 135]$ $26 + 132i$, which corresponds to adding a minus sign in the first term.

E. $a \in [131, 140]$ and $b \in [7, 21]$ $134 + 12i$, which corresponds to adding a minus sign in both terms.

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.

$$1 - 8 \div 19 * 5 - (10 * 3)$$

The solution is -31.105, which is option C.

A. $[-30, -27.4]$ -29.084, which corresponds to an Order of Operations error: not reading left-to-right for multiplication/division.

B. $[29, 33]$ 30.916, which corresponds to not distributing addition and subtraction correctly.

C. $[-32.3, -30.3]$ * -31.105, which is the correct option.

D. $[-34.5, -32.9]$ -33.316, which corresponds to not distributing a negative 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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4. Choose the **smallest** set of Complex numbers that the number below belongs to.

$$\sqrt{\frac{-560}{5}} + \sqrt{0}i$$

The solution is Pure Imaginary, which is option C.

A. 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!

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

C. Pure Imaginary * This is the correct option!

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

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

$$\sqrt{\frac{1170}{10}}$$

The solution is Irrational, which is option E.

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

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

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

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

E. Irrational * This is the correct option!

General Comment: First, you **NEED** to simplify the expression. This question simplifies to $\sqrt{117}$.

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.

$$\frac{72 - 77i}{3 - 4i}$$

The solution is $20.96 + 2.28i$, which is option D.

A. $a \in [-4.5, -2.5]$ and $b \in [-22, -19.5]$ $-3.68 - 20.76i$, which corresponds to forgetting to multiply the conjugate by the numerator and not computing the conjugate correctly.

B. $a \in [23.5, 24.5]$ and $b \in [18.5, 21]$ $24.00 + 19.25i$, which corresponds to just dividing the first term by the first term and the second by the second.

C. $a \in [523, 526.5]$ and $b \in [1.5, 3.5]$ $524.00 + 2.28i$, which corresponds to forgetting to multiply the conjugate by the numerator and using a plus instead of a minus in the denominator.

D. $a \in [19.5, 21.5]$ and $b \in [1.5, 3.5]$ * $20.96 + 2.28i$, which is the correct option.

E. $a \in [19.5, 21.5]$ and $b \in [56, 57.5]$ $20.96 + 57.00i$, 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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7. Simplify the expression below into the form $a + bi$. Then, choose the intervals that a and b belong to.

$$(-3 - 7i)(10 + 2i)$$

The solution is $-16 - 76i$, which is option B.

A. $a \in [-44, -38]$ and $b \in [-66, -61]$ $-44 - 64i$, which corresponds to adding a minus sign in the second term.

B. $a \in [-20, -9]$ and $b \in [-82, -75]$ * $-16 - 76i$, which is the correct option.

C. $a \in [-35, -26]$ and $b \in [-17, -11]$ $-30 - 14i$, 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. $a \in [-44, -38]$ and $b \in [64, 68]$ $-44 + 64i$, which corresponds to adding a minus sign in the first term.

E. $a \in [-20, -9]$ and $b \in [70, 77]$ $-16 + 76i$, which corresponds to adding a minus sign in both terms.

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.

$$17 - 4^2 + 8 \div 7 * 20 \div 9$$

The solution is 3.540, which is option B.

A. $[30.6, 33.4]$ 33.006, which corresponds to two Order of Operations errors.

B. $[2.1, 6.2]$ * 3.540, this is the correct option

C. $[35.2, 39.4]$ 35.540, which corresponds to an Order of Operations error: multiplying by negative before squaring. For example: $(-3)^2 \neq -3^2$

D. $[-1.4, 3]$ 1.006, 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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9. Choose the **smallest** set of Complex numbers that the number below belongs to.

$$-\sqrt{\frac{36}{49}} + 100i^2$$

The solution is Rational, which is option A.

A. Rational * This is the correct option!

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

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

D. 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!

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

$$\sqrt{\frac{400}{5}}$$

The solution is Irrational, which is option C.

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

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

C. Irrational * This is the correct option!

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

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 $\sqrt{80}$.

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.
