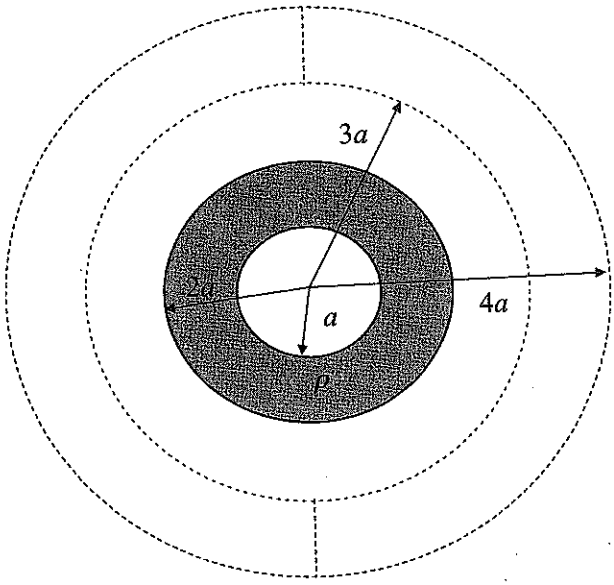
AP PHYSICS C TEST
SECTION II–ELECTRICITY AND MAGNETISM
Time: 45 minutes
3 Questions

Directions: Answer all 3 questions. The suggested time is about 15 minutes for answering each of the questions, which are worth 15 points each. The parts within a question may not have equal weight.

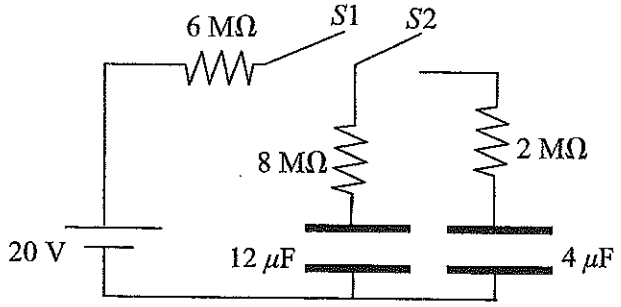


1. A nonconducting shell of radii a and $2a$ has a uniform charge density ρ.
   (a) Determine the electric field in the following regions:
      (i) $r > 2a$
      (ii) $2a > r > a$
      (iii) $r < a$

   (b) Determine the electric potential in the regions:
      (i) $r > 2a$
      (ii) $2a > r > a$
      (iii) $r < a$

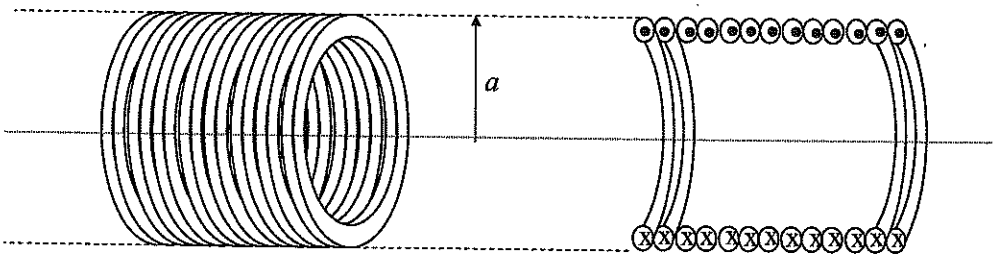
   (c) Two neutral conducting hemispheres of radii $3a$ and $4a$ are assembled concentric to the nonconductor, making a single conducting sphere enclosing the nonconductor. Qualitatively describe how the potential at the center of the nonconductor changes.

GO ON TO THE NEXT PAGE



2. In the circuit shown in the figure, switch $S1$ is closed at $t = 0$.
   (a) Find the current in the 8 MΩ resistor immediately after the switch is closed.
   (b) Find the maximum charge that will reside on the 12 μF capacitor.
   (c) How much energy is stored in the capacitor when it's fully charged?

   After a long time, $S1$ is first opened and then $S2$ is closed.
   (d) Find the current in the 2 MΩ resistor just after $S2$ is closed.
   (e) Letting q be the charge on the 4 μF capacitor at any time, write a differential equation that could be used to determine q as a function of time.
   (f) Find the current in the 2 MΩ resistor 1 minute after $S2$ is closed.
   (g) Determine the final energy stored in the capacitors.



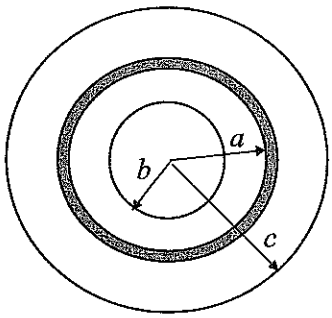
(a)

3. A long solenoid with radius a and n turns per meter carries a steady current i.
   (a) By applying Ampere's law to an appropriate path, determine the magnetic field within the solenoid. Be sure to clearly show your path on the figure.

GO ON TO THE NEXT PAGE

The current in the solenoid is now allowed to oscillate according to $i(t) = i_0 \cos \omega t$. Two loops are inserted concentric to the solenoid as shown in the following figure. One loop, with radius $b < a$, has resistance R_b. The other loop, with radius $c > a$, has resistance R_c.

(b)



(b) Find the magnitude of the induced current in the smaller loop as a function of time.
(c) Find the magnitude of the induced electric field at a point in the smaller loop as a function of time.
(d) Find the magnitude of the induced electric field at a point in the larger loop as a function of time.

STOP
END OF SECTION II, ELECTRICITY AND MAGNETISM

IF YOU FINISH BEFORE TIME IS CALLED, YOU MAY CHECK YOUR WORK ON SECTION II, ELECTRICITY AND MAGNETISM ONLY.

DO NOT TURN TO ANY OTHER TEST MATERIALS.

STOP