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ABSTRACT

As a supplement to the principal reports of the U. S. Naval Academy Self-Paced Physics (ED 062 123 - ED 062 125), the course objectives, structure, and sequence are discussed in this document to provide an overview of the program's development and operation. Following a description of goals, characteristics, content, systems approach, media components, testing, remedials, and laboratories, the objective statements are first presented in the form of core problems to avoid ambiguity in the verbal explanation of level, scope, complexity, emphasis, and assessment measures. Criteria for subject matter sequencing are then given in groups of inclusion and student difficulty. Included are 179 core problem sheets with references to pertinent auxiliary material and a chart of broad subject matter constrained sequences. (Related documents are SE 016 065 - SE 016 088 and ED 062 123 - ED 062 125.) (CC)

Set #3

DOCUMENTATION REPORT

UNITED STATES NAVAL ACADEMY

Self-Paced

PHYSICS

This document is a supplement to the principal reports 5.10, 5.9, and 5.8, developed and produced under the U. S. Office of Education, Bureau of Research Project #8-0446, for the U. S. Naval Academy at Annapolis, Maryland. Contract #N00600-68C-0749.

5.1 COURSE DESCRIPTION

5.2.1 COURSE OBJECTIVES

5.2.2 COURSE STRUCTURE AND SEQUENCE

I COURSE DESCRIPTION

A foreward to put the course in perspective.

A systems approach was applied to the development of a multimedia computer managed course in college physics for the U.S. Naval Academy. This is a brief description of that course.

Goals

Several purposes are served by the program's development and operation. The Academy is provided with a cost-effective physics course designed with the most modern educational technology. The experience garnered in the construction of the program is incorporated into a course development model to serve as a prototype for construction of similar programs in other hard science courses. Extensive record keeping capabilities of the program allow it to serve as a vehicle for educational research.

Characteristics

The course is individualized, self-paced, and self-healing. By offering media options and optional routes through the learning materials each student's learning experience is individualized. Likewise, within broad time constraints, the student can progress through these materials at his own pace.

The self-healing aspect of the program pertains to learning materials and processes. These are improved by an iterative process of successive tryouts and revisions. In this way, the program undergoes an empirical optimization procedure.

Content

Most standard topics in introductory classical physics are included in the two semester course: mechanics, wave phenomena, electricity, magnetism, and optics. One unusual feature is the omission of heat and thermodynamics in favor of more intensive developments in mechanics and optics to suit the Academy's particular needs. The subject matter is loosely defined as university physics with calculus at the level of Halliday and Resnick.

Systems Approach

Optimization of the program must be attained empirically, since no satisfactory predictive theory of educational psychology is known. This situation is well suited to a systems approach when the output of the system can be fed back to modify the system input.

Behavioral Objectives

This approach requires that the course objectives are clearly defined and measurable so that the output of the system is quantitative. Consequently, over a thousand measurable behavioral objectives (MBOs) were developed to completely specify the performance which the program should elicit. MBOs fall into two categories: terminal objectives (TOs) which describe the desired final student behavior, and the subordinate enabling objectives (EOs) which are steps toward the terminal behavior.

The TOs constitute a complete description of course content and are represented in the course by central *core* problems. When a student can answer a core problem correctly, he is said to have achieved that TO. In this way a student knows exactly what is expected of him as to content and level of proficiency.

When a student cannot answer a core problem after a single exposure, he can execute subordinate *enabling* problems which correspond to the EOs. At the end of an enabling sequence, the student is presented with another version of the core problem to check his achievement of the TO. All these problems are contained in the *Problem and Solution Book* volumes.

Media Components

Videotape presentations are available for forty-nine topics. These tapes average about fifteen minutes apiece. Illustrated texts and talking books (taped voice-over illustrations in book form) are available with essentially the same information content as the video tapes. (Computer-assisted instruction (CAI) was initially included as a parallel path for topics in mechanics, primarily to be compared with the other options for cost effectiveness, and was deleted as a learning option in the final revision.) Conventional physics texts are also included among the available learning materials.

Testing

Each student is provided with a *study guide* which directs him through the problem books and various media assignments. When the student completes a specified assignment (roughly approximated by a chapter in Halliday and Resnick), he schedules a *progress check* (test) on the material. This criterion check does not influence his grade but is used for management and remediation purposes. Grades are determined by quarterly tests and final examinations for each semester.

Remedials

Minor remediation is accomplished by distributing a *remedial sheet* associated with each problem missed on the progress check. These sheets have a statement of the appropriate core problem together with references to pertinent auxiliary material. More serious remediation is provided by individual tutorial sessions with a professor.

