Physics 112 Sample Test 2

NAME _____

Please complete this page and turn it in. Then you will receive the rest of the exam with an equation sheet.

Please write down the mathematical connections among all four quantities related to electric interactions. (**Show how to go in both directions for each pair**.)

$U_E \leftrightarrow V$:

$\vec{F}_E \leftrightarrow \vec{E}$:

$\vec{E} \leftrightarrow \Delta V$:

$\vec{F}_E \leftrightarrow \Delta U_E$:

Label the names and units of these quantities. Then indicate which ones depend on the presence of only one charge and which depend on the presence of at least two charges. Then indicate which go as $1/r$ and which go as $1/r^2$.

(circle)

$\vec{F}_E$ name:_____	unit:_____		one charge	two charges	$1/r$	$1/r^2$
$\vec{E}$ name:_____	units (2):_____		one charge	two charges	$1/r$	$1/r^2$
U_E name:_____	unit:_____		one charge	two charges	$1/r$	$1/r^2$
V name:_____	unit:_____		one charge	two charges	$1/r$	$1/r^2$

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By writing my name above, I affirm that this test represents my work only, without aid from outside sources. In all aspects of this course I perform with honor and integrity.

SHOW YOUR WORK ON ALL OF THE PROBLEMS. YOUR APPROACH TO THE PROBLEM IS AS IMPORTANT AS, IF NOT MORE IMPORTANT THAN, YOUR ANSWER. DRAW **CLEAR AND NEAT PICTURES** SHOWING COORDINATE SYSTEMS AND ALL OF THE RELEVANT PROBLEM VARIABLES. ALSO, **UNDERLINE** SHOW THE **BASIC EQUATIONS** YOU ARE USING. BE NEAT AND THOROUGH. THE EASIER IT IS FOR ME TO UNDERSTAND WHAT YOU ARE DOING, THE BETTER YOUR GRADE WILL BE.

$$\vec{F} \leftrightarrow \vec{E}: \qquad \vec{F} = q\vec{E} = q\left(k\frac{Q}{r^2}\hat{r}\right) \qquad \leftrightarrow \qquad \vec{E} = \frac{\vec{F}}{q}$$

$$U \leftrightarrow V: \qquad U = qV = q\left(k\frac{Q}{r}\right) \qquad \leftrightarrow \qquad V = \frac{U}{q}$$

$$\vec{F} \leftrightarrow \Delta U: \qquad \vec{F}_x = -\frac{dU}{dx}\hat{i} \qquad \leftrightarrow \qquad \Delta U = -\int_A^B \vec{F}\cdot d\vec{r}$$

$$\vec{E} \leftrightarrow \Delta V: \qquad \vec{E}_x = -\frac{dV}{dx}\hat{i} \qquad \leftrightarrow \qquad \Delta V = -\int_A^B \vec{E}\cdot d\vec{r}$$

$$\Phi_E = \oint \vec{E}\cdot d\vec{A} = \frac{Q_{in}}{\varepsilon_0}$$

$$\boldsymbol{U_{cap}} = \frac{Q^2}{2C} = \frac{1}{2}C(\Delta V)^2 = \frac{1}{2}Q(\Delta V)$$

$$\int \frac{xdx}{\left(x^2+a^2\right)^{3/2}} = \frac{-1}{\sqrt{x^2+a^2}}$$

$$\int \frac{dx}{\left(x^2+a^2\right)^{3/2}} = \frac{1}{a^2}\frac{x}{\sqrt{x^2+a^2}}$$

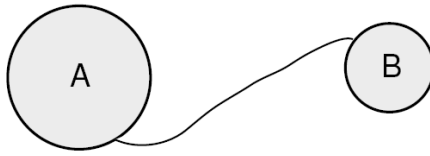$$v = v_{0x} + a_x t$$
$$x = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$$
$$x = x_0 + \frac{1}{2}(v_x + v_{0x})t$$
$$v_x^2 = v_{0x}^2 + 2a_x(x - x_0)$$
$$x = x_0 + v_x t - \frac{1}{2}a_x t^2$$

1.1) Two charged metal spheres are connected by a copper wire. Note that $r_A > r_B$ and that the spheres are far apart. What quantities must be the <u>same</u> for both spheres?

a) The total charge.
b) The potential.
c) The electric field just outside the surface.
d) The electric field everywhere inside.
e) The surface charge density.

