## Physics 9C-A Final Exam Winter of 2013

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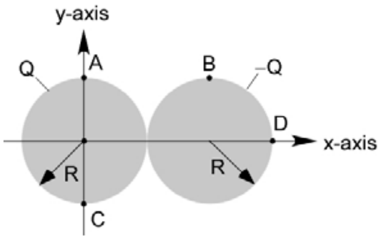
**1.** A solid insulating sphere with radius R and a uniformly distributed positive charge + Q is placed right next to another insulating sphere with same radius R and a uniformly distributed negative charge – Q.

(a) (**10 points**) Find the potential difference $V_{AB} = V_A - V_B$;

(b) (**15 points**) Find the direction and magnitude of the electric field at point C;

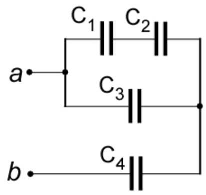
(c) (**10 points**) Find the direction and magnitude of the electric field at point D.




**2.** Four air-gap parallel-plate capacitors have the same value of C = 4 nF and for a network as shown. A potential difference $V_{ab}$ = + 30 V is maintained between point *a* and *b*.

(a) (**20 points**) Find the charges on $C_3$ and $C_4$;

(b) (**10 points**) Now fill the air gap in $C_4$ with a dielectric material of $\kappa = 3$. Find the charge on $C_4$ afterward.

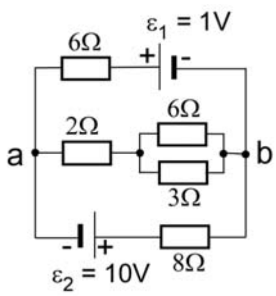



**3.** In the following circuit,

(a) (**20 points**) Find the current through 8Ω resistor;

(b) (**5 points**) Find the potential difference between *a* and *b*;

(c) (**5 points**) Find the power dissipated in 3Ω resistor.



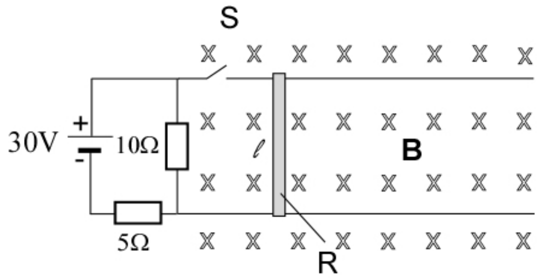
**4.** A metal bar with length $\ell$ = 1.25 m and resistance R = 10 Ω, rests on two horizontal conducting rails. The bar can slide along the rails without friction. A uniform magnetic field B = 1.6 T is applied perpendicular to the horizontal plane (into the paper). The switch S is initially open.

(a) (**10 points**) Find the direction and magnitude of the current through the bar immediately after the switch is closed and the velocity of the bar is still zero;

(b) (**10 points**) Find the direction and magnitude of the magnetic force on the bar immediately after the switch is closed and the velocity of the bar is still zero

(c) (**10 points**) After the switch is closed for a long time, the bar slides at a constant terminal velocity *v* along the rails. Explain why. Under this condition, find the current through the battery at this time;

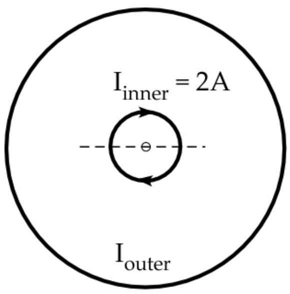
(d) (**5 points**) Find the terminal velocity *v*.




**5.** Two concentric circular loops of wire are placed in the same plane. The inner loop has a radius $R_{inner}$ = 2.5 cm and carries a clockwise current $I_{inner}$ = 2 A. The outer loop has a radius $R_{outer}$ = 10 cm.

(a) (**15 points**) Find the magnitude and the direction of the current $I_{outer}$ in the outer wire loop that make the total magnetic field at the center of the loops equal to zero;

(b) (**10 points**) The inner wire loop carrying a clockwise current $I_{inner}$ = 2 A forms a small magnetic dipole. If the outer wire loop carries a counterclockwise current $I_{outer}$ = 4 A, find the maximum torque that can be exerted by the outer wire loop on the inner wire loop when the inner loop is allowed to rotate about a diagonal as indicated by the dotted line. You can assume that the magnetic field produced by the outer wire loop is uniform in the region of the inner wire loop.

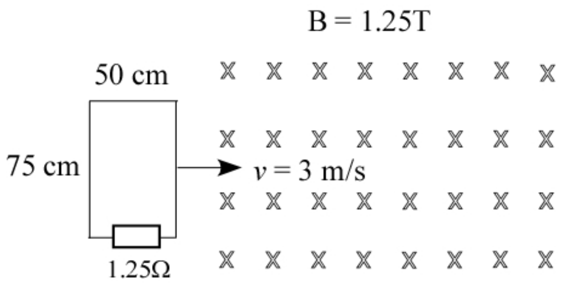


**6.** A rectangular circuit is moved at a constant velocity of 3 m/s into, through, and then out of a rectangular shaped magnetic field of 1.25 T as shown in the figure below. The width of the magnetic field is large than 50 cm.

(a) (**10 points**) Find the magnitude and direction of the current in the circuit as it is entering the region of the magnetic field so that only the right part of it is inside the magnetic field;

(b) (**5 points**) Find the magnitude and direction of the current in the circuit when it is completely inside the region of the magnetic field;

(c) (**10 points**) Find the magnitude and direction of the current as it is moving outside the region of the magnetic field so that the left side of it is still inside the magnetic field.




**7.** A flexible circular loop with diameter of 6 cm lies in a magnetic field with magnitude of 1.5 T as shown in the figure below. The plane of the loop is perpendicular to the magnetic field. The loop is pulled at *c* and *d* to become a loop of zero area in 0.25 sec.

(a) (**10 points**) Find the average emf induced in the circuit that contains the loop;

(b) (**10 points**) Find the direction of the induced current through the resistor R = 1Ω;

(c) (***Bonus 10 points***) Find the total charge that passes through R in the end.