Laboratories

The laboratories have as their objectives the measurement of fundamental physical quantities, including the processing and recording of this data with an error analysis. An innovative aspect of the data analysis is that a dialogue may be established between the student and the computer which would culminate in the student's achievement of the objective. This computer-dialogue laboratory format is not an essential element of the multi-media learning materials, and in the current implementation the Navy Physics staff is using a conventional laboratory experience for the self-paced course.

C O U R S E   O B J E C T I V E S

Abstract: Each objective is represented by a problem so that level, scope, and assessment measures are described in an unambiguous form.

COURSE OBJECTIVES

The behavorial objectives of this course are now defined in unambiguous problem form.

Verbal statements of objectives (see Revised Listing of Objectives, presented as APPENDIX 1) were often found to be imprecise as to level, scope, complexity, emphasis and assessment measures.

Elasticity in objective statements is certainly undesirable, but it did not seriously impede the course writers who had long experience in teaching this course. However, these individuals would probably be adequately guided by little more than a table of contents. Ambiguities can obviously become serious for professors with less specific classroom experience regardless of their scientific expertise and teaching skills. Students are probably most confused by ill-defined terminal objectives since they have virtually no background and experience with which to assess an objective's level and scope.

Formulating objectives in problem form overcomes these difficulties. The emphasis of a problem is manifest in the statement and, of course, a problem solution is used to assess the criterion achievement. When a student is exposed to an objective in problem form, he knows exactly what is expected of him as to content, level, and complexity.

Writing from verbal objectives revealed another more serious, though less obvious, hazard. Enabling objectives are clearly discerned by the objectives writer only when he executes the behavior called for in the terminal objective. Each necessary step toward terminal behavior is then, by definition, an enabling objective. When a terminal objective is "fuzzy" the requisite steps for its achievement are even less clear. Our experience, as revealed in the Revision Process Documentation, has been that this situation leads to a number of redundant enabling problems, poor ordering of enabling problems under a terminal objective, and a few omissions of enabling objectives.

Again, formulating the objectives in problem form eliminated these difficulties. With a precise problem to represent a terminal objective, any subject matter expert can perform the steps for its solution and identify the individual steps as enabling objectives.

Only terminal objectives or core problems are listed in this document. They constitute a well-defined description of the course content. The subordinate enabling problems are included in the Problem Solution Books with their associated core problems so a complete listing of objectives is the content of the Problem Solution Books.

Assignments are listed below each problem statement. These are for students' remedial study, and they appear in the document only because it was expedient to use the existing remedial sheets for a dual purpose.

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10: Newton's Second Law in Terms of Momentum

13: Conservation of Momentum

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5: Impulse and Momentum

11: Conservation of Linear Momentum

15: Inelastic Collision in One Dimension

18: Elastic Collision in One Dimension

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14: Inelastic Collision in Two Dimensions

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LIST OF TITLES

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23: Electric Field Between Two Charged Sheets

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IV: Unknown Resistance in Simple Circuit

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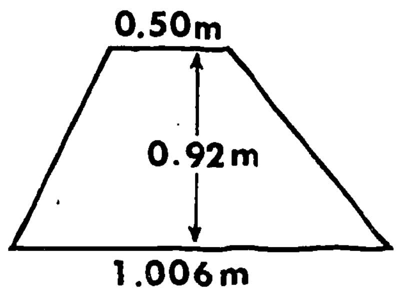
VI: Multiloop Circuits

SEGMENT 1

MEASUREMENT AND VECTORS

Problem 1: Significant Digits

1.



The dimensions of the trapezoid shown in the figure were measured with different instruments. The area of the trapezoid should be written as:

- A. 0.69276 m^2
- B. 0.69 m^2
- C. 0.6946 m^2
- D. 0.7 m^2

Reading Assignment:

Review the Information Panel on significant digits in the P. & S. for Segment 1.

SEGMENT 1

MEASUREMENT AND VECTORS

Problem 6: Addition of Vectors

6. A plane travels 40 miles due north, then changes its course to a direction of 37° east of north and travels for 50 miles. Finally it travels for 30 miles due east. Its total displacement is:

A. 100 miles
B. 120 miles
C. 100 miles at 37° east of north
D. 120 miles at 37° east of north

Reading Assignment:

Halliday and Resnick:	Ch. 2, Sec. 1-3
Semat and Blumenthal:	Vol. I, Ch. 2, Pr 11-18, 36-40

Related Problems:

