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ABSTRACT

The second part of the Self-Paced Physics Course remediation materials is presented for U. S. Naval Academy students who miss core problems on the progress check. The total of 101 problems is incorporated in this volume to match study segments 19 through 40. Each remedial sheet is composed of a statement of the missed problem and references tc pertinent auxiliary material. The content is given under the headings: Electric Charge and Coulomb's Law, The Electric Field, Electric Field Problems, Electric Dipoles and Electric Flux, Gauss's Law, Electric Potential, Electric Potential Energy, Capacitance, Energy Storage in Capacitors, Current and Resistance, Electrical Energy and Electromotive Force, Circuits and Kirchhoff's Rules, Ammeters and Voltmeters, Charge in a Magnetic Field, Current in a Magnetic Field, Magnetic Flux and the Earth's Magnetic Field, Ampere's Law, The Biot-Sacart Law, Faraday's Law of Induction, Self Inductance, The RC Circuit, and the LR Circuit. (Related documents are SE 016 065 - SE 016 088 and ED 062 123 - ED 062 125.) (CC)

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Course Materials - Fall, 1970

REMEDIAL SHEETS FOR PROGRESS CHECKS
Segments 19 thru 40

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SEGMENT 19

ELECTRIC CHARGE AND COULOMB'S LAW

Problem 1: The Electric Charge

1. Charge is

   A. a unit of electrical force.
   B. a source of electrical force.
   C. a unit of current.
   D. an electron

Reading Assignment:

Halliday and Resnick: Ch. 26, Sect. 2

SEGMENT 19

ELECTRIC CHARGE AND COULOMB'S LAW

Problem 2: Quantization of Charge

2. Millikan's Oil Drop experiment suggests that charge is quantized. How many discrete electrons comprise a coulomb of charge?

Reading Assignment:

Halliday and Resnick:	Ch. 26, Sect. 5
Semat and Blumenthal:	Vol 3, Ch. 20, Fr. 20
Joseph and Leahy:	Part II, Ch. 1, Sect 4, Fr. 47-52

SEGMENT 19

ELECTRIC CHARGE AND COULOMB'S LAW

Problem 5: The Ideal Insulator

5. In an IDEAL insulator

   A. charges are fixed at all times.
   B. charges are free to move within the insulator.
   C. charges tend to be displaced from their equilibrium positions under the action of applied electric fields.
   D. charges tend to spread over the surface of the insulator rather than remain localized.

Reading Assignment:

Halliday and Resnick:	Ch. 26, Sect. 3
Semat and Blumenthal:	Vol 3, Ch. 20 Fr. 7-8
Joseph and Leahy:	Part II, Ch. 1, Sect. 2 Fr. 1-11

SEGMENT 19

ELECTRIC CHARGE AND COULOMB'S LAW

Problem 6: Conservation of Charge

6. Two uncharged metal spheres are in contact. A hard rubber rod is stroked with fur and brought very near to one of the two metal spheres (no contact between rod and sphere). The spheres are then separated, and the rod removed from the vicinity. Which of the following can now be said about the metal spheres?

   A. the spheres will attract one another.
   B. the spheres will be negatively charged.
   C. the spheres will be positively charged.
   D. the spheres will repel one another.

Reading Assignment:

Halliday and Resnick:	Ch. 26, Sect. 2, 3, 7
Semat and Blumenthal:	Vol 3, Ch. 20. Fr. 1-5, 21-23
Joseph and Leahy:	Part II, Ch. 1, Sect. 3 Fr. 29-35

ELECTR ... ULOMB'S LAW

Problem 11: Coulomb's Law

11. A certain charge Q is to be divided into two parts, q and Q-q. Find the ratio Q/q if the two parts, placed a given distance apart, are to display maximum electrostatic repulsion.

Reading Assignment:

Halliday and Resnick:	Ch. 26, Sect. 4
Semat and Blumenthal:	Vol 3, Ch. 20 Fr. 10-14
Joseph and Leahy:	Part II, Ch. 1, Sect. 4 Fr. 31-38

Related Problems:

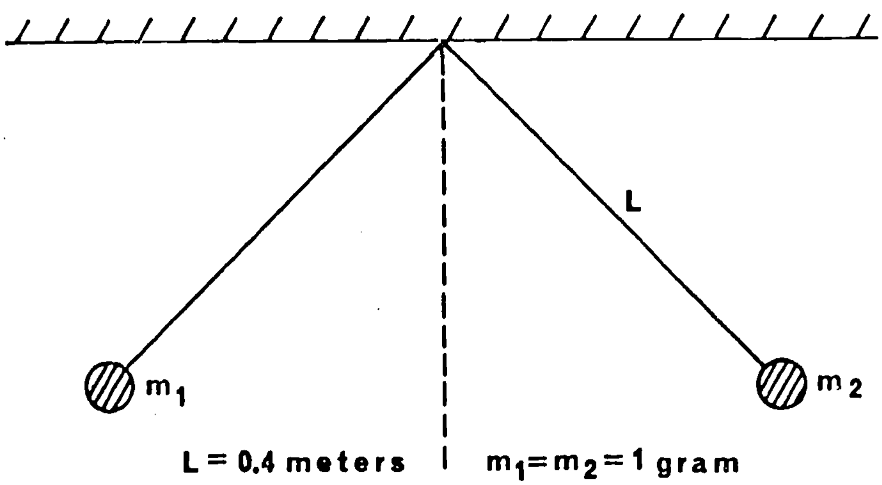
Schaum:	Ch. 22, No. 1, 2, 3

SEGMENT 19

ELECTRIC CHARGE AND COULOMB'S LAW

Problem 15: Application of Coulomb's Law

15. In the accompanying diagram, two equally charged balls are suspended from a common point by (weightless) rods 0.40 meters long. When the balls come to rest, they are 0.40 meter apart. The magnitude of the charge in microcoulombs on the balls is approximately ________.



Reading Assignment:

Halliday and Resnick:	Ch. 26, Sect. 4
Semat and Blumenthal:	Vol 3, Ch. 20, Fr. 15-20
Joseph and Leahy:	Part II, Ch. 1.Sect. 5, Fr. 23-35

Related Problems:

Schaum:	Ch. 22, No. 4

SEGMENT 20

THE ELECTRIC FIELD

›blem 1: The Electric Field

1. What must be the charge on a particle of mass 2.00 gm if it is to remain stationary in the laboratory when placed in a downward-directed electric field of intensity 500 nt/coul.

Reading Assignment:

Halliday and Resnick:	Ch. 27, Sect. 1. 2
Semat and Blumenthal:	Vol 3, Ch. 20, Fr. 32-33
Joseph and Leahy:	Part II, Ch. 2. Sect. 1, Fr. 1-6

Reading Problem:

Schaum:	Ch. 22, Nos. 6, 7

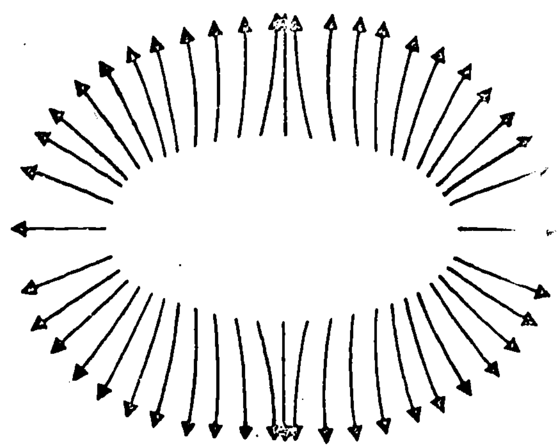
SEGMENT 20

THE ELECTRIC FIELD

Problem 5: Lines of Force

5. A portion of an electric field line diagram (below) has been erased. Of the four choices given below, which is most likely responsible for the illustrated fiel ?

- A. two positive charges
- B. two negative charges
- C. a single positive charge
- D. a single negative charge



Reading Assignment:

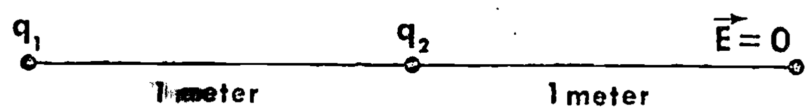
Halliday and Resnick:	Ch. 27, Sect. 3
Semat and Blumenthal:	Vol 3, Ch. 20 Fr. 34-36
Joseph and Leahy:	Part II, Ch. 2, Sect. 2, Fr. 25-30

SEGMENT 20

THE ELECTRIC FIELD

Problem 9: The Electric Field Due to Point Charges

9. Two point charges q_1 and q_2 are one meter apart. The electric field intensity at a point one meter to the right of q_2 and on a line joining q_1 and q_2 is zero. What is the ratio q_1/q_2?



Reading Assignments:

Halliday and Resnick:	Ch. 27, Sect. 4
Semat and Blumenthal:	Vol 3, Ch. 20, Fr. 37-39
Joseph and Leahy:	Part II, Ch. 2, Sect. 1, Fr. 16-30

Reading Problems:

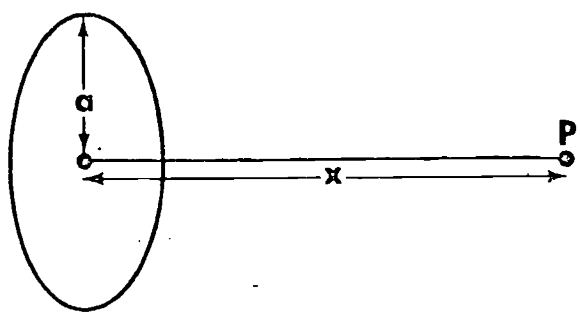
Schaum:	Ch. 22, Nos. 6, 7

SEGMENT 20

THE ELECTRIC FIELD

Problem 13: The Electric Field Due to a Uniformly Charged Ring

13. The electric field $\vec{E}$ for a point on the axis of a uniformly charged ring (see diagram) with total charge q and radius a at a distance x from its center is



A. $E = \frac{1}{4\pi\varepsilon_o} \frac{qx}{(a^2 + x^2)^{3/2}}$
normal to the axis

B. $E = \frac{1}{4\pi\varepsilon_o} \frac{qx}{(a^2 + x^2)^{3/2}}$
along the axis

C. $E = \frac{1}{4\pi\varepsilon_o} \frac{q}{a^2 + x^2}$
normal to the axis

D. $E = \frac{1}{4\pi\varepsilon_o} \frac{q}{a^2 + x^2}$
along the axis

Reading Assignments:

Halliday and Resnick: Ch. 27, Sect. 4

SEGMENT 20

THE ELECTRIC FIELD

Problem 18: The Electric Field Inside a Hollow Spherical Conductor

18. What is the electric field inside a hollow charged spherical conductor of radius R, surface area A, and total charge Q, distributed so that the charge density is σ?

A. $\frac{\sigma A}{4\pi\varepsilon_o R^2}$

B. $\frac{\sigma A}{2\pi\varepsilon_o R^2}$

C. $4\pi\varepsilon_o R^2 Q$

D. none of these

Reading Assignments:

Halliday and Resnick:	Ch. 16, Sect. 6 and Prob. 10; Ch. 27, Sect. 4
Joseph and Leahy:	Vol II. Ch. 2, Sect. 2, Fr. 1-16

SEGMENT 21

ELECTRIC FIELD PROBLEMS

Problem 1: The Electric Field of an Infinitely Long Line Charge

1. An infinitely long wire has a uniform charge density of $\lambda = +3.0 \times 10^{-6}$ coul/m. When a point charge Q is embedded in this wire, the electric field is measured to be zero at all points on a circle of radius 2.0 meters perpendicular to the axis of the wire. If Q is on the wire and at the center of the circle, what is the value of the charge Q?

Reading Assignment:

Halliday and Resnick: Ch. 27, Sect. 4

SEGMENT 21

ELECTRIC FIELD PROBLEMS

Problem 5: The Electric Field Between Two Charged Parallel Plates

5. Two large parallel metal plates adjacent to one another carry uniform surface charge densities $+\sigma$ and $-\sigma$, respectively, on their inner surfaces. The magnitude of σ is 10 coul/m^2. A charge, $q = 3.0 \times 10^{-6}$coul, is placed between these two plates. What is the magnitude of the electric force on it?

Reading Assignments:

Halliday and Resnick: Ch. 27, Sect. 4

Joseph and Leahy: Part II, Ch. 2, Sect. 2, Fr. 33-43

SEGMENT 21

ELECTRIC FIELD PROBLEMS

Problem 10: Kinetic Energy of a Charge Released in an Electric Field

10. Two oppositely charged metal plates are placed parallel to one another separated by a distance of 1.0×10^{-3} m. The uniform electric field between the plates has an intensity of 1.0×10^{3} nt/coul. If a proton is released very close to the positive plate, what will be its kinetic energy at the instant it collides with the negative plate?

Reading Assignment:

Halliday and Resnick: Ch. 27, Sect. 5

Related Problems:

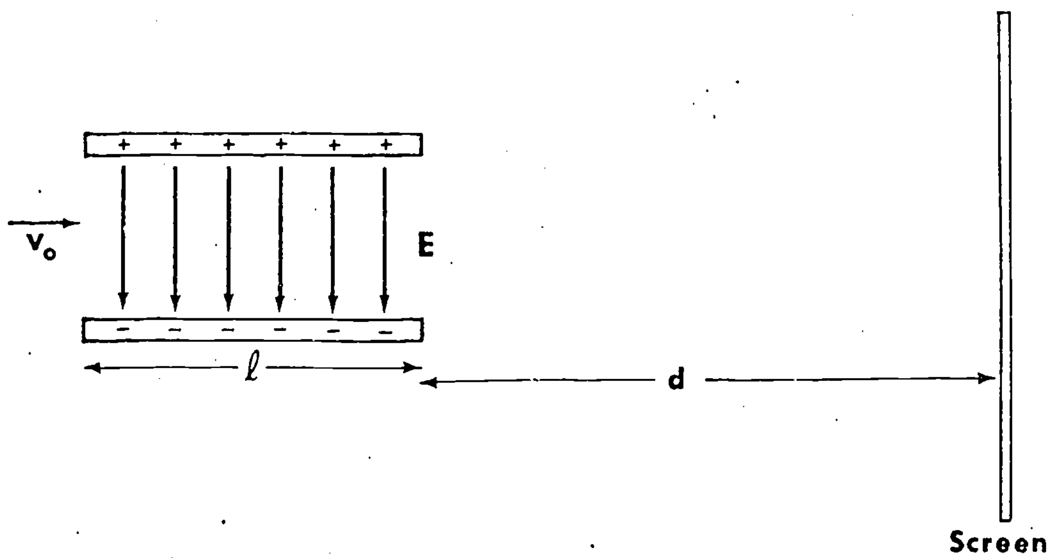
Schaum: Ch. 22, Nos. 8, 13, 15

SEGMENT 21

ELECTRIC FIELD PROBLEMS

Problem 14: Deflection of an Electron Beam in an Electric Field

14. The figure below shows an electron projected with speed $v_o = 1.00 \times 10^7$ m/sec at right angles to a uniform field $\vec{E}$. Find the deflection of the beam on the screen when the length ℓ of the plate is 2.00 cm, the distance d from the end of the plates to the screen is 29.0 cm, and $E = 1.50 \times 10^4$ nt/coul. (Neglect the gravitational effect.)



Reading Assignment:

Halliday and Resnick: Ch. 27, Sect. 5

Related Problems:

Schaum: Ch. 22, No. 8

SEGMENT 22

ELECTRIC DIPOLES AND ELECTRIC FLUX

Problem 1: Direction of Electric Dipole Axis

1. Which of the following choices is the direction of the axis of an electric dipole?

   A. An imaginary line drawn perpendicular to the line joining the two charges with the positive charge to the left of this perpendicular line.

   B. The direction defined by an imaginary straight line drawn from the negative to the positive charge forming the dipole.

   C. The direction defined by an imaginary line drawn from the positive to the negative charge forming the dipole.

   D. The direction defined by an imaginary line drawn perpendicular to the line joining the two charges that form the dipole, with the positive charge to the right of this line.

Reading Assignment:

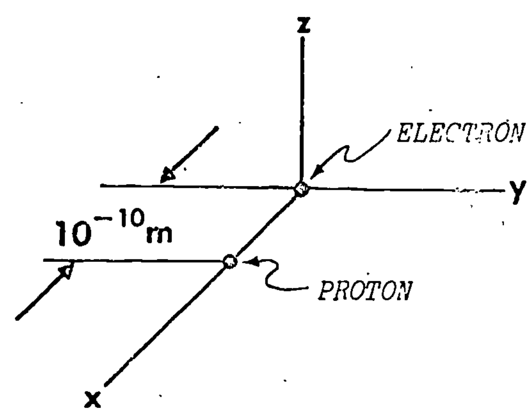
Halliday and Resnick:	Ch. 27, Sect. 4, 6
Sears and Zemansky	Ch. 26, Sect. 7

SEGMENT 22

ELECTRIC DIPOLES AND ELECTRIC FLUX

Problem 4: Electric Dipole Moment

4.



