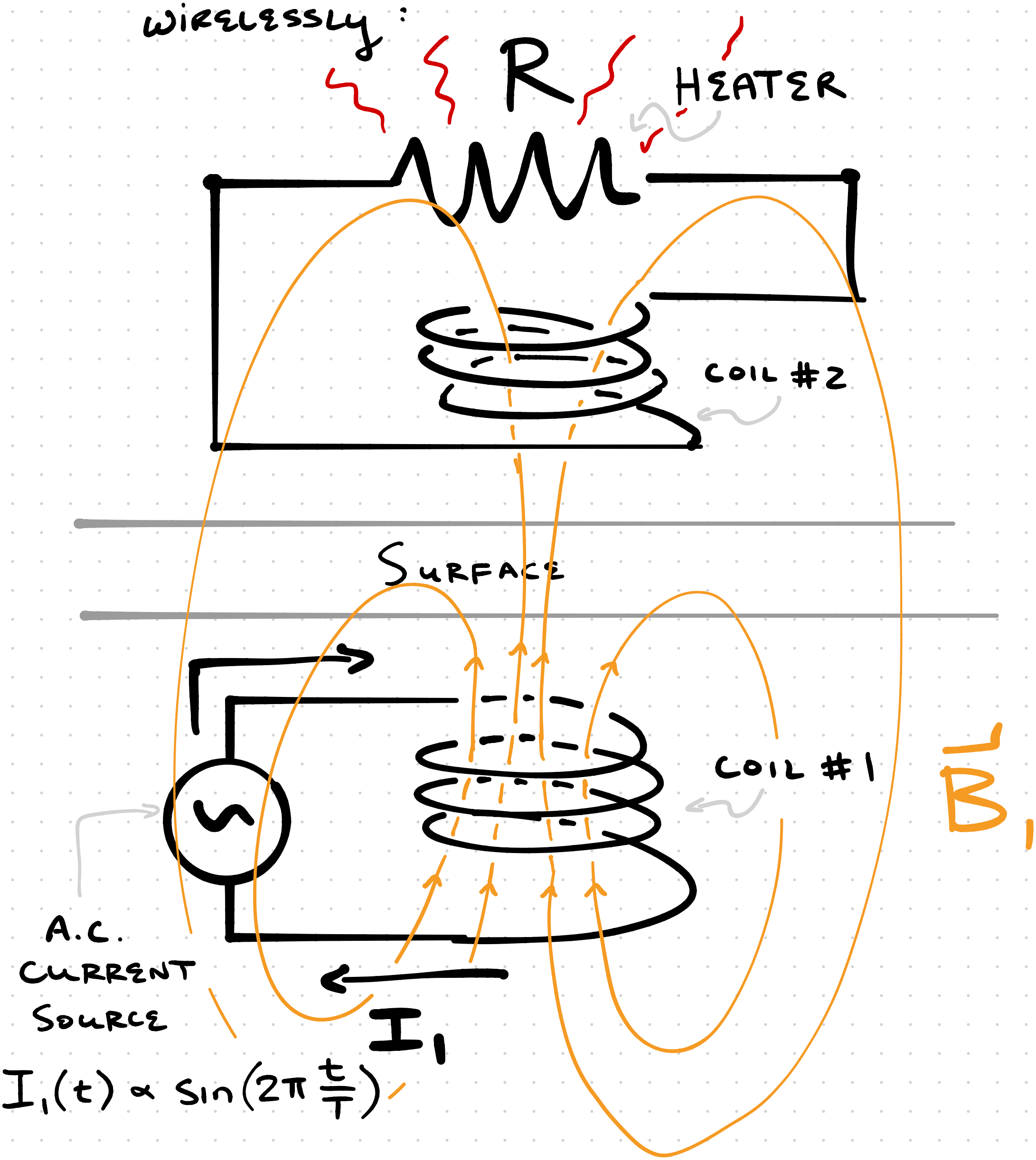
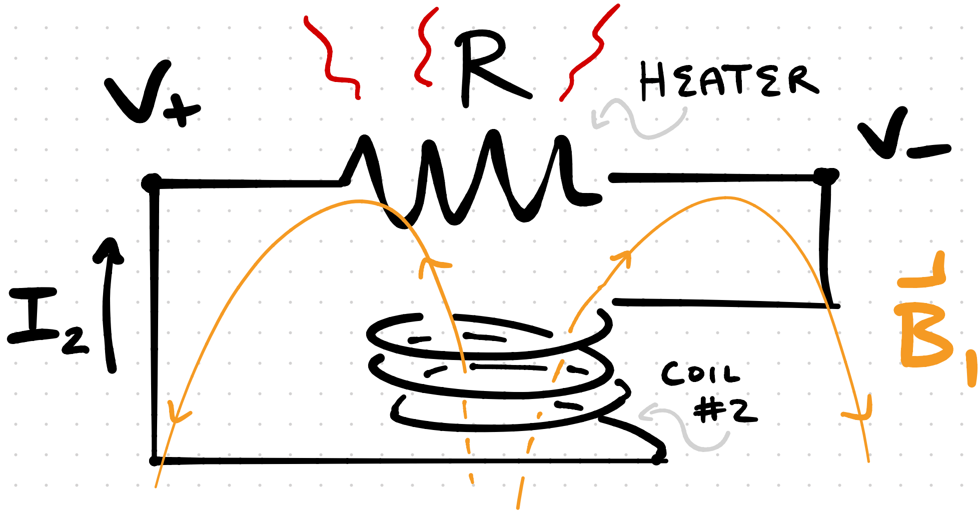
NOTE: THIS EXAMPLE IS JUST TO GIVE YOU A HANDS-ON EXAMPLE OF MUTUAL & SELF INDUCTANCE. THE ANALYSIS IS NOT TOO HARD TO FOLLOW BUT IT WOULD BE DIFFICULT TO SOLVE A SIMILAR PROBLEM ON YOUR OWN.