1.2) Three capacitors, each of identical capacitance C, are combined in a variety of ways (series, parallel, or both) using copper wires. What minimum value of capacitance is found in a combination that uses all three capacitors?

   a) C/6
   b) C/3
   c) C/2
   d) C
   e) 3C/2

1.3) The plates of a parallel-plate capacitor have constant charges of +Q and –Q. Which of the following quantities increases as the separation of the plates increases?

   a) Electric field.
   b) Potential difference between the plates.
   c) The capacitance.

1.4) A charge is released from rest in an electric field. Neglect non-electrical forces.
Independently of the sign of the charge, it will **_always_** move to a position

    a) with higher potential.
    b) with lower potential.
    c) where it has higher potential energy.
    d) where it has lower potential energy.
    e) where the electric field has higher magnitude.
    f) where the electric field has lower magnitude.

1.5) A **_negative_** test charge $Q = -0.6$ C was moved from point A to point B In a uniform electric field $E = 5$ N/C. The test charge is **_at rest_** before and after the move. The distance between A and B is 0.5m and the line connecting A and B is perpendicular to the electric field. How much work was done by the net external force while moving the test charge from A to B?

    a)   1.5J
    b)   0J
    c) −1.5J
    d)   3.0J
    e) −3.0J
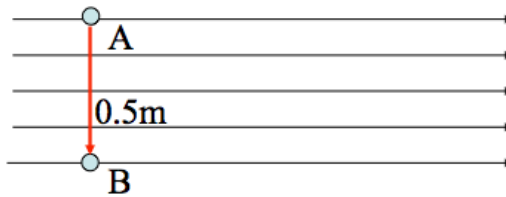
A long solid cylindrical insulator of radius R has a uniform charge density of $+\rho$.

a) Find ΔV along a line perpendicular to the cylinder's central axis from the center of the cylinder to a point eR away (where e is the base of the natural log).

b) A particle with mass m and charge $+q$ is placed against the outer wall of the cylinder and released from rest. Use the *Work Energy Theorem* to find its velocity when it is eR away?

Extra Space

A solid conducting slab is inserted midway between the plates of a capacitor with capacitance C that is charged to initial energy U_I. The slab thickness is 2/3 of the original plate spacing and its area is the same as that of the original plates
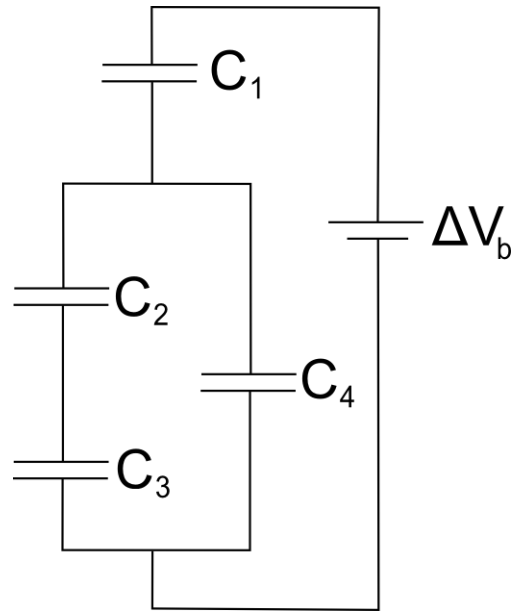.

a) Write an expression for the new capacitance in terms of the original capacitance C.

b) Write an expression for the new stored energy in terms of the initial stored energy, assuming the capacitor is not connected to anything.

Extra Space

In the capacitor network at the right, all capacitors have the same capacitance C and the battery provides a potential difference ΔV_b.

Find an expression for the potential difference, ΔV_3, and the charge, Q_3, on C_3 in terms of C and ΔV_b.

Extra Space