

**ProbBlackBox:** An AC generator is connected to a 'black box' - through a pair of terminals. The box contains a circuit consisting of resistors, capacitors, and inductors whose values we do not know in a configuration we do not know. Measurements outside the box reveal that when

$$\varepsilon(t) = (75.0 \text{ V}) \sin(\omega t)$$

$$i(t) = (1.20 \text{ A}) \sin(\omega t - 42.0^\circ).$$

a) What is the power factor of the circuit?

$$\cos(42) = 0.743$$

b) Does the current lead or lag the emf?

lags

c) Is the circuit in the box largely capacitive or largely inductive in nature?

inductive

d) Must there be a capacitor in the box? An inductor? A resistor?

At least an R and an L

e) If the frequency of the generator were to be increased slightly, would the phase difference between the voltage and the current increase, decrease, or remain the same?

increase

f) At what average rate is energy delivered to the box by the generator?

$$P = \frac{\varepsilon_{rms}^2}{Z^2} R = \varepsilon_{rms} \cdot I_{rms} \cdot \cos \phi = 3.3 \text{ kW}$$