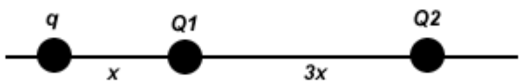
Physics 196 Fall 2008 Name ______________________________

Test 1 - 120 points

Circle the best answer. Or, put your calculation in the box provided. Watch your sig figs.

1) Three equal point charges are held in place. If F_1 is the force on q due to Q_1 and F_2 is the force on q due to Q_2 how do F_1 and F_2 compare? (5pts)

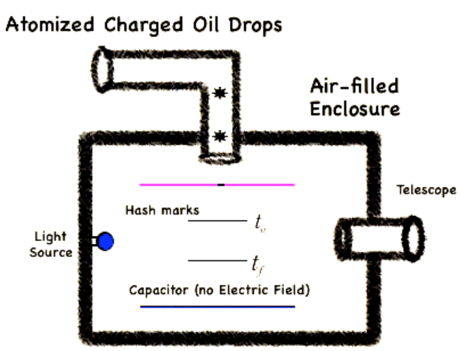


A. F_2=1/9 B. F_2=1/4 C. F_2=1/16 D. F_2=16/1

2) In the Mechanical Universe, you saw the magician use ‘magic’ with the Electroscope. When to rod was brought close to the top of the post what caused the gold leaves to move away from each other? (5 pts)

a) The rod was charged and induced the same charge toward the top of the post leaving the gold leaves with the same charge.
b) The rod and the top are oppositely charged causing charge to flow from the leaves which causes the leaves to move away from each other.
c) The rod is charged and induces the opposite charge toward the top of the post leaving the gold leaves with different charges.
d) The rod is charged and induces the opposite charge toward the top of the post leaving the gold leaves with the same charge.

3) What were the forces on the charged oil drop in Millikan’s Oil Drop experiment? Why did he run the experiment with the electric field on and then off? (5 pts)



a) The electric force, gravitational force and viscous force / he needed to obtain two velocities to help solve for the fundamental mass of the electron.
b) The electric force, viscous force and magnetic force / he needed to obtain two velocities to help solve for the fundamental mass of the electron.
c) The electric force, gravitational force and magnetic force / he needed to obtain two velocities to help solve for the fundamental charge of the electron. d) The electric force, gravitational force and viscous force / he needed to obtain two velocities to help solve for the fundamental charge of the electron.

4) How are the small pieces of paper attracted to the comb? (5pts)

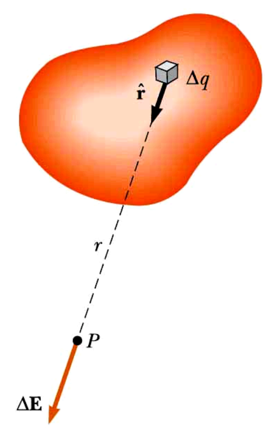
a) Only, the comb is charged.
b) The comb is charged and the pieces of paper are polarized. c) The comb and the pieces of paper are polarized.
d) Only, the paper is charged.
e) The comb is charged and the pieces of paper are charged.

5) An object having a net charge of 28.0 μC is placed in a uniform electric field of 930 N/C directed vertically. What is the mass of this object if it "floats" in the field? (5pts)

6) A proton accelerates from rest in a uniform electric field of 960 N/C. At some later time, its speed is 2.20 x 10^6 m/s. (a) Find the acceleration of the proton. (b) What is its kinetic energy at this time? (5pts)

7) The electric field due to a continuous charge distribution is shown by this equation. Which description best fits the equation. (5pts)

$$E = k\lim_{\Delta q \to 0}\sum_i \frac{\Delta q_i}{r_i^2}\widehat{r}_i = k\int \frac{dq}{r^2}\widehat{r}$$



a) The magnitude and direction of the electric field at a point P is due to the sum of all the charge elements divided by the square of the distance of each charge element from point P. In the limit as the charge element is shrunk in size to zero the discrete sum then becomes the continuous sum (integral) as shown.

b) The magnitude of the electric field at a point P is due to the limit of the sum of all the small charge elements divided by the distance of each charge element from point P. As the charge element is shrunk in size the discrete sum then becomes the continuous sum (integral) as shown.

c) The magnitude and direction of the electric force at a point P is due to the sum of all the charges divided by the square of the distance of each charge element from point P. The charge element is shrunk in size the discrete sum then becomes the continuous sum (integral) as shown.

