4. **What is the power factor (PF) of a purely resistive ac circuit?**
   a. 0.
   b. 1.
   c. 0.707.
   d. Without values, it cannot be determined.

5. **The unit of apparent power is the**
   a. volt-ampere (VA).
   b. watt (W).
   c. volt-ampere reactive (VAR).
   d. joule (J).

6. **A 15-Ω resistance is in series with 50 Ω of $X_L$ and 30 Ω of $X_C$. If the applied voltage equals 50 V, how much real power is dissipated by the circuit?**
   a. 60 W.
   b. 100 W.
   c. 100 VA.
   d. 4.16 W.

7. **An ac circuit has a 100-Ω $R$, a 300-Ω $X_L$, and a 200-Ω $X_C$ all in series. What is the phase angle of the circuit?**
   a. 78.7°.
   b. 45°.
   c. −90°.
   d. 56.3°.

8. **A 10-Ω resistor is in parallel with an $X_L$ of 10 Ω. If the applied voltage is 120 V, what is the power factor of the circuit?**
   a. 0.
   b. 0.5.
   c. 1.
   d. 0.707.

9. **An ac circuit has an 80-Ω $R$, 20-Ω $X_L$, and a 40-Ω $X_C$ in parallel. If the applied voltage is 24 Vac, what is the phase angle of the circuit?**
   a. −26.6°.
   b. 45°.
   c. −63.4°.
   d. −51.3°.

10. **In an ac circuit with only series capacitors,**
    a. $V_T$ leads $I$ by 90°.
    b. $V_T$ lags $I$ by 90°.
    c. each capacitor voltage drop leads $I$ by 90°.
    d. both a and c.

11. **A 10-Ω $R$ is in parallel with a 15-Ω $X_L$. The applied voltage is 120 Vac. How much is the apparent power in the circuit?**
    a. 2.4 kW.
    b. 1.44 kVA.
    c. 1.44 kW.
    d. 1.73 kVA.

12. **The unit of real power is the**
    a. watt (W).
    b. volt-ampere (VA).
    c. joule (J).
    d. volt-ampere reactive (VAR).

13. **In a parallel ac circuit with $X_L$ and $X_C$,**
    a. $I_L$ and $I_C$ are 90° out of phase.
    b. $I_L$ and $I_C$ are in phase.
    c. $I_L$ and $I_C$ are 180° out of phase.
    d. $X_L$ and $X_C$ are 90° out of phase.

14. **In a series *RLC* circuit,**
    a. $X_L$ and $X_C$ are 180° out of phase.
    b. $I_L$ and $I_C$ are 180° out of phase.
    c. $X_L$ and $X_C$ are 90° out of phase.
    d. $X_L$ and $X_C$ are in phase.

15. **A parallel ac circuit with 120 Vac applied has a total current, $I_T$, of 5 A. If the phase angle of the circuit is −53.13°, how much real power is dissipated by the circuit?**
    a. 600 VA.
    b. 480 W.
    c. 360 W.
    d. 3.6 kVA.

## Essay Questions

1. Why can series or parallel resistances be combined in ac circuits the same way as in dc circuits?
2. (a) Why do $X_L$ and $X_C$ reactances in series offset each other? (b) With $X_L$ and $X_C$ reactances in parallel, why can their branch currents be subtracted?
3. Give one difference in electrical characteristics comparing $R$ and $X_C$, $R$ and $Z$, $X_C$ and $C$, $X_L$ and $L$.
4. Name three types of ac meters.
5. Make a diagram showing a resistance $R_1$ in series with the load resistance $R_L$, with a wattmeter connected to measure the power in $R_L$.
6. Make a phasor diagram for the circuit in Fig. 23–8*a* showing the phase of the voltage drops $IR$, $IX_C$, and $IX_L$ with respect to the reference phase of the common current $I$.
7. Explain briefly why the two opposite phasors at +90° for $X_L$ and −90° for $I_L$ both follow the principle that any self-induced voltage leads the current through the coil by 90°.
8. Why is it that a reactance phasor is always at exactly 90° but an impedance phasor can be less than 90°?
9. Why must the impedance of a series circuit be more than either its $X$ or its $R$?
10. Why must $I_T$ in a parallel circuit be more than either $I_R$ or $I_X$?
11. Compare real power and apparent power.
12. Define *power factor.*
13. Make a phasor diagram showing the opposite direction of positive and negative angles.
14. In Fig. 23–15, which circuit has leading current with a positive phase angle $\theta$ where $I$ from the source leads the $V$ applied by the source?

