Name _____

Which section? Wed. Rec.____ , Thur. Rec.____

Work directly on these pages and show your work clearly. Properly labeled figures are important and will figure into the grading.

••• *Some basic equations are given at the end of the last page.* •••

Mark one answer to each of the following five questions.

1. [*5 pts*] The expression V_{rms} means
(a) the square of the average value of the square-root of the voltage.
(b) the square-root of the average value of the voltage squared.
(c) the average value of the magnitude of the voltage.

2. [4 *pts*] Which of the following equalities is NOT true?
(a) $e^{j0} = 1$.
(b) $e^{j3\pi/2} = -j$.
(c) $e^{j4\pi} = 2$.

3. [*5 pts*] The Poynting vector points in the direction of the
(a) current.
(b) electric field.
(c) energy flow.

4. [*5 pts*] Light travels from point A to point B along a path that
(a) is a straight line.
(b) is the shortest distance.
(c) takes the least time.
(d) allows it to go at a constant speed.

5. [*5 pts*] A fundamental measurement leading to the theory of special relativity is that
(a) light can be intrepreted as the motion of a wave.
(b) the speed of light is independent of the motion of observer and source.
(c) the speed of light is faster in vacuum than in transparent materials.

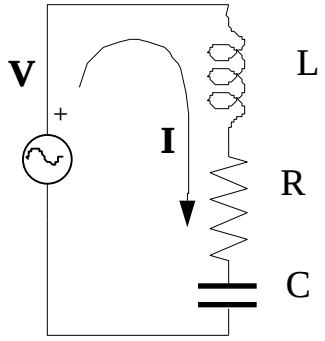
1 - 5. 6. 7. 8. 9. 10.
Total

6. [*15 pts*] If the frequency is such that $\omega L = 6R$ and $1/\omega C = 2R$,

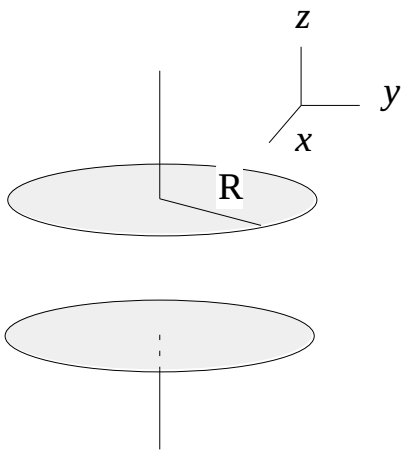
(a) write a complex expression for **V** in terms of R and **I**.

(b) On the complex plane, sketch the position of **V** when **I** is real. You don't need to determine the angle, but label your sketch with what you need to do so.

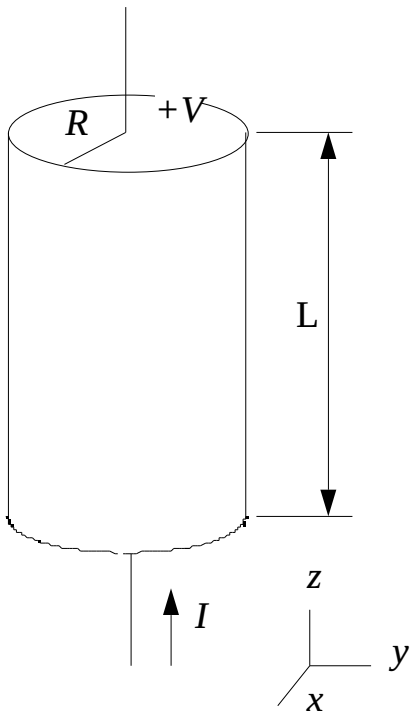
(c) If I is one ampere, what is the amplitude of the voltage in terms of R?



7. [*15 pts*] If the electric field is uniform everywhere between the circular plates of the capacitor shown and ***decreasing*** according to the equation $\vec{\mathbf{E}} = (E_0 - at)\hat{\mathbf{z}}$, determine an expression for the magnetic field **B** at a distance $r < R$ from the axis of the plates. Be sure and indicate the direction of **B**.