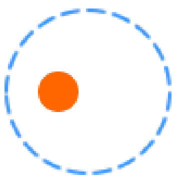
8) Two point charges, Q_1 = +7.20 nC and Q_2 = -4.40 nC are separated by 42.0 cm.(a) What is the potential energy of the pair? (b) What is the electric potential at a point midway between the charges? (Note: Assume a reference level of potential V = 0 at r = infinity.) (5pts)

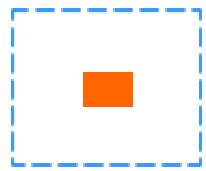
9) According to Fleisch and Serway, Gauss's Law applies to (5pts)

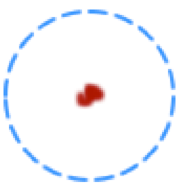
$$\Phi_E = \oint_S E \cdot da = \frac{q_{enc}}{\varepsilon_o}$$

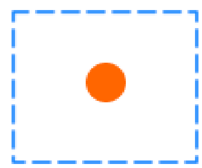
a) a highly symmetric charge distribution
b) any charge distribution
c) discrete charge distributions
d) continuous charge distributions only

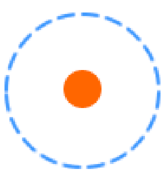
10) Is Gauss's Law useful in determining the E-field of the charge distributions shown below? Yes or No? Why? use the qualifications below by drawing an E-field vector and the area vector to prove your answer
a. the value of the electric field is constant over the surface
b. E and da are parallel on the surface
(10pts)

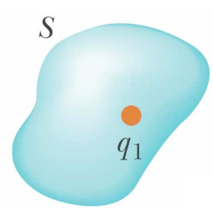
 ______________________

 ______________________

 ______________________

 ______________________

 ______________________



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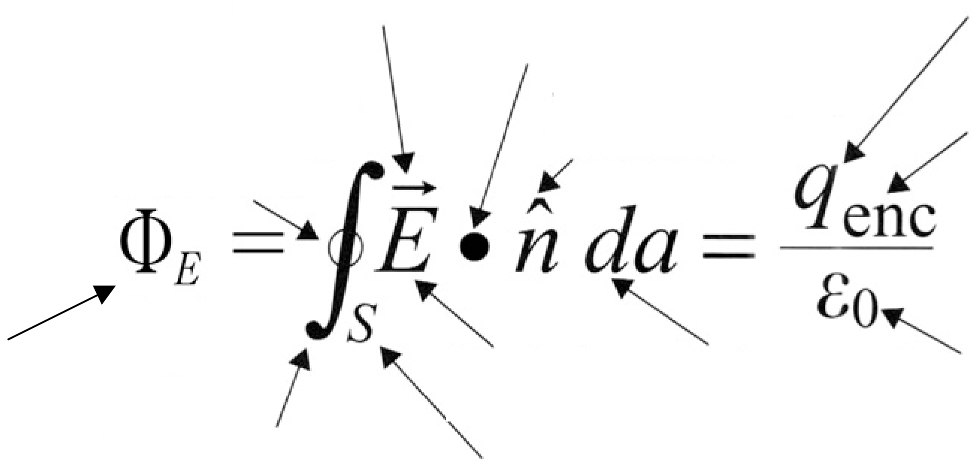
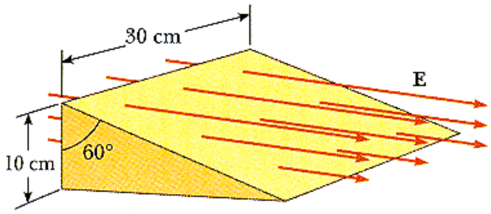
11) Specify what each arrow tells us. Fill in the blanks (5 pts)



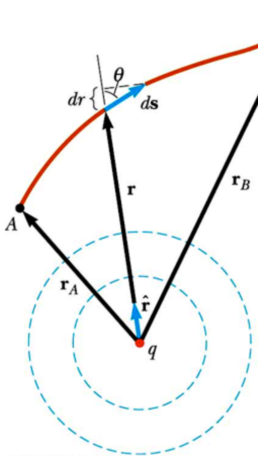
12) Consider a closed triangular box resting within a horizontal electric field of magnitude $E = 9.20 \times 10^4$ N/C. (a) Calculate the electric flux through the vertical rectangular surface of the box. (b) Calculate the electric flux through the slanted surface of the box. (c) Calculate the electric flux through the entire surface of the box. (5pts)



13) A 19.8 g piece of Styrofoam carries a net charge of -3.70 μC and floats above the center of a large horizontal sheet of plastic that has a uniform charge density on its surface. What is the charge per unit area on the plastic sheet? (5pts)

14) An insulating sphere of radius 12.0 cm has a uniform volume charge density $\rho = 33\mu C/m^3$. Calculate the magnitude of the electric field at 8.00 cm. Show your work. (5pts)

