

Exam Total

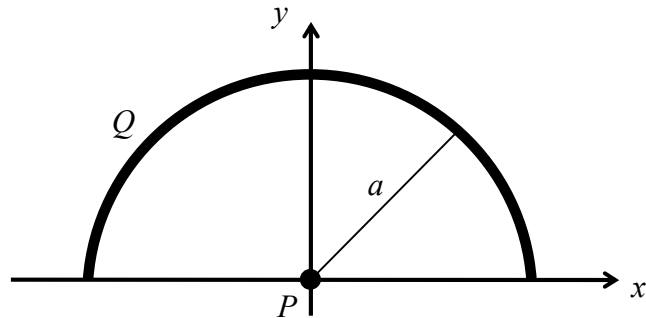
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Physics 2135 Final Exam
December 13, 2022

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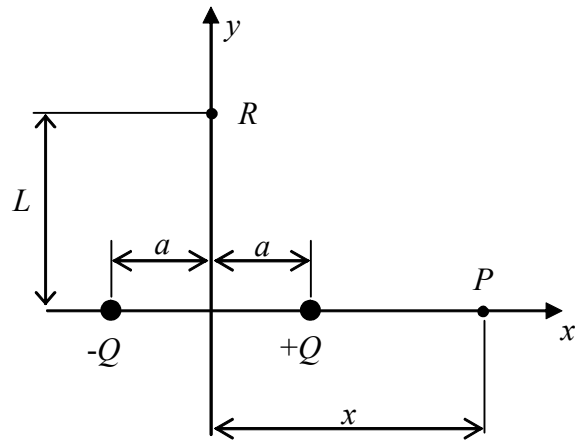
Recitation: _____

1. Positive charge Q is uniformly distributed on a semicircle of radius a centered at the origin (point P in the diagram).
- (20) Find the electric field at P . Express your answer in **unit vector notation** using the coordinate system given.



$\vec{E} =$

2. An electric dipole consists of charges $+Q$ and $-Q$ separated by a distance $2a$. The dipole is located along the x -axis and is centered at the origin as shown.
- (10) a. Calculate the electric potential at point P .



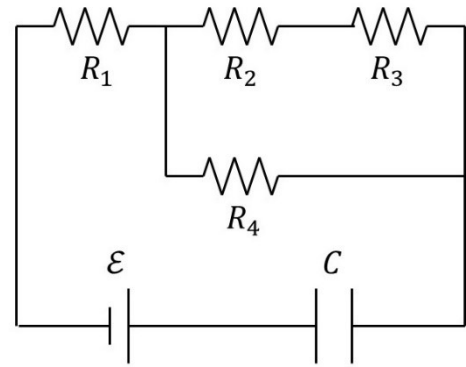
$V =$

- (10) b. If a point charge $+3Q$ is placed at point R , determine the **magnitude and direction** of the electric force on this charge. Express your answer in unit vector notation.

$\vec{F} =$

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3. A set of resistors with a total equivalent resistance R_T is connected in a circuit with a capacitor of capacitance C and an ideal battery with emf \mathcal{E} . [Answer in terms of given quantities.]



- (10) a. Determine $t_{2/3}$ the time when the charge on the capacitor is two thirds of its final charge.

$$t_{2/3} =$$

- (10) b. Determine $V_R(t_{2/3})$ the potential across the combination of resistors when the charge on the capacitor is two thirds of its final charge.

$$V_R(t_{2/3}) =$$

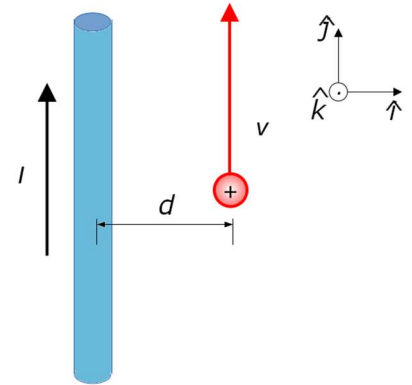
- (10) c. Given that $R_1 = 4\Omega$, $R_2 = 6\Omega$, $R_3 = 18\Omega$ and $R_4 = 8\Omega$, determine R_T the total equivalent resistance of the combination of resistors.

$$R_T =$$

- (10) d. Given that $\mathcal{E} = 24V$, determine I_1 the current through R_1 just after the circuit is connected.

$$I_1 =$$

4. A long straight wire carries a current I in the y direction (see figure). At one instant, a proton at a distance d from the wire, travels with speed v parallel to the wire and in the same direction as the current. Find:



- (10) a. The magnitude of the magnetic force that is acting on the proton because of the magnetic field of the wire as a function of I , d , v , and any required constants from the OSE. **Your answer must be symbolic.**

$F =$

- (10) b. The direction of the magnetic force that is acting on the proton because of the magnetic field of the wire. **Your answer must be written in terms of the unit vectors i , j or k .**

5. A straight solenoid consists of 100 turns of wire and has a length of 10.0 cm.

- (10) Find the magnitude of the magnetic field inside the solenoid when it carries a current of 0.500 A. **Your answer must be numerical and rounded to two significant figures.** If you need π , use $\pi=3.14$.

$B =$

6. Two parallel, long, straight wires carry currents of 5.00 A in opposite directions and are separated by 10.0 cm.

- (10) Find the magnitude of the net magnetic field at a point midway between the wires. **Your answer must be numerical and rounded to two significant figures.** If you need π , use $\pi=3.14$.

$B =$

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7. A spherical concave mirror has a radius $R = 30$ cm. An object is placed at 40 cm from the mirror.

(8) a. Determine the focal length of the mirror.

$$f =$$

(7) b. Determine the image distance from the mirror.

$$s' =$$

(5) c. Is the image UPRIGHT or INVERTED ? (Circle one.)

8. An object is placed 30 cm in front of a diverging lens. It forms an image that is upright and $2/5$ times as tall as the object.

(8) a. Determine the image distance.

$$s' =$$

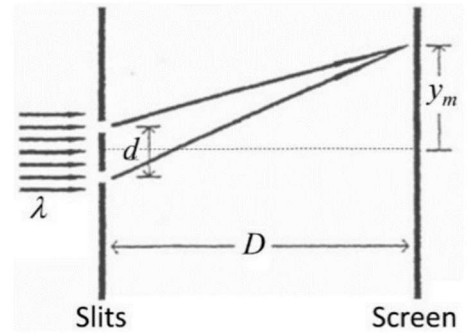
(7) b. Determine the focal point for the lens.

$$f =$$

(5) c. Is the image REAL or VIRTUAL ? (Circle one.)

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9. A monochromatic light source of wavelength λ shines on a pair of slits of separation d producing an interference pattern on a screen located a distance D beyond the slits. Please use the small angle approximation.



- (10) a. Determine the location of the third bright fringe.

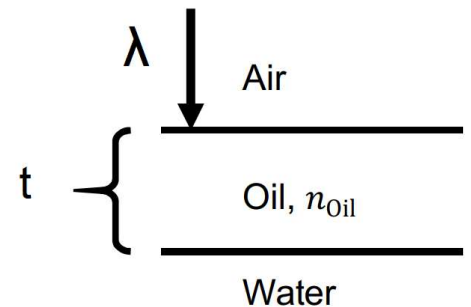
$$y_{3B} =$$

- (10) b. Determine the location of the second dark fringe.

$$y_{2D} =$$

10. A thin film of oil is on top of water. The oil has an index of refraction n_{oil} where $n_{oil} > n_{water}$.

- (20) Determine the minimal non-zero thickness t which minimizes the reflection of light of wavelength λ .



$$t =$$

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