You have an electric heater in your basement. The heater is on a thermostat, so it turns itself on and off. When you are upstairs, you’d like to know when the heater is on and when it is off. You realize that you could make an inductive pick-off that could run a small light bulb for this purpose.

The electrical cord that goes to the heater has two wires. One carries current to the heater and the other carries current coming back from the heater. Of course, there is current in the wires only when the heater is on. You separate the two wires and then put a pickup coil near one wire. (a) Why do you separate the wires?

The heater is a 1200 W heater that operates on the 120 V AC power from the outlet. Since this is AC power and the current varies sinusoidally, the voltage and power are average values. Using average values, $P=IV$ as with DC circuits. However, the peak power is twice the average power and the peak voltage and current are $\sqrt{2}$ times their average values.

You decide to make the pickup coil of 100 turns of fine copper wire and place the coil 1 cm from the wire. The coil is in a square shape 1.2 cm on a side. (b) Estimate the maximum voltage across the coil.