EASY
1. Determine the time required to charge a capacitor in an RC circuit to 90% of full capacity given the following values of resistance and capacitance: R =

A BIT HARDER
2. A 100 mF capacitor is connected in series with a 10.0 Ω resistor. This combination is connected in parallel with a 25.0 Ω resistor. Both branches are then connected in parallel to a 4.50 V battery that can be switched on and off. The capacitor starts off fully discharged.
(a) What is the time constant in both branches when the switch is closed?
(b) What is the maximum charge that the capacitor can attain after the switch is closed?
(c) When will the voltage drop across the 10.0 Ω resistor be equal to 1.50 V after the switch is closed?
(d) If the switch is opened, what will be the value of the new time constant and in which direction will the current flow through the 10.0 Ω resistor?
(e) If the switch is opened after the capacitor is fully charged, how long will it take for there to be only one electron on the capacitor?
(f) If the switch is opened after the capacitor is fully charged, how long will it take for the voltage across the 25.0 Ω resistor to drop to 1.50 V?

WHY WE MIGHT CARE
3. A typical RC circuit can be used as either a low pass or a high pass filter.

At the right you will find a table of capacitive reactance, frequency, impedance, and columns for “rejection ratios”. Data is for a RC circuit with R = 10 kΩ and a capacitance of 0.010 µF. Remember R/Z and Xc/Z represent the ratio of voltage output over voltage input for the high pass side and low pass side of this filter respectively. Complete the calculations for the last two columns and . . .

<table>
<thead>
<tr>
<th>Xc (mF)</th>
<th>Freq. (Hz)</th>
<th>Z (Ω)</th>
<th>R/Z</th>
<th>Xc/Z</th>
</tr>
</thead>
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<td>1.00 x 10^8</td>
<td>10,000</td>
<td>1.000</td>
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<tr>
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</table>

a. Across which circuit element (the resistor or the capacitor) would you monitor the signal if the circuit was being used as a HIGH PASS filter?

b. A typical proton Nuclear Magnetic Resonance spectrometer (with a magnetic field strength of 4.69 Tesla) uses radio frequency (rf) radiation to probe the structure of molecules. The wavelength of the rf is 1.50 meters, what frequency is this?

(c = 3.00 x 10^8 m/s)
c. What energy does this radiation have?

\( h = 6.626 \times 10^{-34} \text{ J} \cdot \text{s} \)

d. Based upon the frequency found above, could the RC circuit described above be used to filter out a 60 Hz line noise from the NMR signal? Look at the numbers above and justify your response.

What fraction of the 60 Hz noise would pass?

e. How could the RC circuit be altered to improve the elimination of 60 Hz noise from the rf signal? Useful equations are:

\[
X_c = \frac{1}{2\pi fC} \quad Z = (R^2 + X_c^2)^{1/2}
\]