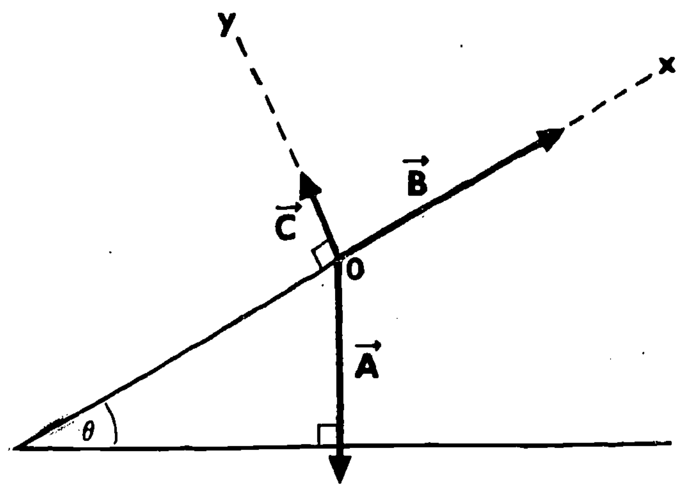
Schaum:	Ch. 1, Nos. 1, 2, 14

SEGMENT 1

MEASUREMENT AND VECTORS

Problem 10: Resolution of Vectors

10.



Find the components R_x and R_y of the vector $\vec{R}$, where vector $\vec{R}$ is the resultant (sum) of the vectors $\vec{A}$, $\vec{B}$, and $\vec{C}$. Use the coordinate system indicated.

A. $R_x = A \sin\theta$ $R_y = A \cos\theta$

B. $R_x = B \cos\theta$ $R_y = A \sin\theta$

C. $R_x = B - A \sin\theta$ $R_y = C - A \cos\theta$

D. $R_x = C - B \cos\theta$ $R_y = A - B \sin\theta$

Reading Assignment:

Halliday and Resnick: Ch. 2, Sect. 3

Semat and Blumenthal: Vol. I, Ch. 2, Pr 34-36

Related Problems:

Schaum: Ch. 1, Nos. 10, 11, 14

SEGMENT 1

MEASUREMENT AND VECTORS

Problem 13: Dimensional Checking

13. A car moving at a constant rate R covers a distance D during a time interval T. Its rate can be expressed in

A. Ft-min
B. sec per ft
C. yd per hr
D. mi-hr.

Reading Assignment:

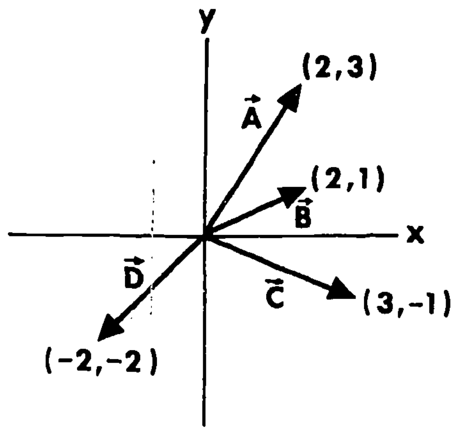
Halliday and Resnick: Ch. 3, Sect. 9

SEGMENT 2

VECTOR MULTIPLICATION AND VELOCITY

Problem 1: Dot (Scalar) Product

1.



Four vectors $\vec{A}$, $\vec{B}$, $\vec{C}$ and $\vec{D}$ are shown in the figure. The dot product $(\vec{A} + \vec{B})\cdot(\vec{C} - \vec{D})$ is equal to:

A. 16
B. 24
C. -8
D. -24

Reading Assignment:

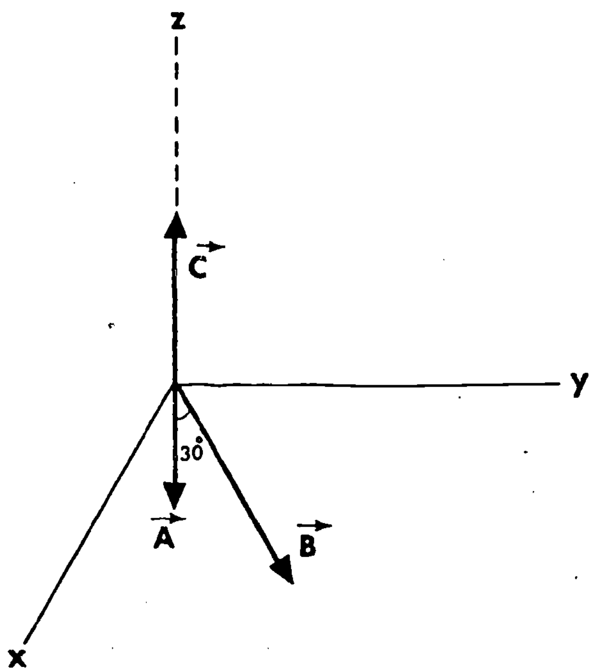
Halliday and Resnick: Ch. 2, Sect. 4

SEGMENT 2

VECTOR MULTIPLICATION AND VELOCITY

Problem 6: Cross (Vector) Product

6.



Two vectors $\vec{A}$ and $\vec{B}$ are in the xy-plane. The magnitude of $\vec{A}$ is one unit and that of $\vec{B}$ is two units. $\vec{C}$ is another vector which is along the positive z-axis. Find the product $(\vec{A}\times\vec{B})\cdot\vec{C}$.

