Official Starting Equations
PHYS 2135, Engineering Physics II

From PHYS 1135:

$x = x_0 + v_{0x}\Delta t + \frac{1}{2}a_x(\Delta t)^2$ $\quad v_x = v_{0x} + a_x\Delta t$ $\quad v_x^2 = v_{0x}^2 + 2a_x(x - x_0)$ $\quad \sum \vec{F} = m\vec{a}$

$F_r = -\frac{mv_t^2}{r}$ $\quad P = \frac{F}{A}$ $\quad \vec{p} = m\vec{v}$ $\quad P = \frac{dW}{dt}$ $\quad W = \int \vec{F} \cdot d\vec{s}$

$K = \frac{1}{2}mv^2$ $\quad U_f - U_i = -W_{\text{conservative}}$ $\quad E = K + U$ $\quad E_f - E_i = (W_{\text{other}})_{i\to f}$ $\quad E = P_{\text{ave}}t$

Constants:

$g = 9.8\,\frac{\text{m}}{\text{s}^2}$ $\quad m_{\text{electron}} = 9.11 \times 10^{-31}\text{kg}$ $\quad m_{\text{proton}} = 1.67 \times 10^{-27}\text{kg}$ $\quad e = 1.6 \times 10^{-19}\text{C}$

$c = 3.0 \times 10^8\,\frac{\text{m}}{\text{s}}$ $\quad k = \frac{1}{4\pi\epsilon_0} = 9 \times 10^9\,\frac{\text{Nm}^2}{\text{C}^2}$ $\quad \epsilon_0 = 8.85 \times 10^{-12}\,\frac{\text{C}^2}{\text{Nm}^2}$ $\quad \mu_0 = 4\pi \times 10^{-7}\,\frac{\text{Tm}}{\text{A}}$

Electric Force, Field, Potential and Potential Energy:

$\vec{F} = k\frac{q_1q_2}{r_{12}^2}\hat{r}_{12}$ $\quad \vec{E} = k\frac{q}{r^2}\hat{r}$ $\quad \vec{F} = q\vec{E}$ $\quad \Delta V = -\int_i^f \vec{E} \cdot d\vec{s}$

$U = k\frac{q_1q_2}{r_{12}}$ $\quad V = k\frac{q}{r}$ $\quad \Delta U = q\Delta V$ $\quad E_x = -\frac{\partial V}{\partial x}$

$\vec{p} = q\vec{d}$ (from – to +) $\quad \vec{\tau} = \vec{p} \times \vec{E}$ $\quad U_{\text{dipole}} = -\vec{p} \cdot \vec{E}$

$\Phi_E = \int_S \vec{E} \cdot d\vec{A}$ $\quad \oint_S \vec{E} \cdot d\vec{A} = \frac{q_{\text{enclosed}}}{\epsilon_0}$ $\quad \lambda \equiv \frac{\text{charge}}{\text{length}}$ $\quad \sigma \equiv \frac{\text{charge}}{\text{area}}$ $\quad \rho \equiv \frac{\text{charge}}{\text{volume}}$

Circuits:

$C = \frac{Q}{V}$ $\quad \frac{1}{C_T} = \sum \frac{1}{C_i}$ $\quad C_T = \sum C_i$ $\quad C_0 = \frac{\epsilon_0 A}{d}$ $\quad C = \kappa C_0$

$U = \frac{1}{2}CV^2 = \frac{1}{2}\frac{Q^2}{C} = \frac{1}{2}QV$ $\quad I = \frac{dq}{dt}$ $\quad J = \frac{I}{A}$ $\quad \vec{J} = nq\vec{v}_d$

$\vec{J} = \sigma\vec{E}$ $\quad V = IR$ $\quad R = \rho\frac{L}{A}$ $\quad \sigma = \frac{1}{\rho}$ $\quad \rho = \rho_0[1 + \alpha(T - T_0)]$

$\sum I = 0$ $\quad \sum \Delta V = 0$ $\quad \frac{1}{R_T} = \sum \frac{1}{R_i}$ $\quad R_T = \sum R_i$ $\quad P = IV = \frac{V^2}{R} = I^2R$

$Q(t) = Q_{\text{final}}\left[1 - e^{-t/\tau}\right]$ $\quad Q(t) = Q_0 e^{-t/\tau}$ $\quad \tau = RC$

Exam Total
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PHYS 2135 Exam I
February 18, 2020

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. An electron is initially traveling vertically with velocity v_0 and entering a region where there is a uniform electric field. The electric field deflects the electron to the right. What is the direction of the electric field?

[A] up [B] down [C] right [D] left

(8) ________ 2. A positive charge $+Q$ inside a spherical Gaussian surface of radius R generates a net electric flux Φ through the surface. Which of the following is true for the net electric flux through the surface, when a second positive charge $+Q$ is placed just outside the Gaussian sphere?

[A] increases [B] is zero
[C] does not change [D] not enough information to determine

(8) ________ 3. A charge is released from rest in a uniform electric field. It then moves under the influence of the electric field. Which of the following is true for the charge's potential energy?

[A] increases [B] decreases
[C] does not changed [D] not enough information to determine

(8) ________ 4. A parallel-plate capacitor is connected to a battery. When the plates are pulled apart which of the following quantities remains unchanged?

[A] charge [B] capacitance
[C] potential difference [D] electric field

(8) ________ 5 (Free). A slice of bread with peanut butter falls to the floor while being subjected to a strong electric field pointed in the upward direction. The peanut buttered bread

[A] is decelerated by the electric field
[B] is accelerated by the electric field
[C] is ignoring the gravity
[D] lands peanut butter side down, as it always does.