The electric dipole-moment, $\vec{p}$, of the configuration is

A. 3.2×10^{-29} coul-m; -z axis

B. 1.6×10^{-29} coul-m; +x axis

C. 1.6×10^{-29} coul-m; +z axis

D. 3.2×10^{-29} coul-m; -x axis

Reading Assignment:

Halliday and Resnick:	Ch. 27, Sect. 6
Sears and Zemansky:	Ch. 26, Sect. 7

SEGMENT 22

ELECTRIC DIPOLES AND ELECTRIC FLUX

Problem 5: Electric Flux Through a Plane Surface

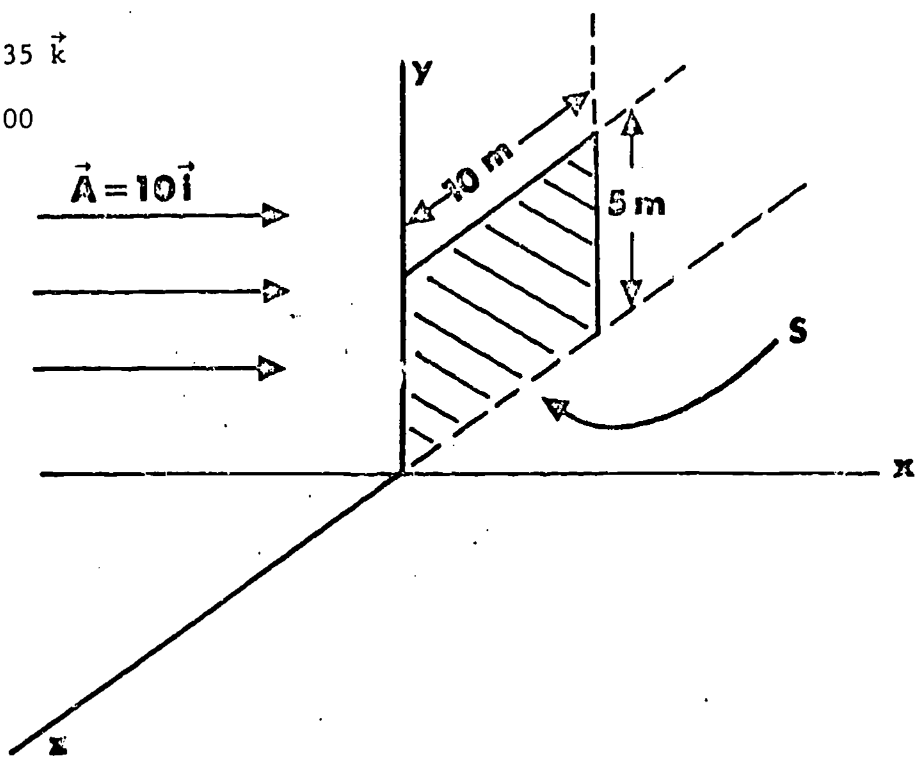
5. The vector field $\vec{A}$ shown in the diagram has a constant magnitude and direction at every point in space. The direction of $\vec{A}$ is always parallel to the x-axis. What is the *flux* of the vector $\vec{A}$ through the surface S shown in the diagram?

A. 210 $\vec{j}$

B. 176

C. 435 $\vec{k}$

D. 500



Reading Assignment:

Halliday and Resnick: Ch. 28, Sect. 1

Sears and Zemansky: Ch. 25, Sect. 4

SEGMENT 22

ELECTRIC DIPOLES AND ELECTRIC FLUX

Problem 9: Electric Flux Through a Cylindrical Surface

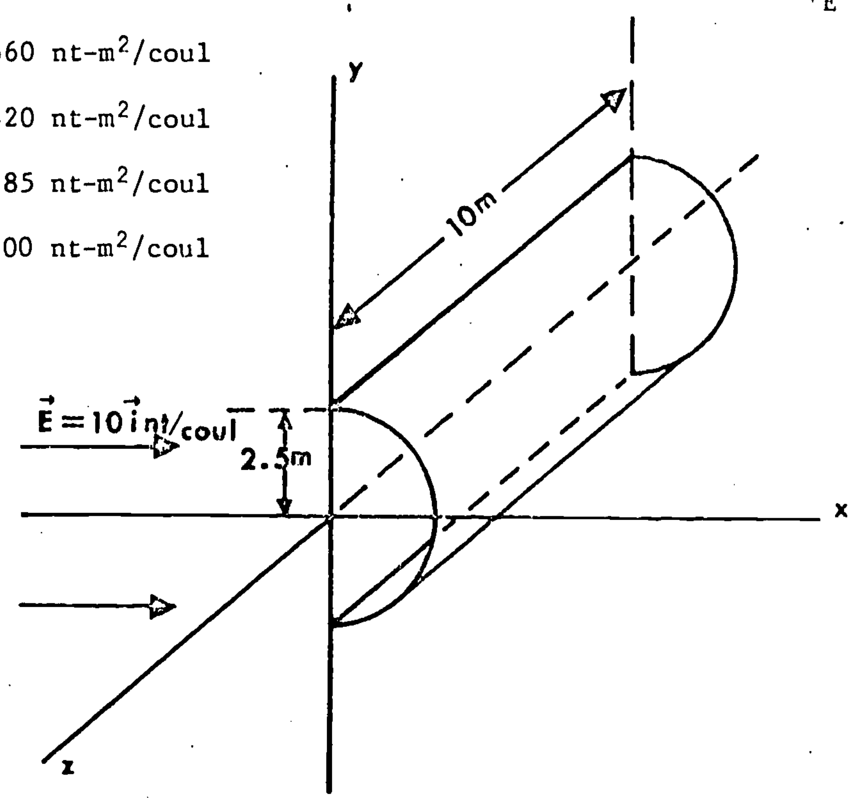
9. In the accompanying figure, a shell is shown which consists only of half a cylinder with no end surfaces. What is the value of Φ_E?

A. 360 nt-m^2/coul

B. 420 nt-m^2/coul

C. 785 nt-m^2/coul

D. 500 nt-m^2/coul



Re[illegible]nment:

Halliday and Resnick: Ch. 28, Sect. 1

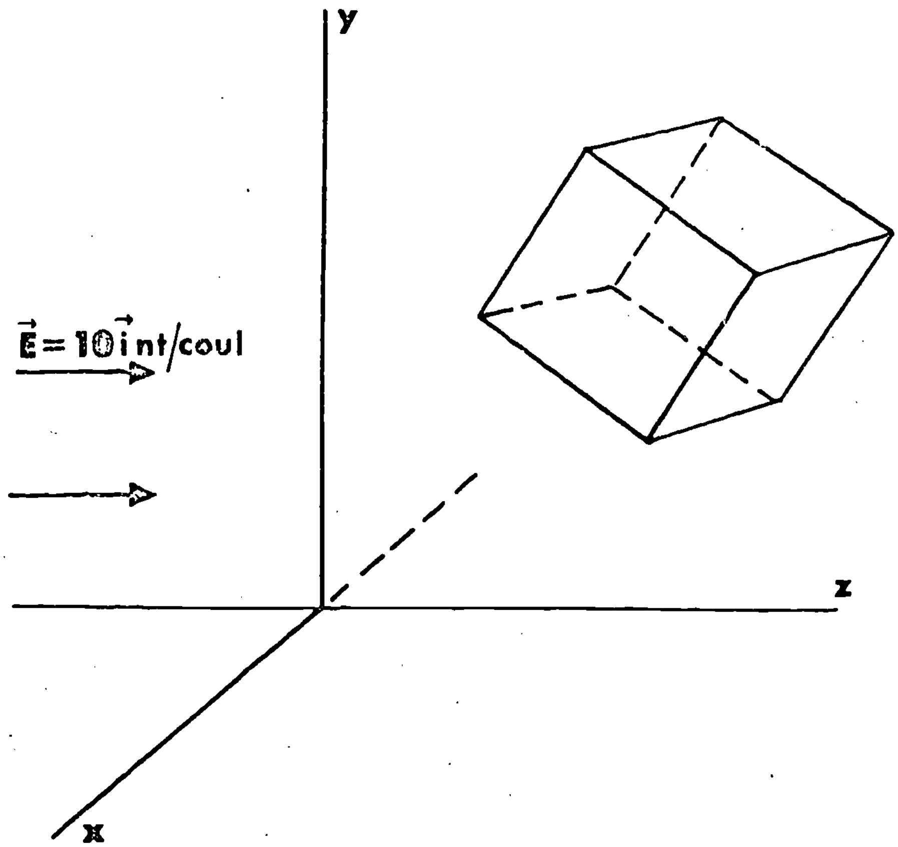
Sears and Zemansky: Ch. 25, Sect. 4

SEGMENT 22

ELECTRIC DIPOLES AND ELECTRIC FLUX

Problem 14: Electric Flux Through a Cubical Surface

14. A cubical surface 5 meters on edge is shown in the diagram. What is the value of the electric flux ϕ_E through the cubical surface?



Reading Assignment:

Halliday and Resnick   Ch. 28, Sect. 1

Sears and Zemansky: Ch. 25, Sect. 4

SEGMENT 23

GAUSS'S LAW

Proble[illegible] [illegible]tribution of Charge in Conducting and Non-Conducting Bodies

1. A non-cond[illegible] [illegible]niformly charged sphere ($\rho = +3$ coul/m^3) has a radius of one [illegible] The sphere is plunged into a very cold solution (temperature = [illegible] and becomes a conductor. What is the surface charge, σ, of [illegible]ere?

A. 1 coul/[illegible]
B. 3.78 co[illegible]
C. 0.025 c[illegible] [illegible]2
D. 3 coul[illegible]

Reading Assignment:

Halliday and Resni[illegible]	Ch. 28, Sect. 4
Semat and Bl[illegible]	Vol. 3, Ch. 20, Fr. 48
Joseph and L[illegible]	Part II, Ch. 2, Sect. 2, Fr

SEGMENT 23

GAUSS'S LAW

Problem 5: Charge Attraction and Repulsion

5. The aluminum foil of a negatively charged electroscope is observed to have a deflection of 45°. Imagine that you have been walking on a rug on a dry winter day and then bring your hand near the knob of this electroscope, causing the angle of deflection to drop to 10°. Which of the following is true about the charge on your hand?

A. Positively charged
B. Negatively charged
C. Not charged
D. It depends on whether you have rubber soled shoes or not

Reading Assignment:

Halliday and Resnick:	Ch. 26, Sect. 2
Semat and Blumenthal:	Vol. 3, Ch. 20, Fr. 21-25
Joseph and Leahy:	Part II, Ch. 1, Sect. 2, Fr. 18-34

SEGMENT 23

GAUSS'S LAW

Problem 9: Gauss's Law

9. The net charge enclosed in a Gaussian surface is q. The general form of Gauss's law is

A. $q = q \oint \vec{E} \cdot d\vec{S}$

B. $q = \frac{1}{4\pi\varepsilon_o} \oint \vec{E} \cdot d\vec{S}$

C. $\oint \vec{E} \cdot d\vec{S} = \frac{1}{\varepsilon_o}$

D. $q = \frac{1}{\varepsilon_o} \oint \vec{E} \cdot d\vec{S}$

Reading Assignment

Halliday and Resnick: Ch. 28, Sect. 2

Sears and Zemansky: Ch. 25, Sect. 4

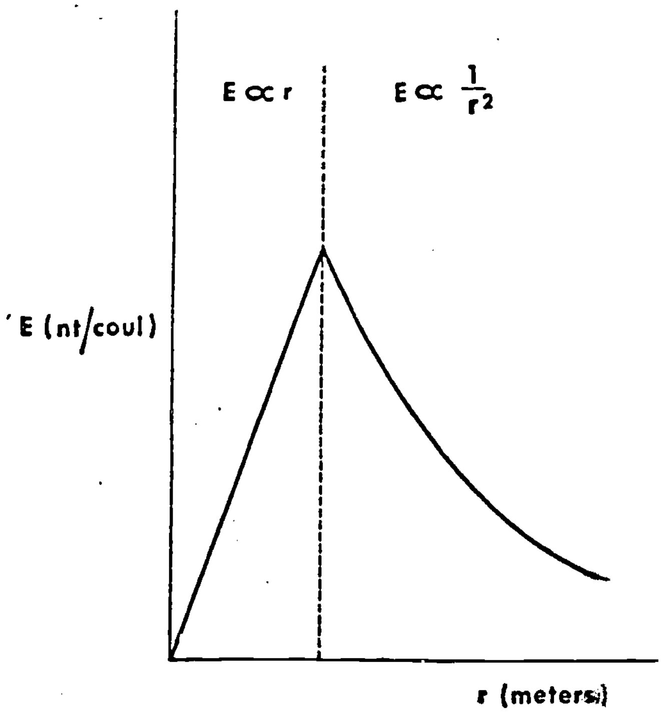
SEGMENT 23

GAUSS'S LAW

Problem 17: Electric Field Plotted as a Function of Distance

17. The diagram below shows the magnitude of the electric field plotted as a function of distance. Which of the following objects could produce such an electric field?

A. A uniformly charged, non-conducting sphere
B. An infinitely large, charged plate
C. A charged conducting cylinder
D. An infinite line of charge



Reading Assignment:

Haliday and Resnick: Ch. 28, Sect. 6

SEGMENT 23

GAUSS'S LAW

Problem 21: Electric Field Due to a Linear Charge

21. Consider an infinitely long straight wire of radius "a". Apply Gauss's law to find the magnitude of the electric field E at a distance r, where r > a. The linear charge density is λ coul/m.

A. $E = \dfrac{\lambda}{2\pi\varepsilon_0 a}$

B. $E = \dfrac{\lambda}{4\pi\varepsilon_0 r^2}$

C. $E = \dfrac{\lambda}{2\pi\varepsilon_0}$

D. $E = \dfrac{\lambda}{2\pi\varepsilon_0 r}$

Reading Assignment:

Halliday and Resnick: Ch. 28, Sect. 6

Sears and Zemansky: Ch. 25, Sect. 5, Par. 4

SEGMENT 23

GAUSS'S LAW

Problem 22: Electric Field Near a Large Charged Plate

22. A thick, flat plate is constructed of copper (a good conductor). The surface dimensions of the plate are 10 m × 10 m. If a charge of four coulombs is placed on the plate, what is the electric field strength one meter from the flat surface of the plate in nt/coul?

Reading Assignment:

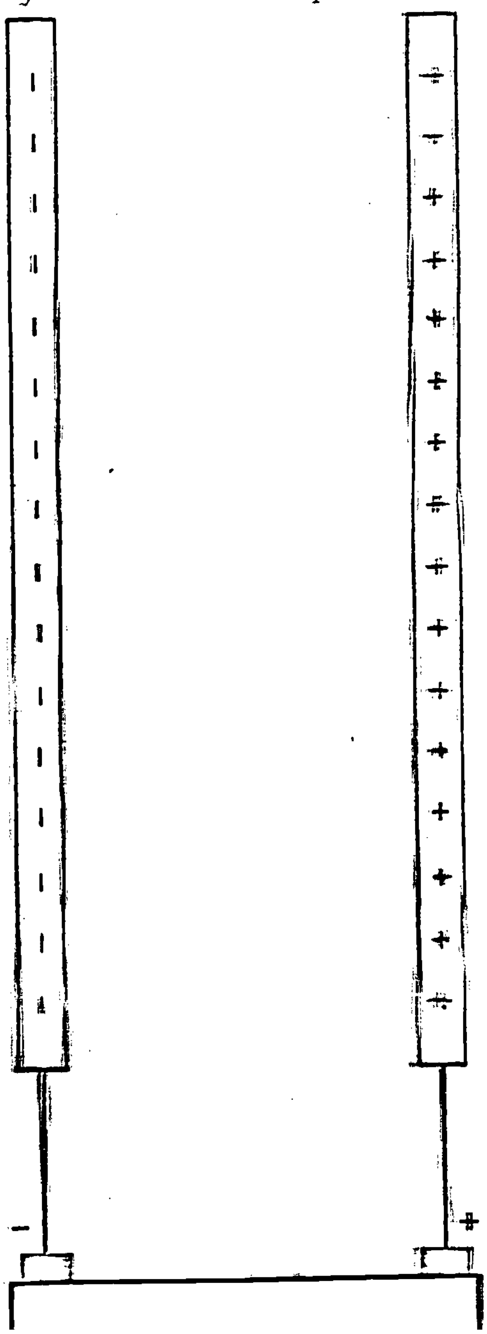
Halliday and Resnick:	Ch. 28, Sect. 6
Sears and Zemansky:	Ch. 25, Sect. 5, Par. 6

SEGMENT 23

GAUSS'S LAW

Problem 23: Electric Field Between Two Charged Sheets

23. Two large sheets of copper are shown in the diagram. The sheets are *very* thin and are oppositely charged. (σ = 3 coulombs per square meter of the copper sheet.) Using Gauss's law, what is the magnitude of E midway between the two plates in nt/coul?



