Official Starting Equations
PHYS 2135, Engineering Physics II

From PHYS 1135:

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

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

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

Constants:

$g = 9.8\,\frac{\text{m}}{\text{s}^2}$ $m_{\text{electron}} = 9.11\times10^{-31}\text{kg}$ $m_{\text{proton}} = 1.67\times10^{-27}\text{kg}$ $e = 1.6\times10^{-19}\text{C}$

$c = 3.0\times10^8\,\frac{\text{m}}{\text{s}}$ $k = \frac{1}{4\pi\epsilon_0} = 9\times10^9\,\frac{\text{Nm}^2}{\text{C}^2}$ $\epsilon_0 = 8.85\times10^{-12}\,\frac{\text{C}^2}{\text{Nm}^2}$ $\mu_0 = 4\pi\times10^{-7}\,\frac{\text{Tm}}{\text{A}}$

Electric Force, Field, Potential and Potential Energy:

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

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

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

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

Circuits:

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

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

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

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

$Q(t) = Q_{\text{final}}\left[1 - e^{-t/\tau}\right]$ $Q(t) = Q_0e^{-t/\tau}$ $\tau = RC$

Integral:

$\int\frac{du}{(u^2+a^2)^{3/2}} = \frac{u}{a^2\sqrt{u^2+a^2}} + c$

Exam Total
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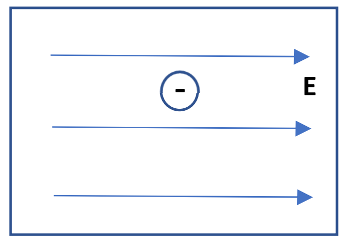
PHYS 2135 Exam I
September 21, 2021

Name: ______________________ Section: _________

For questions 1-5, select the best answer. For problems 6-11, solutions must begin with an Official Starting Equation, when appropriate. Work must be shown to receive credit. Calculators are not allowed.

(8)_________**1.** Two charged particles Q_1 and Q_2 are placed a distance *d* apart and experience a Coulomb force of magnitude *F* from one another. If the magnitude of charge Q_2 is doubled and the distance *d* is tripled, what is the new magnitude of the Coulomb force?
[A] (2/9)*F* [B] (2/3)*F* [C] (4/3)*F* [D] *F*

(8)_________**2.** A negatively charged electron is placed in an electric field which points to the right, as illustrated. In which direction will the electron be accelerated?
[A] Left
[B] Right
[C] Up
[D] Down



(8)_________**3.** Two concentric spherical surfaces enclose a point charge *Q*. The radius of the outer sphere is three times that of the inner one. Which statement is true concerning the electric fluxes crossing these two surfaces?
[A] Inner Sphere Flux = Outer Sphere Flux
[B] Outer Sphere Flux > Inner Sphere Flux
[C] Inner Sphere Flux > Outer Sphere Flux
[D] One cannot compare the two fluxes

(8)_________**4.** A charged particle with non-zero velocity enters a region where the electric potential is constant, and no other forces are present. Which statement best describes the particle's motion in this region?
[A] The particle will stop moving
[B] The particle's speed and direction remain constant
[C] Particle will accelerate due to the non-zero electric field
[D] Not enough information to know

(8)_________**5.** (Free) Which best describes an S&T student?
[A] Naturally curious
[B] Unshakeable love of learning and discovery
[C] Craves immersive opportunities
[D] Desires to leave a mark on the world

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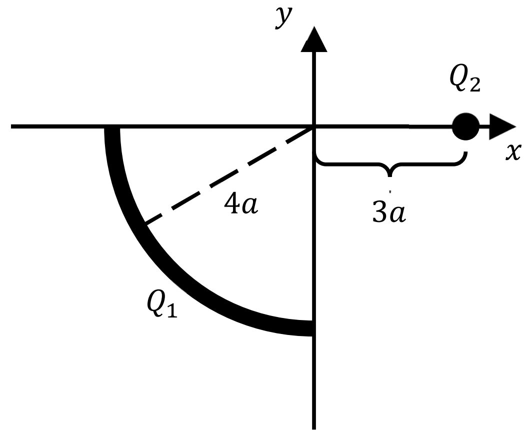
6. A charge $Q_1 = -4q_0$ is uniformly distributed along an arc of radius $R = 4a$ extending from the negative *x*-axis to the negative *y*-axis. A second charge $Q_2 = 6q_0$ is located on the *x*-axis at *x* = 3a.



