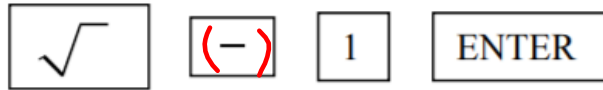


Warm Up

Enter the following keystrokes on a calculator.



Describe what the calculator gives you as a solution.

Repeat the keystrokes with a different negative number.

Why does the calculator give this answer?

3.2 Complex Numbers

Core Concept

The Square Root of a Negative Number

Property

1. If r is a positive real number, then $\sqrt{-r} = i\sqrt{r}$.
2. By the first property, it follows that $(i\sqrt{r})^2 = -r$.

Example

$$\sqrt{-3} = i\sqrt{3}$$

$$(i\sqrt{3})^2 = i^2 \cdot 3 = -3$$

$$* \text{ Since } i = \sqrt{-1}, i^2 = (\sqrt{-1})^2 = -1$$

i: imaginary unit

$$i = \sqrt{-1}$$

Find the square root of each number. *Simplify!*

a. $\sqrt{-25} = i\sqrt{25}$

$5i$

b. $\sqrt{-72} = i\sqrt{72}$

$i\sqrt{36}\sqrt{2}$

$6i\sqrt{2}$

c. $-5\sqrt{-9} = -5i\sqrt{9}$

$-5i(3)$

$-15i$

Find the square root of the number.

d. $\sqrt{-4}$

$2i$

e. $\sqrt{-12}$

$2i\sqrt{3}$

f. $-\sqrt{-36} = -i\sqrt{36}$ g. $2\sqrt{-54} = 2\sqrt{i\sqrt{54}}$

$-6i$

$6(-i)$

$6i\sqrt{6}$

$2(3i\sqrt{6})$

(2) Find the values of x and y that satisfy the equation.

a. $2x - 7i = 10 + yi$ * real parts must be =

* $2x = 10$ @ imaginary parts be =

$x = 5$

@ $-7i = yi$

$-7 = y$

Find the values of x and y that satisfy the equation.

b. $x + 3i = 9 - yi$

$x = 9$

$3 = -y$
 $y = -3$

c. $9 + 4yi = -2x + 3i$

$9 = -2x$
 $x = -9/2$

$4y = 3$
 $y = 3/4$

Core Concept

Sums and Differences of Complex Numbers

To add (or subtract) two complex numbers, add (or subtract) their real parts and their imaginary parts separately.

Sum of complex numbers: $(a + bi) + (c + di) = (a + c) + (b + d)i$

Difference of complex numbers: $(a + bi) - (c + di) = (a - c) + (b - d)i$

(3) Add or subtract. Write the answer in standard form.

a. $(8 - i) + (5 + 4i) = 13 + 3i$

b. $(7 - 6i) - (3 - 6i) = 4$

$-6i + (+6i) = 0$

$\underline{7} - \underline{6i} - \underline{3} + \underline{6i}$

c. $13 - (2 + 7i) + 5i$

~~$11 + 12i$~~

~~$11 + 2i$~~

$11 - 2i$

$\underline{13} - 2(-7i + 5i)$

(4) Multiply. Write the answer in standard form.

a. $4i(-6 + i)$

$$-24i + 4i^2$$

$$-24i + 4(-1)$$

$$-4 - 24i$$

never leave
 i^2 in
final answer

b. $(9 - 2i)(-4 + 7i)$

$$-36 + 63i + 8i - 14i^2$$

$$-36 + 63i + 8i + 14$$

$$-22 + 71i$$

(5) Perform the operation. Write the answer in standard form.

a. $(9 - i) + (-6 + 7i)$

$$3 + 6i$$

b. $(3 + 7i) - (8 - 2i)$

$$-5 + 9i$$

c. $-4 - 1(1 + i) - 5(5 + 9i)$

$$-4 - 1(-i) - 5(-9i)$$

$$-10 - 10i$$

d. $(-3i)(10i) = -30i^2$

$$30 - 30(-1)$$

e. $i(8 - i) = 8i - i^2$

$$1 + 8i$$

f. $(3 + i)(5 - i)$

$$15 - 3i + 5i - i^2$$

$$16 + 2i$$

(6) Solve each equation.

(a) $x^2 + 4 = 0 \rightarrow \sqrt{x^2} = \pm \sqrt{-4} \rightarrow x = \pm 2i$

(b) $2x^2 - 11 = -47$

$$\begin{array}{r} +11 \quad +11 \\ \hline 2x^2 = -36 \\ \hline \frac{2x^2}{2} = \frac{-36}{2} \end{array}$$

$$\sqrt{x^2} = \sqrt{-18}$$

$$x = \pm \sqrt{-18}$$

$$x = \pm i\sqrt{18}$$

$$x = \pm 3i\sqrt{2}$$

(7) Find the zeros of $f(x) = 4x^2 + 20$.

$$4x^2 + 20 = 0$$

$$4x^2 = -20$$

$$\sqrt{x^2} = \sqrt{-5}$$

$$x = \pm i\sqrt{5}$$

Mixed Practice**Solve the equation.**

1. $x^2 = -13$

2. $x^2 + 11 = 3$

3. $3x^2 - 7 = -31$

Find the zeros of the function.

4. $f(x) = x^2 + 7$

5. $f(x) = -x^2 - 4$

6. $f(x) = 9x^2 + 1$