Physics 40C: Final Review

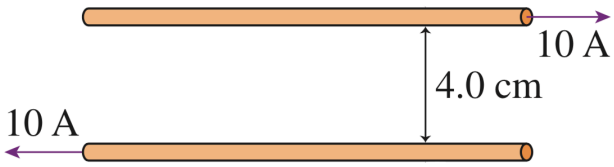
December 7, 2018

1 Magnetic Force between Parallel Wires

Two long parallel wires, shown below, carry equal current in opposite directions.

(a) Do the wires attract or repel each other?

(b) What is the force between the wires?



2 Running to Create a Voltage

You have a 2.5 m long antenna. How fast would you have to run with it to create 1.0 V potential using the Earth's magnetic field? $B_{\text{Earth}} = 50\ \mu\text{T}$.

3 Loop on the Moon

From the moon, Earth's magnetic field can be approximated as a bar magnet. A loop is placed on the moon. The loop surface $S = 100$ m^2 is oriented *tangentially* to the Moon's rotation. Estimate the current induced in the loop.

4 Combatting Faraday's Law

A rectangular loop, laying in the xy plane, is subject to a perpendicular magnetic field $\vec{B} = 1\hat{z}$ T. The loop's initial surface area $S = 20$ cm^2 is decreasing at a rate of 1 cm^2/s. We would like to keep the loop voltage-free.

(a) Phenomenologically, explain how you need to change the $\vec{B}$ field in order to keep the loop voltage-free.

(b) Make a guess as to what the solution, $\vec{B}(t)$, looks like. Should $\dfrac{\mathrm{d}\vec{B}}{\mathrm{d}t}$ be constant? If not, what should it depend on? Should the answer be exponential? Logarithmic?

5 MRI Machines

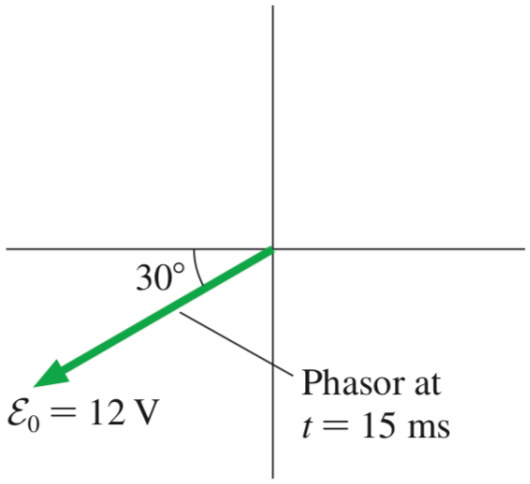
An MRI Machine needs to detect signals that oscillate at very high frequencies. It does so with an LC circuit containing a 15 mH coil. To what value should the capacitance be set to detect a 450 MHz signal?

6 Phasors

The emf phasor in the figure is shown at $t = 15.0$ ms.

(a) What is the angular frequency ω? Assume this is the first rotation.

(b) What is V($t = 15$ms) if $V_0 = 12$ V?



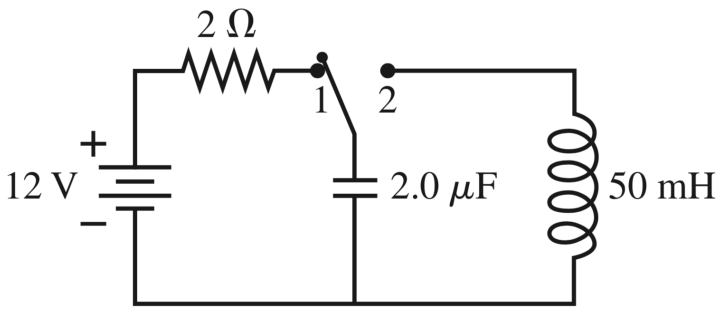
7 LC Switch Circuit

The switch in the circuit below has been in position 1 for a long time. It is changed to position 2 at $t = 0$ sec.

(a) What is the maximum current through the inductor?

(b) What is the first time at which the current is maximum?

(c) Sketch plots of $Q(t)$ and $I(t)$. Explain why the current will never die out in an ideal LC circuit.



8 Building a Solenoid

You have a 1.0 m long copper wire. You want to make an N-turn current loop that generates a 1.0 mT magnetic field at the center when the current is 1 A. You must use the entire wire. What will be the diameter of your coil?

9 Capacitor AC Circuit

The peak current to and from a capacitor is 10 mA. What is the peak current if

(a) The emf frequency is doubled?

(b) The emf peak voltage is doubled (at the original frequency)?

10 Current Junction

A wire carries current I into the junction shown in the figure. What is the magnetic field at the dot?