8. [*15 pts*] The batteries in the flashlight shown develop a voltage V and a current I, and the magnitude of the electric and magnetic fields at the outer shell of the battery are given by $\frac{V}{L}$ and $\frac{\mu_0 I}{2\pi R}$. You'll need to express these and the answers below in terms of the unit vectors $\hat{\boldsymbol{r}}, \hat{\theta}, \text{and } \hat{\boldsymbol{z}}$.



(a) Indicate the direction of the electric and magnetic fields at the outer surface of the batteries. Graphically and with unit vectors.

(b) In terms of the symbols given above, write a reduced expression for the Poynting vector at the curved surface of the battery pack.

(c) Use the Poynting vector to determine a simplified expression for the power generated by the batteries.

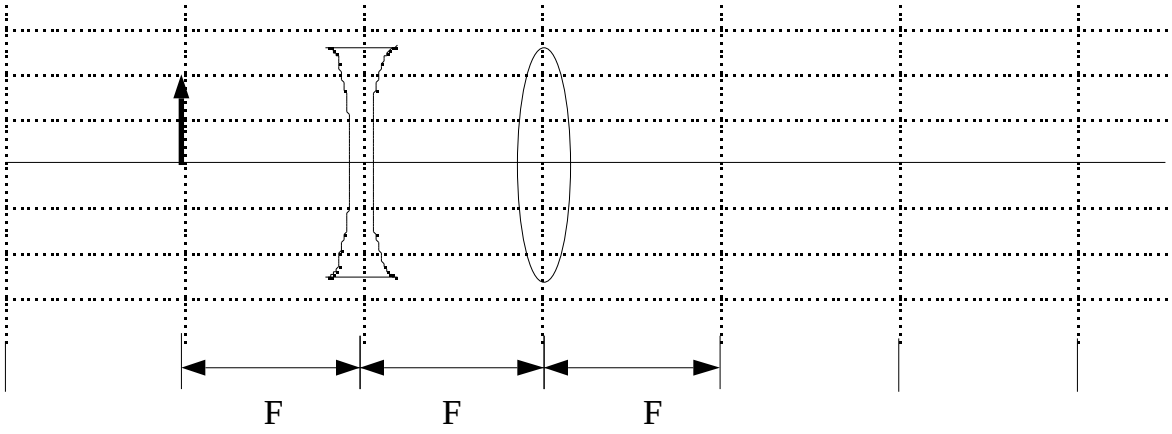
9. [*10 pts*] In this problem, you may use c to represent the velocity of light. A particle of mass $3M$ decays into two identical particles of mass M. What is the magnitude of the momentum of each of the final particles? Your final answer should have units of momentum. You need not simplify the number.

10. [*20 pts*] A lens of -F focal length and a lens of +F focal length are separated by a distance F as shown. The object of height *y* is located at the focal point of the first lens.

(a) From the top of the arrow raw two rays that are principal rays for both lenses, i.e. useful for graphically constructing the final image.

(b) Is the final image real or virtual, erect or inverted?

(c) Use the thin lens equation twice to calculate the position of the intermediate and final images with respect to the +F lens.



Work page

$$\mathbf{Z} = j\omega L, \quad \mathbf{Z} = \frac{1}{j\omega C}$$

$$\oint_S \vec{\mathbf{E}} \cdot d\vec{\mathbf{A}} = \frac{q}{\varepsilon_0}$$

$$\oint_C \vec{\mathbf{E}} \cdot d\vec{\mathbf{r}} = -\frac{d}{dt}\int_S \vec{\mathbf{B}} \cdot d\vec{\mathbf{A}}$$

$$\oint_C \vec{\mathbf{B}} \cdot d\vec{\mathbf{r}} = \mu_0 i + \mu_0\varepsilon_0\frac{d}{dt}\int_S \vec{\mathbf{E}} \cdot d\vec{\mathbf{A}}$$

$$\vec{\mathbf{S}} = \frac{1}{\mu_0}\vec{\mathbf{E}} \times \vec{\mathbf{B}}, \ \eta_{\mathbf{E}} = \frac{\varepsilon_0 E^2}{2}, \ \eta_{\mathbf{B}} = \frac{\mathbf{1}}{2\mu_0}B^2$$

$$P = \int_S \vec{\mathbf{S}} \cdot d\vec{\mathbf{A}} \text{ with units Watts / m}^2$$

$$E^2 = P^2 + M^2 \text{ with } c = 1$$