Reading Assignment:

Halliday and Resnick:

Ch. 28, Sect. 6

Joseph and Leahy:

Part II, Ch. 2, Sect. 2, Fr. 33-40

Sears and Zemansky:

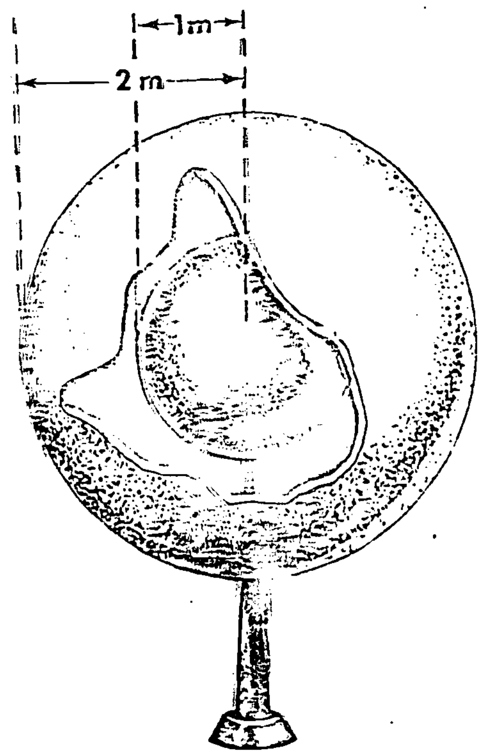
Ch. 25, Sect. 5, Par. 7

SEGMENT 23

GAUSS'S LAW

Problem 24: Electric Field Between Two Concentric Charged Spheres

24. An electron is placed midway between the two concentric spheres as shown at right. What is the magnitude of the force in newtons on the electron if the distance from the center of the concentric spheres is 1.5 m, and each sphere has a charge of +10 coulomb distributed over its surface?



Reading Assignment:

Halliday and Resnick:	Ch. 28, Sect. 6
Sears and Zemansky:	Ch. 25, Sect. 5, Par. 3

SEGMENT 23

GAUSS'S LAW

Problem 25: Electric Field Between Two Concentric Charged Cylinders

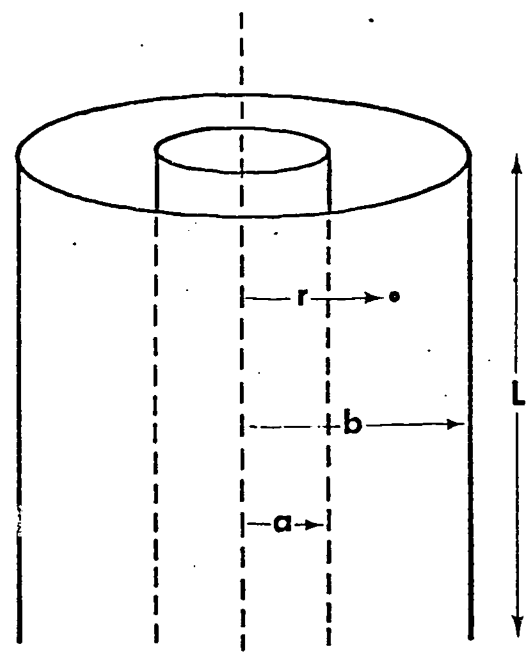
25. Two coaxial hollow metal cylinders of length L with radii a and b (b > a) carry charges +q and -q respectively. The magnitude of the electric field (neglecting edge effects) at a point a < r < b, measured from the common axis is

A. $\frac{qL}{4\pi\varepsilon_o r^2}$

B. $\frac{q}{2\pi\varepsilon_o rL}$

C. $\frac{qL}{2\pi\varepsilon_o}$

D. $\frac{qr}{2\pi\varepsilon_o L}$



Reading Assignment:

Halliday and Resnick: Ch. 28, Sect. 6

Sears and Zemansky: Ch. 25, Sect. 5, Par. 4

SEGMENT 24

ELECTRIC POTENTIAL

Problem 1: Work in an Electric Field

1. A particular electric field can be described by the following equation:

$$\vec{E} = \frac{10}{x}\,\hat{i}$$

How much work must be performed to move a charge $q = +1$ coul from $x = 10$ m to $x = 5$ m?

Reading Assignment:

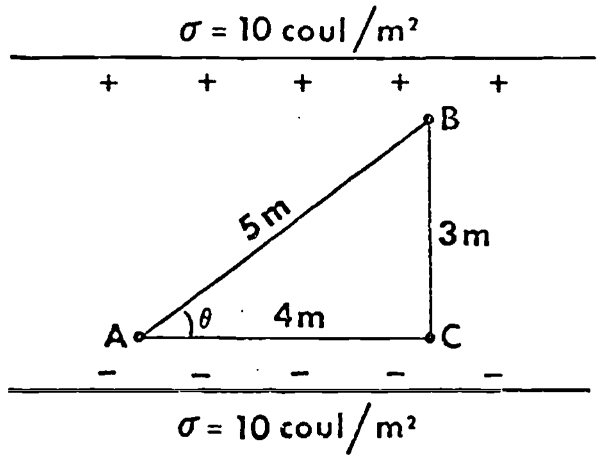
Halliday and Resnick: Ch. 29, Sect. 1, 2

SEGMENT 24

ELECTRIC POTENTIAL

Problem 6: Potential Difference in a Uniform Electric Field

6. Two parallel plates each with a surface charge density $\sigma = 10$ coul/m^2 form a region of uniform electric field as shown in the diagram. Calculate the potential difference $V_{AB} \equiv V_B - V_A$ in volts.



Reading Assignment:

Halliday and Resnick:	Ch. 29, Sect. 1, 2
Semat and Blumenthal:	Vol. 3, Ch. 20, Fr. 40-45
Joseph and Leahy:	Part II, Ch. 2, Sect. 5, Fr. 16-20 Sect 4, Fr. 50-54

SEGMENT 24

ELECTRIC POTENTIAL

Problem 11: Potential Due to a Point Charge

11. Recalling that the potential difference between two points A and B is given by the expression

$$V_B - V_A = -\int_A^B \vec{E}\cdot d\vec{s} \qquad (1)$$

we can define the electric potential by taking point A to be at infinity, so that $V_A = 0$

$$V = -\int_\infty^B \vec{E}\cdot d\vec{s} \qquad (2)$$

Using this definition, calculate the potential due to a point charge q at a distance r from it.

A. $V = \frac{1}{4\pi\varepsilon_o}\frac{q}{r}$

B. $V = \frac{1}{4\pi\varepsilon_o}\frac{q}{r^2}$

C. $V = \frac{1}{4\pi\varepsilon_o} qr$

D. $V = \frac{1}{4\pi\varepsilon_o} r^2$

Reading Assignment:

Halliday and Resnick:	Ch. 29, Sect. 3
Semat and Blumenthal:	Vol. 3, Ch. 20, Fr. 46-47
Joseph and Leahy:	Part II, Ch. 2, Sect. 4, Fr. 20-28

Related Problems:

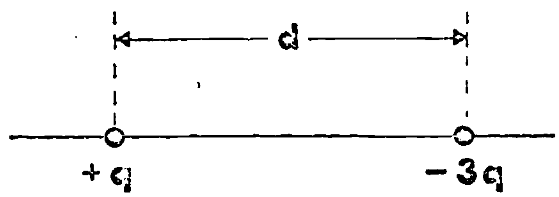
Schaum:	Ch. 22, No. 9

SEGMENT 24

ELECTRIC POTENTIAL

Problem 15: Potential Due to Two Point Charges

15. Two charges of magnitude q and -3q are separated by a distance of 2 m. Find the two points on the line joining the two charges wehre the potential V = 0.



A. 1 m left of +q; 0.5 m right of +q

B. 0.5 m left of +q; 1 m right of +q

C. 0.5 m right of +q

D. 1 m left of +q

Reading Assignment:

Halliday and Resnick:	Ch. 29, Sect. 3, 4
Semat and Blumenthal:	Vol. 3, Ch. 20, Fr. 46-47
Joseph and Leahy:	Part II, Ch. 2, Sect. 4, Fr. 41-47

Related Problems:

Schaum:	Ch. 22, No. 11

SEGMENT 25

ELECTRIC POTENTIAL ENERGY

Problem 1: Calculation of E from V for an Electric Dipole

1. At a point P the electric potential due to a dipole located at the origin of an xy-plane system is given by

$$V = \frac{1}{4\pi\varepsilon_o} \frac{p \cos\theta}{r^2}$$

where $p = 2\ aq$ and $r^2 = x^2 + y^2$ and θ is measured from +y axis.

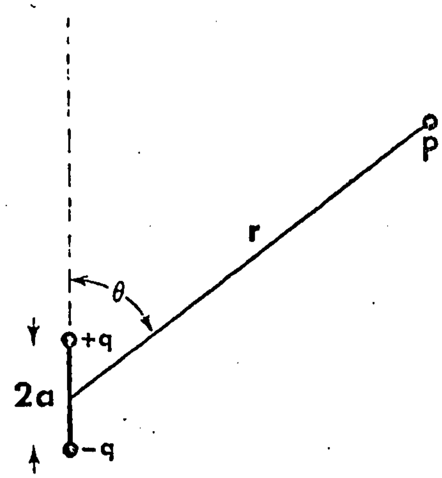
What is the y component of the electric field E_y at P?

A. $E_y = -\frac{p}{4\pi\varepsilon_o} \frac{x^2 - 2y^2}{(x^2 + y^2)^{3/2}}$

B. $E_y = -\frac{p}{4\pi\varepsilon_o} \frac{x^2 - 2y^2}{(x^2 + y^2)^{5/2}}$

C. $E_y = -\frac{p}{4\pi\varepsilon_o} \frac{y^2}{(x^2 + y^2)^{3/2}}$

D. $E_y = -\frac{p}{4\pi\varepsilon_o} \frac{x}{(x^2 + y^2)^{3/2}}$



Reading Assignment:

Halliday and Resnick: Ch. 29, Sect. 5, 7

Sears and Zemansky: Ch. 26, Sect. 6, 7

SEGMENT 25

ELECTRIC POTENTIAL ENERGY

Problem 6: Potential Difference Between Two Concentric Spherical Shells

6. Two concentric, conducting spherical shells have radii r and R, respectively ($R > r$). The respective charges in the shells are $+q$ and $-q$. What is the potential difference between the two spheres?

A. $V_r - V_R = \frac{q}{4\pi\varepsilon_o}\left(\frac{1}{R} - \frac{1}{r}\right)$

B. $V_r - V_R = \frac{q}{4\pi\varepsilon_o}\left(\frac{1}{r} - \frac{1}{R}\right)$

C. $V_r - V_R = 0$

D. $V_r - V_R = \frac{1}{4\pi\varepsilon_o}\frac{2q}{r}$

Reading Assignment:

Halliday and Resnick:	Ch. 28, Sect. 6 Ch. 29, Sect. 2
Sears and Zemansky:	Ch. 26, Sect. 3, 4

SEGMENT 25

ELECTRIC POTENTIAL ENERGY

Problem 10: Electric Potential Due to a Non-Conducting Charged Sphere

10. The potential at a point a distance r from the center of a non-conducting sphere of radius R, charged uniformly with a total charge Q, is proportional to

A. r^2 for $r < R$; $1/r$ for $r > R$

B. $1/r^2$ for $r < R$; $1/r$ for $r > R$

C. r for $r < R$; $1/r^2$ for $r > R$

D. constant for $r < R$; $1/r$ for $r > R$

Reading Assignment:

Halliday and Resnick:	Ch. 28, Sect. 6 Ch. 29, Sect. 2
Sears and Zemansky:	Ch. 26, Sect. 3, 4

SEGMENT 25

ELECTRIC POTENTIAL ENERGY

Problem 14: Electric Potential Energy

14. A proton (mass $m_p = 1.67 \times 10^{-27}$ kg and charge $q_p = 1.6 \times 10^{-19}$ coul) with an initial velocity $v = 2.00 \times 10^7$ m/sec is directed towards a fixed charge $Q = 1.00 \times 10^{-4}$ coul a distance $r = 1.00$ m from the initial position of the proton. Find the distance of closest approach for the proton to the fixed charge Q.

Reading Assignment:

Halliday and Resnick:	Ch. 29, Sect. 6
Joseph and Leahy:	Part II, Ch. 2, Sect. 3, Fr. 1-15

SEGMENT 26

CAPACITANCE

Problem 1: The Parallel Plate Capacitor

1. A parallel plate capacitor consists of two parallel conducting plates of area A separated by a distance d. The plates carry charge +q and -q respectively. *Derive* the expression for capacitance in terms of ε_o, plate area, and distance between plates, then select the correct answer:

A. $C = \dfrac{d}{\varepsilon_o A}$

B. $C = \dfrac{\varepsilon_o A}{d}$

C. $C = \varepsilon_o A d$

D. $C = \varepsilon_o d$

Reading Assignment:

Halliday and Resnick: Ch. 30, Sect. 2

Semat and Blumenthal: Vol. 3, Ch. 21, Fr. 1-6

Related Problems:

Schaum: Ch. 22, No. 22(a)

CAPACITANCE

Problem 6: The Cylindrical Capacitor

6. *Derive* the equation for the capacitance of a capacitor formed by two concentric hollow cylinders of length L with radii a and b ($b > a$); then select the correct answer.

A. $C = 4\pi\varepsilon_0(b - a)$

B. $C = 2\pi\varepsilon_0 L \ \ell n(b/a)$

C. $C = \dfrac{2\pi\varepsilon_0 L}{\ell n(b/a)}$

D. $C = \dfrac{\ell n(b/a)}{2\pi\varepsilon_0 L}$

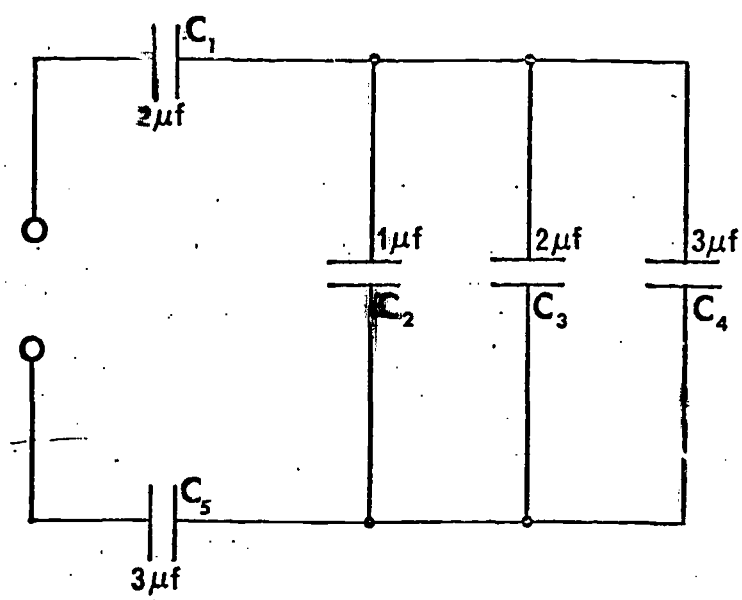
Reading Assignment:

Halliday and Resnick: Ch. 30, Sect. 2

SEGMENTS AND CORE PROBLEMS

Problem 10: Equivalent Capacitance

10. For the circuit shown below, what is the equivalent capacitance in μf?



Reading Assignment:

Halliday and Resnick: Ch. 30, Sect. 2

Semat and Blumenthal: Vol. 3, Ch. 21, Fr. 17-22

Related Problems:

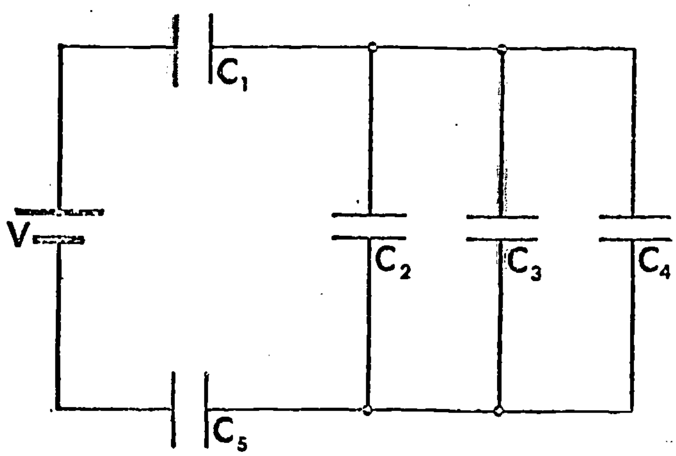
Schaum: Ch. 22, Nos. 20, 21

SEGMENT 26

CAPACITANCE

Problem 15: Analysis of Capacitor Circuits

15. For the circuit shown below, what is the total charge in microcoulombs supplied by the battery?



$V = 12$ volts

$C_1 = C_3 = 2.0\ \mu f$

$C_2 = 1.0\ \mu f$

$C_4 = C_5 = 3.0\ \mu f$

Reading Assignment:

Halliday and Resnick: Ch. 30, Sect. 2

Semat and Blumenthal: Vol. 3, Ch. 21, Fr. 19, 23

Related Problems

Schaum: Ch. 22, Nos. 20, 21

SEGMENT 27

ENERGY STORAGE IN CAPACITORS

Problem 1: Work Done in Charging a Capacitor

1. Find the work done in charging a parallel plate capacitor to produce a final charge magnitude $Q = 5 \times 10^{-3}$ coul on each plate and a potential difference between the plates of $V = 100$ volts.

