AC Circuit

4. Figure P32.4 shows three lightbulbs connected to a 120-V AC (rms) household supply voltage. Bulbs 1 and 2 have a power rating of 150 W, and bulb 3 has a 100-W rating. Find (a) the rms current in each bulb and (b) the resistance of each bulb. (c) What is the total resistance of the combination of the three lightbulbs?

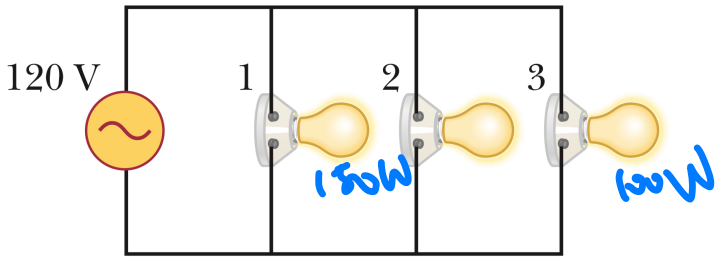


Figure P32.4

19. An *RLC* circuit consists of a 150-Ω resistor, a 21.0-μF capacitor, and a 460-mH inductor connected in series with a 120-V, 60.0-Hz power supply. (a) What is the phase angle between the current and the applied voltage? (b) Which reaches its maximum earlier, the current or the voltage?

Power Transmission

35. Energy is to be transmitted over a pair of copper wires in a transmission line at the rate of 20.0 kW with only a 1.00% loss over a distance of 18.0 km at potential difference $\Delta V_{\text{rms}} = 1.50 \times 10^3$ V between the wires. Assuming the current density is uniform in the conductors, what is the diameter required for each of the two wires?

4.

(a) $P = IV \Rightarrow I = \frac{P}{V}$

$$\begin{cases} 1, 2: & I = 1.25 \\ 3: & I = 0.83 \end{cases} \quad (A)$$

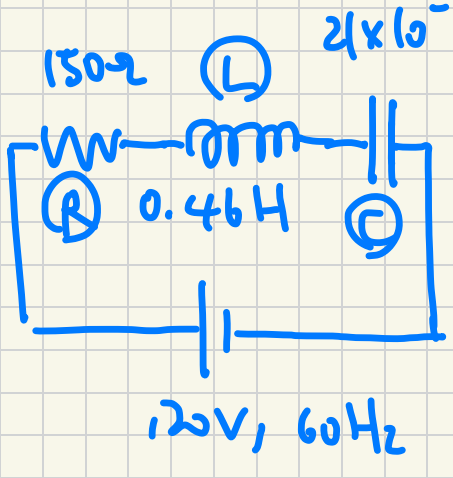
(b) $P = \frac{V^2}{R} \Rightarrow R = \frac{V^2}{P}$

$$\begin{cases} 1, 2: & R = \frac{120^2}{150} = 96 \\ 3: & R = \frac{120^2}{100} = 144 \end{cases} \quad (\Omega)$$

(c) $$\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$= \frac{2}{96} + \frac{1}{144} \Rightarrow R_{total} = 36\ (\Omega) \#$$

19.



19.

(a) $\tan^{-1}\dfrac{X_L - X_C}{R} = \tan^{-1}\dfrac{\omega L - \frac{1}{\omega C}}{R}$

$= \tan^{-1}\dfrac{(120\pi)(0.46) - 1/[(120\pi)(4\times10^{-6})]}{150}$

$\approx 17.39\,(^\circ)$

(b) voltage

($\rho_{copper} = 1.68\times10^{-8}$)

35.

$P = IV \Rightarrow I = \dfrac{P}{V} = \dfrac{20\times10^3}{1.5\times10^3} = 13.3$

$P_{loss} = I^2R \Rightarrow R = \dfrac{P_{loss}}{I^2} = \dfrac{200}{(13.3)^2} = 1.13$

For each wire: $R = \dfrac{1.13}{2} = 0.565$

$R = \rho\dfrac{l}{\pi\left(\frac{d}{2}\right)^2}$

$\Rightarrow d = 2\sqrt{\dfrac{\rho l}{\pi R}}$

$= 2.6\times10^{-2}\ (m)$

Transformer

31. BIO A person is working near the secondary of a transformer as shown in Figure P32.31. The primary voltage is 120 V at 60.0 Hz. The secondary voltage is 5 000 V. The capacitance C_s, which is the stray capacitance between the hand and the secondary winding, is 20.0 pF. Assuming the person has a body resistance to ground of $R_b = 50.0\ \text{k}\Omega$, determine the rms voltage across the body. *Suggestion:* Model the secondary of the transformer as an AC source.

