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. Simplify the expression below into the form $a + bi$.

$$\frac{54 - 11i}{-8 + 3i}$$

The solution is $-6.37 - 1.01i$.

Plausible alternative answers include: $-5.47 + 3.42i$, which corresponds to forgetting to multiply the conjugate by the numerator and not computing the conjugate correctly. $-465.00 - 1.01i$, which corresponds to forgetting to multiply the conjugate by the numerator and using a plus instead of a minus in the denominator. $-6.37 - 74.00i$, which corresponds to forgetting to multiply the conjugate by the numerator. $-6.75 - 3.67i$, which corresponds to just dividing the first term by the first term and the second by the second. * $-6.37 - 1.01i$, 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 $2 - 3i$.

---

2. Simplify the expression below into the form $a + bi$.

$$\frac{-63 - 55i}{-3 + 6i}$$

The solution is $-3.13 + 12.07i$.

Plausible alternative answers include:* $-3.13+12.07i$, which is the correct option. $-141.00+12.07i$, which corresponds to forgetting to multiply the conjugate by the numerator and using a plus instead of a minus in the denominator. $11.53 - 4.73i$, which corresponds to forgetting to multiply the conjugate by the numerator and not computing the conjugate correctly. $-3.13 + 543.00i$, which corresponds to forgetting to multiply the conjugate by the numerator. $21.00-9.17i$, 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 $2 - 3i$.

---

3. What is the **smallest** set of Complex numbers that the number below belongs to?

$$\sqrt{\frac{361}{225}} + 25i^2$$

The solution is Rational.

Plausible alternative answers include:* This is the correct option! This is not a number. The only non-Complex number we know is dividing by 0 as this is not a number! These cannot be written as a fraction of Integers. Remember: π is not an Integer! This is a Complex number $(a + bi)$ that **only** has an imaginary part like $2i$. 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.

---

4. Simplify the expression below into the form $a + bi$.

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

The solution is $82 + 22i$.

Plausible alternative answers include: $82 - 22i$, which corresponds to adding a minus sign in both terms. $-62 - 58i$, which corresponds to adding a minus sign in the second term. $10 - 72i$, 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. $-62 + 58i$, which corresponds to adding a minus sign in the first term. * $82 + 22i$, 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.

---

5. What is the **smallest** set of Real numbers that the number below belongs to?

$$-\sqrt{\frac{1320}{10}}$$

The solution is Irrational.

Plausible alternative answers include: These are the counting numbers with 0 (0, 1, 2, 3, ...) * This is the correct option! These are numbers that can be written as fraction of Integers (e.g., -2/3) These are Nonreal Complex numbers **OR** things that are not numbers (e.g., dividing by 0). These are the negative and positive counting numbers (..., -3, -2, -1, 0, 1, 2, 3, ...)

General Comment: First, you **NEED** to simplify the expression. This question simplifies to $-\sqrt{132}$.

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.

---

6. What is the **smallest** set of Complex numbers that the number below belongs to?

$$\frac{-19}{-12} + \sqrt{-36}i$$

The solution is Rational.

Plausible alternative answers include: This is a Complex number $(a + bi)$ that is not Real (has i as part of the number). This is a Complex number $(a + bi)$ that **only** has an imaginary part like $2i$. * This is the correct option! This is not a number. The only non-Complex number we know is dividing by 0 as this is not a number! These cannot be written as a fraction of Integers. Remember: π 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.

---

7. Simplify the expression below into the form $a + bi$.

$$(7 + 2i)(9 - 5i)$$

The solution is $73 - 17i$.

Plausible alternative answers include: $63 - 10i$, 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. $73 + 17i$, which corresponds to adding a minus sign in both terms. $53 - 53i$, which corresponds to adding a minus sign in the first term. $53 + 53i$, which corresponds to adding a minus sign in the second term. * $73 - 17i$, 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.

---

8. Simplify the expression below.

$$14 - 10 \div 8 * 5 - (3 * 15)$$

The solution is -37.250.

Plausible alternative answers include: -31.250, which corresponds to an Order of Operations error: not reading left-to-right for multiplication/division. 58.750, which corresponds to not distributing addition and subtraction correctly. 71.250, which corresponds to not distributing a negative correctly. * -37.250, which is the correct option. 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.

---

9. Simplify the expression below.

$$11 - 19^2 + 2 \div 9 * 8 \div 1$$

The solution is -348.222.

Plausible alternative answers include: 373.778, which corresponds to an Order of Operations error: multiplying by negative before squaring. For example: $(-3)^2 \neq -3^2$ -349.972, which corresponds to an Order of Operations error: not reading left-to-right for multiplication/division. 372.028, which corresponds to two Order of Operations errors. * -348.222, this is the correct option 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.

---

10. What is the **smallest** set of Real numbers that the number below belongs to?

$$\sqrt{\frac{10816}{169}}$$

The solution is Whole.

Plausible alternative answers include:* This is the correct option! These are the negative and positive counting numbers (..., -3, -2, -1, 0, 1, 2, 3, ...) These cannot be written as a fraction of Integers. These are numbers that can be written as fraction of Integers (e.g., -2/3) 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 104.

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.