Reading Assignment:

Halliday and Resnick: Ch. 30, Sect. 7

Semat and Blumenthal: Vol. 3, Ch. 21, Fr. 11-14

Related Problems

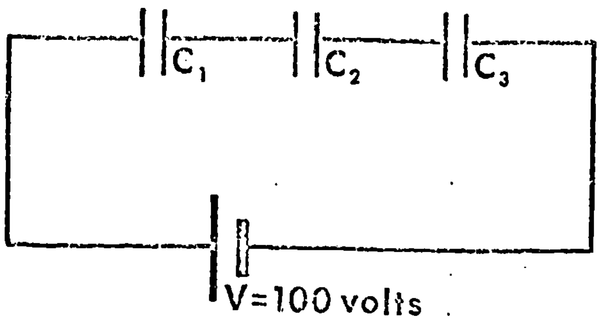
Schaum: Ch. 22, Nos. 19, 22

SEGMENT 27

ENERGY STORAGE IN CAPACITORS

Problem 6: Transfer of Energy in Capacitors

6.



C_1 = 400 μf

C_2 = 400 μf

C_3 = 200 μf

Three large capacitors having capacitances of C_1 = 400 μf, C_2 = 400 μf and C_3 = 200 μf are connected in series across a 100-volt battery. After the capacitors are charged, the battery is disconnected and the capacitors are connected in parallel with the positively charged plates connected together. Find the *difference* in stored energy in the system of three capacitors in the two situations described above.

Reading Assignment:

Halliday and Resnick: Ch. 30, Sect. 7

Semat and Blumenthal: Vol. 3, Ch. 21, Fr. 15, 16, 19, 23, 24

Related Problems

Schaum Ch. 22, Nos. 20, 21, 22

SEGMENT 27

ENERGY STORAGE IN CAPACITORS

Problem 10: Dielectric Constant

10. A dielectric slab of thickness b and dielectric constant κ is inserted between the plates of a parallel-plate capacitor of plate separation d and area A. What is the capacitance of the capacitor?

A. $C = \dfrac{\varepsilon_0 A}{d - b}$

B. $C = \dfrac{\kappa\varepsilon_0 A}{\kappa d - b(\kappa - 1)}$

C. $C = \dfrac{\kappa\varepsilon_0 A}{d}$

D. $C = \dfrac{\varepsilon_0 A}{\kappa(d - b)}$

Reading Assignment:

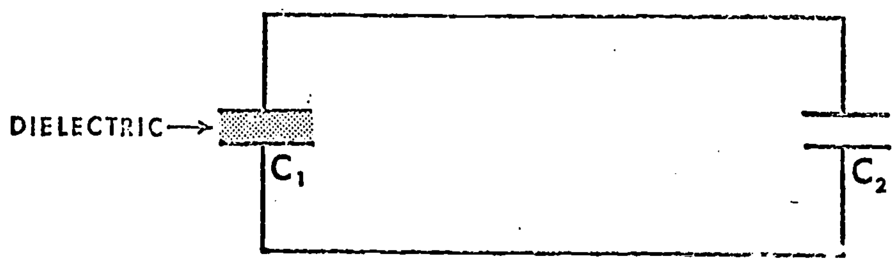
Halliday and Resnick: Ch. 30, Sect. 5

Semat and Blumenthal: Vol. 3, Ch. 21, Fr. 6-9

ENERGY STORAGE IN CAPACITORS

Problem 16: Effect of Capacitor Dielectric on Stored Energy

16. An air capacitor having capacitance $C_1 = 1.5$ μf is connected to a 100-volt battery. After the capacitor is fully charged it is disconnected from the battery and filled with a dielectric material of dielectric constant $\kappa = 3.0$. If the capacitor with the dielectric is now connected to another uncharged capacitor $C_2 = 3.0$ μf as shown in the diagram, find the energy stored in the final system.



Reading Assignments:

Halliday and Resnick:	Ch. 30, Sect. 7
Semat and Blumenthal:	Vol. 3, Ch. 21, Fr. 9,24

Related Problems

Schaum	Ch. 22, Nos. 16, 20, 22

SEGMENT 28

CURRENT AND RESISTANCE

Problem 1: Establishing an Electric Current

1. A continuous current will be present in a metallic conductor if

   A. a continuous field or potential gradient is maintained within it

   B. the conductor has a connection to ground

   C. the conductor has an induced charge on its surface

   D. charges in the conductor are free to move

Reading Assignment:

Halliday and Resnick:	Ch. 31, Sect. 1
Semat and Blumenthal:	Vol. 3, Ch. 22, Fr. 1-3
Joseph and Leahy:	Part II, Ch. 3, Sect. 1,

SEGMENT 28

CURRENT AND RESISTANCE

Problem 6: Current Density

6. Current enters a cylindrical wire of diameter 1/4 in, the current density being 80 amp/m^2. The wire eventually tapers down to a diameter of 1/16 in. What is the current density in this thinner portion of the wire, in amp/m^2?

Reading Assignment

Halliday and Resnick:	Ch. 31, Sect. 1
Joseph and Leahy:	Part II, Ch. 3, Sect. 2, Fr. 16-19

SEGMENT 28

CURRENT AND RESISTANCE

Problem 10: Resistance

10. A wire with a resistance of 9.0 ohms is drawn out so that its new length is three times its original length. Find the new value of its resistance, assuming that the resistivity and the density of the material are not changed during the drawing process.

Reading Assignment:

Halliday and Resnick:	Ch. 31, Sect. 2
Semat and Blumenthal:	Vol. 3, Ch. 22, Fr. 14-16
Joseph and Leahy:	Part II, Ch. 3, Sect. 3, Fr. 37-53

Reading Problems:

Schaum:	Ch. 25, Nos. 1, 4

SEGMENT 28

CURRENT AND RESISTANCE

Problem 15: Ohm's Law

15. A current of 2 amp exists in a wire 2 m long and 2 mm in diameter, when a 12-volt battery is connected across it. What will be the current through a wire 4 m long and 4 mm in diameter, made up of exactly the same material (same ρ), if a 6-volt battery is connected across it?

Reading Assignment:

Halliday and Resnick:	Ch. 31, Sect. 2, 3
Semat and Blumenthal:	Vol. 3, Ch. 22, Fr. 11, 12, 28
Joseph and Leahy:	Part II, Ch. 3, Sect. 4, Fr. 5-14

Related Problems

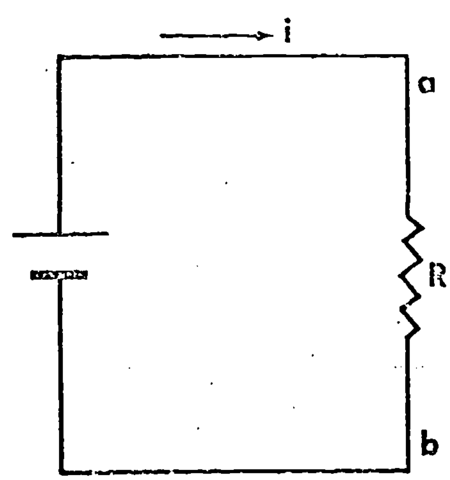
Schaum:	Ch. 23, No. 4; Ch. 25, No. 1

SEGMENT 29

ELECTRICAL ENERGY AND ELECTROMOTIVE FORCE

Problem 1: Energy Transfer in an Electric Circuit

1. In the circuit shown in the accompanying diagram, the power developed in the resistor may be given as $P = iV_{ab}$. Derive from this the equation which expresses the rate at which heat is developed in the resistor R in terms of i and R.



Reading Assignment:

Halliday and Resnick:	Ch. 31, Sect. 5
Semat and Blumenthal:	Vol. 3, Ch. 22, Fr. 6-10
Joseph and Leahy:	Part II, Ch. 3, Sect. 5, Fr. 1-13

SEGMENT 29

ELECTRICAL ENERGY AND ELECTROMOTIVE FORCE

Problem 5: Joule Heating

5. A reisitor dissipates 100 watts when it is connected to a 100-volt supply. If this voltage drops to 90 volts, what will be the percentage drop in heat output, provided the resistance remains the same?

Reading Assignment:

Halliday and Resnick:	Ch. 31, Sect. 5
Semat and Blumenthal:	Vol. 3, Ch. 22, Fr. 11, 12, 28
Joseph and Leahy:	Part II, Ch. 3, Sect. 5, Fr. 16-20

Reading Problems:

Schaum:	Ch. 24, Nos. 4, 6

SEGMENT 29

ELECTRICAL ENERGY AND ELECTROMOTIVE FORCE

Problem 9: Electromotive Force

9. Which of the following correctly defines emf in terms of the work done by a seat of emf in moving a charge dq from a lower potential to a higher potential?

A. $\varepsilon = -q dW$

B. $\varepsilon = \frac{dW}{dq}$

C. $\varepsilon = -\frac{dW}{dq}$

D. $\varepsilon = \frac{dq}{dW}$

where: dW is the work done by the source of emf on a charge dq, in moving this charge from a lower to a higher potential

Reading Assignment:

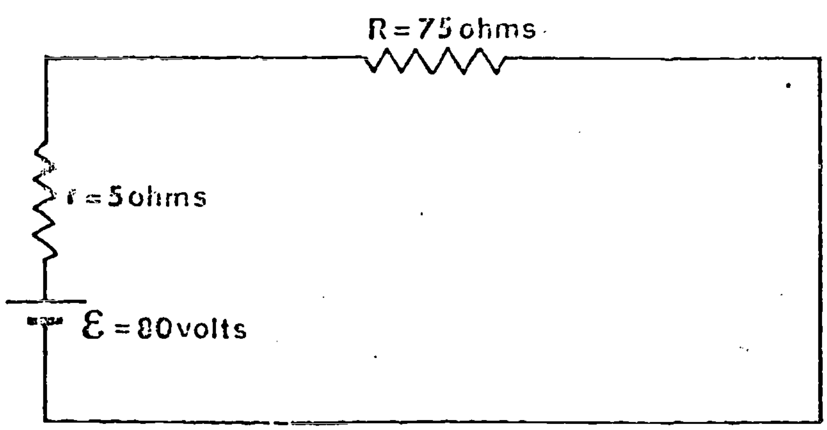
Halliday and Resnick:	Ch. 32, Sect. 1
Joseph and Leahy:	Part II, Ch. 2, Sect. 7, Fr. 1-22

SEGMENT 29

ELECTRICAL ENERGY AND ELECTROMOTIVE FORCE

Problem 15: Single Loop Circuit - Joule Heating

15. For the data given in the circuit below, what is the rate at which heat is being generated in the 75-ohm resistor?



Reading Assignment:

Halliday and Resnick:	Ch. 31, Sect. 5, Ch. 32, Sect. 2, 3
Semat and Blumenthal	Vol. 3, Ch. 22, Fr. 11, 12
Joseph and Leahy:	Part II, Ch. 3, Sect. 5, Fr. 19-22

Reading Problems:

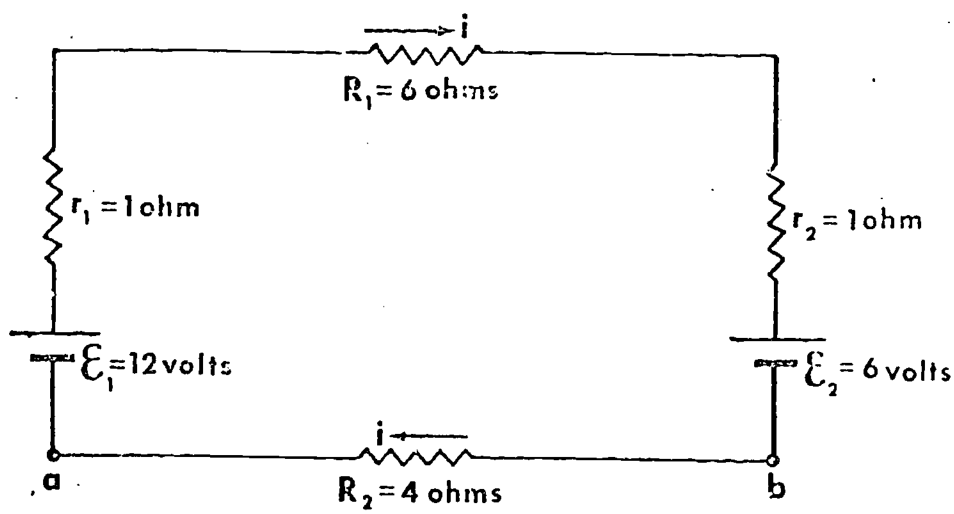
Schaum:	Ch. 24, Nos. 4, 6

SEGMENT 29

ELECTRICAL ENERGY AND ELECTROMOTIVE FORCE

Problem 21: Single Loop Circuit - Potential Difference

21. Find the potential difference $V_b - V_a$ in the circuit shown below.



Reading Assignment

Halliday and Resnick:	Ch. 32, Sect. 2, 3, 4
Semat and Blumenthal:	Vol. 3, Ch. 22, Fr. 22, 23
Joseph and Leahy:	Part II, Ch. 3, Sect. 6, Fr. 22-29, 44-49

SEGMENT 30

CIRCUITS AND KIRCHHOFF'S RULES

Problem 1: Current and Resistance in Basic Circuits

1. A circuit consists of three resistors, R_1 = 1 ohm, R_2 = 2 ohms, and R_3 = 3 ohms. The current in each resistor is found to be inversely proportional to its resistance. This means that

   A. all three resistors are connected in series

   B. all three resistors are connected in parallel

   C. the first two resistors are connected in parallel and the combination is connected in series with the third resistor

   D. this is always true regardless of the way these resistors are connected.

Reading Assignment:

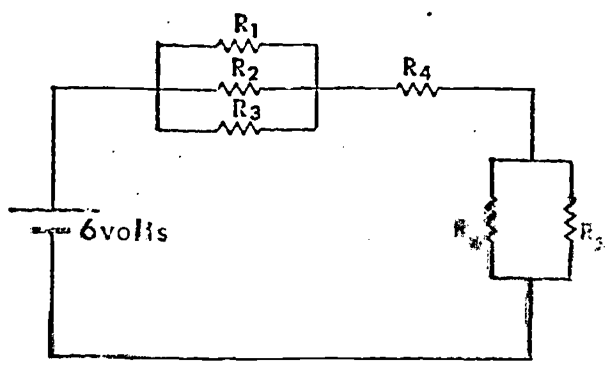
Halliday and Resnick: Ch. 32, Sect. 5

SEGMENT 30

CIRCUITS AND KIRCHHOFF'S RULES

Problem 5: Equivalent Resistance

5. What is the equivalent resistance of the circuit shown below?



$R_1 = R_2 = R_3 = 15$ ohms

$R_4 = 10$ ohms

$R_5 = 10$ ohms

$R_6 = 5$ ohms

Reading Assignment

Halliday and Resnick:	Ch. 32, Sect. 3, 5
Semat and Blumenthal:	Vol. 3, Ch. 22, Fr. 21-25
Joseph and Leahy:	Part II, Ch. 3, Sect. 6, Fr. 9-21; Sect. 7, Fr. 5-21