Reading Assignment:

Halliday and Resnick: Ch. 2, Sect. 4

SEGMENT 2

VECTOR MULTIPLICATION AND VELOCITY

Problem 10: Average Speed and Average Velocity

10. A student drives due east at 80 mi/hr for one hour, then drives at 60 mi/hr for another hour due north, and then returns to the starting point with a speed of 50 mi/hr. His average velocity ($\vec{v}$) and average speed (v) over the entire journey are:

A. 0, 60 mi/hr
B. 0, 0
C. 30 mi/hr, 30 mi/hr
D. 60 mi/hr, 0

Reading Assignment:

Halliday and Resnick:	Ch. 3, Sect. 3, 4
Semat and Blumenthal:	Vol I, Ch. 3, Fr 2-6, 17
Joseph and Leahy:	Part I, Ch. 2, Sect. 5, Fr 14-46

SEGMENT 2

VECTOR MULTIPLICATION AND VELOCITY

Problem 14: Instantaneous Velocity

14. A particle moves in one dimension. Its position is described by the equation

$$x = \alpha(2t-t^2) + \beta t^3$$

where α and β are constants. Given that the particle's position changes from $x = 3$ m at $t = 1$ sec to $x = 16$ m at $t = 2$ sec, the magnitude of the particle's velocity in m/sec at $t = 3$ sec is:

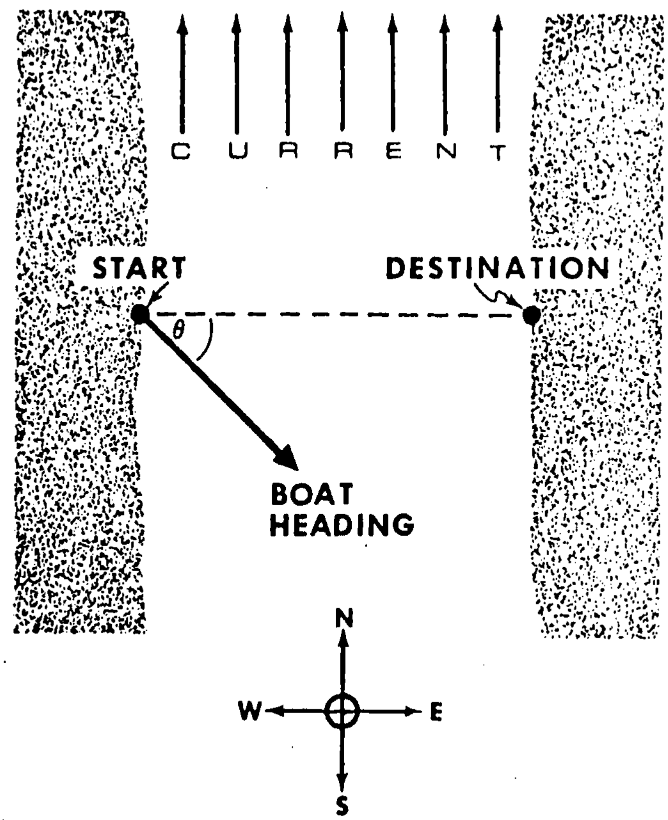
Reading Assignment:

Halliday and Resnick:	Ch. 3, Sect. 4, 5
Semat and Blumenthal:	Vol. I, Ch. 3, Fr 16-17
Joseph and Leahy:	Part I, Ch. 2, Sec. 5, Fr 14-55

VECTOR MULTIPLICATION AND VELOCITY

Problem 17: Relative Velocity

17. A boat travels at the speed of 8 mi/hr relative to the water on a 1.5 mile wide river which flows due north at 10 mi/hr. A man starting from a point on the west bank wishes to reach the east bank at a point directly opposite to his point of start. Since the boat can not travel as fast as the stream, it is incapable of landing at the destination point; consequently the man must land downstream and run back. He runs at the rate of 6 mi/hr. Find the angle θ at which the man must head his boat to reach his destination in minimum time.



Reading Assignment:

Halliday and Resnick: Ch. 3, Sect. 4; Ch. 4, Sect. 6

Semat and Blumenthal: Vol. I, Ch. 3, Fr 7-15

SEGMENT 3

MOTION IN ONE AND TWO DIMENSIONS

Problem 1: Motion in a Vertical Direction

1. A rocket ascends with an effective, resultant constant acceleration of 64 ft/sec^2. Five seconds after lift-off, however, its engine shuts off. What is the highest altitude it reaches?

