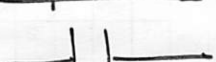
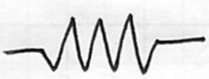
We've studied inductance generally, but now we want see how it might be used more practically. We noticed a few things about self inductance,

$$\phi = LI$$

the emf that is generated when the current changes with time $I = I(t)$, is a back emf, which reflects Lenz's Law. The EMF will be produced to fight the change,

$$\mathcal{E} = -\frac{d\phi}{dt} = -L\frac{dI}{dt}$$

In this equation we can see that the inductance, L, acts like a damping constant on the current, I. We will study the inductors in circuits so let's remind ourselves of the different circuit elements.

Symbol	Circuit Relation	Geometry	Field
	$Q = CV$ or $I = C\,dV/dt$	$C = \frac{\varepsilon_0 A}{d}$ (parallel plates)	$E = \sigma_q/\varepsilon_0$
	$V = IR$	$R = \rho L/A$ (uniform rod)	$J = \sigma E$
	$V = -L\frac{dI}{dt}$	$L = \mu_0 n A * N_{turns}$	$B = \mu_0 n I$ or $\phi_B = LI$

Kirchoff's Laws say, $\sum_{\text{around any closed loop}} \Delta V = 0$ and $\sum_{\text{all currents entering any node}} I_{in} = 0$

"Solving a circuit problem" means finding $I(t)$ +/or $V(t)$ for all circuit elements.

A few more notes before we get into solving problems,

Sources in circuits can be AC or DC, voltage or current sources,

<u>Constant Voltage</u>

Battery $V = V_0$

<u>Function Generators</u>

AC Voltage Source $V = V_0 \sin(\omega t + \delta)$

AC current source $I = I_0 \sin(\omega t + \delta)$

Mone Notes:

$\varepsilon_0 = 8.85 \cdot 10^{-12} \frac{\text{farad}}{m}$

– real capacitors range from $\lesssim 1pf$ (10^{-12} F) to $> 1F$ (serious dielectrics)

– Typical resistors range from $< 1\Omega$ to several $M\Omega$ ($\sim 10^6 \Omega$)

$\mu_0 = 4\pi \cdot 10^{-7} \frac{H}{m}$ (and $L = \frac{\mu_0 N^2 A}{\ell}$) means

– real life inductors range from $< 10^{-6}$ H to ~ 1 Henry

You might be worried about putting an inductor into a circuit and how we define a potential drop across it. This is where ΔV & EMF start to get a little confusing. Both are related to energy &/or work. So what we are saying when we say $\mathcal{E} = -L\, dI/dt$ is that the work per unit charge for this element is $-L\, dI/dt$ so we can use this form in Kirchoff's Law

$$\Sigma \Delta V = 0.$$