Related Problems

Schaum:	Ch. 25, Nos. 5, 8, 9, 10, 11

SEGMENT 30

CIRCUITS AND KIRCHHOFF'S RULES

Problem 10: Potential Drop Across Parallel Resistors

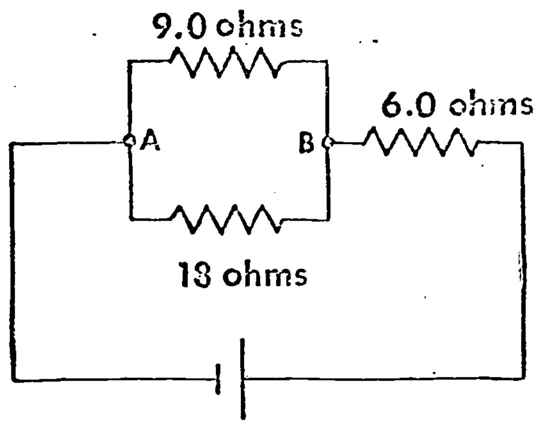
). In this circuit, the voltage drop across the 6.0-ohm resistor is

A. equal to V_{AB}

B. greater than V_{AB}

C. smaller than V_{AB}

D. zero



Reading Assignment:

ılliday and Resnick:	Ch. 32, Sect. 4, 5
›mat and Blumenthal:	Vol. 3, Ch. 22, Fr. 26,27
›seph and Leahy	Part II, Ch. 3, Sect. 8, Fr. 1-8

Related Problems:

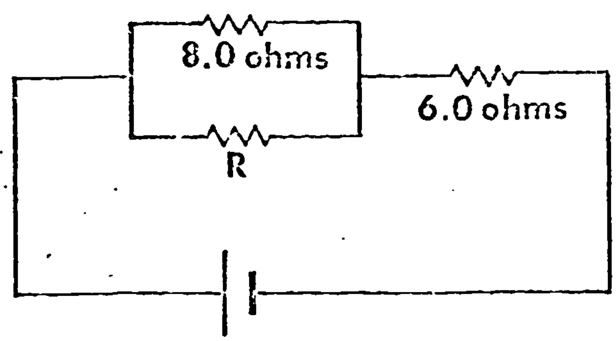
:haum:	Ch. 25, Nos. 12, 13

SEGMENT 30

CIRCUITS AND KIRCHHOFF'S RULES

Problem 16: Unknown Resistance in Simple Circuit

16. For the circuit shown in the figure, find the value of the resistance R such that the current in the 6-ohm resistor is *three* times the current in the resistor R.



Reading Assignment:

Halliday and Resnick:	Ch. 32, Sect. 5
Semat and Blumenthal:	Vol. 3, Ch. 22, Fr. 26

Related Problems

Schaum:	Ch. 25, Nos. 12, 13

CIRCUITS AND KIRCHHOFF'S RULES

Problem 19: Kirchhoff's First Rule

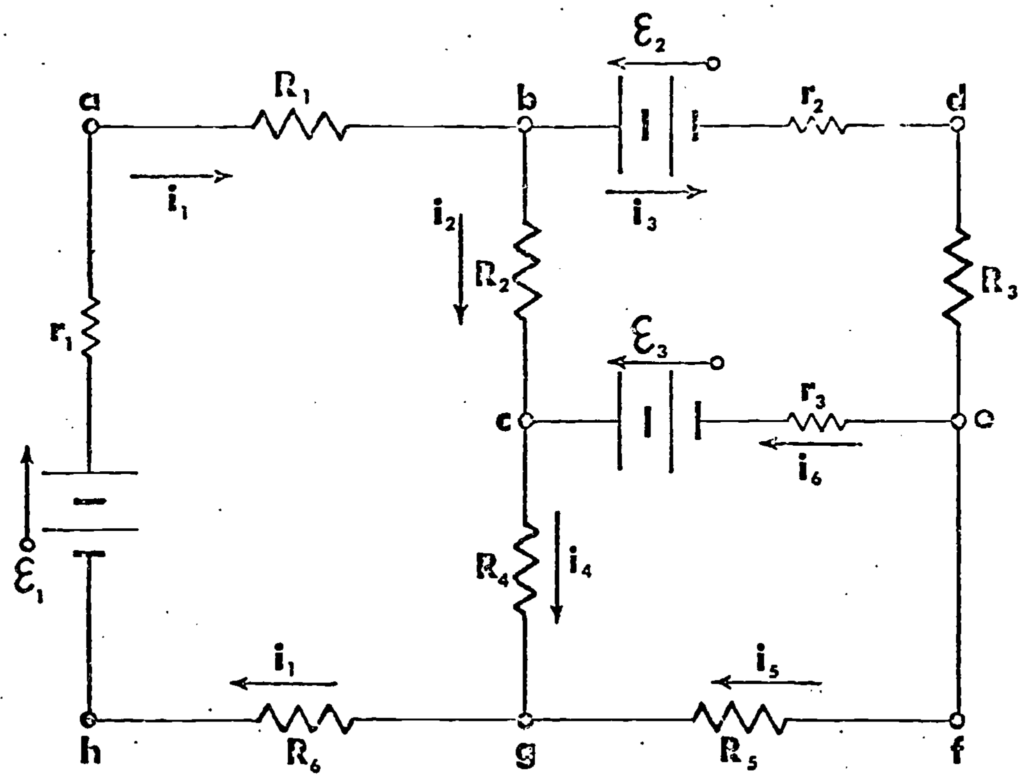
19. The current equations for the three branch points b, c, g in the accompanying circuit are, respectively

A. $i_1 - i_2 - i_3 = 0$; $i_2 - i_4 + i_6 = 0$; $-i_1 + i_4 + i_5 = 0$

B. $i_1 + i_2 + i_3 = 0$; $i_2 + i_4 + i_6 = 0$; $i_1 + i_4 + i_5 = 0$

C. $i_1 - i_2 - i_3 = 0$; $i_2 + i_4 - i_6 = 0$; $i_1 - i_4 - i_5 = 0$

D. $i_1 - i_2 - i_3 = 0$; $i_2 - i_4 + i_6 = 0$; $-i_1 + i_2 + i_4 + i_5 = 0$



Reading Assignment:

Halliday and Resnick: Ch. 32, Sect. 5

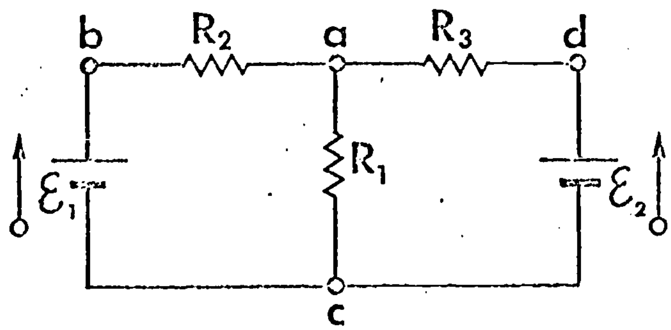
Sears and Zemansky: Ch. 29, Sect. 2

SEGMENT 30

CIRCUITS AND KIRCHHOFF'S RULES

Problem 23: Multiloop Circuits

23.



R_1 = 5.0 ohms

R_2 = 10 ohms

R_3 = 15 ohms

ε_1 = 12 volts

ε_2 = 6.0 volts

For the circuit shown in the figure, find the magnitude of the current through resistor R_1.

Reading Assignments

Halliday and Resnick:	Ch. 32, Sect. 5
Sears and Zemansky:	Ch. 29, Sect. 2

Related Problems:

Schaum:	Ch. 25, Nos. 25, 26

SEGMENT 31

AMMETERS AND VOLTMETERS

Problem 1: The Ammeter

1. The resistance of the coil of a pivoted coil galvanometer is 10.0 ohms and a current of 0.0200 amp causes a full-scale deflection. It is desired to convert this galvanometer into an ammeter reading 10.0 amps full-scale. The only shunt available has a resistance of 0.0300 ohms. What resistance R must be connected in series with the coil so that the ammeter will read properly?

Reading Assignment:

Halliday and Resnick:	Ch. 32, Sect. 6
Sears and Zemansky	Ch. 29, Sect. 3; Ch. 31, Sect. 5, 6
Semat and Blumenthal:	Vol. 3, Ch. 25, Fr. 38-39

Related Problems:

Schaum:	Ch. 29, Nos. 1,2

SEGMENT 31

AMMETERS AND VOLTMETERS

Problem 7: The Voltmeter

7. A 150-volt voltmeter has a resistance of 20,000 ohms. When connected in series with a large resistance R across a 110-volt line the meter reads 5.0 volts. Find the resistance R.

Reading Assignment:

Halliday and Resnick:	Ch. 32, Sect. 6
Sears and Zemansky:	Ch. 29, Sect. 3
Semat and Blumenthal:	Vol. 3, Ch. 25, Fr. 40

Related Problems:

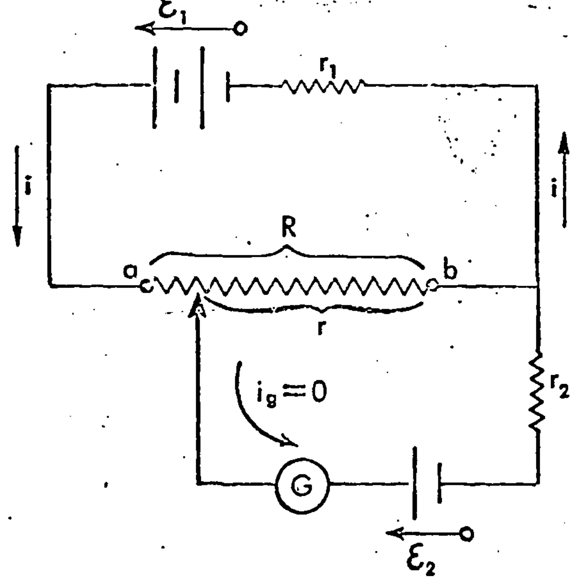
Schaum:	Ch. 29, Nos. 3,4

SEGMENT 31

AMMETERS AND VOLTMETERS

Problem 11: The Potentiometer

11. In the circuit below, the various elements have the following values:



R = 100 ohms ε_1 = 9 volts

r = 68 ohms ε_2 = ?

$r_1 = r_2 = 2$ ohms

Calculate the value of ε_2.

Reading Assignment:

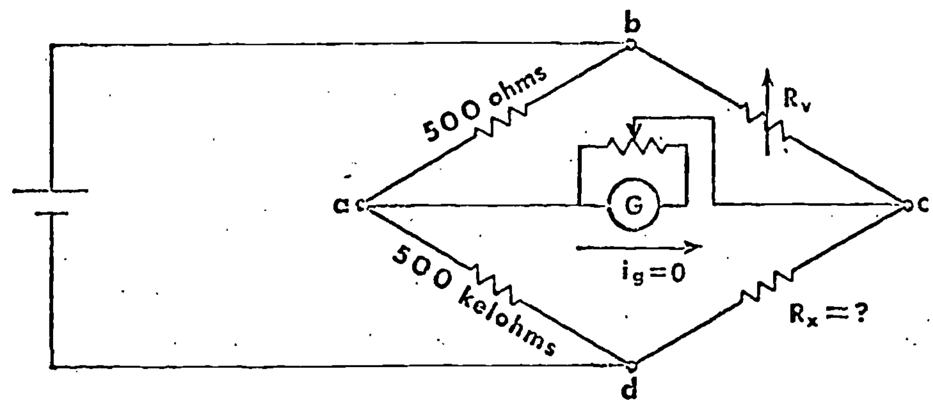
Halliday and Resnick:	Ch. 32, Sect. 7
Sears and Zemansky:	Ch. 29, Sect. 6
Semat and Blumenthal:	Vol. 3, Ch. 23, Fr. 28-29

SEGMENT 31

AMMETERS AND VOLTMETERS

Problem 15: The Wheatstone Bridge

15.



In the Wheatstone Bridge illustrated, the variable resistor R_V is adjusted to 1550 ohms in order to make the galvanometer current (i_g) equal to zero. What is the value of R_X in ohms?

Reading Assignment:

Sears and Zemansky: Ch. 29, Sect. 4

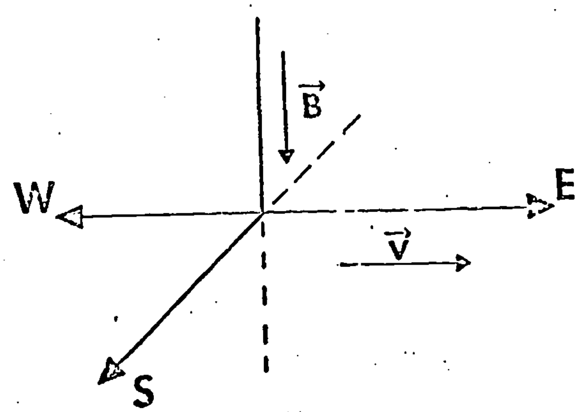
Semat and Blumenthal: Vol. 3, Ch. 22, Fr. 30-33

SEGMENT 32

CHARGE IN A MAGNETIC FIELD

Problem 1: Magnetic Force on a Charge

1. An electron in a television picture tube has a speed of 6×10^5 m/sec. The tube is oriented so that the electrons move horizontally from west to east. The vertical component of the Earth's magnetic field points downward and has an intensity of $B = 5 \times 10^{-5}$ T. What is the force exerted on the electron? (Recall that $q_e = -e = -1.6 \times 10^{-19}$ coul.)



A. 9.6×10^{-14} nt; north

B. 4.8×10^{-18} nt; south

C. 9.6×10^{-14} nt; north

D. 4.8×10^{-18} nt; south

Reading Assignment:

Halliday and Resnick: Ch. 33, Sect. 1,2

Semat and Blumenthal: Vol. 3, Ch. 25, Fr. 29

Joseph and Leahy: Part II, Ch. 4, Sect. 5, Fr. 13, 15-

Related Problems:

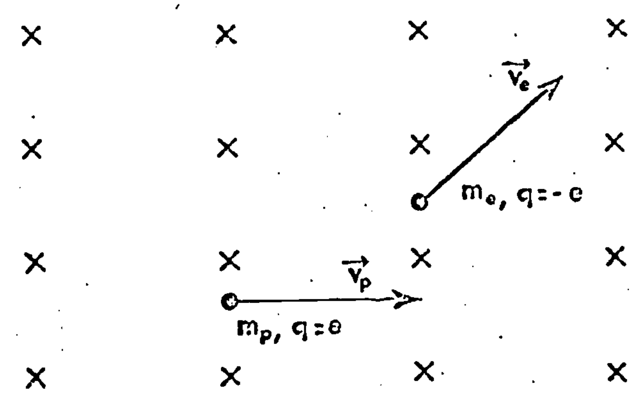
Schaum: Ch. 27, No. 12

SEGMENT 32

CHARGE IN MAGNETIC FIELD

Problem 4: Orbits of Charges in the Magnetic Field

4. The proton is positively charged and 1836 times as massive as the negatively-charged electron. Each is released with its velocity in the plane of the paper, there being a uniform magnetic field directed perpendicularly into the plane of the paper. If the proton and the electron are released with equal kinetic energies, the electron's orbit is



A. larger than the proton's orbit

B. smaller than the proton's orbit

C. the same size as the proton's orbit

D. no conclusion can be drawn about the relative sizes of the orbits

Reading Assignment:

Halliday and Resnick:	Ch. 33, Sect. 1,2
Semat and Blumenthal:	Vol 3, Ch. 25, Fr. 30-33
Joseph and Leahy:	Part II, Ch. 4, Sect. 5, Fr. 23-33

Related Problems:

Schaum:	Ch. 27, Nos. 14, 15

SEGMENT 32

CHARGE IN A MAGNETIC FIELD

Problem 9: The Cyclotron

9. If the oscillator frequency of a cyclotron is fixed at 15.3 MHz but the magnitude of the magnetic induction can be changed from zero to 1 T and its direction can be reversed, for which of the following particles, other than the proton, can this cyclotron be used?