Reading Assignment:

Halliday and Resnick:	Ch. 3, Sect. 8, 10, 11
Semat and Blumenthal:	Vol. I, Ch. 3, Fr 29-36
Joseph and Leahy:	Part I, Ch. 2, Sect. 8, Fr 1-8, 25-34

Related Problems:

Schaum:	Ch. 4, Nos. 7, 8, 11, 12

SEGMENT 3

MOTION IN ONE AND TWO DIMENSIONS

Problem 6: Motion in a Vertical Direction

6. A batted baseball leaves the bat in a vertical upward direction. At the time of contact the bat was 5.0 ft above the ground. Four (4.0) seconds later the ball lands on the plate. What is the highest point above the ground that the ball reached?

Reading Assignment:

Halliday and Resnick:	Ch. 3, Sect. 8, 10, 11
Semat and Blumenthal:	Vol. I, Ch. 3, Fr 29-36
Joseph and Leahy:	Part I, Ch. 2, Sect. 8, Fr 1-8, 25-34

Related Problems:

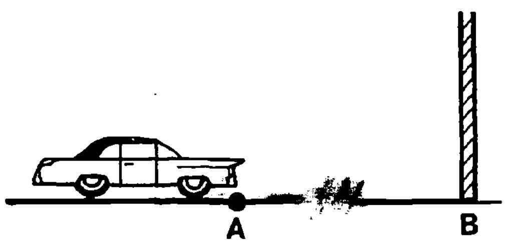
Schaum:	Ch. 4, Ncs. 11, 12

SEGMENT 3

ON IN ONE AND TWO DIMENSIONS

Motion in a Horizontal Direction

9.



The distance between point A and wall B is 3000 ft. A car can develop a maximum acceleration of 15 ft/sec^2. The maximum deceleration that the brakes can provide is 30 ft/sec^2. The driver of the car wants to reach the wall B in the shortest possible time, starting from rest at point A. He uses the full accelerating capacity of the car. What is the shortest distance from B at which he must apply the brakes if he is to avoid crashing into the wall?

Reading Assignment:

Halliday and Resnick:	Ch. 3, Sect. 8
Semat and Blumenthal:	Vol. I, Ch. 3, Fr 26-28
Joseph and Leahy:	Part I, Ch. 2, Sect. 8, Fr 9-24, 39-45

Related Problems:

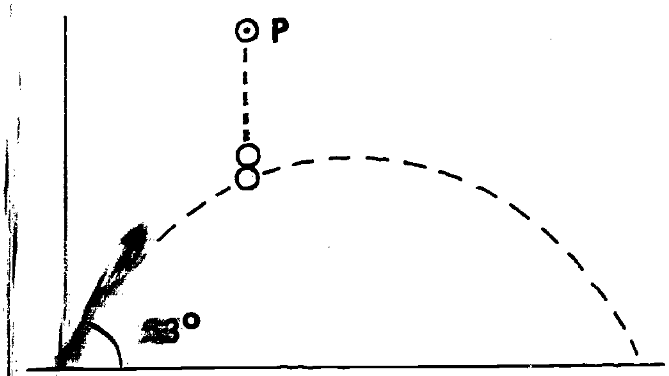
Schaum:	Ch. 4, Nos. 1, 2, 5, 6

SEGMENT 3

MOTION IN ONE AND TWO DIMENSIONS

Problem 12: Projectile Motion

[illegible] A ball is shot from the origin with an initial velocity of [illegible] m/sec at 53° above the horizontal. At the same instant, a second ball is released from a point P shown in the figure. In one second (1 sec), the two balls collide in mid-air. What is the altitude of the point P? (HINT: Consider the two balls as point particles.)



A. 5.6 m
B. 20 m
C. 14 m
D. 10 m

Reading Assignment:

Halliday and Resnick:	Ch. 4, Sect. 1-3
[illegible] and Blumenthal:	Vol. I, Ch. 3, Fr 37-50
Joseph and Leahy:	Part I, Ch. 4, Sect. 5, Fr 1-21; Sect. 6, Fr 5-11

Related Problems:

[illegible]	Ch. 4, Nos. 17, 18

SEGMENT 3

MOTION IN ONE AND TWO DIMENSIONS

Problem 18: Projectile Motion

18. A cannon can project a shell with initial speed of 5000 ft/sec. Assume that the shell leaves the cannon at ground level, and that air resistance may be neglected. Find the maximum range of the cannon in miles.

