The following are a few practice problems. There is no guarantee the practice problems will match the material on the test.

**Midterm II Concepts**

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**Solenoids**

Two solenoids have the same cross-sectional area and total number of turns. Solenoid B is three times as long as solenoid A. Compare the inductance of the two solenoids.

**Motional EMF**

When exactly half the loop is inside the magnetic field, a current of 10 x 10^-6 A is measured. What is the magnitude of the magnetic field? And what is the direction of the current?

**RL Circuit**

A circuit is constructed with three resistors and one inductor as shown. The values for the resistors are: R1 = 2Ω, R2 = R4 = 2Ω and R3 = 4Ω. The battery voltage is V = 12V. The switch S is initially open.

After the switch has been opened a long time, it is closed. What is the magnitude of the voltage across L immediately after the switch is closed?
**Magnetic Dipole**
Draw the magnetic field lines for this magnetic dipole.

**RC Circuits**

Next 3 questions

1) Three resistors, three capacitors, a battery and two switches are connected in the circuit shown below. The values of all circuit elements are given in the figure. Originally, the switches $S_1$ and $S_2$ are open (as shown) and all of the capacitors are uncharged. At time $t = 0$, both switches are closed. $V_B = 20\, \text{V}$, $R_1 = 30\, \Omega$, $R_2 = 60\, \Omega$, $R_3 = 90\, \Omega$, $C_1 = 30\, \mu\text{F}$, $C_2 = 60\, \mu\text{F}$, $C_3 = 90\, \mu\text{F}$.

What is the current $I_1$ through resistor $R_1$ immediately after the switches are closed?

![ Circuit Diagram ]

2) A very long time after the switches are closed, the current $I_2$ is:

3) What is the charge $Q_2$ on capacitor $C_2$ a very long time after the switches are closed?

**Magnetic Force**

1) Two long wires carry currents $I_1$ and $I_2$ as shown in the figure. The first wire runs parallel to the $x$ axis but is a distance $d$ above the $x$-$y$ plane. The second wire lies along the $y$ axis and passes through the origin.

What is the direction of the torque on the wire carrying $I_1$ due to the current $I_2$ in the other wire?
**Faraday’s Law**

1) A rectangular wire loop of height $h$ and width $w$, centered on the origin, carries current $I$ in the direction shown in the figure. The angle between the positive $x$-axis and the plane of the loop is $\theta$, defined as shown in the figure below. (When $\theta = 0$ the loop lies in the $x$-$z$ plane.) This entire region of space is filled with a uniform external magnetic field $B$ pointing in the $+x$ direction.

When $\theta = 50^\circ$, the force on the leg of length $h$ with the upward-going current is in the______ direction.

2) The magnitude of the work, $|W|$, involved in the rotation of the loop from $\theta = 0^\circ$ to $\theta = 50^\circ$ is:

3) The figure shows a circular wire loop of total resistance $R$. The loop is contained within a region having a uniform magnetic field $B$ pointing out of the page, and is attached to a motor that keeps it rotating around the $y$-axis in a clockwise direction (when looking in the negative $y$-direction) at constant angular velocity $\omega$. The loop is initially parallel to the $x$-$y$ plane (the plane of the paper), as shown.

Which one of the following graphs best represents the EMF induced in the loop as a function of time? ($\varepsilon$ changes sign if the induced current changes direction; $\varepsilon = 0$ is denoted on the graphs. In the initial ($t = 0$) position shown in the figure above, $\varepsilon$ is defined to be positive if it leads to clockwise current in the loop).
Ampere’s Law
1) A solid, infinitely-long, conducting rod has radius $a = 15$ cm and lies along the $z$ axis. It carries a current $I = 30$ A in the $+z$ direction. The current is uniformly distributed across the rod. It is surrounded, at a distance $b = 30$ cm, by a thin coaxial conducting shell that carries a current of the same magnitude but directed in the $-z$ direction. Find the magnitude $B$ of the magnetic field at a distance of 10 cm from the origin.