**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.

$$(-9 - 3i)(-8 + 4i)$$

The solution is $84 - 12i$, which is option B.

A. $a \in [60, 63]$ and $b \in [-61, -51]$

$60 - 60i$, which corresponds to adding a minus sign in the first term.

B. $a \in [84, 89]$ and $b \in [-17, -11]$

* $84 - 12i$, which is the correct option.

C. $a \in [84, 89]$ and $b \in [8, 13]$

$84 + 12i$, which corresponds to adding a minus sign in both terms.

D. $a \in [70, 73]$ and $b \in [-17, -11]$

$72 - 12i$, 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. $a \in [60, 63]$ and $b \in [57, 62]$

$60 + 60i$, which corresponds to adding a minus sign in the second 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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2. Simplify the expression below and choose the interval the simplification is contained within.

$$5 - 4 \div 10 * 7 - (8 * 15)$$

The solution is $-117.800$, which is option B.

A. $[-90, -84]$

-87.000, which corresponds to not distributing a negative correctly.

B. $[-122.8, -116.8]$

* -117.800, which is the correct option.

C. $[-116.06, -107.06]$

-115.057, which corresponds to an Order of Operations error: not reading left-to-right for multiplication/division.

D. $[119.94, 128.94]$

124.943, 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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3. Choose the **smallest** set of Real numbers that the number below belongs to.

$$\sqrt{\frac{2304}{36}}$$

The solution is Whole, which is option A.

A. Whole

* This is the correct option!

B. Irrational

These cannot be written as a fraction of Integers.

C. Rational

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

D. Integer

These are the negative and positive counting numbers (..., -3, -2, -1, 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 48.

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

$$\sqrt{\frac{81}{625}} + \sqrt{85}i$$

The solution is Nonreal Complex, which is option B.

A. Rational

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

B. Nonreal Complex

* This is the correct option!

C. 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!

D. Pure Imaginary

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

E. Irrational

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

**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.

$$\sqrt{\frac{65025}{289}}$$

The solution is Whole, which is option C.

A. Irrational

These cannot be written as a fraction of Integers.

B. Integer

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

C. Whole

* This is the correct option!

D. Rational

These are numbers that can be written as fraction of Integers (e.g., -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 255.

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.

$$\frac{18 + 66i}{-8 + 5i}$$

The solution is $2.09 - 6.94i$, which is option E.

A. $a \in [-6.5, -4.5]$ and $b \in [-5.5, -3.5]$

$-5.33 - 4.92i$, which corresponds to forgetting to multiply the conjugate by the numerator and not computing the conjugate correctly.

B. $a \in [184.5, 187.5]$ and $b \in [-8.5, -6]$

$186.00 - 6.94i$, which corresponds to forgetting to multiply the conjugate by the numerator and using a plus instead of a minus in the denominator.

C. $a \in [-3.5, -1]$ and $b \in [12.5, 14.5]$

$-2.25 + 13.20i$, which corresponds to just dividing the first term by the first term and the second by the second.

D. $a \in [1.5, 2.5]$ and $b \in [-619, -617.5]$

$2.09 - 618.00i$, which corresponds to forgetting to multiply the conjugate by the numerator.

E. $a \in [1.5, 2.5]$ and $b \in [-8.5, -6]$

* $2.09 - 6.94i$, 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.

$$(7 - 10i)(2 + 8i)$$

The solution is $94 + 36i$, which is option E.

A. $a \in [-70, -65]$ and $b \in [-78, -70]$

$-66 - 76i$, which corresponds to adding a minus sign in the second term.

B. $a \in [11, 18]$ and $b \in [-83, -77]$

$14 - 80i$, 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. $a \in [91, 99]$ and $b \in [-41, -34]$

$94 - 36i$, which corresponds to adding a minus sign in both terms.

D. $a \in [-70, -65]$ and $b \in [72, 78]$

$-66 + 76i$, which corresponds to adding a minus sign in the first term.

E. $a \in [91, 99]$ and $b \in [34, 37]$

* $94 + 36i$, 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 into the form $a + bi$. Then, choose the intervals that $a$ and $b$ belong to.

$$\frac{9 - 66i}{3 + 5i}$$

The solution is $-8.91 - 7.15i$, which is option B.

A. $a \in [9.5, 11]$ and $b \in [-5, -3.5]$

$10.50 - 4.50i$, which corresponds to forgetting to multiply the conjugate by the numerator and not computing the conjugate correctly.

B. $a \in [-10, -8.5]$ and $b \in [-8.5, -6]$

* $-8.91 - 7.15i$, which is the correct option.

C. $a \in [-10, -8.5]$ and $b \in [-243.5, -242]$

$-8.91 - 243.00i$, which corresponds to forgetting to multiply the conjugate by the numerator.

D. $a \in [-304.5, -302]$ and $b \in [-8.5, -6]$

$-303.00 - 7.15i$, which corresponds to forgetting to multiply the conjugate by the numerator and using a plus instead of a minus in the denominator.

E. $a \in [2, 3.5]$ and $b \in [-13.5, -12.5]$

$3.00 - 13.20i$, 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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9. Simplify the expression below and choose the interval the simplification is contained within.

$$11 - 1^2 + 4 \div 8 * 10 \div 7$$

The solution is 10.714, which is option C.

A. $[12.09, 14.12]$

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

B. $[9.13, 10.51]$

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

C. $[10.06, 10.93]$

* 10.714, this is the correct option

D. $[11.32, 12.2]$

12.007, 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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10. Choose the **smallest** set of Complex numbers that the number below belongs to.

$$\frac{\sqrt{182}}{6} + \sqrt{-3}i$$

The solution is Irrational, which is option B.

A. Nonreal Complex

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

B. Irrational

* This is the correct option!

C. Pure Imaginary

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

D. Rational

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

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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