# Physics 204

Problems for Assignment 13

Due Friday, 25 April 2008

# 1 Cylindrical Capacitor

Consider two hollow concentric cylinders of length $l$ with equal and opposite charge on them. The inner cylinder has a radius $a$ and charge $+Q$ on it. The outer cylinder has a radius $b$ and a charge $-Q$ on it. (Hint: See section 28-3 of your text.)

(a) Use Gauss' law to compute the electric field for $r < a$, $a < r < b$, and $r > b$. Neglect edge effects.

(b) Compute the the potential difference between the two cylinders.

(c) Compute the capacitance of this cylindrical capacitor.

## 2 Spherical Capacitor

Consider two hollow concentric spheres with equal and opposite charge on them. The inner sphere has a radius $a$ and charge $-Q$ on it. The outer sphere has a radius $b$ and a charge $+Q$ on it. (Hint: See section 28-3 of your text.)

(a) Use Gauss' law to compute the electric field for $r < a$, $a < r < b$, and $r > b$.

(b) Compute the the potential difference between the two spheres.

(c) Compute the capacitance of this spherical capacitor.

## 3 Multiple Capacitors

(a) Show that the equivalent capacitance of multiple capacitors in series $C_{eq}$ is given by $1/C_{eq} = \sum_i 1/C_i$

(b) Show that the equivalent capacitance of multiple capacitors in parallel $C_{eq}$ is given by $C_{eq} = \sum_i C_i$

(Hint: See section 28.4 of your text.)

## 4 Discharging a Capacitor

Consider a circuit with a charged capacitor, a resistor, and a switch (initially open) connected in series. (Hint: See section 28-9 of your text.)

(a) What is the [differential] equation that describes the charge in this circuit after the switch is closed. Explain your signs carefully in this equation. (Hint: Use the loop rule.)

(b) Guess a solution to this differential equation and verify that it is a solution by plugging it back in.

(c) Complete Touchstone Example 28-5 from your text.

# 5 Touchstone Example 32-2: Two Inductors and Three Resistors

Figure 32-9*a* shows a circuit that contains three identical resistors with resistance $R = 9.0\,\Omega$, two identical ideal inductors with inductance $L = 2.0\,\text{mH}$, and an ideal battery with emf $\varepsilon = 18\,\text{V}$.

(a) What is the current $i$ through the battery just after the switch is closed?

(b) What is the current $i$ through the battery long after the switch has been closed?

## 6 Cummings 32.7: Inductors in Series

Two inductors $L_1$ and $L_2$ are connected in series and separated by a large distance.

(a) Show that the equivalent inductance $L_{eq}$ is given by $L_{eq} = L_1 + L_2$

(b) Why must their separation be large for this relationship to hold?

(c) What is the generalization for (a) for $N$ inductors in parallel?

## 7 Cummings 32.10: Inductors in Parallel

Two inductors $L_1$ and $L_2$ are connected in parallel and separated by a large distance.

(a) Show that the equivalent inductance $L_{eq}$ is given by $1/L_{eq} = 1/L_1 + 1/L_2$

(b) Why must their separation be large for this relationship to hold?

(c) What is the generalization for (a) for $N$ inductors in series?

# 8 Cummings 33.18: SHM

A 0.50 kg body oscillates in simple harmonic motion on a spring that, when extended 2.0 mm from its equilibrium has an 8.0 N restoring Force.

(a) What is the angular frequency of oscillation?

(b) What is the period of oscillation?

(c) What is the capacitance of an LC circuit with the same period if $L$ is chosen to be 5.0 H?