Phyx 135-2, Fall 2016, Quiz #4 **Name** ______________________________
Section 02 (1 pm)

1) (10 points) Suppose you have a 0.4 farad capacitor which has been charged to 81 volts. Then, you suddenly place a screwdriver across the capacitor which has a resistance of only 1.7 x 10^{-5} Ω. How much current is flowing in the screwdriver 10 μs after it touches the capacitor?

Solution
The voltage across the capacitor (and therefore across the screwdriver) will drop exponentially according to the equation $V = V_0 \exp(-t/RC)$. Inserting the given numbers yields:

$V = 81 \exp[-10^{-5} / (0.4)(1.7 \times 10^{-5})] = 18.6$ volts at 10 μs after contact.

V = iR then gives us $i = 18.6 / 1.7 \times 10^{-5} = 1.09 \times 10^{6}$ amps.

2) (10 points) An α-particle is a sub-atomic particle which has a mass of 6.7 x 10^{-27} kg and carries twice the charge of an electron. Suppose such a particle emerges from the edge of a small cyclotron which has a radius of 50 cm and a uniform magnetic field of 0.5 T in its interior. What would be the kinetic energy of the particle expressed in MeV (mega-electron-volts)?

Solution
For a particle rotating in a magnetic field, we know that the centrifugal force must equal the Lorentz force, so $mv^2 / r = qvB$, which means $v = qBr / m$. The kinetic energy will be given by $E = ½ mv^2$, so $E = q^2 B^2 r^2 / 2m = 2e^2 B^2 r^2 / m$. Conversion into eV means we must divide through by "e", so our final equation is $E = 2e B^2r^2 / m$. Inserting numbers gives us:

$E = (2)(1.6 \times 10^{-19})(0.5)^2(0.5)^2 / (6.7 \times 10^{-27}) = 3 \times 10^{6}$ eV = 3 MeV.