Massachusetts Institute of Technology - Physics Department

Physics - 8.02 **Assignment #3** February 22, 2002.

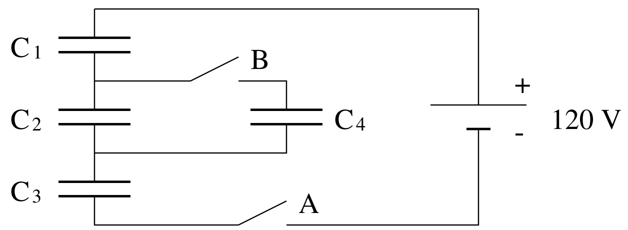
*We **strongly** recommend that you read about a topic before it is covered in lectures.*

Lecture Date	Topics Covered	Reading from Giancoli
#9 Mon 2/25	Currents - Resistivity - Ohm's Law	Chapter 25 through Sect. 25-4
#10 Wed 2/27	Batteries - EMF - Energy Conservation - Power	Sect. 25-5 through 25-8
	Kirchhoff's Rules - Circuits	Chapter 26 through Sect. 26-3
	Kelvin Water Dropper	*(take notes in lecture)*
#11 Fri 3/1	Magnetic field - Lorentz force - Torques	Chapter 27 through Sect. 27-7
	Electric Motors (DC)	
	Cathode Ray Tube, Oscilloscope	Sect. 23-9

Due before 4 PM Friday, March 1 in 4–339B.

Problem 3.1
Capacitors in series and parallel.
Giancoli 24-23.

Problem 3.2
Switching Capacitors.
In the diagram below, the four capacitors have the same capacitance; the battery provides 120 V.



Consider two cases, starting in both cases with uncharged capacitors.

Case I.

(a) While switch B is kept open, switch A is closed and then opened after C_1, C_2, and C_3 are fully charged. What is now the electric potential difference across each capacitor?

(b) Subsequently switch B is closed. What is now the electric potential difference across each capacitor?

Case II.

(c) Switch A is open. Switch B is first closed. What is now the electric potential difference across each capacitor?

(d) Subsequently switch A is closed. What now is the potential difference across each capacitor?

Problem 3.3.
The effect of a dielectric medium on the capacitance.
Giancoli 24-60.

Problem 3.4
Comparing cylindrical and spherical capacitors.

(a) Compare the capacitance of a capacitor of 2 concentric spheres with $R_1 = 6\,\text{cm}$ and $R_2 = 9\,\text{cm}$, with that of a cylindrical capacitor having the same radii and axial length of 15 cm. Why are the capacitance values nearly equal?

(b) Show that, when R_1 and R_2 are nearly equal ($R_2 = R_1 + \delta; \delta << R_1$) the formulas for the spherical and cylindrical capacitors may be approximated by the formula for the parallel-plate capacitor, $C = \varepsilon_0 A/d$ (eq. 24-2). *Hint: make use of Taylor's expansion in terms of* δ/R_1.

Problem 3.5
The Van de Graaff
The spherical dome of a Van de Graaff electrostatic generator has a radius of $R\,\text{m}$. A rubberized belt 50 cm wide travels at a velocity of $30\,\text{m/sec}$. The belt is given a surface charge density which produces a field of approximately $10^6\,\text{V/m}$ on each side of the belt. (see Figure 23-37 on page 612).

(a) What is the current carried by the belt?

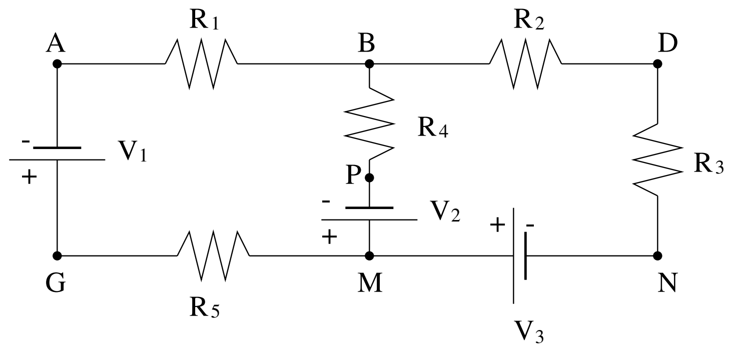
(b) What is the maximum charge that the spherical dome can hold, and how long will it take to reach this value?

(c) What is the maximum electrostatic potential of the spherical dome?

(d) What are your answers under (b) and (c) for $R = 0.15$ and $R = 0.5\,\text{m}$?

Problem 3.6
Resistor Circuit.
Giancoli 26-25

Problem 3.7
Resistor Network.
A circuit consists of 5 resistors and 3 batteries (see diagram); the connecting wires have all a negligible resistance. The values for R_1, R_2, R_3, R_4, and R_5 are $10\,\Omega$, $30\,\Omega$, $50\,\Omega$, $70\,\Omega$, and $100\,\Omega$, respectively. The batteries have a negligible internal resistance; their voltages V_1, V_2, and V_3, are 12 V, 24 V, and 36 V, respectively (for their polarities, see the diagram).



(a) Calculate the current (magnitude and direction) of the currents through each of the 5 resistors.

(b) What is the potential difference (observe signs!) between the points A&P, P&N, and G&D.

Problem 3.8
Wire resistance.
Giancoli 25-52.

Problem 3.9
Energy consumption of heater.
Giancoli 25-61.

Problem 3.10
Electric car.
Giancoli 25-72.

Recitations.

There are 28 recitation sections (see the 8.02 Website). If *for any reason* you want to change section, please see Maria Springer in 4-352.