Reading Assignment:

Halliday and Resnick:	Ch. 4, Sect. 1-3
Semat and Blumenthal:	Vol. I, Ch. 3, Fr 51
Joseph and Leahy:	Part I, Ch. 4, Sect. 5 Fr 1-21; Sect. 6, Fr 5-11

Related Problems:

Schaum:	Ch. 4, Nos. 18, 19

SEGMENT 4

NEWTON'S LAWS OF MOTION

Problem 1: Newton's First Law

> 1. A body must be in translational equilibrium if
>
> A. it is acted upon by a constant force
> B. it has a constant velocity
> C. it has a constant acceleration
> D. no friction forces are involved

Reading Assignment:

Halliday and Resnick:	Ch 5, Sect 1, 2
Semat and Blumenthal:	Vol I, Ch 2, Fr 19-22
Joseph and Leahy:	Part I, Ch 3, Sect 8, Fr 27-36, 40-44

SEGMENT 4

NEWTON'S LAWS OF MOTION

Problem 2: Newton's First Law

2. A Particle is set in motion along a frictionless horizontal surface at a speed of one foot per second. What is its speed after ten seconds?

Reading Assignment:

Halliday and Resnick: Ch 5, Sect , 2

Semat and Blumenthal: Vol I, Ch 4, Pr 1-6

SEGMENT 4

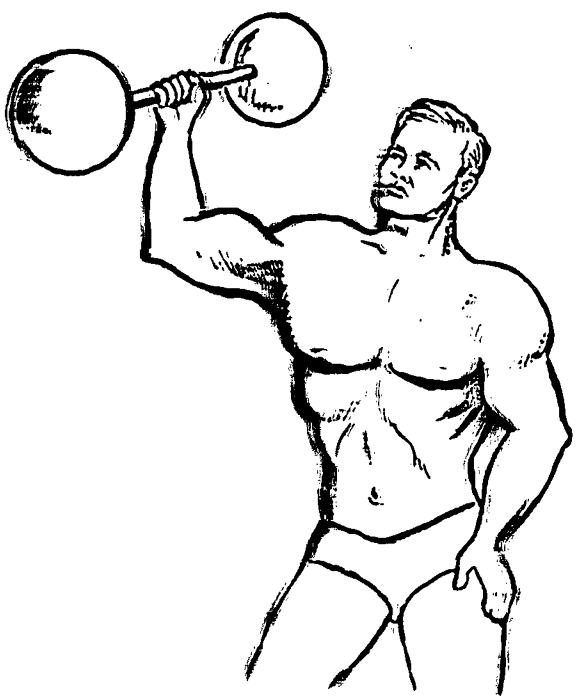
NEWTON'S LAWS OF MOTION

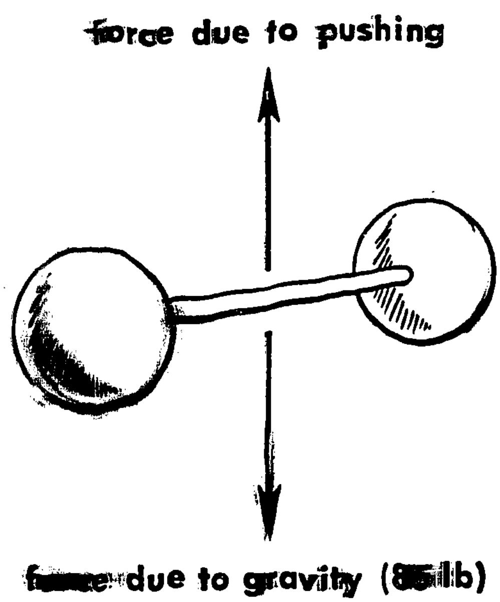
Problem 5: Newton's Second Law

5. Please study the figure below.

A weightlifter pushes an 85-lb dumbbell vertically upward at a constant speed of 1 ft/sec. The magnitude of the force he applies to the dumbbell

A. is greater than 85 lb
B. is equal to 85 lb
C. is less as the dumbbell rises
D. is more as the dumbbell rises





Reading Assignment:

Halliday and Resnick:	Ch 5, Sect 3, 4
Semat and Blumenthal:	Vol I, Ch 4, Pr 3-7, 17, 18

SEGMENT 4

NEWTON'S LAWS OF MOTION

Problem 6: Acceleration Components in Projectile Motion

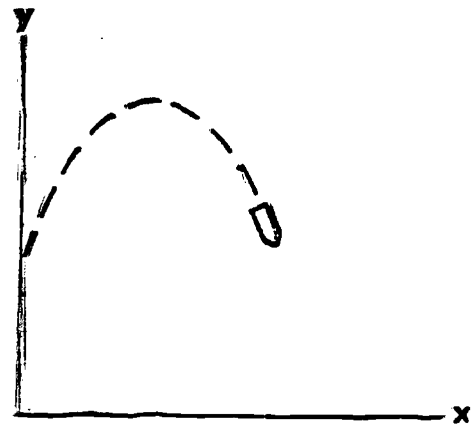
6. A projectile moves in an x-y plane (horizontal-vertical). The only force on the projectile is the force due to gravity, a force with magnitude w acting vertically downward. The mass of the projectile is m. Which of the following sets of equations (based upon Newton's second law) is correct?

