**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.*

---

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

$$\frac{8}{-11} + 81i^2$$

The solution is Rational, which is option C.

A. Irrational

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

B. Pure Imaginary

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

C. Rational

* 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. 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.

---

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

$$18 - 12 \div 5 * 3 - (14 * 13)$$

The solution is $-171.200$, which is option C.

A. $[-169.8, -161.8]$

-164.800, which corresponds to an Order of Operations error: not reading left-to-right for multiplication/division.

B. $[-42.6, -38.6]$

-41.600, which corresponds to not distributing a negative correctly.

C. $[-171.2, -167.2]$

* -171.200, which is the correct option.

D. $[199.2, 204.2]$

199.200, 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.

---

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

$$14 - 18^2 + 4 \div 7 * 16 \div 20$$

The solution is $-309.543$, which is option B.

A. $[-310.18, -309.96]$

-309.998, which corresponds to an Order of Operations error: not reading left-to-right for multiplication/division.

B. $[-309.57, -309.3]$

* -309.543, this is the correct option

C. $[338.37, 338.53]$

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

D. $[337.99, 338.44]$

338.002, 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.

---

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

$$\sqrt{\frac{289}{81}}$$

The solution is Rational, which is option C.

A. Whole

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

B. Irrational

These cannot be written as a fraction of Integers.

C. Rational

* This is the correct option!

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 $\frac{17}{9}$.

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.

---

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

$$\frac{54 - 11i}{4 - 7i}$$

The solution is $4.51 + 5.14i$, which is option A.

A. $a \in [4, 6]$ and $b \in [4.5, 6]$

* $4.51 + 5.14i$, which is the correct option.

B. $a \in [1, 3]$ and $b \in [-7, -5]$

$2.14 - 6.49i$, which corresponds to forgetting to multiply the conjugate by the numerator and not computing the conjugate correctly.

C. $a \in [291.5, 293.5]$ and $b \in [4.5, 6]$

$293.00 + 5.14i$, which corresponds to forgetting to multiply the conjugate by the numerator and using a plus instead of a minus in the denominator.

D. $a \in [4, 6]$ and $b \in [332.5, 335]$

$4.51 + 334.00i$, which corresponds to forgetting to multiply the conjugate by the numerator.

E. $a \in [13, 14]$ and $b \in [0.5, 2]$

$13.50 + 1.57i$, 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 $2 - 3i$.

---

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

$$\sqrt{\frac{1001}{7}} + \sqrt{119}i$$

The solution is Nonreal Complex, which is option B.

A. Pure Imaginary

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

B. Nonreal Complex

* This is the correct option!

C. Irrational

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

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.

---

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

$$(-10 + 7i)(3 - 4i)$$

The solution is $-2 + 61i$, which is option C.

A. $a \in [-58, -55]$ and $b \in [-21, -13]$

$-58 - 19i$, which corresponds to adding a minus sign in the second term.

B. $a \in [-30, -21]$ and $b \in [-29, -26]$

$-30 - 28i$, 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. $a \in [-3, 2]$ and $b \in [58, 64]$

* $-2 + 61i$, which is the correct option.

D. $a \in [-58, -55]$ and $b \in [19, 24]$

$-58 + 19i$, which corresponds to adding a minus sign in the first term.

E. $a \in [-3, 2]$ and $b \in [-61, -59]$

$-2 - 61i$, 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.

---

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

$$\frac{63 + 33i}{-1 + 5i}$$

The solution is $3.92 - 13.38i$, which is option E.

A. $a \in [-64.5, -62.5]$ and $b \in [4.5, 7.5]$

$-63.00 + 6.60i$, which corresponds to just dividing the first term by the first term and the second by the second.

B. $a \in [3, 4.5]$ and $b \in [-348.5, -347.5]$

$3.92 - 348.00i$, which corresponds to forgetting to multiply the conjugate by the numerator.

C. $a \in [-10.5, -8.5]$ and $b \in [10, 12]$

$-8.77 + 10.85i$, which corresponds to forgetting to multiply the conjugate by the numerator and not computing the conjugate correctly.

D. $a \in [101, 102.5]$ and $b \in [-14, -13]$

$102.00 - 13.38i$, which corresponds to forgetting to multiply the conjugate by the numerator and using a plus instead of a minus in the denominator.

E. $a \in [3, 4.5]$ and $b \in [-14, -13]$

* $3.92 - 13.38i$, 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 $2 - 3i$.

---

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

$$(-10 - 7i)(9 - 6i)$$

The solution is $-132 - 3i$, which is option C.

A. $a \in [-134, -127]$ and $b \in [3, 8]$

$-132 + 3i$, which corresponds to adding a minus sign in both terms.

B. $a \in [-91, -85]$ and $b \in [38, 48]$

$-90 + 42i$, 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.

C. $a \in [-134, -127]$ and $b \in [-4, -1]$

* $-132 - 3i$, which is the correct option.

D. $a \in [-51, -47]$ and $b \in [-133, -121]$

$-48 - 123i$, which corresponds to adding a minus sign in the second term.

E. $a \in [-51, -47]$ and $b \in [122, 127]$

$-48 + 123i$, 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.

---

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

$$\sqrt{\frac{23104}{361}}$$

The solution is Whole, which is option B.

A. Irrational

These cannot be written as a fraction of Integers.

B. Whole

* 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 152.

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.

---