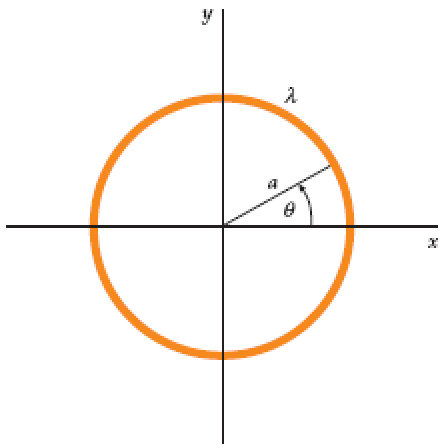
Name ____________________________________**Student ID** ____________ **Score**______

last *first*

EACH OF THE LECTURE QUESTIONS 1-22 IS WORTH 5 POINTS

I. COULOMB'S LAW

1. A ring of radius α has a charge distribution on it that varies as $\lambda(\theta) = \lambda_0 \sin(\theta)$, where $\lambda_0 > 0$, as shown in the figure.



What is the direction of the electric field at the center of the ring?

A. Radially outward
B. Radially inward
C. Upward (i.e., in the +y direction)
D. Downward (i.e., in the −y direction)
E. At θ=315 degrees

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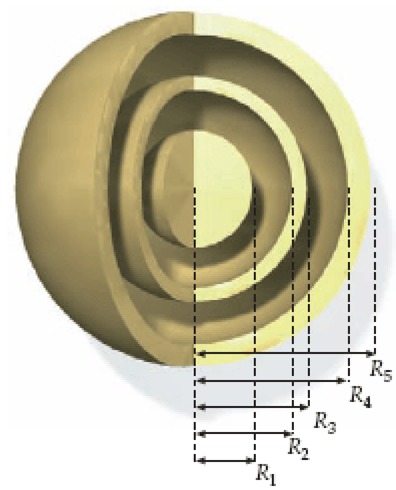
II. GAUSS'S LAW

Consider the concentric metal sphere and spherical shells that are shown in the figure below. The innermost is a solid sphere that has a radius R_1. A spherical shell surrounds the sphere and has an inner radius R_2 and an outer radius R_3. The sphere and the shell are both surrounded by a second spherical shell that has an inner radius R_4 and an outer radius R_5. None of the three objects initially have net charge. Then, a negative charge –Q is placed on the inner sphere and a positive charge +Q is placed on the outermost shell.



After the charges have reached equilibrium:

2. What will be the direction of the electric field between the sphere and the middle shell?

   A. radially towards the center of the sphere

   B. radially away from the center of the sphere

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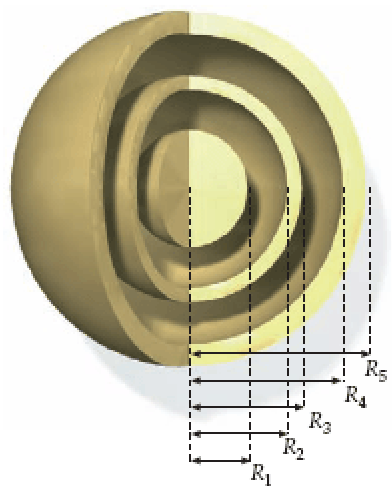
II. GAUSS'S LAW, cont'd

Figure is shown again for convenience.



After the charges have reached equilibrium:

3. What will be the charge on the inner surface of the middle shell?

   A. 0 B. +Q C. –Q D. +2Q E. –2Q

4. What will be the charge on the inner surface of the outermost shell?

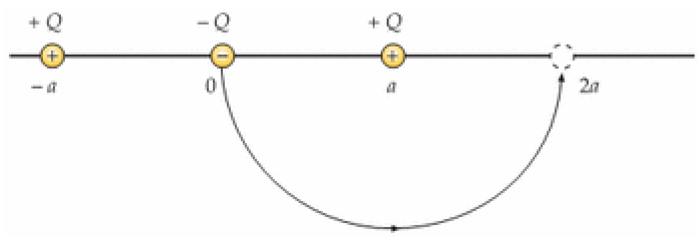
   A. 0 B. +Q C. –Q D. +2Q E. –2Q

5. What will be the charge on the outer surface of the outermost shell?

   A. 0 B. +Q C. –Q D. +2Q E. –2Q

III. ELECTRIC POTENTIAL

A positive point charge +Q is located on the x axis at point x = –a.