A. only the electron

B. only the electron and deuteron

C. only the deuteron and the α-particle

D. all three (electron, deuteron and α-particle)

Reading Assignment:

Halliday and Resnick:	Ch. 33, Sect. 6,7
Joseph and Leahy:	Part II, Ch. 4, Sect. 8, Fr. 1-32

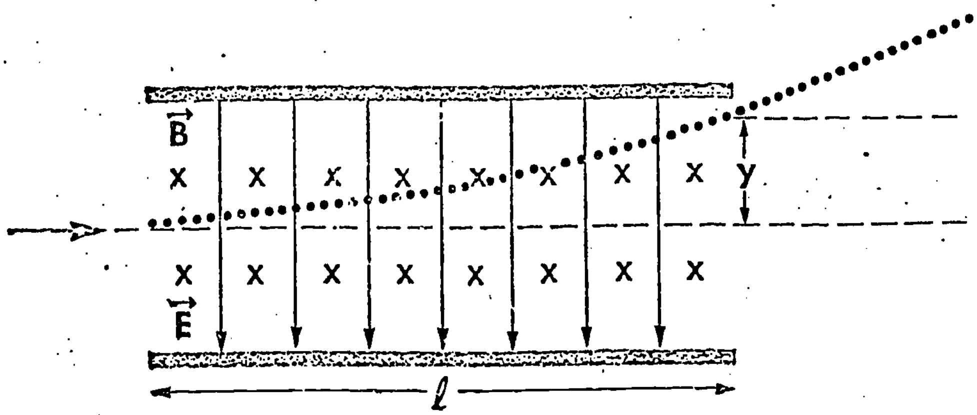
Related Problems:

Schaum:	Ch. 27, No. 16

CHARGE IN A MAGNETIC FIELD

Problem 16: Motion of an Electron in Crossed E and B Fields

16. A beam of electrons enters a region where it is acted upon by an electric and a magnetic field simultaneously. The initial velocity, the direction of the electric field and the direction of the magnetic field are mutually perpendicular to each other. The electrons are found to leave the region of length ℓ = 10 cm undeflected if E = .50 nt/coul and B = 1.0×10^{-5} T. If the $\vec{B}$ field is turned off, the electrons are found to be deflected a distance y = 1.7 mm; find the ratio e/m for the electrons in coul/kg.



Reading Assignment

Halliday and Resnick: Ch. 33, Sect. 8

Semat and Blumenthal: Vol. 3, Ch. 25, Fr. 34

Joseph and Leahy: Part II, Ch. 4, Sect. 5, Fr. 40-44
Sect. 6, Fr. 1-25

Related Problems:

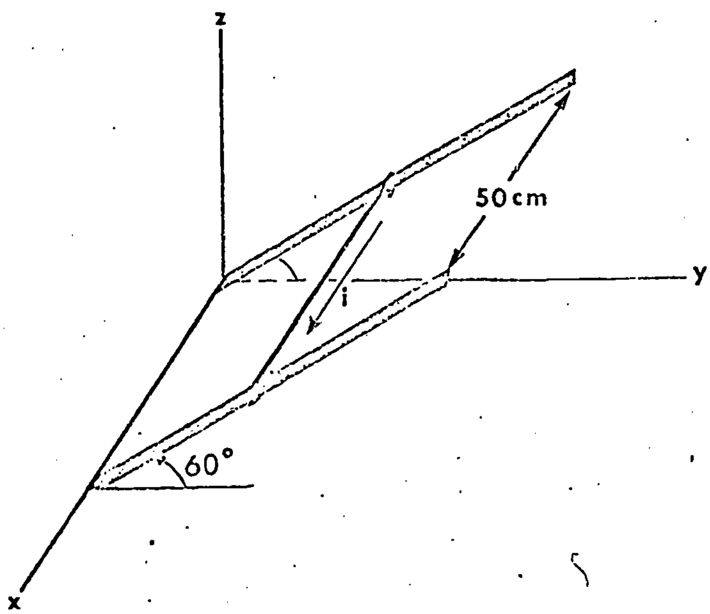
Schaum: Ch. 27, No. 13

SEGMENT 33

CURRENT IN A MAGNETIC FIELD

Problem 1: Magnetic Force on a Current-Carrying Wire

1. A metal wire of length 50 cm and mass 20 gm carries a current of 0.1 amp. It rests on a pair of frictionless rails inclined at an angle of 60° to the horizontal (the xy-plane is the horizontal plane and the wire is parallel to the x-axis). A horizontal uniform magnetic field exists in the region. What must be the magnitude of the field in teslas and its direction if the wire is not to slide up or down the incline?



Reading Assignment:

Halliday and Resnick: Ch. 33, Sect. 3

Semat and Blumenthal: Vol. 3, Ch. 25, Fr. 23-25

Joseph and Leahy: Part II, Ch. 4, Sect. 3, Fr. 1-23
Sect. 4, Fr. 1-15

Related Problems:

Schaum: Ch. 27, No. 6

SEGMENT 33

CURRENT IN A MAGNETIC FIELD

Problem 5: Magnetic Force on a Current Loop

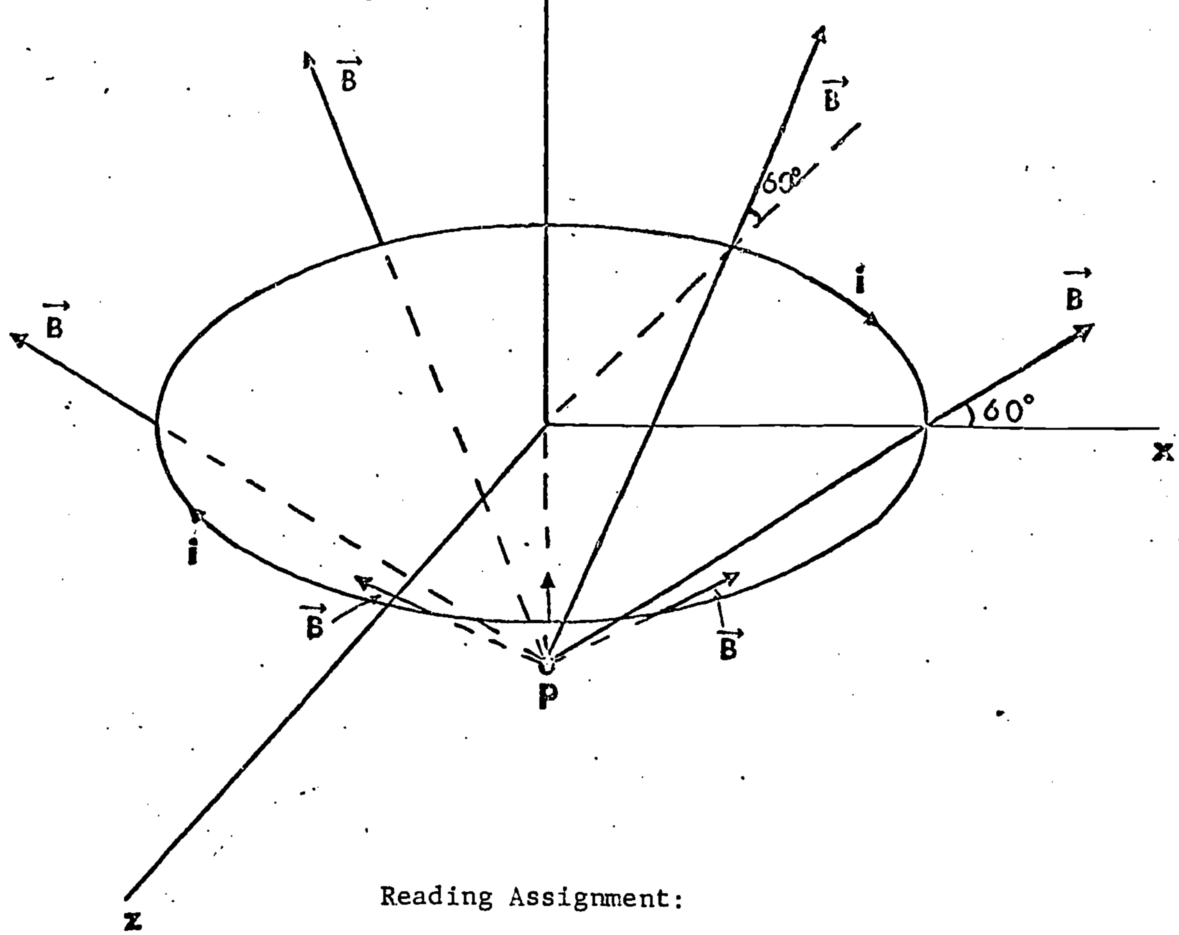
5. A circular loop of radius 40 cm carries a current of 1 milliampere in the sense shown in the diagram. The loop is placed in a symmetrically diverging magnetic field such that $\vec{B}$ is everywhere perpendicular to the loop itself and makes an angle of 60° with the plane of the loop (the plane of the loop is the xz-plane, and the magnetic field lines meet at a point P on the negative y-axis. The magnitude of $\vec{B}$ at the site of the loop is 0.1 T. What is the net force on the loop?

A. $2\pi \times 10^{-5}\ \hat{j}$ nt

B. $-2\pi \times 10^{-5}\ \hat{j}$ nt

C. $4\pi \times 10^{-5}\ \hat{j}$ nt

D. $-4\pi \sqrt{3} \times 10^{-5}$ nt



Reading Assignment:

Halliday and Resnick: Ch. 33, Sect. 3

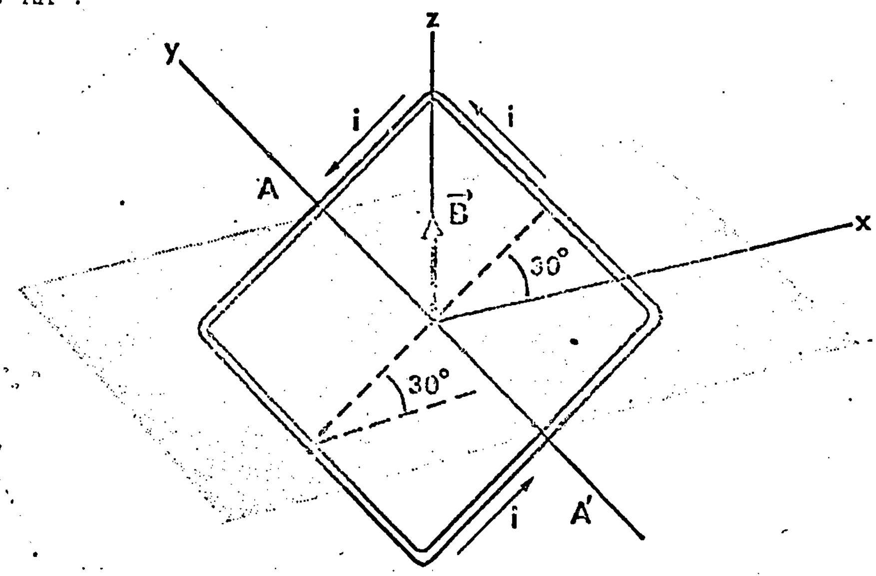
Sears and Zemansky: Ch. 31, Sect. 1, 3

SEGMENT 33

CURRENT IN A MAGNETIC FIELD

Problem 9: Torque on a Current Loop

9. A rectangular loop of sides 5 cm and 6 cm carrying a current i = 2 amp, is placed in a uniform magnetic field B = 2 T directed along the z-axis as shown. The normal to the plane of the loop makes a 30° angle with the direction of $\vec{B}$. What is the torque in nt - m on the loop about axis AA'?



Reading Assignment:

Halliday and Resnick:	Ch. 33, Sect. 4
Semat and Blumenthal:	Vol. 3, Ch. 25, Fr. 35-36
Sears and Zemansky:	Ch. 31, Sect. 3

Related Problems:

Schaum:	Ch. 27, No. 9

SEGMENT 33

CURRENT IN A MAGNETIC FIELD

Problem 14: Magnetic Moment of a Current Loop

14. In the Bohr model of the hydrogen atom, an electron revolves around a nucleus in a circular orbit of radius $r = 5.00 \times 10^{-11}$ m. If the electron has a speed $v = 2.25 \times 10^{6}$ m/sec, find the magnitude of the magnetic moment (in amp - m^2) of the electron (orbital). Assume the circulating charge to be equivalent to a tiny current loop of radius r.

Reading Assignment:

Halliday and Resnick:	Ch. 33, Sect. 4
Sears and Zemansky:	Ch. 31, Sect. 3

SEGMENT 34

MAGNETIC FLUX AND THE EARTH'S MAGNETIC FIELD

Problem 1: Average Value of Torque on a Current-Carrying Loop

1. In order to develop a fairly constant torque in a dc motor, it is customary to wrap a large number, N, of rectangular current loops around a cylinder (the armature), which necessitates a correspondingly more complicated commutator. In the limit of very large N, the torque is constant and equal to its average value. Derive an expression for this average value of τ for N loops. The loop area is A.

A. $\tau = NiAB$

B. $\tau = 2NiAB$

C. $\tau = NiAB/\pi$

D. $\tau = 2NiAB/\pi$

Reading Assignment:

Halliday and Resnick:	Ch. 33, Sect. 4
Sears and Zemansky:	Ch. 31, Sect. 3

Reread the Information Panel on this Problem

Related Problems:

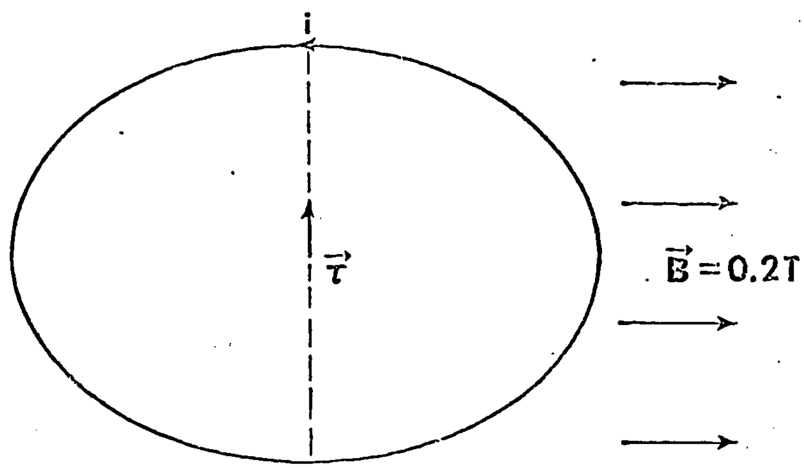
Schaum:	Ch. 27, No. 9

SEGMENT 34

MAGNETIC FLUX AND THE EARTH'S MAGNETIC FIELD

Problem 5: Work Done in Rotating a Magnetic Moment in a Magnetic Field

5. If a current loop of magnetic moment $\mu = 4.5 \times 10^{-3}$ amp-m^2 is free to rotate about its minor axis in the $\vec{B}$ field of 0.2 T magnitude as shown, it will do so according to the right-hand rule; i.e., if the thumb of your right hand points in the direction of the torque, the loop will accelerate in the sense your fingers curl. How much work in joules is done by the magnetic field in turning the loop through one quarter of a revolution from the rest position shown?



Reading Assignment:

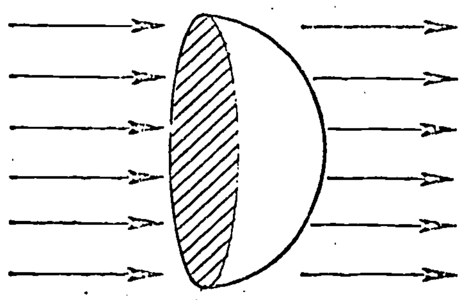
Halliday and Resnick: Ch. 33, Sect. 4

SEGMENT 34

MAGNETIC FLUX AND THE EARTH'S MAGNETIC FIELD

Problem 9: Magnetic Flux

9. A hemispherical bowl of radius 15 cm is placed in a uniform magnetic field of magnitude 2.0 T. The open (flat) end of the bowl is normal to the field. Calculate the magnetic flux through the bowl.



Reading Assignment:

Halliday and Resnick:	Ch. 33, Sect. 1
Sears and Zemansky:	Ch. 30, Sect. 4
Joseph and Leahy:	Part II, Ch. 5, Sect. 3, Fr. 1-7

SEGMENT 34

MAGNETIC FLUX AND THE EARTH'S MAGNETIC FIELD

Problem 13: The Magnetic Field of the Earth

13. The magnitude of the Earth's magnetic induction at Cambridge, Massachusetts is $B = 58\ \mu T$. The inclination and declination are 73° north and 15° west, respectively. What are the eastward (B_E), northward (B_N) and upward (or vertical B_v) components of B there?

