

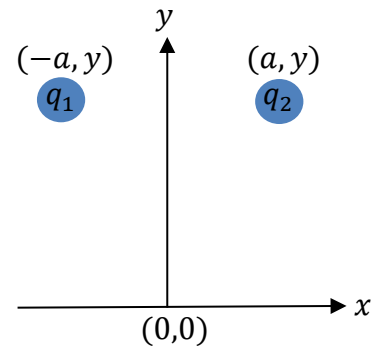
Name _____

Physics 111 Quiz #2, January 22, 2021

Please show all work, thoughts and/or reasoning in order to receive partial credit. The quiz is worth 10 points total.

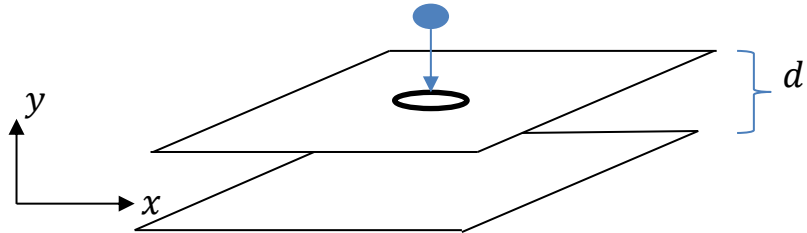
I affirm that I have carried out my academic endeavors with full academic honesty.

1. Suppose you have the two-point charges shown below, with $q_1 = q_2 = +30nC$. Point-charge q_1 is located at $(x, y) = (-a, y)$, while point-charge q_2 is located at $(x, y) = (a, y)$, where $a = 10cm$ and $y = 50cm$. What is the magnitude of the electric field at the origin $(0,0)$? Hint: do not assume that $y \gg a$.



2. What is the direction of the electric field at the origin due to these two point-charges? To earn full credit, justify your answer with a calculation or with a sentence or two.
3. Suppose that a third point-charge $q_3 = -3nC$ is placed at the origin. What net electric force would q_3 feel?

4. A set of parallel metal plates are shown below. In the middle of the upper plate there is a small hole drilled. The plates are separated by a distance $d = 10\text{cm}$ and a uniform electric field with magnitude $E = 50,000 \frac{\text{N}}{\text{C}}$ exists between the plates due to the equal and opposite charges on the plates. A proton is fired vertically downward through the hole in the upper plate. What speed would the proton need to have at the upper plate, as it passes through the hole in order, to just come to rest at the lower plate?



5. Which of the following gives the charge on the lower plate and the direction of the electric field between the plates?
- a. The charge on the lower plate is $+Q$ and the electric field points from the lower to the upper plate.
 - b. The charge on the lower plate is $+Q$ and the electric field points from the upper to the lower plate.
 - c. The charge on the lower plate is $-Q$ and the electric field points from the lower to the upper plate.
 - d. The charge on the lower plate is $-Q$ and the electric field points from the upper to the lower plate.
 - e. None of the above choices are correct.

Physics 111 Equation Sheet

Electric Forces, Fields and Potentials

$$\vec{F} = k \frac{Q_1 Q_2}{r^2} \hat{r}$$

$$\vec{E} = \frac{\vec{F}}{q}$$

$$\vec{E}_Q = k \frac{Q}{r^2} \hat{r}$$

$$PE = k \frac{Q_1 Q_2}{r}$$

$$V(r) = k \frac{Q}{r}$$

$$E_x = -\frac{\Delta V}{\Delta x}$$

$$W = -q\Delta V_{f,i}$$

Magnetic Forces and Fields

$$F = qvB\sin\theta$$

$$F = IlB\sin\theta$$

$$\tau = NIAB\sin\theta = \mu B\sin\theta$$

$$PE = -\mu B\cos\theta$$

$$B = \frac{\mu_0 I}{2\pi r}$$

$$\mathcal{E}_{induced} = -N \frac{\Delta\phi_B}{\Delta t} = -N \frac{\Delta(BA\cos\theta)}{\Delta t}$$

