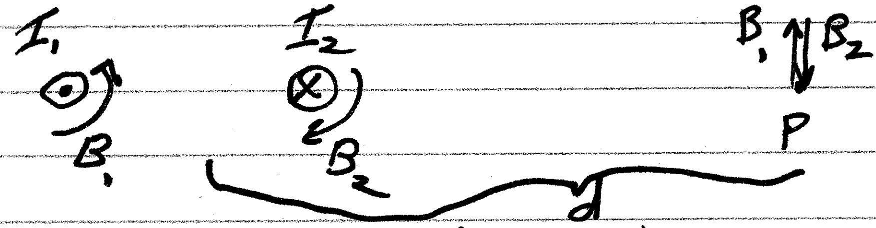
(1) Phys 2426 2014-10-15

HW3 #18

a) Single Wire

$$B = \frac{\mu_0 I}{2\pi r}$$

b) Twin Lead Wire



B_1 is a little smaller than (a).
B_2 ... larger ... .

B is very small. (Few dozen nT)

c) Where is the field 10X smaller?

$$B = \frac{\mu_0 I_1}{2\pi r_1} - \frac{\mu_0 I_2}{2\pi r_2}$$

$$= \frac{\mu_0 I}{2\pi(d+1.5\,mm)} + \frac{-\mu_0 I}{2\pi(d-1.5\,mm)}$$

First guess: d = 350 cm (10 X further)
result: B = 100 X smaller

For a dipole:

$$B \propto 1/r^2$$

(2)

Exam 2 Wed 10/29

Magnetism

Induced Voltages

AC Circuits

- General
- Transformers
- Inductors (L)
- Capacitors (C)
- Resistors (R)
- Series RLC.

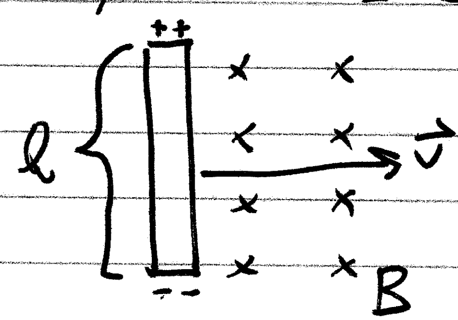
Induced Voltages

General $\mathcal{E} = -\frac{d\Phi_B}{dt}$ $\Phi = NBA\cos\theta$

Generator $\mathcal{E} = NBA\omega$

Moving Bar $\mathcal{E} = Bv\ell$

(Velocity Selector $E = Bv$)



③

Ex: Airplane wing

$\ell = 15\ m$

$B = 50\ \mu T$

$v = 250\ m/s$

Generated Voltage

$$\mathcal{E} = Bv\ell = (50\times10^{-6}\ T)(250\ m/s)(15\ m)$$
$$= 0.19\ V$$

Inductors - a coil

$I \rightarrow B \rightarrow \Phi_B$

$B = \mu_0 I N/\ell$

$\Phi = NBA$

Changing I $\rightarrow$ Changing B $\rightarrow$ Changing Φ_B $\rightarrow$ V

$$V_L = -L\frac{dI}{dt}$$

L = inductance in henries (H)

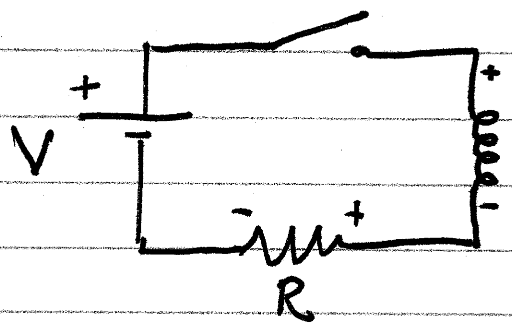
Solenoid $L = \mu_0 (N/\ell) N A$

(4)

Inductors oppose changes in current.

$$V_L = -L\frac{dI}{dt}$$

First hook it up: V_L opposes I



$$\Delta V = 0$$

$$V_{Batt} - IR - L\frac{dI}{dt} = 0$$

Recall Capacitor

$$V_c = Q/C \qquad \frac{\Delta Q}{\Delta t} = I$$

$$\frac{dV}{dt} = \frac{1}{C}\frac{dQ}{dt}$$

$$\frac{dV}{dt} = \frac{1}{C} I$$

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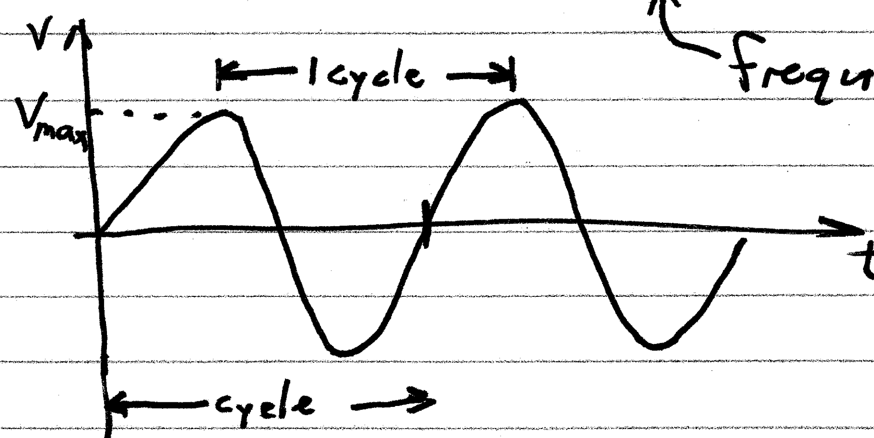
AC Electricity

A spinning generator produces a changing voltage.

$$V(t) = V_{max} \sin(2\pi f t)$$

frequency



frequency = # cycles per second

$1\ Hz = 1\ cycle/s$

period (T) = time of one cycle

$$f = \frac{1}{T} \qquad T = \frac{1}{f}$$

Alternate voltage measurement

RMS voltage: $V_{RMS} = \frac{V_{max}}{\sqrt{2}}$

In the US, every household outlet is:

$V_{RMS} = 120\ V$ $\qquad f = 60\ Hz$

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Transformers

Two coils that share B.

I into primary $\longrightarrow B$

$$\Phi_1 = N_1 BA \qquad \Phi_2 = N_2 BA$$

$$\varepsilon_1 = -\frac{d\Phi_1}{dt} \qquad \varepsilon_2 = -\frac{d\Phi_2}{dt}$$

The ratio of ε's is the ratio of N's.

Primary: $\varepsilon_1 = -L_1 \frac{dI}{dt}$

Can think of $I \rightarrow \varepsilon$ or $\varepsilon \rightarrow I$.

Transformer $\varepsilon_1 \xrightarrow[N_2/N_1]{} \varepsilon_2 = \frac{N_2}{N_1}\varepsilon_1$

If N_2 is bigger, ε_2 is bigger.