A. $B_E = 17\ \mu T$; $B_N = 17\ \mu T$; $B_v = 55\ \mu T$

B. $B_E = 0$; $B_N = 17\ \mu T$; $B_v = 55\ \mu T$

C. $B_E = -14\ \mu T$; $B_N = 54\ \mu T$; $B_v = -17\ \mu T$

D. $B_E = -4.4\ \mu T$; $B_N = 16\ \mu T$; $B_v = -55\ \mu T$

Reading Assignment:

Sears and Zemansky: Ch. 34, Sect. 10

Semat and Blumenthal: Vol. 3, Ch. 24, Fr. 23-26

Reread the Information Panel on this Problem

SEGMENT 35

AMPERE'S LAW

Problem 1: Magnetic Field Near a Long Current-Carrying Wire

1. An infinitely long, thin copper wire carries a 50-amp current. What is the magnitude of magnetic field $\vec{B}$ at a distance of 0.50 m from the wire?

Reading Assignment:

Halliday and Resnick:	Ch. 34, Sect. 1
Semat and Blumenthal:	Vol. 3, Ch. 25, Fr. 1-5, 14-15(c),
Joseph and Leahy:	Part II, Ch. 4, Sect. 2, Fr. 17-21 24-25 Sect. 4, Fr. 16-18

Related Problems:

Schaum:	Ch. 27, No. 1

SEGMENT 35

AMPERE'S LAW

Problem 6: Magnetic Field In a Current-Carrying Cylindrical Shell

6. What is the magnitude of $\vec{B}$ at a distance r from the axis of a current-carrying cylindrical shell in which the current density is uniform? The inner radius is a, the outer radius is b, and b > r > a.

A. zero

B. $\frac{\mu_o (r^2 - a^2)}{2\pi (b^2 - a^2)} \frac{I}{r}$

C. $\frac{\mu_o \, a^2}{2\pi \; b^2 - r^2} \frac{I}{r}$

D. $\frac{\mu_o \, b^2}{2\pi \; r^2 - a^2} \frac{I}{r}$

Reading Assignment:

Halliday and Resnick: Ch. 34, Sect. 2

SEGMENT 35

AI [illegible] LAW

Problem 10: The Force Between Parallel Current-Carrying Wires

10. Two long wires carrying parallel currents of 2.7 and 5.0 amp, respectively, in the same direction are separated by a distance of 3.0 cm. What is the force per unit length of each wire on the other?

A. 9.0×10^{-5} nt/m, attractive

B. 9.0×10^{-5} nt/m, repulsive

C. 9.0×10^{-7} nt/m, attractive

D. 9.0×10^{-7} nt/m, repulsive

Reading Assignment:

Halliday and Resnick:	Ch. 34, Sect. 4
Semat and Blumenthal:	Vol. 3, Ch. 25, Fr. 26-28
Joseph and Leahy:	Part II, Ch. 4, Sect. 4, Fr. 19-26

Related Problems:

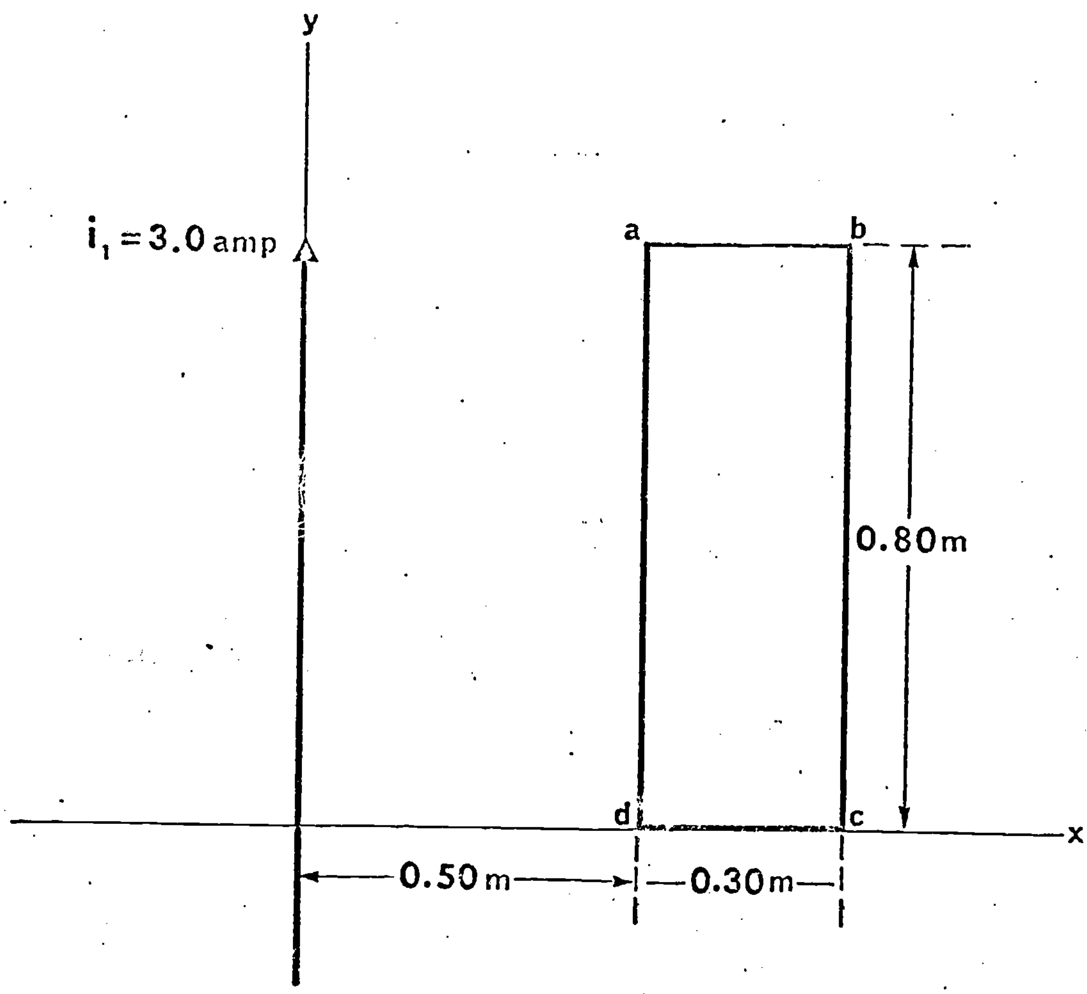
Schaum:	Ch. 27, Nos. 7,8

SEGMENT 35

AMPERE'S LAW

Problem 15: The Force Between a Rectangular Loop and a Long Wire

15. A clockwise current $i_2 = 2.0$ amp is set up in the rectangular loop in the accompanying diagram. What is the net force on the loop due to the magnetic field produced by i_1?



Reading Assignment:

Halliday and Resnick:	Ch. 34, Sect. 4
Semat and Blumenthal:	Vol 3, Ch. 25, Fr. 26-28
Joseph and Leahy:	Part II, Ch. 4, Sect. 4, Fr. 38-46

Related Problems:

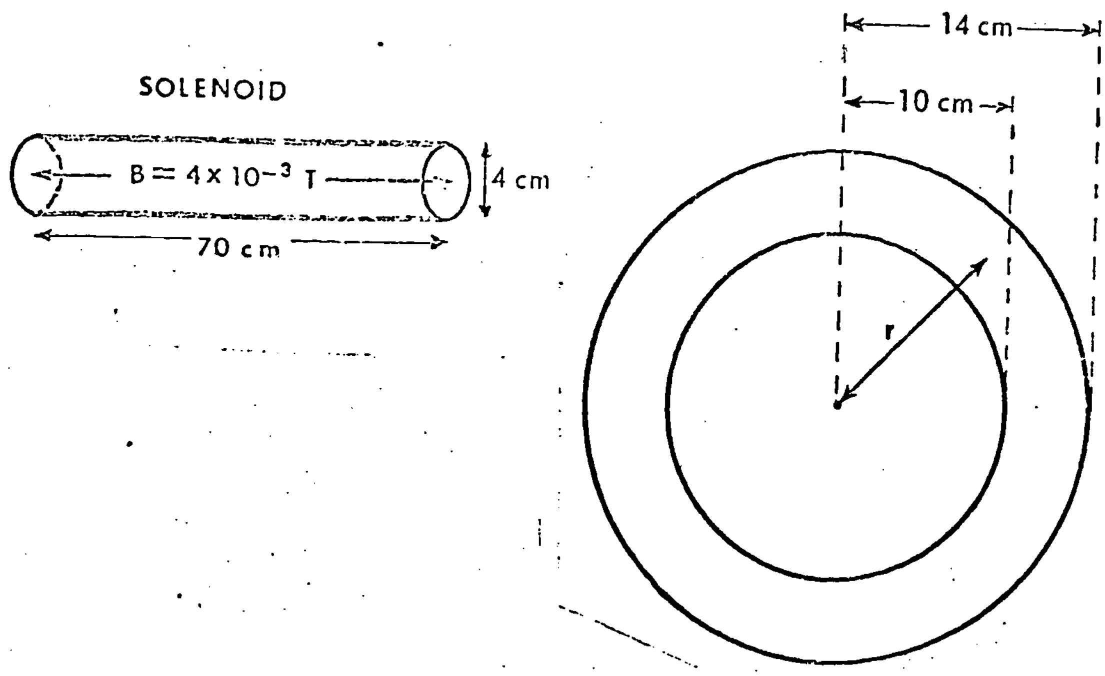
Schaum:	Ch. 27, Nos. 7,8

SEGMENT 36

THE BIOT-SAVART LAW

Problem 1: Magnetic Field of a Toroid

1. A flexible solenoid of length 70 cm and diameter 4 cm is bent into a toroid (the shape of a doughnut) which has inner and outer radii of 10 cm and 14 cm respectively. If the solenoid produces a uniform magnetic field of $B = 4 \times 10^{-3}$ T, what is the value of B inside the toroid at a distance r = 11 cm as shown in the diagram?



Reading Assignment:

Halliday and Resnick: Ch. 34, Sect. 5

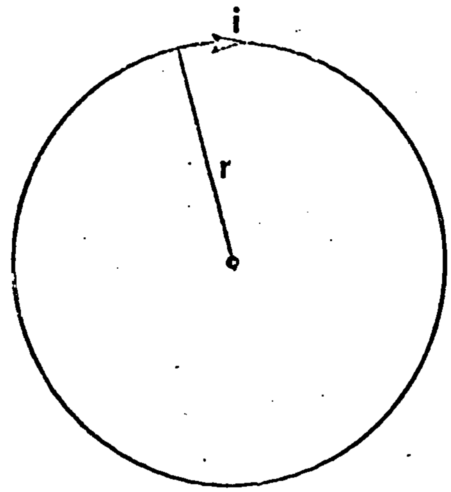
Sears and Zemansky: Ch. 32, Sect. 6

SEGMENT 36

THE BIOT-SAVART LAW

Problem 6: Magnetic Field at the Center of a Circular Current Loop

6. A wire in the form of circle of radius r carries a current i as shown in the diagram. The expression for the magnitude of the magnetic field at its center is



A. $B = \frac{\mu_o i}{2\pi r}$

B. $B = \frac{\mu_o i}{2r}$

C. $B = \frac{\mu_o i}{2r^2}$

D. $B = \frac{\mu_o i}{4\pi r^2}$

Reading Assignment:

Halliday and Resnick:	Ch. 34, Sect. 6
Semat and Blumenthal:	Vol. 3, Ch. 25, Fr. 7-9, 11, 19
Joseph and Leahy:	Part II, Ch. 4, Sect. 4, Fr. 27-37

Related Problems:

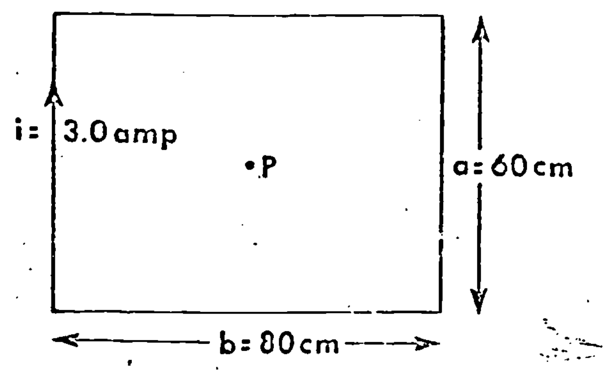
Schaum:	Ch. 27, Nos. 2,4

SEGMENT 36

THE BIOT-SAVART LAW

Problem 10: Magnetic Field at the Center of a Rectangular Current Loop

10. A rectangular loop having dimensions 60 cm × 80 cm carries a current of 3.0 amp in the clockwise sense. Find the magnetic induction at the center of the loop.



A. Zero

B. 9.0×10^{-7} T into the paper

C. 1.6×10^{-6} T into the paper

D. 5.0×10^{-6} T into the paper

Reading Assignment:

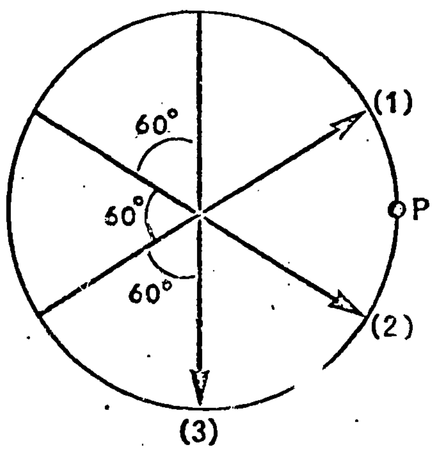
Halliday and Resnick: Ch. 34, Sect. 6

Sears and Zemansky: Ch. 32, Sect. 1,2

THE BIOT-SAVART LAW

Problem 15: Magnetic Field Due to Three Current-Carrying Wires

15. Three 10-m insulated wires, each carrying a current of 2.0 amp intersect at their midpoints making angles of 60° with respect to each other as shown in the diagram. Find the $\vec{B}$ field at point P due to the three conductors.



A. 2.8×10^{-8} T into plane of paper

B. 5.6×10^{-8} T into plane of paper

C. 2.8×10^{-8} T out of plane of paper

D. 5.6×10^{-8} T out of plane of paper

Reading Assignment:

Halliday and Resnick: Ch. 34, Sect. 6

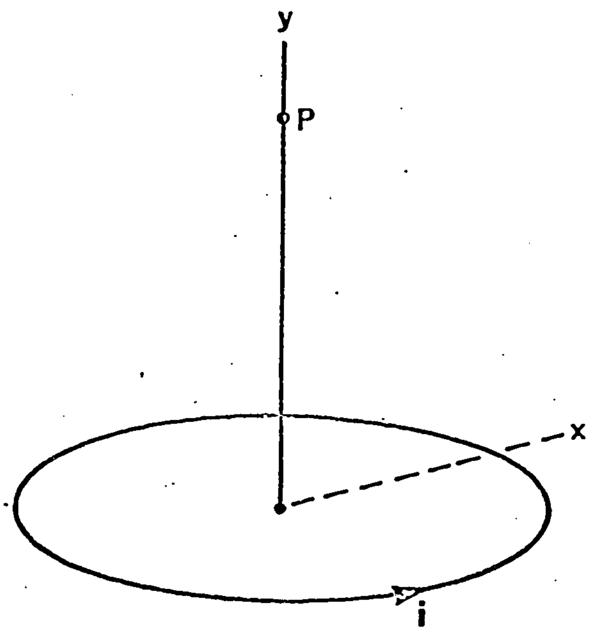
Sears and Zemansky: Ch. 32, Sect. 1, 2

SEGMENT 36

THE BIOT-SAVART LAW

Problem 16: Magnetic Field on the Axis of a Circular Current Loop

16. A circular loop of radius a is carrying a current i. What is the magnetic field $\vec{B}$ for points on the axis?



A. $\dfrac{\mu_0 i a^2}{2(a^2 + y^2)^{3/2}} \hat{j}$

B. $\dfrac{\mu_0 i}{2(a^2 + y^2)} \hat{j}$

C. $-\dfrac{\mu_0 i}{2(a^2 + y^2)} \hat{j}$

D. $\dfrac{\mu_0 i}{2y} \hat{j}$

Reading Assignment:

Halliday and Resnick:	Ch. 34, Sect. 6
Sears and Zemansky:	Ch. 32, Sect. 4

Related Problems:

Schaum:	Ch. 27, No. 11

SEGMENT 37

FARADAY'S LAW OF INDUCTION

Problem 1: Induced emf

1. A flat coil of 50 turns is placed perpendicularly to a uniform magnetic field $B = 2.0$ T. The coil is collapsed so that the area is reduced with a constant rate of 0.1 m^2/sec. What is the emf developed in the coil?

