Exam 1

P202 Spring 2007,
Instructor: Prof. Abanov

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Name_____________ Section_____________
(print)
Problem 1.

Four charges $Q_1$, $Q_2$, $Q_3$, and $Q_4$ are positioned in the corners of a square whose side measures $a=0.5\text{m}$. $Q_1=+3.0\text{mC}$, $Q_4=+3.0\text{mC}$, and $Q_2=+1.0\text{mC}$ is positive.

What is the magnitude and direction of the force with which charge $Q_1$ acts on charge $Q_2$?_______ (show direction on the figure)

What is the magnitude and direction of the force with which charge $Q_4$ acts on charge $Q_2$?_______ (show direction on the figure)

What does $Q_3$ have to be so that the total force on $Q_2$ to be zero?_______

What will be the total force acting on $Q_2$ if we double $Q_3$?_______
Problem 2.

Three charges $Q_1$, $Q_2$, and $Q_3$ are positioned in the corners of a triangle whose side measures $a=0.5\text{m}$ and angle $\theta=60^\circ$. $Q_1=Q_2=+3.0\text{mC}$ and $Q_3=+1.0\text{mC}$.

What is the magnitude and direction of the force with which charge $Q_1$ acts on charge $Q_3$? ________ (show direction on the figure)

What is the magnitude and direction of the force with which charge $Q_2$ acts on charge $Q_3$? ________ (show direction on the figure)

What is the magnitude and direction of the total force which acts on charge $Q_3$? ________ (show direction on the figure)

What would be the magnitude and direction of the total force which acted on charge $Q_3$, if charge $Q_2=-3.0\text{mC}$? ________ (show direction on the figure)

Problem 3.

A solid, conducting sphere of radius $a=3.5\text{cm}$ carries an excess charge of $Q=+6.0\mu\text{C}$. This sphere is located at the center of a hollow, conducting sphere with an inner radius of $b=10.0\text{cm}$ and an outer radius of $c=12.0\text{cm}$ as shown. The hollow sphere also carries a total excess charge of $q=+6.0\mu\text{C}$.

What is the magnitude and direction of the electric field at a distance 2cm from the center? __________
What is the magnitude and direction of the electric field at a distance 5cm from the center? 

What is the magnitude and direction of the electric field at a distance 11cm from the center? 

What is the magnitude and direction of the electric field at a distance 15cm from the center? 

What is the total charge at the outer surface of the hollow sphere? 

**Problem 4.**
Two protons are released from the rest when they are 0.8nm apart.

What is the maximum speed they will reach? 

When does this speed occur? 

What is the maximum acceleration they will achieve? 

When does this acceleration occur?
Problem 5.
Three charges Q1, Q2, and Q3 are positioned in the corners of a triangle whose side measures a=0.5m and angle \( \theta = 60^\circ \). Q1=Q2=+3.0 mC and Q3= +1.0 mC. The mass of charge Q3 is M=10g. At initial time the charge Q3 is released.

What is initial acceleration of the charge Q3?_____

What is the velocity of the charge Q3 at infinity?_____

What would the velocity at infinity be if charge Q3 started from midpoint between charges Q1 and Q2?_____

Problem 6.
The plates of the parallel-plate capacitor are d=10mm apart, and each carries a charge of magnitude Q=8.0\( \mu \)C. The electric field between the plates has a magnitude of \( E = 4.0 \times 10^6 \) V/m.

What is the potential difference between the plates?_____

What is the area of each plate?_____

What is the capacitance?_____

How will the capacitance and the potential difference change if we double the distance between the plates?_____

**Problem 7.** (spherical capacitor)

A solid, conducting sphere of radius $a = 3.5\text{cm}$ is located at the center of a hollow, conducting sphere with an inner radius of $b = 10.0\text{cm}$ and an outer radius of $c = 12.0\text{cm}$ as shown. The charge of the solid sphere is $Q = -6.0\mu\text{C}$. The hollow sphere also carries a total excess charge of $q = +6.0\mu\text{C}$.

What is the potential difference between the solid and the hollow spheres?________

What is the capacitance of this system of conductors?_______

**Problem 8.**

A parallel plate capacitor is set up horizontally and has a distance between plates $d = 1\text{cm}$ and the potential difference between the plates $V = 100\text{Volts}$. A small object in between the plates has a small charge $Q = 1\mu\text{C}$.

What is the magnitude and direction of the electric field in between the plates?________

What electrostatic force is acting on the object?_______

What should be the mass of the object in order for the object to be at rest?($g = 9.8\text{m/s}^2$)_______
Problem 9.
A system of capacitors is shown on the figure, $C_1=2 \mu F$, $C_2=3 \mu F$. Potential difference between points a and b is $V=10$ Volts.

What is the charge $Q_1$ on capacitor $C_1$? ___________

What is the charge $Q_2$ on capacitor $C_2$? ___________

What is the total capacitance of the system? ___________

Problem 10.
A system of capacitors is shown on the figure, $C_1=2 \mu F$, $C_2=3 \mu F$. Potential difference between points a and b is $V=10$ Volts.

What is the total capacitance of the system? ___________

What is the charge $Q_1$ on capacitor $C_1$? ___________

What is the charge $Q_2$ on capacitor $C_2$? ___________

What is the voltage difference $V_1$ across the capacitor $C_1$? ___________

What is the voltage difference $V_2$ across the capacitor $C_2$? ___________