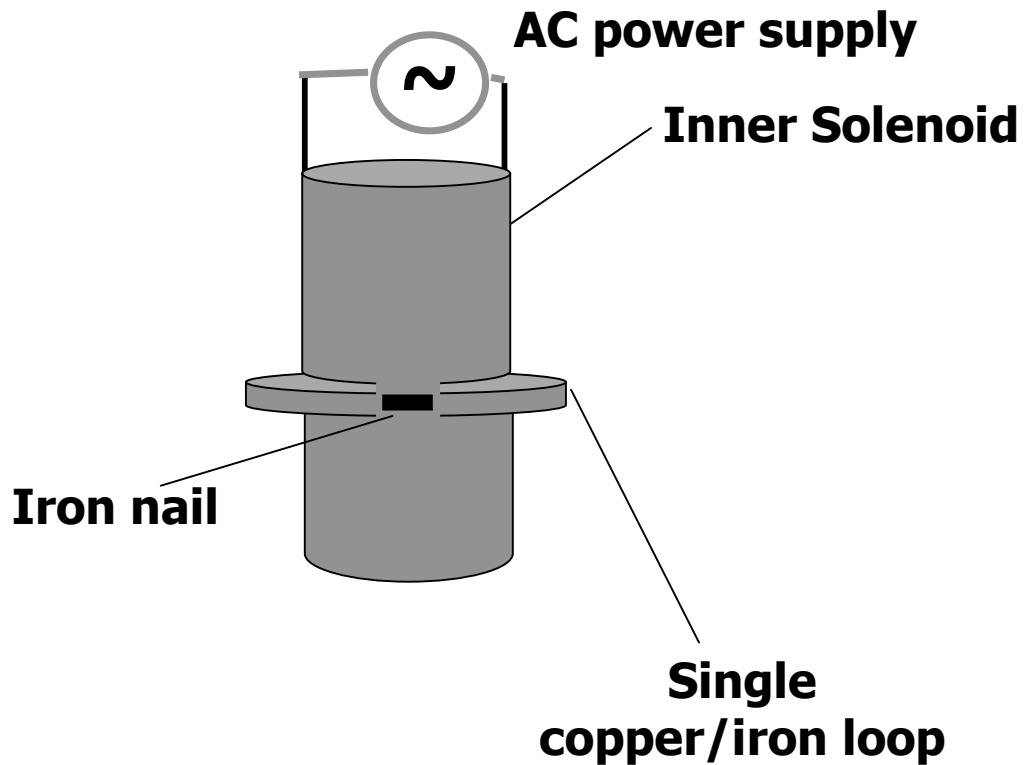


## Problem 2 (20 points) Transformer action

In one of the lecture demos, a long solenoid with 100 turns was connected to an AC power supply providing a varying voltage of  $V_{rms} = 100V$  on average. A single loop was put around the solenoid. The loop consists of a thick copper wire and a thin iron nail. When the AC was powered up, the iron nail heated up and eventually melted.

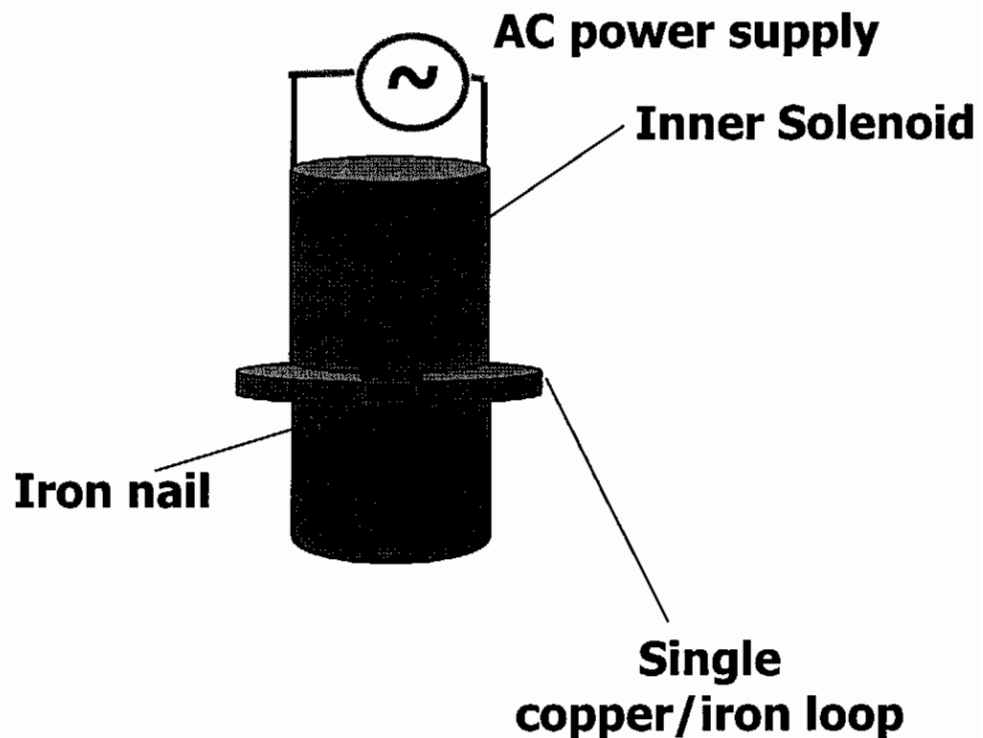


**(a) How are power, voltage and current in the primary solenoid related to those in the iron/copper loop?**

**(b) Assume that the resistance of the nail is 0.1 Ohm. Estimate the power dissipated in the nail.**

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(a) How are power, voltage and current in the primary solenoid related to those in the iron/copper loop?

$$P_{\text{primary}} = P_{\text{loop}}$$

$$V_{\text{primary}} = N_{\text{primary}} V_{\text{loop}} = 100 V_{\text{loop}}$$

$$I_{\text{primary}} V_{\text{primary}} = I_{\text{loop}} V_{\text{loop}} \Rightarrow I_{\text{primary}} 100 V_{\text{loop}} = I_{\text{loop}} V_{\text{loop}}$$

$$\Rightarrow I_{\text{loop}} = 100 I_{\text{primary}}$$

(b) Assume that the resistance of the nail is 0.1 Ohm. Estimate the power dissipated in the nail.

$$V_{\text{loop}} = 1V$$

$$P = \frac{V^2}{R} = \frac{1}{0.1} = 10 \text{ W}$$