Name KEY SP222 Quiz

A certain electrical device (perhaps a window air conditioner) draws 10 *A* rms and has an average power of 720 *W* when connected to a 120-*V* rms, 60-*Hz* power line.

1. What are the peak values of current and voltage? (1.5)

$I_{RMS} = I_p/\sqrt{2}$

$I_p = I_{RMS}\sqrt{2} = 10\sqrt{2}\,A = 14.1\,A$

$V_p = V_{RMS}\sqrt{2} = 120\sqrt{2}\,V = 169.7\,V$

2. From the peak voltage and current, what is the impedance of the device, Z? (1.5)

$Z = \frac{V_p}{I_p} = \frac{169.7\,V}{14.1\,A} = 12.0\,\Omega$

3. What are the power factor and the phase constant, δ? (2)

$P_{Ave} = \frac{1}{2} V_p I_p \cos\delta = 720\,W = \frac{1}{2}(169.7\,V)(14.1\,A)\cos\delta$

$p.f. = \cos\delta = .602$

$\delta = 53^\circ$ OR $.925$ rad

4. Assume this air conditioner can be modeled as a single resistor and a single inductor in series (no capacitor).
   a. What would be the value of the resistance, R? (2)

$\cos\delta = \frac{R}{Z} \Rightarrow R = 12.0\,\Omega\,(.602) = 7.2\,\Omega$

OR $P_{AVE} = \frac{1}{2} I_p^2 R \Rightarrow R = \frac{2P_{AVE}}{I_p^2} = \frac{2(720\,W)}{(14.1\,A)^2} = 7.2\,\Omega$

   b. What would be the value of the inductive reactance, X_L? (1.5)

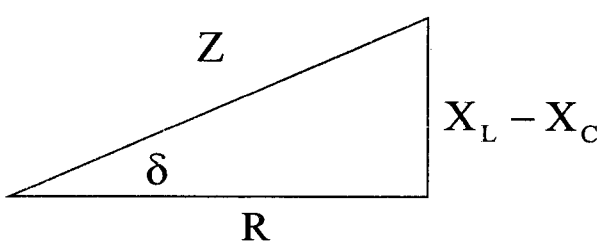
$\sin\delta = \frac{X_L}{Z} \Rightarrow X_L = 12.0\,\Omega \sin(53^\circ) = 9.58\,\Omega$

OR $X_L = \sqrt{Z^2 - R^2} = \sqrt{(12\,\Omega)^2 - (7.2\,\Omega)^2} = 9.6\,\Omega$

   c. What would be the value of the inductance, L? (1.5)

$X_L = 9.6\,\Omega = \omega L = 2\pi\,60\,Hz\;L$

$L = .025\,H$



$$I = I_{peak}\cos(\omega t - \delta) \qquad I_{peak} = \frac{V_{app\ peak}}{Z}$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2} \qquad \delta = \tan^{-1}\left(\frac{X_L - X_C}{R}\right)$$

$$P_{ave} = \frac{1}{2} I_{peak}^2 R = \frac{1}{2} I_{peak} V_{app\ peak}\cos\delta$$

$$X_L = \omega L \qquad X_C = \frac{1}{\omega C}$$

Extra Credit: Regarding household electrical work, what actor announced, "220, 221, whatever it takes." In what movie did he say this line?