DON'T WORRY ABOUT HAVING TO SOLVE THIS PARTICULAR PROBLEM ON AN EXAM. JUST TRY TO UNDERSTAND CONCEPTUALLY.

EXAMPLE: INDUCTION STOVE

- USING A PAIR OF COILS WE CAN GENERATE HEAT WIRELESSLY:





- MUTUAL INDUCTANCE (M) BETWEEN TWO COILS LEADS TO VOLTAGE ACROSS COIL FROM A.C. CURRENT $I_1(t)$:

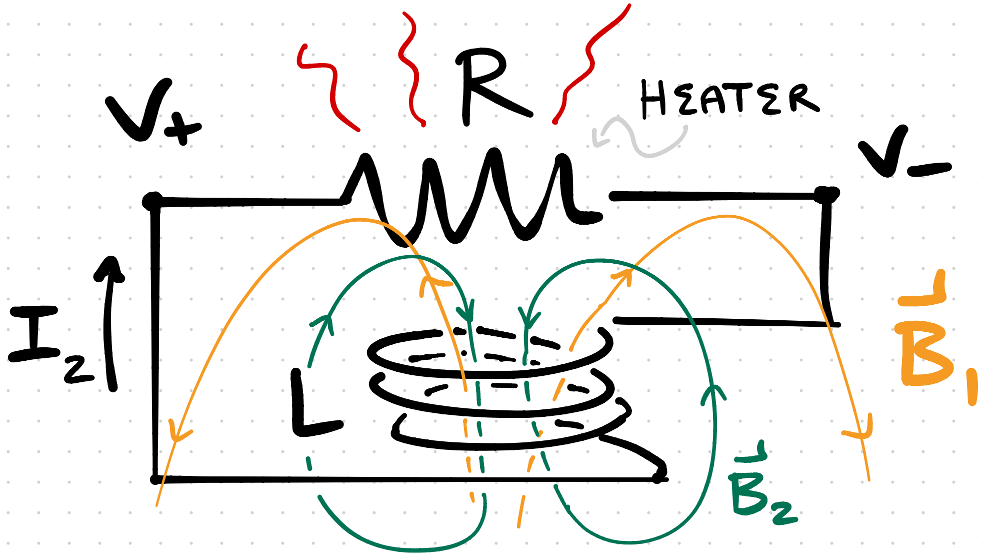
$$V = V_+ - V_- = M \frac{\Delta I_1}{\Delta t}$$

$$= M \frac{2\pi}{T} I_1$$

(A.C. AMPLITUDE)

($T = \frac{1}{f}$ IS PERIOD OF OSCILLATION)

- VOLTAGE DRIVES CURRENT $I_2 = V/R$ IN HEATER.
- SINCE $P = I_2 \times V$ IN RESISTOR, SHOULD WE MAKE R SMALL TO MAXIMIZE POWER TO HEATER?



- CAREFUL! COIL #2 ALSO HAS SELF-INDUCTANCE (L), i.e. THE A.C. CURRENT $I_2(t)$ INDUCED BY $I_1(t)$ WILL GENERATE AN OPPOSING FLUX VIA $\vec{B}_2$:

$$V = M\frac{\Delta I_1}{\Delta t} - L\frac{\Delta I_2}{\Delta t}$$

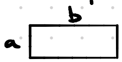
$$= M\frac{2\pi}{T}I_1 - L\frac{2\pi}{T}I_2$$

$$\longrightarrow \boxed{MI_1 = \frac{T}{2\pi}V + LI_2}$$

$$\longrightarrow \quad MI_1 = \underbrace{\frac{T}{2\pi}V + LI_2}$$

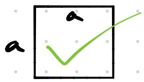
ANALOGY:

MAXIMIZE AREA ENCLOSED BY FENCE OF FIXED PERIMETER:



$a + b = \text{fixed}$

$\longrightarrow$ MAKE IT A SQUARE: $a = b$ MAXIMIZES AREA



SUM FIXED, WANT TO MAXIMIZE PRODUCT $\propto VI_2 = P$

POWER

- HEATER POWER OPTIMIZED WHEN

$$\frac{T}{2\pi}V = LI_2$$

(REARRANGING) $\longrightarrow$ $$\frac{L}{V/I_2} = \boxed{\frac{L}{R}} = \frac{T}{2\pi}$$

UNITS OF TIME!

- SO WE WANT TO PICK OUR HEATER RESISTANCE R SO THAT THE "TIME CONSTANT" $\tau \equiv \frac{L}{R}$ OF OUR HEATER + COIL COMBO MATCHES* THE PERIOD OF OSCILLATION T OF THE CURRENT $I_1(t)$ SUPPLYING THE POWER!

* W/IN A FACTOR OF 2π :)