Exam Total

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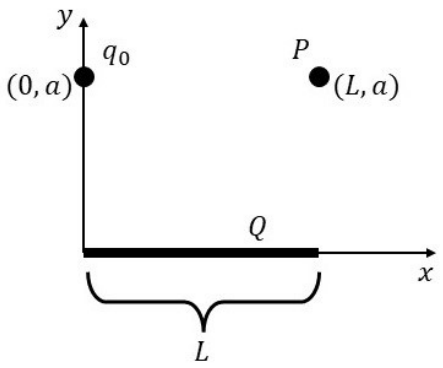
Physics 2135 Final Exam
May 10, 2023

Printed Name: _____

Recitation: _____

1. A positive point charge q_0 is held fixed at $(0, a)$. A positive charge Q is uniformly fixed along a line segment from the origin to $(L, 0)$.



(15) a. Determine $\vec{E}_{q_0}$, the electric field at P located at (L, a), due to the point charge q_0.

$\vec{E}_{q_0} =$

(15) b. Set up an integral to determine $\vec{E}_Q$, the electric field at P, due to the line of charge Q. [Only set up the integral. Do not evaluate the integral.]

$\vec{E}_Q =$

2. A positive charge q_1 and mass m_1 has potential energy U_1 when located at P_1. q_1 is released at P_1.

(10) Determine v_f, the final speed of q_1.

$v_f =$

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3. Consider a circuit consisting of a resistor R = 1 kΩ and a capacitor C = 1 μF.

(5) a. Calculate the time constant.

$\tau =$

(10) b. The initial charge stored in the capacitor is Q_0, and the capacitor started discharging at t = 0. Write the time when the stored charge is one-half Q_0.

$t =$

(15) c. Determine the electric current through the resistor in t = 1 ms when the initial voltage across the capacitor is 1 kV.

$I =$

(10) d. Assume the resistor is made out of one kind of material and is a cylinder of radius r = 1 mm and the length $l = \pi$ m. What is the resistivity of the material?

$\rho =$

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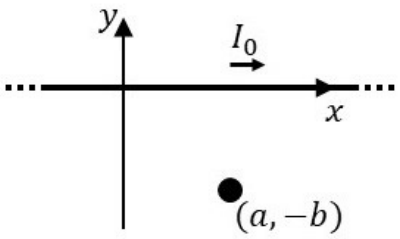
4. An infinitely long wire carries a current I_0 in the positive x-direction along the x-axis.



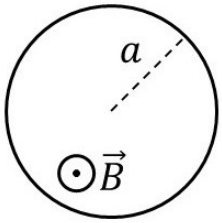
(10) a. **Use Ampere's Law** to determine the magnitude of the magnetic field at P located at $(a,-b)$ due to the current I_0. [a is positive. $-b$ is negative.]

$B =$

(10) b. Circle the direction of the magnetic field at P due to the current I_0.

$\hat{\imath}$ $\quad -\hat{\imath}$ $\quad \hat{\jmath}$ $\quad -\hat{\jmath}$ $\quad \hat{k}$ $\quad -\hat{k}$

5. A circular loop of conducting wire of radius a and resistance R is in a region with a spatially uniform magnetic field $\vec{B} = \vec{B}_0\left(1 - e^{-t/\tau}\right)$ that is normal to the plane of the loop, as illustrated.



(10) a. Determine the I_I, the magnitude of the current induced in the conducting loop.

$I_i =$

(10) b. Determine the direction, if any, of the induced current in the conducting loop. [Circle one option.]

[A] Clockwise
[B] Counter-clockwise
[C] Zero
[D] The direction cannot be determined from the given information.

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6. An object is positioned 32 cm to the left of a lens. The image of the object is formed on a screen 8 cm to the right of the lens.

(15) a. Find the focal length of the lens. Is the lens converging or diverging?

$f =$

Converging Diverging

[Circle one.]

(5) b. Determine the magnification.

$m =$

7. A spherical concave shaving mirror has a radius of curvature of 28.0 cm. It is positioned so that the upright image of a man's face is 2.00 times the actual size of his face.

(15) a. How far is the mirror from the man's face?

$s =$

(5) b. Where (how far from the mirror ***and*** on which side) is the image of the man's face located?

$|s'| =$

Reflecting(front) Non-reflecting(Back)

[Circle one.]

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8. A spectrograph has resolving power of $R = 900$ at wavelength $\lambda = 360\ \text{nm}$.

(10) a. Find the wavelength resolution, $\Delta\lambda$, of the spectrograph at $\lambda = 360\ \text{nm}$.

$\Delta\lambda =$

(10) b. Determine how many diffraction grating lines must be illuminated to resolve two wavelengths near $\lambda = 360\ \text{nm}$ in first order.

$N =$

(10) c. If the spectrograph has a diffraction grating with 500 lines per cm, find the sine of the angular position for the first-order bright fringe.

$\sin\theta =$

9. A laser beam shines from air down on a thin layer of water (index of refraction $n_w > 1$) which is placed on top of a glass (index of refraction $n_g < n_w$). The water layer has thickness t.

(10) Find **the longest wavelength** at which the laser light shining normal to the surface is maximally reflected. Give your answer in terms of given symbols and constants.

$\lambda =$

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