A. $a_x = 0; \quad a_y = -w/m$

B. $a_x = -w/m; \quad a_y = w/m$

C. $a_x = w/m; \quad a_y = -w/m$

D. $a_x = w/m; \quad a_y = 0$



Reading Assignment:

Halliday and Resnick: Ch 4, Sect 2, 3; Ch 5, Sect 8

Semat and Blumenthal: Vol I, Ch 3, Fr 29,37,38; Ch 4, Fr 13,14

SEGMENT 4

NEWTON'S LAWS OF MOTION

Problem 11: Mass and Weight

11. Near the surface of the moon, objects fall with an acceleration of 1.6 m/sec^2. What is the weight of a 3000 gram mass at the moon's surface?

Reading Assignment:

Halliday and Resnick:	Ch 5, Sect 8
Semat and Blumenthal:	Vol I, Ch 4, Fr 13, 14
Joseph and Leahy:	Part I, Ch 4, Sect 3, Fr 1-17

Related Problems:

Schaum:	Ch 5, Nos 1, 2

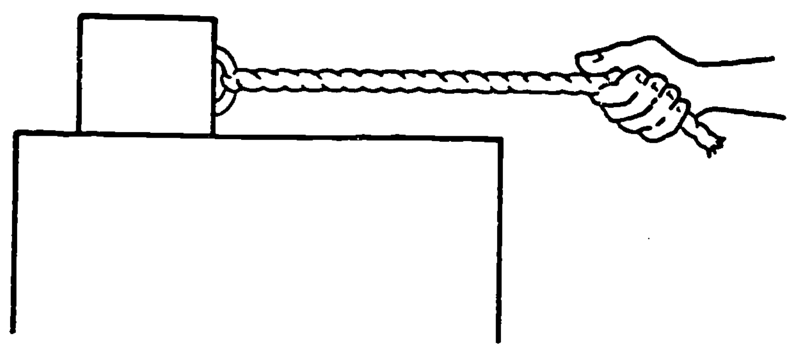
SEGMENT 4

NEWTON'S LAWS OF MOTION

Problem 16: Newton's Third Law

16. In the figure below, the reaction force to the force exerted by the hand pulling on the rope is

A. the force of the rope on the block
B. the force of the block on the rope
C. the force exerted by the block on the hand
D. the force exerted by the rope on the hand



Reading Assignment:

Halliday and Resnick: Ch 5, Sect 5

Semat and Blumenthal: Vol I, Ch 4, Fr 35, 36

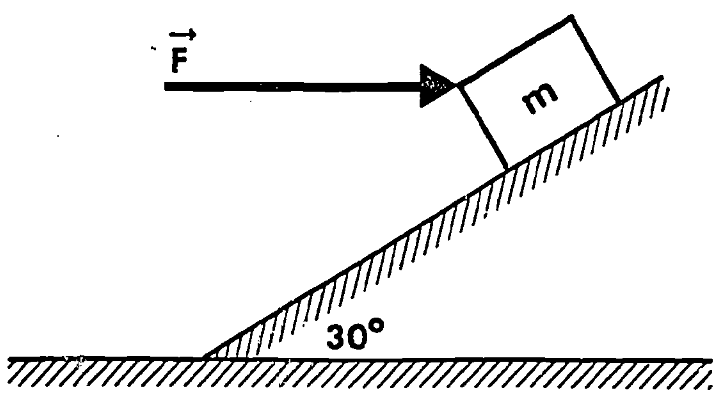
Joseph and Leahy: --------

SEGMENT 4

NEWTON'S LAWS OF MOTION

Problem 21: Resolving and Equating Forces

21. A force $\vec{F}$, as shown below, of 10 nt pushes a 3-kg block along a plane inclined at 30°. If $\vec{F}$ is parallel to the horizontal surface, calculate the value of the normal force on the block.



Reading Assignment:

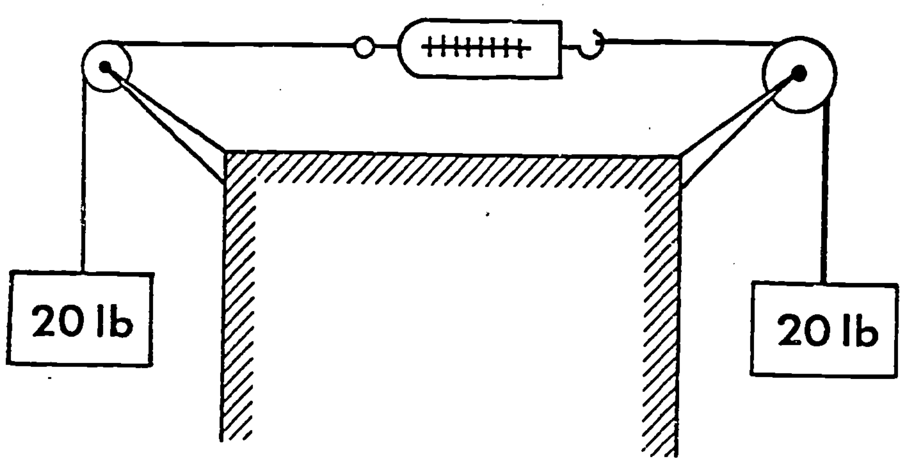
Halliday and Resnick:	Ch 2, Sect 3, Ch 5, Sect 10
Semat and Blumenthal:	Vol I, Ch 2, Fr 31-35
Joseph and Leahy:	Part I, Ch 3, Sect 6, Fr 1-30

