Schematics, Diagrams, Circuits, and Given Data: $\tilde{\mathbf{V}}_S = 60\angle 0$ V; $R = 3\ \Omega$; $jX_L = j9\ \Omega$; $jX_C = -j5\ \Omega$.

Assumptions: Use rms values for all phasor quantities in the problem.

Analysis: First, we compute the load current:

$$\tilde{\mathbf{I}}_L = \frac{\tilde{\mathbf{V}}_L}{Z_L} = \frac{60\angle 0}{3 + j9 - j5} = \frac{60\angle 0}{5\angle 0.9273} = 12\angle(-0.9273)\ \text{A}$$

Next, we compute the complex power, as defined in equation 7.28:

$$S = \tilde{\mathbf{V}}_L \tilde{\mathbf{I}}_L^* = 60\angle 0 \times 12\angle 0.9273 = 720\angle 0.9273 = 432 + j576\ \text{VA}$$

Therefore

$$P_{\text{av}} = 432\ \text{W} \qquad Q = 576\ \text{VAR}$$

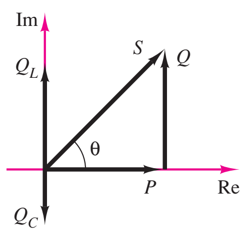
If we observe that the total reactive power must be the sum of the reactive powers in each of the elements, we can write $Q = Q_C + Q_L$ and compute each of the two quantities as follows:

$$Q_C = |\tilde{\mathbf{I}}_L|^2 \times X_C = (144)(-5) = -720\ \text{VAR}$$
$$Q_L = |\tilde{\mathbf{I}}_L|^2 \times X_L = (144)(9) = 1{,}296\ \text{VAR}$$

and

$$Q = Q_L + Q_C = 576\ \text{VAR}$$

Comments: The power triangle corresponding to this circuit is drawn in Figure 7.17. The vector diagram shows how the complex power S results from the vector addition of the three components P, Q_C, and Q_L.



Note: $S = P_R + jQ_C + jQ_L$

Figure 7.17

CHECK YOUR UNDERSTANDING

Compute the power factor for the load of Example 7.7 with and without the inductor in the circuit.

Answer: $pf = 0.6$, lagging (with L in circuit); $pf = 0.5145$, leading (without L)

The distinction between leading and lagging power factors made in Table 7.2 is important, because it corresponds to opposite signs of the reactive power: Q is positive if the load is inductive ($\theta > 0$) and the power factor is lagging; Q is negative if the load is capacitive and the power factor is leading ($\theta < 0$). It is therefore possible to improve the power factor of a load according to a procedure called **power factor correction,** that is, by placing a suitable reactance in parallel with the load so that the reactive power component generated by the additional reactance is of opposite sign to the original load reactive power. Most often the need is to improve the power factor of an inductive load, because many common industrial loads consist of electric motors, which are predominantly inductive loads. This improvement may be accomplished by placing a capacitance in parallel with the load. Example 7.8 illustrates a typical power factor correction for an industrial load.