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 $a + bi$.

$$\frac{27 + 88i}{5 - 4i}$$

The solution is $-5.29 + 13.37i$.

Plausible alternative answers include: $-5.29 + 548.00i$, which corresponds to forgetting to multiply the conjugate by the numerator. $5.40 - 22.00i$, which corresponds to just dividing the first term by the first term and the second by the second. * $-5.29 + 13.37i$, which is the correct option. $11.88 + 8.10i$, which corresponds to forgetting to multiply the conjugate by the numerator and not computing the conjugate correctly. $-217.00 + 13.37i$, 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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2. Simplify the expression below into the form $a + bi$.

$$\frac{-27 + 55i}{-4 + 2i}$$

The solution is $10.90 - 8.30i$.

Plausible alternative answers include: $-0.10 - 13.70i$, which corresponds to forgetting to multiply the conjugate by the numerator and not computing the conjugate correctly. $6.75 + 27.50i$, which corresponds to just dividing the first term by the first term and the second by the second. $10.90 - 166.00i$, which corresponds to forgetting to multiply the conjugate by the numerator. * $10.90 - 8.30i$, which is the correct option. $218.00 - 8.30i$, 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 $2 - 3i$.

---

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

$$\sqrt{\frac{715}{11}} + 6i^2$$

The solution is Irrational.

Plausible alternative answers include: This is not a number. The only non-Complex number we know is dividing by 0 as this is not a number! These are numbers that can be written as fraction of Integers (e.g., -2/3 + 5) * This is the correct option! 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 $2i$.

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

$$(7 + 6i)(5 + 4i)$$

The solution is $11 + 58i$.

> **Plausible alternative answers include:** $11 - 58i$, which corresponds to adding a minus sign in both terms. $35 + 24i$, 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. $59 - 2i$, which corresponds to adding a minus sign in the first term. * $11 + 58i$, which is the correct option. $59 + 2i$, 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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5. What is the **smallest** set of Real numbers that the number below belongs to?

$$\sqrt{\frac{1872}{8}}$$

The solution is Irrational.

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

General Comment: First, you **NEED** to simplify the expression. This question simplifies to $\sqrt{234}$.

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

$$\sqrt{\frac{0}{6}} + \sqrt{6}i$$

The solution is Pure Imaginary.

> **Plausible alternative answers include:**This is not a number. The only non-Complex number we know is dividing by 0 as this is not a number! These are numbers that can be written as fraction of Integers (e.g., -2/3 + 5) These cannot be written as a fraction of Integers. Remember: π is not an Integer! * This is the correct option! 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.

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

$$(-7 - 10i)(2 + 9i)$$

The solution is $76 - 83i$.

Plausible alternative answers include:* $76 - 83i$, which is the correct option. $-104 - 43i$, which corresponds to adding a minus sign in the first term. $76 + 83i$, which corresponds to adding a minus sign in both terms. $-104 + 43i$, which corresponds to adding a minus sign in the second term. $-14 - 90i$, 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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8. Simplify the expression below.

$$20 - 1 \div 19 * 13 - (2 * 3)$$

The solution is 13.316.

Plausible alternative answers include: 51.947, which corresponds to not distributing a negative correctly. 13.996, which corresponds to an Order of Operations error: not reading left-to-right for multiplication/division. * 13.316, which is the correct option. 25.996, which corresponds to not distributing addition and subtraction correctly. 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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9. Simplify the expression below.

$$2 - 7^2 + 9 \div 16 * 13 \div 4$$

The solution is -45.172.

Plausible alternative answers include: 51.011, which corresponds to two Order of Operations errors. 52.828, which corresponds to an Order of Operations error: multiplying by negative before squaring. For example: $(-3)^2 \neq -3^2$ * -45.172, this is the correct option -46.989, which corresponds to an Order of Operations error: not reading left-to-right for multiplication/division. 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. What is the **smallest** set of Real numbers that the number below belongs to?

$$-\sqrt{\frac{19}{0}}$$

The solution is Not a Real number.

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

General Comment: First, you **NEED** to simplify the expression. This question simplifies to $-\sqrt{\frac{19}{0}}$.

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

$$\frac{-54 + 77i}{-2 + 5i}$$

The solution is $17.00 + 4.00i$.

