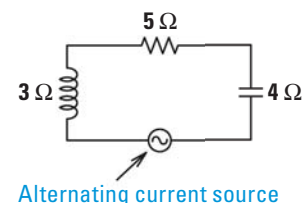**EXAMPLE 3** **Use addition of complex numbers in real life**

ELECTRICITY Circuit components such as resistors, inductors, and capacitors all oppose the flow of current. This opposition is called *resistance* for resistors and *reactance* for inductors and capacitors. A circuit's total opposition to current flow is *impedance*. All of these quantities are measured in ohms (Ω).

READING
Note that while a component's resistance or reactance is a real number, its impedance is a complex number.

Component and symbol	Resistor ⎓⎓⎓	Inductor ⎓⎓⎓	Capacitor ⊣⊢
Resistance or reactance	R	L	C
Impedance	R	Li	$-Ci$

5 Ω
3 Ω
4 Ω
Alternating current source

The table shows the relationship between a component's resistance or reactance and its contribution to impedance. A *series circuit* is also shown with the resistance or reactance of each component labeled.

The impedance for a series circuit is the sum of the impedances for the individual components. Find the impedance of the circuit shown above.

Solution

The resistor has a resistance of 5 ohms, so its impedance is 5 ohms. The inductor has a reactance of 3 ohms, so its impedance is $3i$ ohms. The capacitor has a reactance of 4 ohms, so its impedance is $-4i$ ohms.

$$\text{Impedance of circuit} = 5 + 3i + (-4i) \quad \textbf{Add the individual impedances.}$$
$$= 5 - i \quad \textbf{Simplify.}$$

▶ The impedance of the circuit is $5 - i$ ohms.

MULTIPLYING COMPLEX NUMBERS To multiply two complex numbers, use the distributive property or the FOIL method just as you do when multiplying real numbers or algebraic expressions.

EXAMPLE 4 **Multiply complex numbers**

Write the expression as a complex number in standard form.

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

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

Solution

AVOID ERRORS
When simplifying an expression that involves complex numbers, be sure to simplify i^2 to -1.

a. $4i(-6 + i) = -24i + 4i^2$ **Distributive property**
$$= -24i + 4(-1) \quad \textbf{Use } i^2 = -1.$$
$$= -24i - 4 \quad \textbf{Simplify.}$$
$$= -4 - 24i \quad \textbf{Write in standard form.}$$

b. $(9 - 2i)(-4 + 7i) = -36 + 63i + 8i - 14i^2$ **Multiply using FOIL.**
$$= -36 + 71i - 14(-1) \quad \textbf{Simplify and use } i^2 = -1.$$
$$= -36 + 71i + 14 \quad \textbf{Simplify.}$$
$$= -22 + 71i \quad \textbf{Write in standard form.}$$