6. How much work is required to bring an identical point charge from infinity to the point x = +a on the x axis?

A. $kQ^2/2a$ B. $-kQ^2/2a$ C. $2kQ^2/a$ D. $-2kQ^2/a$ E. $kQ^2/3a$

7. With the two identical point charges in place at x = –a and x = +a, how much work is required to bring a third point charge –Q from infinity to the origin?

A. . $kQ^2/2a$ B. $-kQ^2/2a$ C. $2kQ^2/a$ D. $-2kQ^2/a$ E. $kQ^2/3a$

8. How much work is required to move the charge –Q from the origin to a point on the x axis at x = 2a along the semicircular path shown in the figure?

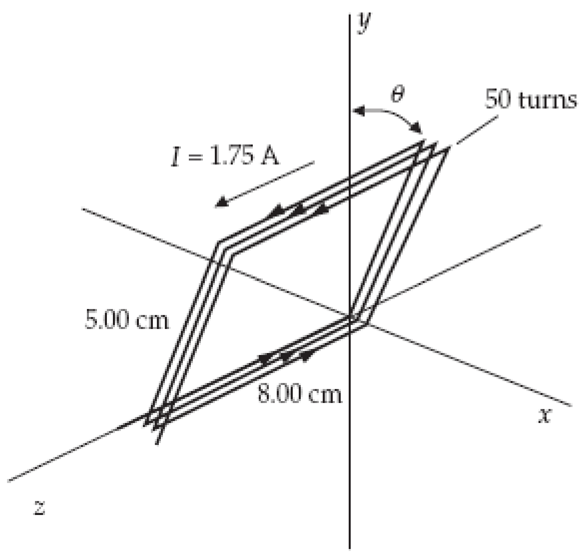
A. . $2kQ^2/a$ B. $-2kQ^2/a$ C. $2kQ^2/3a$ D. $-2kQ^2/3a$ E. $kQ^2/3a$

9. The electric potential is the same everywhere on the surface of a conductor. Does this mean that the surface charge density is also the same everywhere on the surface?

A. Yes B. No

IV. TORQUES ON CURRENT LOOPS

A rectangular 50-turn coil is pivoted about the z axis, as shown in the figure. It carries a current of 1.75 A.



10. If the wires in the z=0 plane make an angle $\theta=37^{o}$ with the y axis, what angle does the magnetic moment of the coil make with the unit vector **i**?

A. 37^{o} B. 53^{o} C. 127^{o} D. 143^{o}

11. What is the magnetic moment of the coil? (Bold characters denote vectors.)

A. $\boldsymbol{\mu} = (0.21\,\mathbf{i} + 0.28\,\mathbf{j})\ \mathrm{A\cdot m^2}$

B. $\boldsymbol{\mu} = (0.21\,\mathbf{i} - 0.28\,\mathbf{j})\ \mathrm{A\cdot m^2}$

C. $\boldsymbol{\mu} = (0.28\,\mathbf{i} + 0.21\,\mathbf{j})\ \mathrm{A\cdot m^2}$

D. $\boldsymbol{\mu} = (0.28\,\mathbf{i} - 0.21\,\mathbf{j})\ \mathrm{A\cdot m^2}$

E. $\boldsymbol{\mu} = (-0.28\,\mathbf{i} + 0.21\,\mathbf{j})\ \mathrm{A\cdot m^2}$

IV. TORQUES ON CURRENT LOOPS, cont'd

12. What is the torque on the coil when there is a uniform magnetic field **B** = 1.5 T **j** in the region occupied by the coil? (Bold characters denote vectors.)