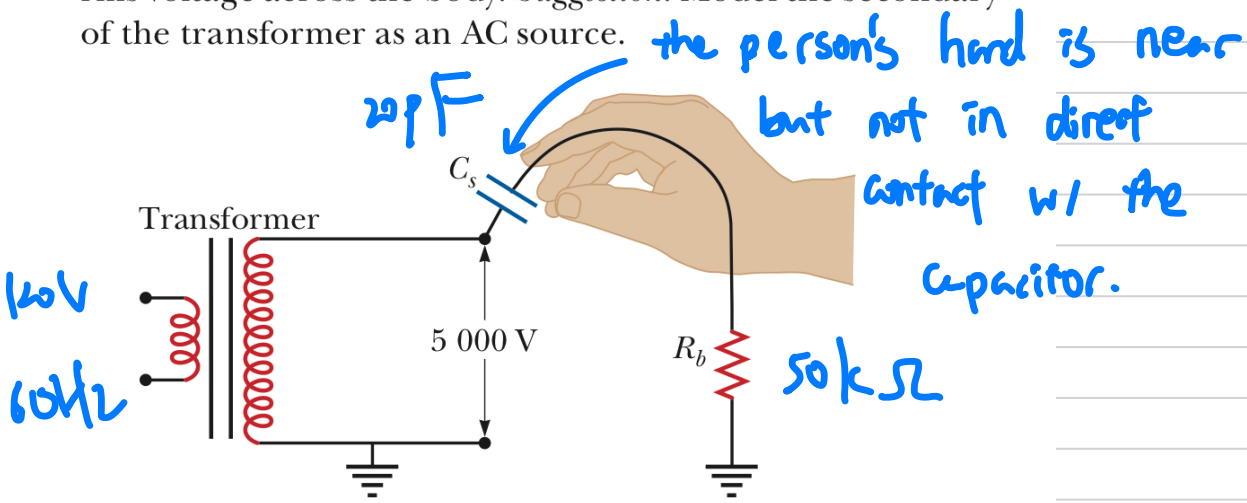


Figure P32.31

Energy carried by EW

15. V High-power lasers in factories are used to cut through cloth and metal (Fig. P33.15). One such laser has a beam diameter of 1.00 mm and generates an electric field having an amplitude of 0.700 MV/m at the target. Find (a) the amplitude of the magnetic field produced, (b) the intensity of the laser, and (c) the power delivered by the laser.

3(.

$$5000 \times \frac{50000}{\sqrt{(50\times10^3)^2 + \left(\frac{1}{(2\pi 60)(20\times10^{-12})}\right)^2}}$$

$$= \frac{50000}{\sqrt{2.5\times10^9 + (1.32\times10^8)^2}} \times 5000$$

$$= 1.89 \text{ (A)}$$

15. (a) $E = Bc \Rightarrow 7\times10^5 = B(3\times10^8)$

$$\Rightarrow B = 2.33 \times 10^{-3} \text{ (T)}$$

(b) $$\text{Intensity} = S_{avg} = \frac{E_{max} B_{max}}{2\mu_0}$$

$$= \frac{(7\times10^5)(2.33\times10^{-3})}{2(4\pi\times10^{-7})}$$

$$= 6.5\times10^8 \left(\text{Watt}/m^2\right)$$

(c) $$I = \frac{P}{A} \Rightarrow P = IA$$

$P = (6.5 \times 10^{8})($

Momentum, Radiation Pressure

25. Q|C A plane electromagnetic wave of intensity 6.00 W/m^2, moving in the x direction, strikes a small perfectly reflecting pocket mirror, of area 40.0 cm^2, held in the yz plane. (a) What momentum does the wave transfer to the mirror each second? (b) Find the force the wave exerts on the mirror. (c) Explain the relationship between the answers to parts (a) and (b).

43. **Review.** A 1.00-m-diameter circular mirror focuses the Sun's rays onto a circular absorbing plate 2.00 cm in radius, which holds a can containing 1.00 L of water at 20.0°C. (a) If the solar intensity is 1.00 kW/m^2, what is the intensity on the absorbing plate? At the plate, what are the maximum magnitudes of the fields (b) $\vec{\mathbf{E}}$ and (c) $\vec{\mathbf{B}}$? (d) If 40.0% of the energy is absorbed, what time interval is required to bring the water to its boiling point?