Force from B-field on moving charge.

RHR1 $\Rightarrow$ hand always flat:
fingers $\rightarrow$ direction of **B**-field
thumb $\rightarrow$ direction of moving charge (**v**)
palm $\rightarrow$ dirction of B force ($\mathbf{F}_B$)
($\mathbf{F}_B$ is always $\perp$ to **v** and **B**.)

$\boxed{\lvert\mathbf{F}_B\rvert = qvBsin\theta}$	(direction from RHR1)
$\mathbf{F}_E = q\mathbf{E}$	Coulomb's Law
$\mathbf{F}_{tot} = \mathbf{F}_E + \mathbf{F}_B$	(vector addition, remember)

Stuff to never forget:

B-fields do no work	(motion is always $\perp$ to force: $W = Fx\cos\theta$ with $\theta = 90$)
$F = ma$	(as always)
$E_i = E_f$; $E = KE + PE$	(conservation of energy)

Circular motion of a charged particle in a B-field:

$$\text{if } \mathbf{v} \perp \mathbf{B} \text{ then:} \quad F = ma_{\perp} = m\frac{v^2}{r} = qvB\sin(90) \Rightarrow r = \frac{mv}{qB}$$

B-fields and current carrying wires.

Force *on a wire* in a B-field: $\boxed{\lvert\mathbf{F}\rvert = ILB\sin\theta}$ with direction from RHR1

Torque on a flat circuit (coil or otherwise): $\boxed{\tau = NIAB\sin\phi}$ where ϕ is angle of normal to B-field

B-field *caused* by a long, straight wire: $\boxed{\lvert\mathbf{B}\rvert = \frac{\mu_0 I}{2\pi r}}$ with direction given by RHR2

RHR2 $\Rightarrow$ allows us to find the direction of **B** around a wire
Step 1: thumb $\rightarrow$ direction of current, I (always)
Step 2: hand flat: finger tip $\rightarrow$ the point where you want to find direction of B
Step 3: Bend fingers in 90 degrees: fingers now point with **B**

In this manner the magnetic field "curls" around a wire, tangent to a circle drawn perpindicular to the direction of the current.

B-field in center of circular loop: $\boxed{B = N\frac{\mu_0 I}{2R}}$ with direction from RHR2

Interior of a solenoid: $\boxed{B = \mu_0 nI}$ with direction from RHR2 and where $n = N/L$, turns per unit length

Parallel wires with *currents in the same direction* **attract**.
Parallel wires with *currents in opposite directions* **repel**.

Magnetic induction: Changing magnetic fields can *induce* an emf, $\mathcal{E}$ and possibly a current, I, in a conductor.

$\mathcal{E}$ is just a voltage difference so for all practical purpose, $\mathcal{E} = V$ and ($P = I\mathcal{E}$; $\mathcal{E} = IR$; $P = Et$) work just like they do for V.

If $v \perp B \perp L$ then $\mathcal{E} = vBL$ (as in a rod moving in a $\perp$ B-field).

$$\boxed{\mathcal{E} = -\frac{\Delta\Phi}{\Delta t} = -\frac{\Delta(BA\cos\phi)}{\Delta t}}$$

where Φ is the magnetic flux. So, a change in the magnetic flux over time—either because of a changing area, a changing magnetic field, or both—results in an emf.

$\mathcal{E} = -N\frac{\Delta\Phi}{\Delta t}$ for N coils.

The negative sign comes from the fact that whatever current is induced because of the emf, the resultant B-induced and thus F_B acts to oppose the motion $\Rightarrow$ **Lenz's Law**.

Lenz's Law or *The law of their ain't no such thing as a perpetual motion machine*:
Remember Newton's first law which says that things in motion like to stay in motion (inertia)? It works pretty much the same for magnetic fields to. The system always tries to maintain the status quo for as long as possible. So if the magnetic field (thus the magnetic flux) is increasing in one direction, any induced current will create an induced magnetic field that opposes the change (points opposite to the increasing B-field). And vice-versa. If it happened the other way, the magnetic field would just keep getting bigger and bigger—and that ain't right.

generator equation: $\boxed{\mathcal{E} = NAB\omega\sin\omega t}$ which is greatest when $\sin\omega t = 1$.

Mutual inductance:

$$M = \frac{N_2\Phi_2}{I_1} \text{ in Henries, H}$$

Self inductance:

$$L = \frac{N\Phi}{I}$$

$$\mathcal{E} = V_L = -L\frac{\Delta I}{\Delta t}$$

$$L_{solenoid} = \mu_0 n^2 A l$$

$$\text{Energy stored in inductor} = \frac{1}{2}LI^2$$

Transformers:

$$\text{p} = \text{primary}$$

$$\text{s} = \text{secondary}$$

$$V_S = \frac{N_s}{N_p}V_p$$

$$I_S = \frac{N_p}{N_s}I_p$$