Reading Assignment:

Halliday and Resnick:	Ch. 35, Sect. 1,2
Semat and Blumenthal:	Vol. 3, Ch. 26, Fr. 1-7
Joseph and Leahy:	Part II, Ch. 5, Sect. 1, Fr. 1-42; Sect. 3, Fr. 1-32

Related Problems:

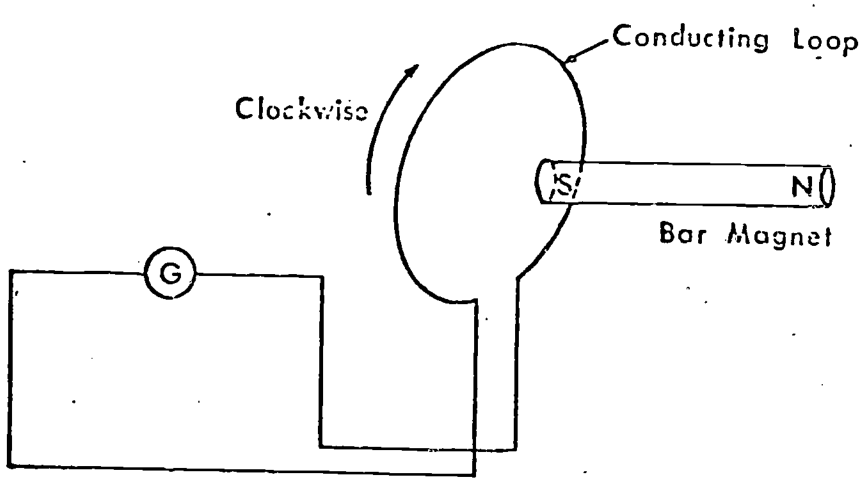
Schaum:	Ch. 30, No. 2

SEGMENT 37

FARADAY'S LAW OF INDUCTION

Problem 6: Induced Current

6. As shown in the diagram, the loop is moved away from the magnet with a speed v. Next, the loop is replaced by a coil of N turns of identical wire and wound closely so that it occupies approximately the same space as the original loop. If this coil is moved away from the magnet exactly in the same manner as the single loop and with the same speed v, the *current* in the N-turn coil as compared to that in the single loop will be



A. unchanged

B. N times as large

C. N times less

D. N^2 times as large

Reading Assignment:

Halliday and Resnick: Ch. 35, Sect. 1,2
Semat and Blumenthal: Vol 3, Ch. 26, Fr. 1-7
Joseph and Leahy: Part II, Ch. 5, Sect. 1, Fr. 1-42

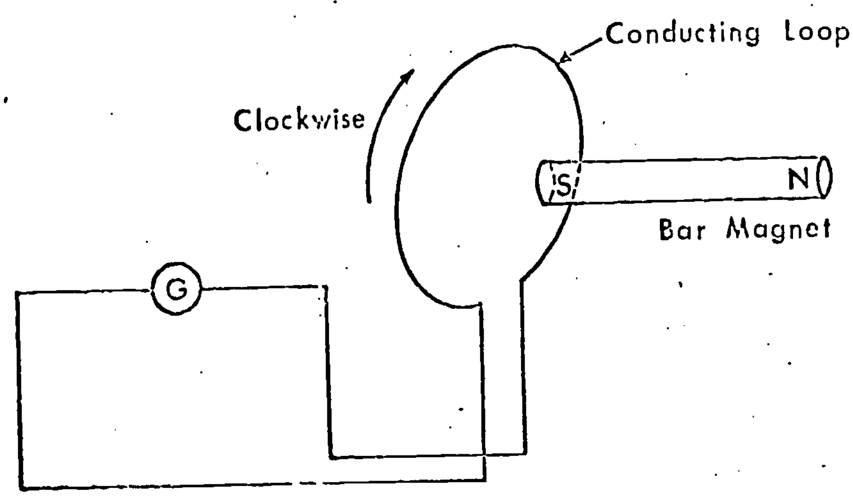
Related Problems:

Schaum: Ch. 30, No. 5

FARADAY'S LAW OF INDUCTION

Problem 10: Lenz's Law

10. If the south pole of the magnet in the diagram is moving toward the loop (toward the left), the current in the loop is (the magnet is parallel to the axis of the loop)



A. clockwise

B. counterclockwise

C. zero

D. decreasing in the counterclockwise direction

Reading Assignment:

Halliday and Resnick:	Ch. 35, Sect. 3
Semat and Blumenthal:	Vol. 3, Ch. 26, Fr. 8-10
Joseph and Leahy:	Part II, Ch. 5, Sect. 2, Fr. 1-30

SEGMENT 37

FARADAY'S LAW OF INDUCTION

Problem 14: Direction of Induced emf

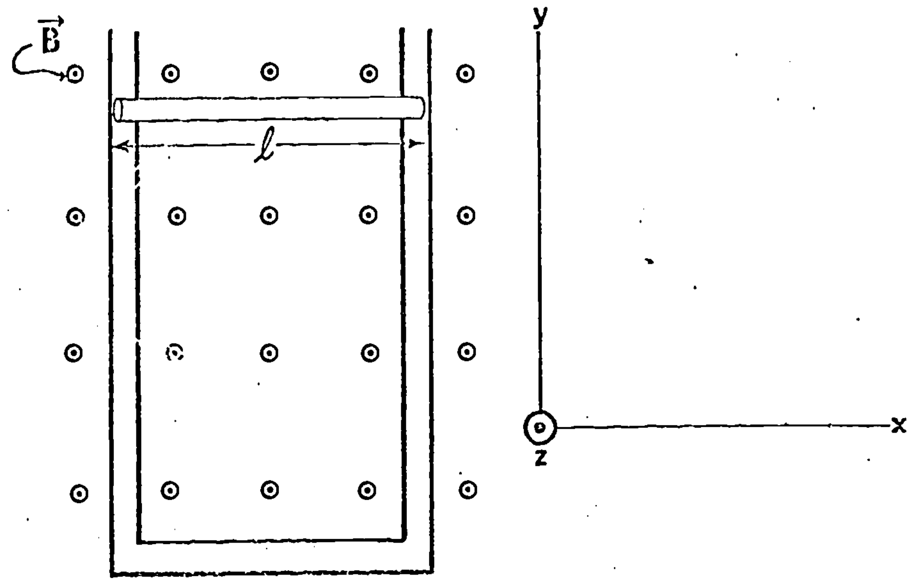
14. A wire of length ℓ, mass m and resistance R slides without friction vertically downward along parallel conducting rails of negligible resistance as shown in the diagram. The rails are connected to each other at the bottom by a conductor of negligible resistance. The wire and the rails form a closed rectangular conducting loop. A uniform magnetic field $\vec{B}$ pointing in the +Z direction (out of the plane of paper) exists throughout the region. The steady state speed of the wire is

A. zero

B. $\frac{mg\ell}{R^2B^2}$

C. $\frac{mg\ell}{2R^2B^2}$

D. $\frac{mgR}{\ell^2B^2}$



Reading Assignment:

Halliday and Resnick: Ch. 35, Sect. 4

Semat and Blumenthal: Vol. 3, Ch. 26, Fr. 11-15

Joseph and Leahy: Part II, Ch. 5, Sect. 2, Fr. 1-30

Related Problems:

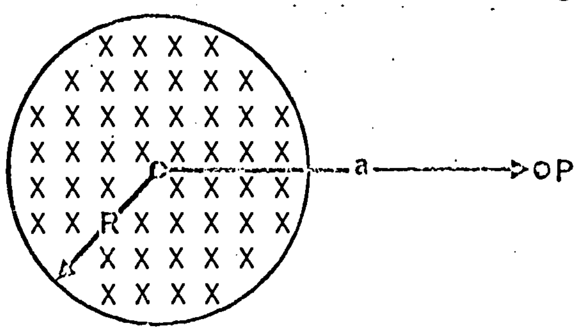
Schaum: Ch. 30, No. 1

SEGMENT 38

SELF INDUCTANCE

Problem 1: Time-Varying Magnetic Fields

1. The figure below shows a uniform magnetic field $\vec{B}$ confined in a region of cylindrical volume of radius R = 10 cm. The $\vec{B}$ field is decreasing in magnitude at a constant rate of 2×10^{-2} T/sec. Find the magnitude of the instantaneous acceleration in meters per second per second of an electron placed at point P a distance a = 20 cm from the center of the cylindrical symmetry. (Neglect the fringing effect of the $\vec{B}$ field beyond R.)



Reading Assignment:

Halliday and Resnick: Ch. 35, Sect. 5

Joseph and Leahy: Part II, Ch. 5, Sect. 3, Fr. 28-46

SEGMENT 38

SELF INDUCTANCE

Problem 6: Self Inductance of a Toroid

6. A coreless, closely wound toroidal coil carries current i and has an outside radius b, inner radius a, and N turns. Assuming that the magnetic field B inside the coil is $\mu_o Ni/(\pi a + \pi b)$, find the self-inductance.

A. $(1/4)\ \mu_o N\ (b - a)^2/(b + a)$

B. $(1/4)\ \mu_o N^2\ (b - a)^2/(b + a)$

C. $\mu_o N b^2/(b + a)$

D. $\mu_o N^2 b^2/(b + a)$

Reading Assignment:

Halliday and Resnick:	Ch. 36, Sect. 1,2
Semat and Blumenthal:	Vol. 3, Ch. 26, Fr. 29-33
Sears and Zemansky:	Ch. 33, Sect. 10

Related Problems:

Schaum:	Ch. 31, No. 1

SEGMENT 38

SELF INDUCTANCE

Problem 11: The Power Delivered to an Inductor

11. An emf is applied to a device with a self inductance L and a resistance R causing the current to increase. The power delivered, εi, is equal to

A. $i^2R - Li\, di/dt$

B. $Li\, di/dt$

C. $i^2R + Li\, di/dt$

D. $-Li\, di/dt$

Reading Assignment:

Halliday and Resnick: Ch. 36, Sect. 4

SEGMENT 38

SELF INDUCTANCE

Problem 18: Energy Stored in an Inductor

18. An inductor with inductance L = 5 millihenrys is connected in a series circuit with an open switch. When the switch is closed, the current in the circuit builds up from zero to a steady state current of 2 amp. Calculate the energy in joules stored in the inductor.

Reading Assignment:

Halliday and Resnick:	Ch. 36, Sect. 4
Semat and Blumenthal:	Vol. 3, Ch. 26, Fr. 34-35
Sears and Zemansky:	Ch. 33, Sect. 11

Related Problems:

Schaum:	Ch. 31, No. 1

SEGMENT 38

SELF INDUCTANCE

Problem 22: Energy Density

22. A long coaxial cable consists of two concentric cylinders with radii a and b. Its central conductor carries a steady current i, the outer conductor providing the return path. What is the energy stored in the magnetic field for a length ℓ of such a cable? You may assume that the energy is stored in the space between the conductors.

A. $\dfrac{\mu_o i^2}{8\pi^2 r^2}$

B. $\dfrac{\mu_o i^2 \ell}{4\pi} \ln (b/a)$

C. $\dfrac{\mu_o i^2 \ell}{4\pi} \left(\dfrac{1}{a} - \dfrac{1}{b}\right)$

D. $\dfrac{\mu_o i^2 \ell}{4\pi} (b - a)$

Reading Assignment:

Halliday and Resnick: Ch. 36, Sect. 5

SEGMENT 39

THE RC CIRCUIT

Problem 1: The Variation of Current in an RC Charging Circuit

1. A 3.0 megohm resistor and a 1.0 microfarad capacitor are connected in series with a seat of emf of $\varepsilon = 6.0$ volts. At 3.0 sec after the connection is made, what is the rate at which the charge on the capacitor is increasing (in amps)?

Reading Assignment:

Halliday and Resnick:	Ch. 32, Sect. 8
Sears and Zemansky:	Ch. 29, Sect. 7

SEGMENT 39

THE RC CIRCUIT

Problem 7: The Time Constant in an RC Charging Circuit

7. In Figure 1 of the preceding Information Panel, the current in an RC circuit is plotted against the time. Using this graph, determine the approximate value of the RC time constant.

A. 1 millisecond

B. 2 milliseconds

C. 5 milliseconds

D. 10 milliseconds

Reading Assignment:

Halliday and Resnick:	Ch. 32, Sect. 8
Sears and Zemansky:	Ch. 29, Sect. 7

SEGMENT 39

THE RC CIRCUIT

Problem 10: The RC Discharge Process

10. A 60-ohm resistor and a 2.1-microfarad capacitor are connected in series with a seat of emf equal to 5.3 volts. After 1 minute, the seat of emf is removed and the capacitor is allowed to discharge. What is the magnitude of the current immediately after the capacitor starts to discharge?

Reading Assignment:

Halliday and Resnick:	Ch. 32, Sect. 8
Sears and Zemansky:	Ch. 29, Sect. 7

SEGMENT 39

THE RC CIRCUIT

Problem 15: Work Done in Charging a Capacitor Through a Resistor

15. An uncharged 10-microfarad capacitor is charged by a constant emf through a 100-ohm resistor to a potential difference of 50 volts. What is the total work done?

Reading Assignment:

Halliday and Resnick: Ch. 32, Sect. 8

Reread the Information Panel on this Problem.

SEGMENT 40

THE LR CIRCUIT

Problem 1: The LR Time Constant

1. It is found that the time constant for the decay of current through a certain coil is halved when a 10-ohm resistor is added in series with the coil. Furthermore, when a pure inductance of 30 millihenrys is added in series with the original coil and the series resistor, the time constant is the same as that for the coil alone. What is the coil's internal resistance?

Reading Assignment:

Halliday and Resnick:	Ch. 36, Sect. 3
Sears and Zemansky:	Ch. 33, Sect. 12

SEGMENT 40

THE LR CIRCUIT

Problem 7: Current Growth in an LR Circuit

7. A coil having an inductance of 4 millihenrys and a resistance of 10 ohms is connected to a battery with an emf of 12 volts and internal resistance of 2 ohms. How long must one wait after the switch is closed before the current is 90% of its equilibrium value?

Reading Assignment:

Halliday and Resnick:	Ch. 36, Sect. 3
Sears and Zemansky:	Ch. 33, Sect. 12

SEGM[illegible]

THE LR CIRCUIT

Problem 11: Current Decay in an LR Circuit

11. A 20-ohm resistor and a 2-henry inductor are connected in series with a seat of emf equal to 5 volts. After equilibrium is reached, the seat of emf is removed and the inductor is allowed to discharge its stored energy through the resistor. Find the time when the current through the circuit is 50 percent of the equilibrium current.

Reading Assignment:

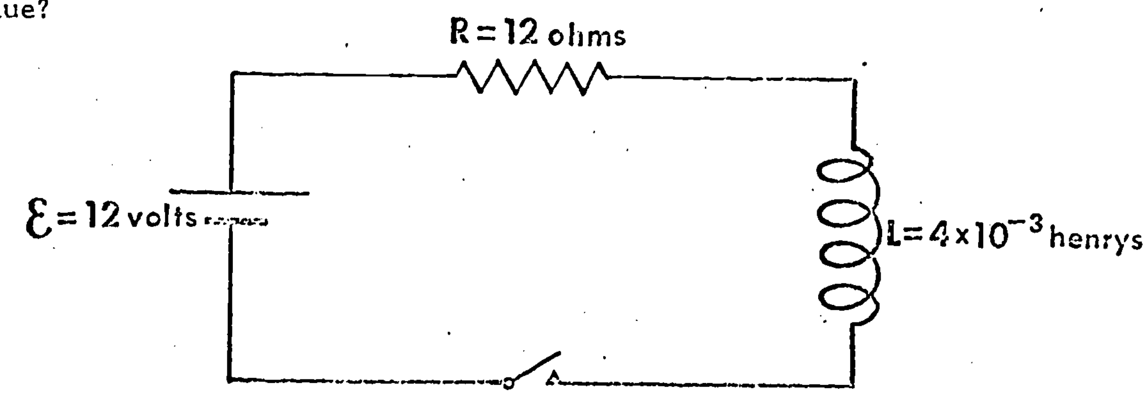
Halliday and Resnick:	Ch. 36, Sect. 3
Sears and Zemansky:	Ch. 33, Sect. 12

SEGMENT 40

THE LR CIRCUIT

Problem 15: Energy Stored in an LR Circuit

15. In the circuit shown below, how long must one wait after the switch is closed before the energy stored in the inductor is 90% of its equilibrium value?



Reading Assignment:

Halliday and Resnick: Ch. 36, Sect. 3,4

Sears and Zemansky: Ch. 33, Sect. 11, 12