> **Plausible alternative answers include:** $-9.55 - 14.62i$, which corresponds to forgetting to multiply the conjugate by the numerator and not computing the conjugate correctly. * $17.00 + 4.00i$, which is the correct option. $17.00 + 116.00i$, which corresponds to forgetting to multiply the conjugate by the numerator. $27.00 + 15.40i$, which corresponds to just dividing the first term by the first term and the second by the second. $493.00 + 4.00i$, 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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12. Simplify the expression below into the form $a + bi$.

$$\frac{-63 + 11i}{5 + 8i}$$

The solution is $-2.55 + 6.28i$.

> **Plausible alternative answers include:** $-2.55 + 559.00i$, which corresponds to forgetting to multiply the conjugate by the numerator. $-227.00 + 6.28i$, which corresponds to forgetting to multiply the conjugate by the numerator and using a plus instead of a minus in the denominator. * $-2.55 + 6.28i$, which is the correct option. $-12.60 + 1.38i$, which corresponds to just dividing the first term by the first term and the second by the second. $-4.53 - 5.04i$, 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 $2 - 3i$.

---

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

$$\sqrt{\frac{-2805}{15}}i + \sqrt{182}i$$

The solution is Nonreal Complex.

> **Plausible alternative answers include:**These are numbers that can be written as fraction of Integers (e.g., -2/3 + 5) This is a Complex number ($a + bi$) that **only** has an imaginary part like $2i$. These cannot be written as a fraction of Integers. Remember: π is not an Integer! * 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!

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

$$(2 - 5i)(-4 + 7i)$$

The solution is $27 + 34i$.

Plausible alternative answers include: $-43 + 6i$, which corresponds to adding a minus sign in the second term. $-43 - 6i$, which corresponds to adding a minus sign in the first term. * $27 + 34i$, which is the correct option. $-8 - 35i$, 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. $27 - 34i$, 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.

---

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

$$-\sqrt{\frac{130321}{361}}$$

The solution is Integer.

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

General Comment: First, you **NEED** to simplify the expression. This question simplifies to -361.

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

$$\sqrt{\frac{0}{289}} + \sqrt{3}i$$

The solution is Pure Imaginary.

Plausible alternative answers include: This is not a number. The only non-Complex number we know is dividing by 0 as this is not a number! These are numbers that can be written as fraction of Integers (e.g., -2/3 + 5) These cannot be written as a fraction of Integers. Remember: π is not an Integer! * This is the correct option! 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.

---

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

$$(4 - 6i)(5 + 2i)$$

The solution is $32 - 22i$.

Plausible alternative answers include: $32 + 22i$, which corresponds to adding a minus sign in both terms. $8 - 38i$, which corresponds to adding a minus sign in the second term. $8 + 38i$, which corresponds to adding a minus sign in the first term. * $32 - 22i$, which is the correct option. $20 - 12i$, 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.

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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18. Simplify the expression below.

$$11 - 5^2 + 7 \div 1 * 19 \div 4$$

The solution is 19.250.

Plausible alternative answers include: -13.908, which corresponds to an Order of Operations error: not reading left-to-right for multiplication/division. 36.092, which corresponds to two Order of Operations errors. * 19.250, this is the correct option 69.250, which corresponds to an Order of Operations error: multiplying by negative before squaring. For example: $(-3)^2 \neq -3^2$ 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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19. Simplify the expression below.

$$11 - 5 \div 17 * 19 - (1 * 4)$$

The solution is 1.412.

Plausible alternative answers include: 6.985, which corresponds to an Order of Operations error: not reading left-to-right for multiplication/division. * 1.412, which is the correct option. 14.985, which corresponds to not distributing addition and subtraction correctly. 17.647, which corresponds to not distributing a negative correctly. 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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20. What is the **smallest** set of Real numbers that the number below belongs to?

$$\sqrt{\frac{-2366}{13}}$$

The solution is Not a Real number.

Plausible alternative answers include: 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 the counting numbers with 0 (0, 1, 2, 3, ...) These are numbers that can be written as fraction of Integers (e.g., -2/3) * This is the correct option!

General Comment: First, you **NEED** to simplify the expression. This question simplifies to $\sqrt{182}i$.

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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21. 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 $2 - 3i$.

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22. 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 $2 - 3i$.

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23. 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.

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24. 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.

---

25. 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.

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26. 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.

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27. 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.

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28. 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.

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29. 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.

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30. 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.