A. **τ** = (0.31 N·m) **k**

B. **τ** = (−0.31 N·m) **k**

C. **τ** = (0.42 N·m) **k**

D. **τ** = (−0.42 N·m) **k**

E. **τ** = (0.52 N·m) **k**

13. What is the potential energy of the coil in this field? (The potential energy is zero when θ=0.)

A. U = 0.31 J

B. U = −0.31 J

C. U = 0.42 J

D. U = −0.42 J

E. U = 0.52 J

V. BIOT-SAVART LAW

An infinitely long wire lies along the z axis and carries a current of 20 A in the $+z$ direction. A second infinitely long wire is parallel to the z axis and intersects the x axis at $x = 10.0$ cm.

14. What is the current in the second wire if the magnetic field is zero at (x,y,z)=(2.0cm, 0, 0)?

A. 5 A B. 10 A C. 20 A D. 40 A E. 80 A

15. What is the magnetic field at (x,y,z)=(5.0cm, 0, 0)?

A. (+0.24 mT) **i**

B. (−0.24 mT) **i**

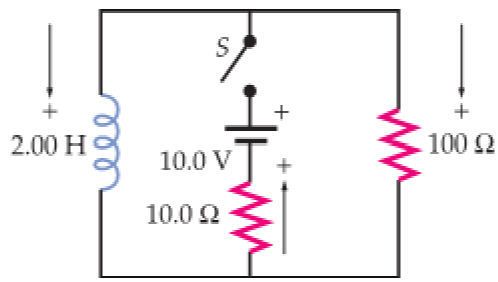
C. (+0.24 mT) **j**

D. (−0.24 mT) **j**

E. (+0.24 mT) **k**

VI. RL CIRCUITS

Consider the circuit shown in the figure. The battery and the inductor have negligible resistance. The switch *S* has been open for a long time.



16. The switch is then closed. What is the current in the 100-Ω resistor immediately after the switch is closed? (Take the current in the resistor as positive when it is in the direction indicated in the figure.)

A. 0.00 A B. −0.01 A C. 0.09 A D. −1.00 A E. 5 A

17. What is the current in the 100-Ω resistor a long time after the switch is closed? (Take the current in the resistor as positive when it is in the direction indicated in the figure.)

A. 0.00 A B. −0.01 A C. 0.09 A D. −1.00 A E. 5 A

18. After being closed for a long time, the switch is now re-opened. What is the current in the 100-Ω resistor immediately after the switch is re-opened? (Take the current in the resistor as positive when it is in the direction indicated in the figure.)

A. 0.00 A B. −0.01 A C. 0.09 A D. −1.00 A E. 5 A

19. What is the current in the 100-Ω resistor a long time after the switch is re-opened? (Take the current in the resistor as positive when it is in the direction indicated in the figure.)

A. 0.00 A B. −0.01 A C. 0.09 A D. −1.00 A E. 5 A

Name ____**Student ID** _____________ **Score**_______
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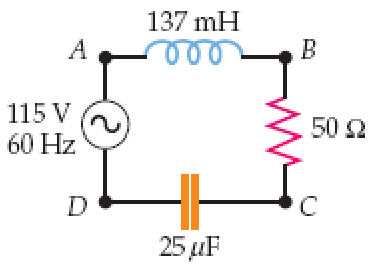
VII. DRIVEN RLC CIRCUITS

In the circuit shown in the figure below, the ideal generator produces an rms voltage of 115 V when operated at 60 Hz.



20. What is the rms voltage between points A and B?

A. 75 V B. 78 V C. 81 V D. 84 V E. 87 V

21. What is the rms voltage between points B and C?

A. 75 V B. 78 V C. 81 V D. 84 V E. 87 V

22. What is the rms voltage between points C and D?

A. 155 V B. 160 V C. 165 V D. 170 V E. 175 V