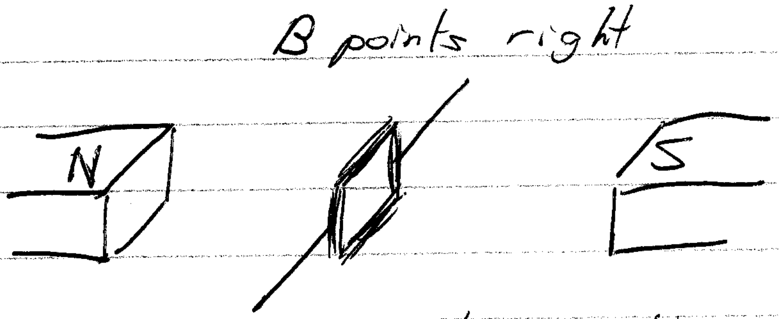
Phys 1402 2015-10-15 Lec 15

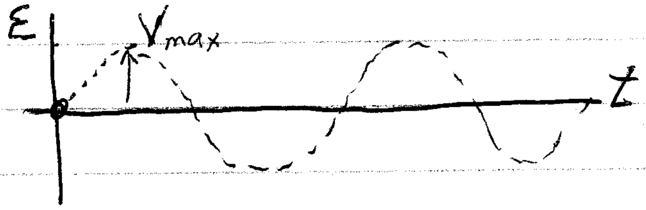
Any current $I \rightarrow$ causes B.
B affects $I \rightarrow$ causes Force.
Any changing $B \rightarrow$ generates EMF

HW4a is posted. 4b coming soon.
Exam 2 in 2 weeks.

Electric Generator (aka Alternator)



Spinning the coil generates voltage.
This voltage is not steady. It alternates.



Voltage is on-and-off, ⊕ and ⊖.

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

When does $\sin\theta$ repeat? $\theta = 2\pi$

$2\pi f t = 2\pi$

$f t = 1 \rightarrow T = \frac{1}{f}$ is repeat time

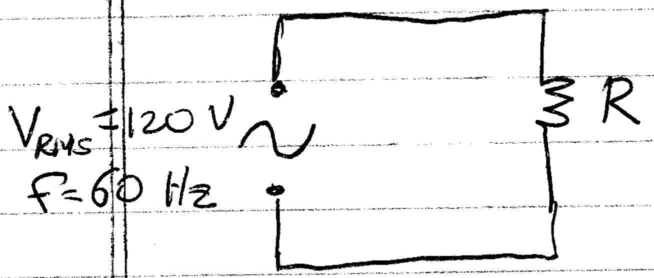
US Household Electricity:

$V_{max} = 170$ V $f = 60$ Hz

We usually remember a different voltage.

$V_{RMS} = 120$ V Why?

Hook up a light bulb:



$V(t)$ (V)	Bulb
0	Off
170	On, bright
0	Off
-170	On, bright
Average 0	On, medium

The bulb is as bright as if $\mathcal{E} = 120$ V, and the voltage is steady DC.

$$V_{RMS} = 120 \text{ V} \approx V_{DC} = 120 \text{ V}$$

Can use DC circuit eqns for resistors in AC.

$V_{RMS} = I_{RMS} R$ $P_{AVG} = V_{RMS} I_{RMS}$

$V_{RMS} = \frac{1}{\sqrt{2}} V_{max}$ | $I_{RMS} = \frac{1}{\sqrt{2}} I_{max}$ | $P_{avg} = \frac{1}{2} P_{max}$

Ex: Cell phone charger

Standby power = 1.0 W

Effect: heats the air.

Cost?

$$\text{Cost} = \underbrace{\text{Energy}}_{\underbrace{\left(\frac{\text{Energy}}{\text{Time}}\right)}_{P} \cdot \Delta t} \cdot \underbrace{\text{Rate}}_{\$0.12/\text{kWh}}$$

$$\text{Cost} = (0.001\ \text{kW})(720\ \text{hour})(\$0.12/\text{kWh})$$

$$= \$0.09$$

This is for a 1.0 W device.

Electric Current?

$$P = IV$$

$$(1.0\text{W}) = I(120\ \text{V}) \rightarrow I = 8.3\ \text{mA}$$

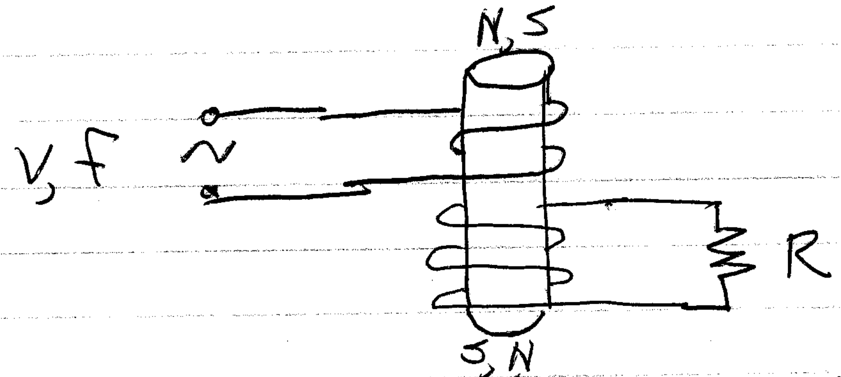
When on, $P = 10\ \text{W} \Rightarrow I = 83\ \text{mA}$

Charging phone with $V = 5\ \text{V}$

$$(10\ \text{W}) = I\,(5\ \text{V}) \Rightarrow I = 2\ \text{A}$$

④

Transformers - two interlocking coils.



Primary Coil is hooked to an AC voltage source.

Current causes magnetic field B.

Since I fluctuates, so does B.

The steel core turns into a magnet that keeps "flipping".

Each coil has varying Φ_B.

Varying Φ_B generates EMF in each coil.

What does it do?

Primary: Opposes voltage source to keep the current from getting too large.

Secondary: Acts like a voltage source, pushing current thru R.

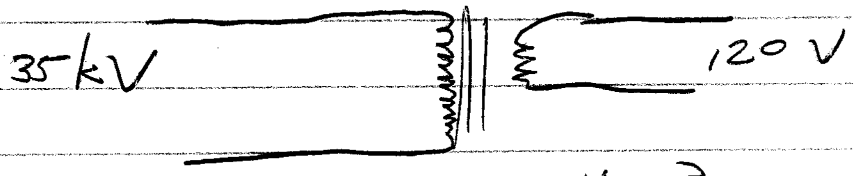
The voltages, currents can be different.

The powers are equal. (except for inefficiency)

$$V_1 I_1 = V_2 I_2$$

⑤

Transformer for a home



$N_1 = 70000$ $N_2 = ?$

$$\frac{V_1}{V_2} = \frac{N_1}{N_2}$$

$$\frac{35k}{120} = \frac{70000}{N_2}$$

$$N_2 = \frac{70000}{35000} 120 = 240$$

House needs $I_2 = 200$ A.

$$V_1 I_1 = V_2 I_2$$

$$(35000 \text{ V}) I_1 = (120 \text{ V})(200 \text{ A})$$

$$I_1 = 0.686 \text{ A}$$