Exam 1

P202 Spring 2008,
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 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= +3.0mC and Q3= +1.0mC.

What is the magnitude and direction of the force with which charge Q1 acts on charge Q3? ________ (show direction on the figure)

What is the magnitude and direction of the force with which charge Q2 acts on charge Q3? ________ (show direction on the figure)

What is the magnitude and direction of the total force which acts on charge Q3? ________ (show direction on the figure)

What would be the magnitude and direction of the total force which acted on charge Q3, if charge Q2=-3.0mC? ________ (show direction on the figure)
Problem 3.
A solid, conducting sphere of radius \( a = 3.5 \text{cm} \) carries an excess charge of \( Q = +6 \mu C \). 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 carries a total excess charge of \( q = -6 \mu C \).

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 (at what distance) does this speed occur? _______________

What is the maximum acceleration they will achieve? __________

When (at what distance) 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=+3.0mC and Q3= +1.0mC. 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=8.0μC. The electric field between the plates has a magnitude of 
\[ E = 4.0 \times 10^6 \text{ V/m} \]

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 \( Q = -8 \mu C \). The hollow sphere carries a total excess charge of \( q = +8 \mu C \).

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 the 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, $C_1=2\mu\text{F}$, $C_2=3\mu\text{F}$. Potential difference between points a and b is $V=10\text{Volts}$.

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 \( C_2 \)? ____________