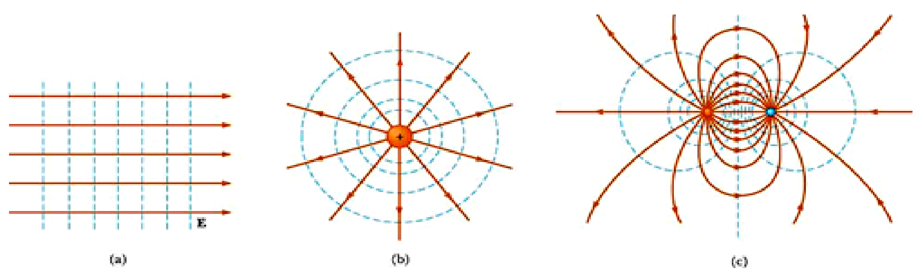
15) **E** • d**s** represents the component of d**s** _____ to the direction of **E** and will contribute to the total _______ . The component of ds perpendicular to **E** _____ contribute to the potential difference. The integral shows us that **E** • d**s** is ______ of the path between points A and B which means that the particle can travel any path between A and B. The potential only depends upon the _______ between the radial coordinates A and B. (5pts)



a) parallel, potential energy, will, dependent, difference
b) perpendicular, potential difference, will not, independent, difference
c) parallel, potential difference, will, dependent, potential difference
d) parallel, potential difference, will not, independent, difference

$$V_B - V_A = -\int_A^B E \cdot ds$$

16) Because the potential is constant along an equipotential surface, this surface must always be perpendicular to electric field lines. (5pts)



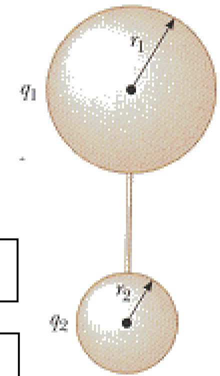
a) This is true because the line integral is simply picking out all the components of d**s** that are perpendicular to **E** and summing them over the interval from A to B. The product **E** • d**s** (parallel) = 0. So the potential is constant.

b) This is true otherwise there would be a component of the e-field prpendicular to the equipotential surface which would suggest that a charged particle there would experience a force due to the e-field which would accelerate the charge along the equipotential surface.

c) This is true otherwise there would be a component of the e-field parallel to the equipotential surface which would suggest that a charged particle there would experience a force due to the e-field which would accelerate the charge along the equipotential surface.

d) This is true because the line integral is simply picking out all the components of d**s** that are parallel to **E** and summing them over the interval from A to B. The product **E** • d**s** (perpendicular) = 0. So the potential is constant.

17) Electric charge can accumulate on an airplane in flight. You may have observed needle-shaped metal extensions on the wing tips and tail of an airplane. Their purpose is to allow charge to leak off before much of it accumulates. The electric field around the needle is much larger than the field around the body of the airplane and, can become large enough to produce dielectric breakdown of the air, discharging the airplane. To model this process, assume that two charged spherical conductors are connected by a long conducting wire and a charge of 25.0 μC is placed on the combination. One sphere, representing the body of the airplane, has a radius of 10.00 cm, and the other, representing the tip of the needle, has a radius of 3.00 cm. (a) What is the electric potential of each sphere? (b) What is the electric field at the surface of each sphere? (10pts)



18) Regarding the Earth and a cloud layer 1100 m above the Earth as the "plates" of a capacitor, calculate the capacitance. Assume the cloud layer has an area of 1 km^2 and that the air between the cloud and the ground is pure and dry. Assume charge builds up on the cloud and on the ground until a uniform electric field of 3.00×10^6 N/C throughout the space between them makes the air break down and conduct electricity as a lightning bolt. What is the maximum charge the cloud can hold? (5pts)

19) An air-filled capacitor consists of two parallel plates, each with an area of 9.60 cm^2, separated by a distance of 2.40 mm. (a) If a 23.0 V potential difference is applied to these plates, calculate the electric field between the plates. (b) What is the surface charge density? (c) What is the capacitance? (d) Find the charge on each plate. (5pts)

DRS Problem. Diagram (5pts), Reasoning (5pts) and Solution (5pts).
Choose either problem 20 or problem 21. Not both.

20) Protons are projected upward at some angle with an initial speed $v_i = 9.89 \times 10^3$ m/s into a region where a uniform electric field E = (720 j) N/C is present and downward. The protons hit at a point that lies at a horizontal distance of 1.27 mm from the point where the protons enter the electric field. (a) Find the two projection angles θ that will result in a hit. (b) Find the total time of flight for each trajectory.

DRS Problem. Diagram (5pts), Reasoning (5pts) and Solution (5pts).
Choose either problem 20 or problem 21. Not both.

21) Consider two thin, conducting, spherical shells as shown in cross-section in the figure. The inner shell has a radius r_1 = 11.0 cm and a charge of 30.0 nC. The outer shell has a radius r_2 = 30.0 cm and a charge of -15.0 nC. Let r_A = 4.0 cm, r_B = 22.0 cm, and r_C = 32.0 cm. (a) Find the electric field (E) at A, B, and C. (b) Find the electric potential (V) at A, B, and C, with V = 0 at r = infinity.