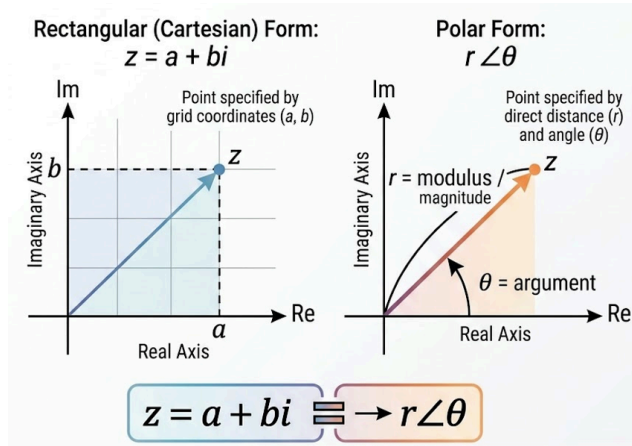


In a complex algebra, a complex number is traditionally written in rectangular (or Cartesian) form as  $z = a + bi$ , where  $a$  represents the horizontal position along the real axis and  $b$  represents the vertical position along the imaginary axis.

Alternatively, **polar form** describes that same complex number using a vector geometry perspective. Instead of using grid coordinates, polar form specifies the point using its direct distance from the origin—known as the **modulus or magnitude** ( $r$ )—and its counterclockwise direction angle relative to the positive real axis—known as the **argument** ( $\theta$ ).



Mathematically, it can be written as  $r(\cos\theta + i \sin\theta)$ , which is often abbreviated in engineering contexts as  $r \angle \theta$ .

To convert the rectangular complex number  $4 + 8i$  into polar form, we must independently calculate its modulus ( $r$ ) and its argument ( $\theta$ ) using standard trigonometric relations:

1. **Calculate the Magnitude ( $r$ ):** The modulus is found by treating the real and imaginary components as the sides of a right triangle and applying the Pythagorean theorem:

$$r = \sqrt{a^2 + b^2} = \sqrt{4^2 + 8^2} \approx 8.944$$

2. **Calculate the Angle ( $\theta$ ):** The directional argument is found by evaluating the inverse tangent of the ratio of the imaginary part to the real part:

$$\theta = \arctan\left(\frac{b}{a}\right) = \arctan\left(\frac{8}{4}\right) \approx 63.43^\circ$$

Combining these two calculated parameters gives the complete polar coordinate description:  $8.944 \angle 63.43^\circ$ .

### CALCULATOR TIPS:

Manually writing out square roots and arctangent operations leaves too much room for mistake. Solve this in under 5 seconds using your calculator's built-in conversion system:



### The Complex Mode Polar Conversion Shortcut (Casio fx-991ES Plus / ClassWiz)

Your calculator can translate between coordinate layouts automatically.

1. **Enter Complex Mode:** Press **MODE 2** (on the fx-991ES Plus) or **MENU 2** (on the fx-991EX ClassWiz).
2. **Type the Complex Number:** Input the rectangular form exactly onto your screen using the **ENG** key for the imaginary unit:  $4 + 8i$ .
3. **Execute the Polar Conversion Command:**
  - **On the fx-991ES Plus:** Press **SHIFT 2 3**. This adds the conversion syntax command  $\blacktriangleright r \angle \theta$  to your expression line. Press **=**.
  - **On the fx-991EX ClassWiz:** Press the **OPTN** key, scroll down one page using the arrow pad, select **1:  $\blacktriangleright r \angle \theta$** , and press **=**.
4. The screen will instantly display  $4\sqrt{5} \angle 63.4349^\circ$ . Press the **Leftrightarrow** button to view the magnitude as a decimal, yielding  $8.94 \angle 63.4349^\circ$ .

**Note:** Always make sure your calculator is set to **Degree Mode (D)** and not Radian Mode (R) before executing coordinate conversions. If you see an **R** at the top of your screen, change it immediately by pressing **SHIFT MODE 3** (on older models) or **SHIFT MENU 2 1** (on modern models).