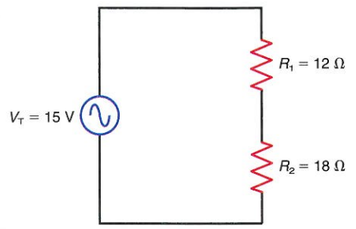


## Problems

### SECTION 23–1 AC CIRCUITS WITH RESISTANCE BUT NO REACTANCE

**23–1** In Fig. 23–17, solve for $R_T$, $I$, $V_1$, and $V_2$.

Figure 23–17

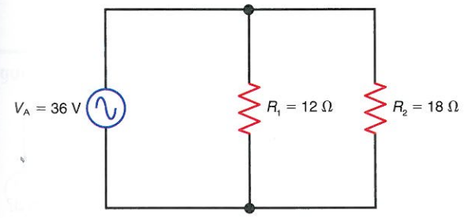



**23–2** In Fig. 23–17, what is the phase relationship between
a. $V_T$ and $I$?
b. $V_1$ and $I$?
c. $V_2$ and $I$?

**23–3** In Fig. 23–18, solve for $I_1$, $I_2$, $I_T$, and $R_{EQ}$.

**23–4** In Fig. 23–18, what is the phase relationship between
a. $V_A$ and $I_1$?
b. $V_A$ and $I_2$?
c. $V_A$ and $I_T$?

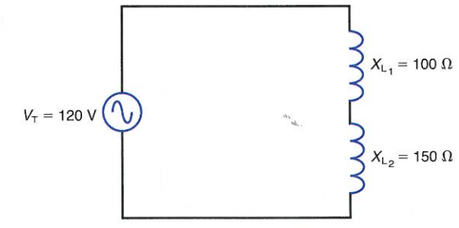
Figure 23–18




### SECTION 23–2 CIRCUITS WITH $X_L$ ALONE

**23–5** In Fig. 23–19, solve for $X_{L_T}$, $I$, $V_1$, and $V_2$.

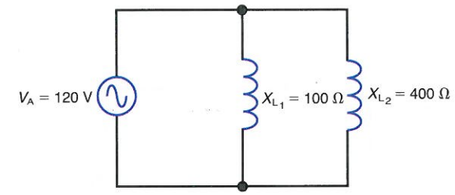
Figure 23–19




**23–6** In Fig. 23–19, what is the phase relationship between
a. $V_T$ and $I$?
b. $V_1$ and $I$?
c. $V_2$ and $I$?

**23–7** In Fig. 23–20, solve for $I_1$, $I_2$, $I_T$, and $X_{L_{EQ}}$.

Figure 23–20

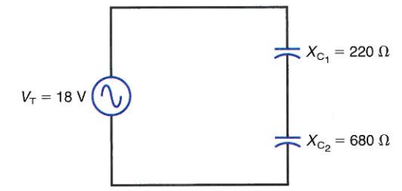



**23–8** In Fig. 23–20, what is the phase relationship between
a. $V_A$ and $I_1$?
b. $V_A$ and $I_2$?
c. $V_A$ and $I_T$?

### SECTION 23–3 CIRCUITS WITH $X_C$ ALONE

**23–9** In Fig. 23–21, solve for $X_{C_T}$, $I$, $V_1$, and $V_2$.

Figure 23–21




**23–10** In Fig. 23–21, what is the phase relationship between
a. $V_T$ and $I$?
b. $V_1$ and $I$?
c. $V_2$ and $I$?

**23–11** In Fig. 23–22, solve for $I_1$, $I_2$, $I_T$, and $X_{C_{EQ}}$.

Figure 23–22