**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 and choose the interval the simplification is contained within.

$$20 - 2 \div 12 * 13 - (19 * 10)$$

The solution is $-172.167$, which is option D.

A. $[-12.8, -9.3]$

-11.667, which corresponds to not distributing a negative correctly.

B. $[207.5, 212.6]$

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

C. $[-171.7, -168.3]$

-170.013, which corresponds to an Order of Operations error: not reading left-to-right for multiplication/division.

D. $[-173.4, -171.5]$

* -172.167, which is the correct option.

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

$$(8 + 5i)(6 + 4i)$$

The solution is $28 + 62i$, which is option B.

A. $a \in [65, 75]$ and $b \in [-7, 1]$

$68 - 2i$, which corresponds to adding a minus sign in the second term.

B. $a \in [24, 32]$ and $b \in [61, 66]$

* $28 + 62i$, which is the correct option.

C. $a \in [65, 75]$ and $b \in [-1, 9]$

$68 + 2i$, which corresponds to adding a minus sign in the first term.

D. $a \in [24, 32]$ and $b \in [-69, -58]$

$28 - 62i$, which corresponds to adding a minus sign in both terms.

E. $a \in [47, 49]$ and $b \in [19, 21]$

$48 + 20i$, 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. Choose the **smallest** set of Complex numbers that the number below belongs to.

$$\sqrt{\frac{1053}{9}} + \sqrt{143}i$$

The solution is Nonreal Complex, which is option E.

A. Irrational

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

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. 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. Nonreal Complex

* This is the correct option!

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

$$\sqrt{\frac{19600}{196}}$$

The solution is Whole, which is option A.

A. Whole

* This is the correct option!

B. Integer

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

C. Rational

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

D. Irrational

These cannot be written as a fraction of Integers.

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 140.

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

$$\sqrt{\frac{0}{144}} + \sqrt{10}i$$

The solution is Pure Imaginary, which is option B.

A. Rational

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

B. Pure Imaginary

* This is the correct option!

C. Irrational

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

D. Nonreal Complex

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

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

$$1 - 18 \div 16 * 4 - (9 * 8)$$

The solution is $-75.500$, which is option B.

A. $[71.72, 73.72]$

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

B. $[-82.5, -71.5]$

* -75.500, which is the correct option.

C. $[-75.28, -70.28]$

-71.281, which corresponds to an Order of Operations error: not reading left-to-right for multiplication/division.

D. $[-101, -96]$

-100.000, 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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7. Simplify the expression below into the form $a + bi$. Then, choose the intervals that $a$ and $b$ belong to.

$$(5 + 2i)(8 - 9i)$$

The solution is $58 - 29i$, which is option E.

A. $a \in [20, 28]$ and $b \in [59, 62]$

$22 + 61i$, which corresponds to adding a minus sign in the second term.

B. $a \in [40, 43]$ and $b \in [-21, -7]$

$40 - 18i$, 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. $a \in [20, 28]$ and $b \in [-67, -59]$

$22 - 61i$, which corresponds to adding a minus sign in the first term.

D. $a \in [57, 60]$ and $b \in [28, 30]$

$58 + 29i$, which corresponds to adding a minus sign in both terms.

E. $a \in [57, 60]$ and $b \in [-30, -23]$

* $58 - 29i$, 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. Choose the **smallest** set of Real numbers that the number below belongs to.

$$\sqrt{\frac{1980}{10}}$$

The solution is Irrational, which is option B.

A. Whole

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

B. Irrational

* This is the correct option!

C. Integer

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

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 $\sqrt{198}$.

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

$$\frac{-18 - 11i}{6 - 5i}$$

The solution is $-0.87 - 2.56i$, which is option C.

A. $a \in [-53.25, -52.45]$ and $b \in [-4, -1]$

$-53.00 - 2.56i$, which corresponds to forgetting to multiply the conjugate by the numerator and using a plus instead of a minus in the denominator.

B. $a \in [-3.1, -2.7]$ and $b \in [1, 3.5]$

$-3.00 + 2.20i$, which corresponds to just dividing the first term by the first term and the second by the second.

C. $a \in [-1.6, -0.45]$ and $b \in [-4, -1]$

* $-0.87 - 2.56i$, which is the correct option.

D. $a \in [-1.6, -0.45]$ and $b \in [-156.5, -155]$

$-0.87 - 156.00i$, which corresponds to forgetting to multiply the conjugate by the numerator.

E. $a \in [-2.85, -2.6]$ and $b \in [-0.5, 0.5]$

$-2.67 + 0.39i$, 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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10. Simplify the expression below into the form $a + bi$. Then, choose the intervals that $a$ and $b$ belong to.

$$\frac{-9 + 22i}{6 - 7i}$$

The solution is $-2.45 + 0.81i$, which is option C.

A. $a \in [-2.6, -2.3]$ and $b \in [68.5, 70]$

$-2.45 + 69.00i$, which corresponds to forgetting to multiply the conjugate by the numerator.

B. $a \in [0.65, 1.3]$ and $b \in [2, 2.5]$

$1.18 + 2.29i$, which corresponds to forgetting to multiply the conjugate by the numerator and not computing the conjugate correctly.

C. $a \in [-2.6, -2.3]$ and $b \in [0, 2]$

   * $-2.45 + 0.81i$, which is the correct option.

D. $a \in [-1.9, -0.75]$ and $b \in [-3.5, -2]$

   $-1.50 - 3.14i$, which corresponds to just dividing the first term by the first term and the second by the second.

E. $a \in [-208.2, -207.95]$ and $b \in [0, 2]$

   $-208.00 + 0.81i$, which corresponds to forgetting to multiply the conjugate by the numerator and using a plus instead of a minus in the denominator.

**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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