(5) (a) Determine the charge per unit length λ_{arc} of the "arc" of charge.

$\lambda_{arc} =$

(20) (b) Determine the electric field at the origin due to the "arc" of charge. Express your answer in unit vector notation.

$\vec{E}_{arc} =$

(15) (c) Determine the electric field at the origin due to the point charge. Express your answer in unit vector notation.

$\vec{E}_{point} =$

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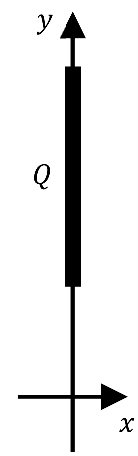
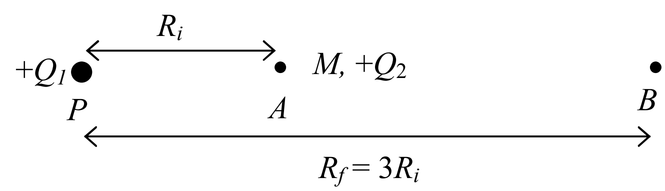
7. A charge Q is uniformly distributed along the y-axis from $y = 2a$ to $y = 6a$.



(15) (a) Determine the electric potential at the origin due to the line of charge.

(5) (b) Determine the potential energy of a charge q_0 if it were placed at the origin

8. A positive point charge $+Q_1$ **is fixed at point *P***. A second positive charge with mass M and charge $+Q_2$ is initially fixed at point A, a distance R_i from point P. The second charge is then released.



(15) (a) Determine the speed of the second charge when it reaches point B, a distance $R_f = 3R_i$ from point P.

$v =$

(5) (b) Which point (A or B) is at a higher electric potential?

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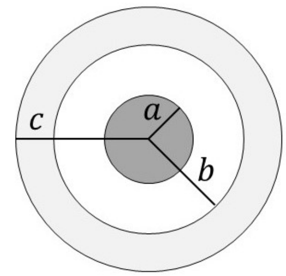
9. A long insulating cylindrical solid of radius a has a charge per length 2λ uniformly distributed throughout its volume. A conducting cylindrical shell of inner radius b and outer radius c has a charge per length 4λ and is coaxial with the insulating solid.

Side View



End View

(10) (a) Determine the electric field within the insulating cylindrical solid. $(r < a)$

$\vec{E} =$

(10) (b) Determine the electric field between the insulating cylindrical solid and the conducting shell. $(a < r < b)$.

$\vec{E} =$

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

$\vec{E} =$

(10) (d) Determine the charge per length on the inner and outer surfaces of the conducting shell.

$\lambda_b =$

$\lambda_c =$

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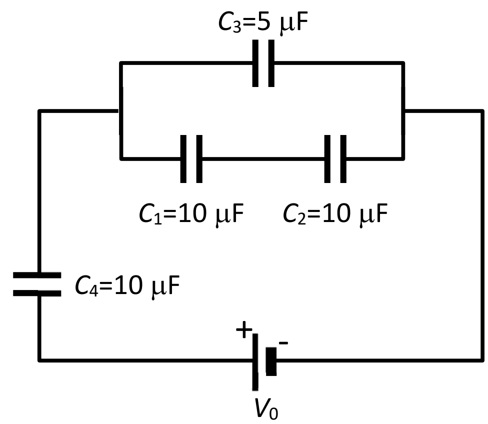
10. Consider the illustrated network.

(15) (a) Calculate the total (equivalent) capacitance of the network.

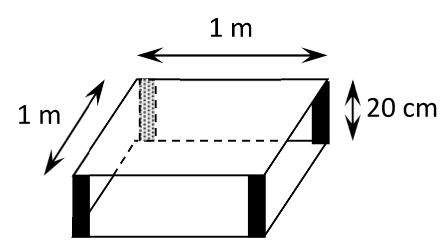


$C_T =$

(15) (b) If the charge on capacitor C_4 is 100 μC, what is the battery voltage V_0?

$V_0 =$

11. A small animal shed has a flat metal roof and a metal floor. The square roof and floor measure approximately one meter by one meter. The roof is supported by nonconducting wooden posts that are 20 cm tall. During a thunderstorm the potential difference between the roof and floor is measured to be 20,000 volts.



(10) Model the building as if it were a parallel-plate capacitor and calculate the amount of charge on the roof and the floor of the building.

$Q =$

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