**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.

$$\frac{72 + 44i}{-6 - 7i}$$

The solution is $-8.71 + 2.82i$, which is option E.

A. $a \in [-740.5, -739.5]$ and $b \in [2.5, 4.5]$

$-740.00 + 2.82i$, which corresponds to forgetting to multiply the conjugate by the numerator and using a plus instead of a minus in the denominator.

B. $a \in [-3, -1]$ and $b \in [-11.5, -8.5]$

$-1.46 - 9.04i$, which corresponds to forgetting to multiply the conjugate by the numerator and not computing the conjugate correctly.

C. $a \in [-10, -8]$ and $b \in [239.5, 241]$

$-8.71 + 240.00i$, which corresponds to forgetting to multiply the conjugate by the numerator.

D. $a \in [-13, -10.5]$ and $b \in [-6.5, -5]$

$-12.00 - 6.29i$, which corresponds to just dividing the first term by the first term and the second by the second.

E. $a \in [-10, -8]$ and $b \in [2.5, 4.5]$

* $-8.71 + 2.82i$, 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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2. Choose the **smallest** set of Real numbers that the number below belongs to.

$$-\sqrt{\frac{10000}{25}}$$

The solution is Integer, which is option D.

A. Not a Real number

These are Nonreal Complex numbers **OR** things that are not numbers (e.g., dividing by 0).

B. Whole

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

C. Irrational

These cannot be written as a fraction of Integers.

D. Integer

* 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 $-100$.

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

$$(5 + 6i)(-4 + 9i)$$

The solution is $-74 + 21i$, which is option B.

A. $a \in [34, 40]$ and $b \in [-75, -67]$

$34 - 69i$, which corresponds to adding a minus sign in the second term.

B. $a \in [-76, -72]$ and $b \in [18, 23]$

* $-74 + 21i$, which is the correct option.

C. $a \in [-76, -72]$ and $b \in [-29, -20]$

$-74 - 21i$, which corresponds to adding a minus sign in both terms.

D. $a \in [-23, -14]$ and $b \in [50, 59]$

$-20 + 54i$, 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.

E. $a \in [34, 40]$ and $b \in [65, 71]$

$34 + 69i$, 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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4. Choose the **smallest** set of Complex numbers that the number below belongs to.

$$\frac{-9}{10} + \sqrt{-9}i$$

The solution is Rational, which is option C.

A. Nonreal Complex

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

B. Irrational

These cannot be written as a fraction of Integers. Remember: $\pi$ is not an Integer!

C. Rational

* This is the correct option!

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. Pure Imaginary

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

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

$$\frac{-63 - 55i}{2 + 4i}$$

The solution is $-17.30 + 7.10i$, which is option E.

A. $a \in [-32, -30.5]$ and $b \in [-14.5, -12.5]$

$-31.50 - 13.75i$, which corresponds to just dividing the first term by the first term and the second by the second.

B. $a \in [-347, -344.5]$ and $b \in [6.5, 8.5]$

$-346.00 + 7.10i$, which corresponds to forgetting to multiply the conjugate by the numerator and using a plus instead of a minus in the denominator.

C. $a \in [2.5, 5.5]$ and $b \in [-19, -17.5]$

$4.70 - 18.10i$, which corresponds to forgetting to multiply the conjugate by the numerator and not computing the conjugate correctly.

D. $a \in [-18, -17]$ and $b \in [141, 142.5]$

$-17.30 + 142.00i$, which corresponds to forgetting to multiply the conjugate by the numerator.

E. $a \in [-18, -17]$ and $b \in [6.5, 8.5]$

* $-17.30 + 7.10i$, 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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6. Simplify the expression below and choose the interval the simplification is contained within.

$$6 - 14 \div 19 * 18 - (5 * 2)$$

The solution is $-17.263$, which is option B.

A. $[-27.53, -20.53]$

-24.526, which corresponds to not distributing a negative correctly.

B. $[-18.26, -15.26]$

* -17.263, which is the correct option.

C. $[10.96, 16.96]$

15.959, which corresponds to not distributing addition and subtraction correctly.

D. $[-10.04, -0.04]$

-4.041, 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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7. Simplify the expression below into the form $a + bi$. Then, choose the intervals that $a$ and $b$ belong to.

$$(7 + 3i)(-4 - 8i)$$

The solution is $-4 - 68i$, which is option A.

A. $a \in [-7, -3]$ and $b \in [-68, -67]$

* $-4 - 68i$, which is the correct option.

B. $a \in [-7, -3]$ and $b \in [68, 72]$

$-4 + 68i$, which corresponds to adding a minus sign in both terms.

C. $a \in [-31, -26]$ and $b \in [-24, -21]$

$-28 - 24i$, 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. $a \in [-55, -51]$ and $b \in [43, 49]$

$-52 + 44i$, which corresponds to adding a minus sign in the second term.

E. $a \in [-55, -51]$ and $b \in [-45, -37]$

$-52 - 44i$, 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. Choose the **smallest** set of Real numbers that the number below belongs to.

$$\sqrt{\frac{990}{9}}$$

The solution is Irrational, which is option B.

A. Integer

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

B. Irrational

* 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. Whole

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

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 $\sqrt{110}$.

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

$$\frac{6}{-19} + 36i^2$$

The solution is Rational, which is option D.

A. Irrational

These cannot be written as a fraction of Integers. Remember: $\pi$ is not an Integer!

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. Rational

* This is the correct option!

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

$$19 - 20^2 + 12 \div 17 * 3 \div 16$$

The solution is $-380.868$, which is option A.

A. $[-380.98, -380.74]$

* -380.868, this is the correct option

B. $[-381.23, -380.87]$

-380.985, which corresponds to an Order of Operations error: not reading left-to-right for multiplication/division.

C. $[418.93, 419.11]$

419.015, which corresponds to two Order of Operations errors.

D. $[419.09, 419.4]$

419.132, which corresponds to an Order of Operations error: multiplying by negative before squaring. For example: $(-3)^2 \neq -3^2$

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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