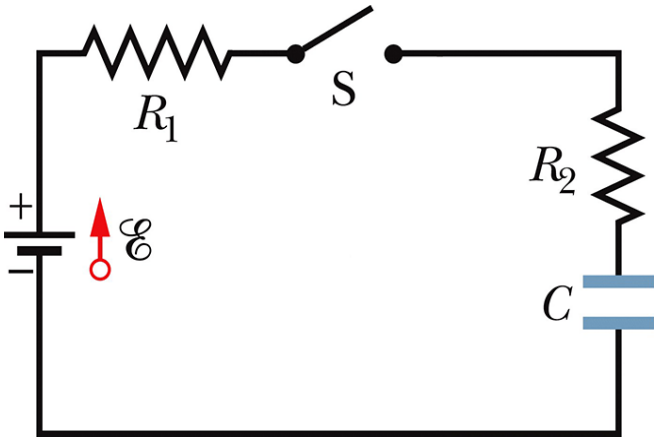
Phyx 135-2, Fall 2016, Quiz #4 **Name** _____
Section 01 (10 am)

1) (12 points) In the circuit at right, an ideal 9-volt battery is connected to R_1 = 10 MΩ, R_2 = 20 MΩ, and C = 4 μF. The capacitor is uncharged. Then, the switch S is closed. At t = one minute later, what will be the voltage drop across R_1?



Solution
The voltage across the capacitor will rise with time according to the formula:
$V = V_o[1 - \exp(-t/RC)]$.

In this case t = 60 sec, R = 30 MΩ, and C = 4 μF, so t / RC = 60 / 120 = 0.5, and the voltage across the capacitor is $V = 9(1 - e^{-0.5}) = 3.54$ volts. This voltage will *oppose* the voltage from the battery, so the voltage across R_1 and R_2 at t = 60 s is 9 – 3.54 = 5.46 v. Finally, since R_1 and R_2 are in series, 10 / (10 + 20) = $^1/_3$ of this voltage will appear across R_1, so V_1 = 1.82 v.

2) (8 points) An α-particle is a sub-atomic particle which has a mass of 6.7×10^{-27} kg, and carries twice the charge of an electron. If an α-particle is shot into a uniform magnetic field of 2 Tesla (with v at right angles to B), and proceeds to rotate in a circle of 1 mm radius, what is the velocity of the α-particle?

Solution
From basic mechanics we know that a particle rotating in a circle in a magnetic field must have a Lorentz force acting on it that is equal to the centrifugal force, or $mv^2 / r = qvB$. This tells us that $v = qBr / m = (2)(1.6 \times 10^{-19})(2)(10^{-3}) / (6.7 \times 10^{-27}) = 9.6 \times 10^4$ m/s.