Constants

$$g = 9.8 \frac{m}{s^2}$$

$$1e = 1.6 \times 10^{-19} C$$

$$k = \frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \frac{Nm^2}{C^2}$$

$$\epsilon_0 = 8.85 \times 10^{-12} \frac{C^2}{Nm^2}$$

$$1eV = 1.6 \times 10^{-19} J$$

$$\mu_0 = 4\pi \times 10^{-7} \frac{Tm}{A}$$

$$c = 3 \times 10^8 \frac{m}{s}$$

$$h = 6.63 \times 10^{-34} Js$$

$$m_e = 9.11 \times 10^{-31} kg = \frac{0.511 MeV}{c^2}$$

$$m_p = 1.67 \times 10^{-27} kg = \frac{937.1 MeV}{c^2}$$

$$m_n = 1.69 \times 10^{-27} kg = \frac{948.3 MeV}{c^2}$$

$$1amu = 1.66 \times 10^{-27} kg = \frac{931.5 MeV}{c^2}$$

$$N_A = 6.02 \times 10^{23}$$

$$Ax^2 + Bx + C = 0 \rightarrow x = \frac{-B \pm \sqrt{B^2 - 4AC}}{2A}$$

Electric Circuits

$$I = \frac{\Delta Q}{\Delta t}$$

$$V = IR = I \left(\frac{\rho L}{A} \right)$$

$$R_{series} = \sum_{i=1}^N R_i$$

$$\frac{1}{R_{parallel}} = \sum_{i=1}^N \frac{1}{R_i}$$

$$P = IV = I^2 R = \frac{V^2}{R}$$

$$Q = CV = \left(\frac{\kappa \epsilon_0 A}{d} \right) V = (\kappa C_0) V$$

$$PE = \frac{1}{2} QV = \frac{1}{2} CV^2 = \frac{Q^2}{2C}$$

$$Q_{charge}(t) = Q_{max} \left(1 - e^{-\frac{t}{RC}} \right)$$

$$Q_{discharge}(t) = Q_{max} e^{-\frac{t}{RC}}$$

$$C_{parallel} = \sum_{i=1}^N C_i$$

$$\frac{1}{C_{series}} = \sum_{i=1}^N \frac{1}{C_i}$$

Light as a Particle & Relativity

$$E = hf = \frac{hc}{\lambda} = pc$$

$$KE_{max} = hf - \phi = eV_{stop}$$

$$\Delta\lambda = \frac{h}{m_e c} (1 - \cos\phi)$$

$$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$$

$$p = \gamma mv$$

$$E_{total} = KE + E_{rest} = \gamma mc^2$$

$$E_{total}^2 = p^2 c^2 + m^2 c^4$$

$$E_{rest} = mc^2$$

$$KE = (\gamma - 1)mc^2$$

Geometry

$$Circles C = 2\pi r = \pi D \quad A = \pi r^2$$

$$Triangles A = \frac{1}{2}bh$$

$$Spheres A = 4\pi r^2 \quad V = \frac{4}{3}\pi r^3$$

Light as a Wave

$$c = f\lambda = \frac{1}{\sqrt{\epsilon_0 \mu_0}}$$

$$S(t) = \frac{energy}{time \cdot area} = c\epsilon_0 E^2(t) = c \frac{B^2(t)}{\mu_0}$$

$$I = S_{avg} = \frac{1}{2} c\epsilon_0 E_{max}^2 = c \frac{B_{max}^2}{2\mu_0}$$

$$P = \frac{S}{c} = \frac{Force}{Area}$$

$$S = S_o \cos^2 \theta$$

$$v = \frac{1}{\sqrt{\epsilon m}} = \frac{c}{n}$$

$$q_{inc} = q_{refl}$$

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

$$M = \frac{h_i}{h_o} = -\frac{d_i}{d_o}$$

$$M_{total} = \sum_{i=1}^N M_i$$

$$S_{out} = S_{in} e^{-\sum_i \alpha_i n_{pi}}$$

$$HU = \frac{m_u - m_h}{m_p}$$

Nuclear Physics

$$E_{binding} = (Zm_p + Nm_n - m_{rest})c^2$$

$$\frac{\Delta N}{\Delta t} = -\lambda N_o \rightarrow N(t) = N_o e^{-\lambda t}$$

$$A(t) = A_o e^{-\lambda t}$$

$$m(t) = m_o e^{-\lambda t}$$

$$t_{\frac{1}{2}} = \frac{\ln 2}{\lambda}$$

Misc. Physics 110 Formulae

$$\vec{F} = \frac{\Delta \vec{p}}{\Delta t} = \frac{\Delta(mv)}{\Delta t} = m\vec{a}$$

$$\vec{F} = -k\vec{y}$$

$$\vec{F}_C = m \frac{v^2}{R} \hat{r}$$

$$W = \Delta KE = \frac{1}{2} m (v_f^2 - v_i^2) = -\Delta PE$$

$$PE_{gravity} = mgy$$

$$PE_{spring} = \frac{1}{2} ky^2$$

$$|\vec{A}| = \sqrt{A_x^2 + A_y^2}$$

$$\phi = \tan^{-1} \left(\frac{A_y}{A_x} \right)$$

$$\vec{v}_f = \vec{v}_i + \vec{a}t$$

$$v_f^2 = v_i^2 + 2a\Delta x$$

$$\vec{x}_f = \vec{x}_i + \vec{v}_i t + \frac{1}{2} \vec{a} t^2$$