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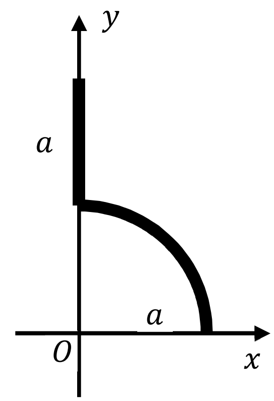
6. A charged plastic rod has a uniform charge per length λ and is shaped such that it has an arc of radius a and a straight segment of length a as illustrated. We wish to determine the electric field at the origin O. [You must solve the integrals to receive full credit.]



(15) (a) Determine the electric field due to the arc. Express your answer in unit vector notation.

$\vec{E} =$

(15) (b) Determine the electric field due to the straight segment. Express your answer in unit vector notation.

$\vec{E} =$

(10) (c) An electron is placed at the origin. Determine the force on the electron. Express your answer in unit vector notation.

$\vec{F} =$

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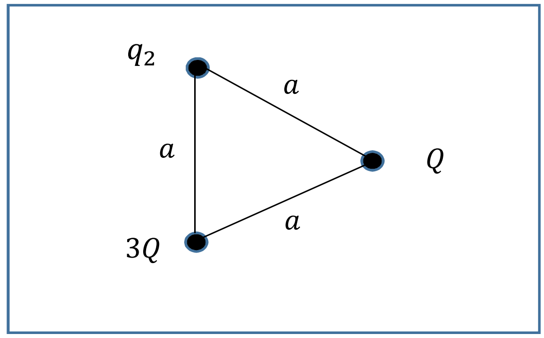
7. Three point charges Q, q_2, and $3Q$ are arranged in an equilateral triangle as depicted in the figure. q_2 is unknown.



(10) (a) If the total potential energy of the set of charges is $k\frac{23Q^2}{a}$, determine q_2.

$q_2 =$

(10) (b) Determine the electric potential at the location of q_2. (Assume q_2 is not present.)

$V_2 =$

(10) (c) Determine the potential energy of q_2 due to the other charges.

$U_2 =$

(10) (d) Assume particle q_2 has mass m and is released from rest. Determine q_2's maximum speed.

$v_{\text{max}} =$

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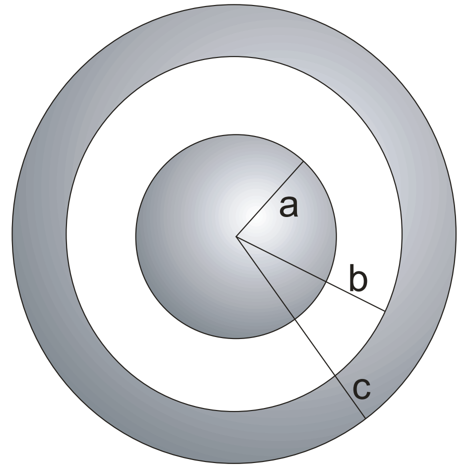
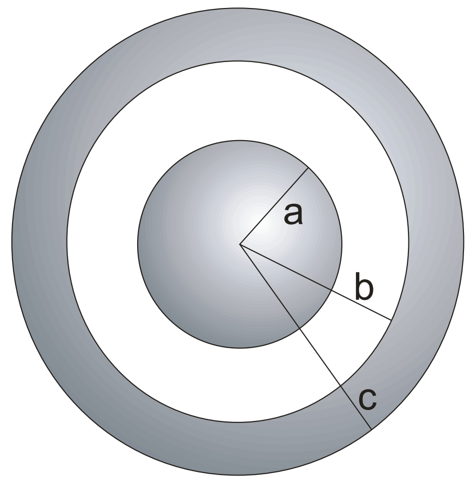
8. An insulating sphere of radius *a* is uniformly charged with total **negative** charge -*Q*. It is surrounded by a concentric conducting spherical shell of unknown net charge Q_S.



(15) (a) Use Gauss law to determine the magnitude and direction of the electric field inside the insulating sphere, i.e., for distances $r < a$ from the center. Draw the Gaussian surface in the figure and label its radius.



(15) (b) Find the electric field (magnitude and direction) for $a < r < b$. Draw the corresponding Gaussian surface in the figure and label its radius.

(5) (c) You observe that the electric field outside the conducting shell ($r > c$) vanishes. Find the net charge Q_S of the conducting shell in terms of the other system parameters.

$Q_S =$

(5) (d) Find the induced surface charges on the inner and outer surface of the conducting shell.

$Q_b =$

$Q_c =$

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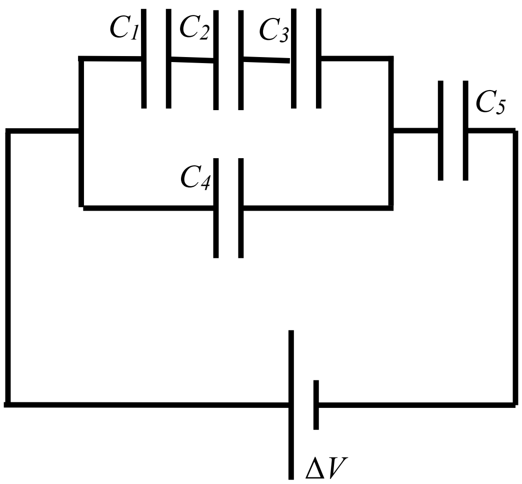
9. For the capacitor circuit shown $C_1 = 3\mu\text{F}$, $C_2 = 6\mu\text{F}$, $C_3 = 2\ \mu\text{F}$, $C_4 = 5\ \mu\text{F}$, and $C_5 = 6\ \mu\text{F}$.

(20) (a) Find the equivalent capacitance.

$C_T =$



(20) (b) If the charge on C_3 is $12\ \mu\text{C}$ find ΔV.

$\Delta V =$

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