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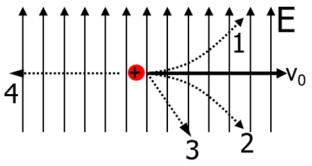
PHYS 2135 Exam I
September 17, 2019

Name: _____ Section: _____

For questions 1-5, select the best answer. For problems 6-9, solutions must begin with an Official Starting Equation, when appropriate. Work must be shown to receive credit. Calculators are not allowed.

(8) _____ **1.** A proton is moving with speed $\vec{v}_0$ in a uniform electric field. Which of the four dotted lines best represents the trajectory of the proton?

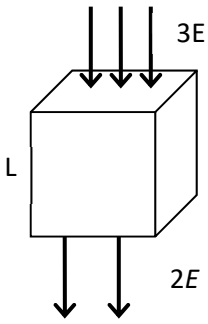


[A] 1 [B] 2 [C] 3 [D] 4

(8) _____ **2.** The electric potential in a certain region of space is $V = 6xy^2(\mathrm{V/m^4}) - 4x^2(\mathrm{V/m^3}) + 62y(\mathrm{V/m^2})$. The *x*-component of the electric field at *x* = 2.0 m, y = 1.0 m is …

[A] +10 V/m
[B] -10 V/m
[C] -65 V/m
[D] 58 V/m

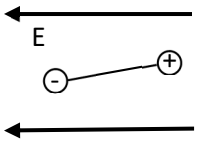
(8) _____ **3.** A cube of side *L* has a vertical electric field of uniform magnitude 3*E* at its top surface and of magnitude 2*E* at its bottom surface. What is the charge contained in the cube?



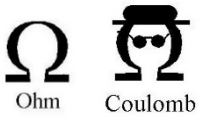
[A] 0 [B] $\varepsilon_0 EL^2$ [C] $-\varepsilon_0 EL^2$ [D] $5\varepsilon_0 EL^2$.

(8) _____ **4**. An electric dipole is released in a uniform electric field, as illustrated. Which direction will the dipole rotate and what is its potential energy? [The dipole is in the plane of the paper.]

[A] counterclockwise, U is near its minimum
[B] counterclockwise, U is near its maximum
[C] clockwise, U is near its minimum
[D] clockwise, U is near its maximum



(8) _____ **5** (Free). For those reading ahead, what's the difference between an Ohm and a Coulomb?



[A]
[B] Ask Sherlock Ohms
[C] Only Ohm can resist Coulomb.
[D] Ohm doesn't know how to conduct himself.

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6. Two point charges are placed on the x-axis. The first point charge $+Q$ is placed at $x = 0$ and the second point charge $+9Q$ is placed at $x = D$.

(10) (a) Find a location on the x-axis that the net electric field is zero. Express your answer in terms of the given parameters.

(10) (b) A third point charge $+q_0$ is located midway between the two point charges, $+Q$ and $+9Q$. What is the net force on the third charge? Express your answer in unit vector notation.

(20) (c) Find the electric field at point $(0, D)$. If a third point charge $+q_0$ is located at $(0, D)$, what is the net force on the third charge? Express your answer in unit vector notation.

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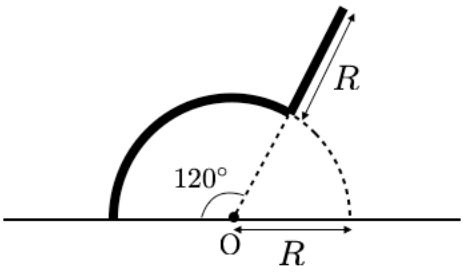
7. An arc of radius R and a rod of length R are located as shown. The arc subtends an angle of 120 degrees. Both the arc and the rod have a negative uniform charge per unit length $-\lambda$. Express your answers with R, λ, and constants. If your work involves an integral, you need to perform the integral to get a full credit.



(6) (a) Determine the total charge sum of the arc and the rod.

(12) (b) Determine the electric potential from **the arc** at the origin. You may assume that $V = 0$ at infinity.

(12) (c) Determine the electric potential from **the rod** at the origin. You may assume that $V = 0$ at infinity.

(10) (d) An electron (mass m and charge $-e$) is released from rest at the origin. Determine the maximum velocity of the electron after it is released.

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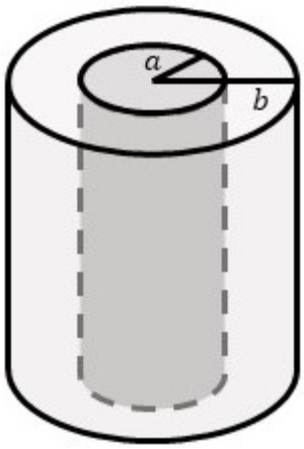
8. An infinitely long insulating cylinder of radius a with uniform charge density ρ lies along the axis of symmetry of an infinitely long conducting cylindrical shell of inner radius a and outer radius b, as illustrated. The electric field outside the conducting cylindrical shell ($r > b$) is found to be zero.



(15) (a) Determine the electric field inside the insulating cylinder ($0 < r < a$).

(10) (b) Determine the electric field within the conducting cylindrical shell ($a < r < b$).

(10) (c) Express the surface charge density σ_a at the inner surface of the conducting shell in terms of variables introduced above.

(5) (d) Express the surface charge density σ_b at the outer surface of the conducting shell in terms of variables introduced above.

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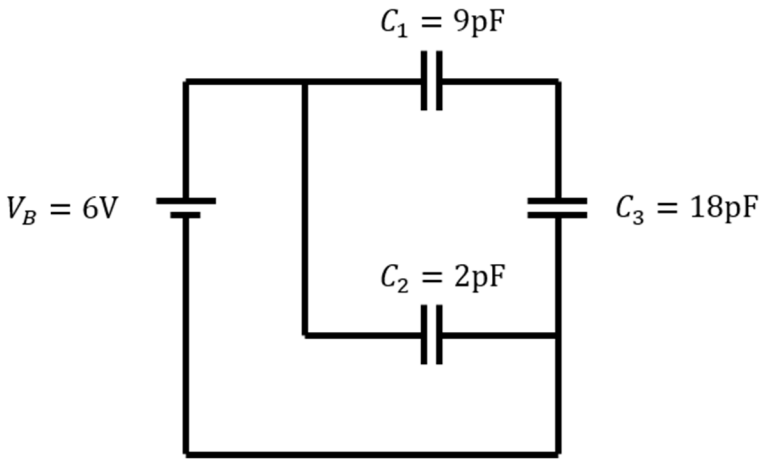
9. Consider the given circuit. [Provide numerical answers for each part.]



(15) (a) Determine C_T, the total equivalent capacitance.

(15) (b) Determine Q_3, the charge on C_3.

(10) (c) Determine V_3, the potential across C_3.

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