SEGMENT 4

NEWTON'S LAWS OF MOTION

Problem 26: Forces in Equilibrium

26. Below, two stationary 20-lb blocks are shown attached to a spring balance. The string connecting each block to the balance is massless and the pulleys (different radii) are also massless and frictionless. What is the reading on the spring balance?



Reading Assignment:

Halliday and Resnick: Ch 5, Sect 9, 10

Semat and Blumenthal: Vol I, Ch 2, Fr 9; Ch 4, Fr 7, 17

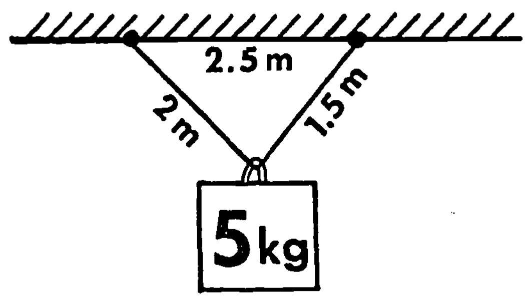
SEGMENT 4

NEWTON'S LAWS OF MOTION

Problem 29: Forces in Equilibrium

29. A mass of 5 kg is suspended from the ceiling by two cords, one of length 1.5 m and the other of length 2 m. The distance between the points of support on the ceiling is 2.5 m. What is the tension in the 2-m cord? (Note: dimensions shown form 3-4-5 triangle.)

A. 3 kg
B. 4 nt
C. 39.2 nt
D. 29.4 nt



Reading Assignment:

Halliday and Resnick: Ch 5, Sect 10, Ex 3

Semat and Blumenthal: Vol I, Ch 2, Fr 38-40

Related Problems:

Schaum: Ch 3, Nos 1, 5

SEGMENT 4

NEWTON'S LAWS OF MOTION

Problem 32: Newton's Second Law

32. A sled of mass m slides down an icy slope that makes an angle θ with the horizontal. Assuming perfectly frictionless conditions, derive general equations for:

(a) the acceleration a of the sled
(b) the resultant (or total) force R acting on the sled
(c) the reaction force N acting on the sled

Reading Assignment:

Halliday and Resnick:	Ch 5, Sect 4, 8, 10
Semat and Blumenthal:	Vol I, Ch 4, Fr 23, 24
Joseph and Leahy:	Part I, Ch 3, Sect 10, Fr 20-23

Related Problems:

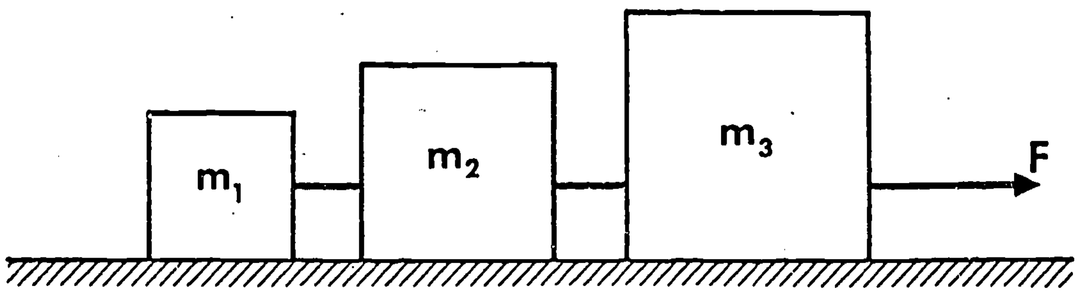
Schaum:	Ch 5, No 20

SEGMENT 5

LINEAR MOTION; FRICTION

Problem 1: Newton's Laws of Motion

1. In the figure below, a force F of 90 nt accelerates three blocks of mass m_1 = 20 kg, m_2 = 30 kg, and m_3 = 40 kg. What is the tension in the cord connecting m_1 and m_2? (The plane is frictionless.)



A. 20 nt
B. 40 nt
C. 90 nt
D. 30 nt

Reading Assignment:

Halliday and Resnick: Ch 5, Sect 4, 5, 10

Related Problems:

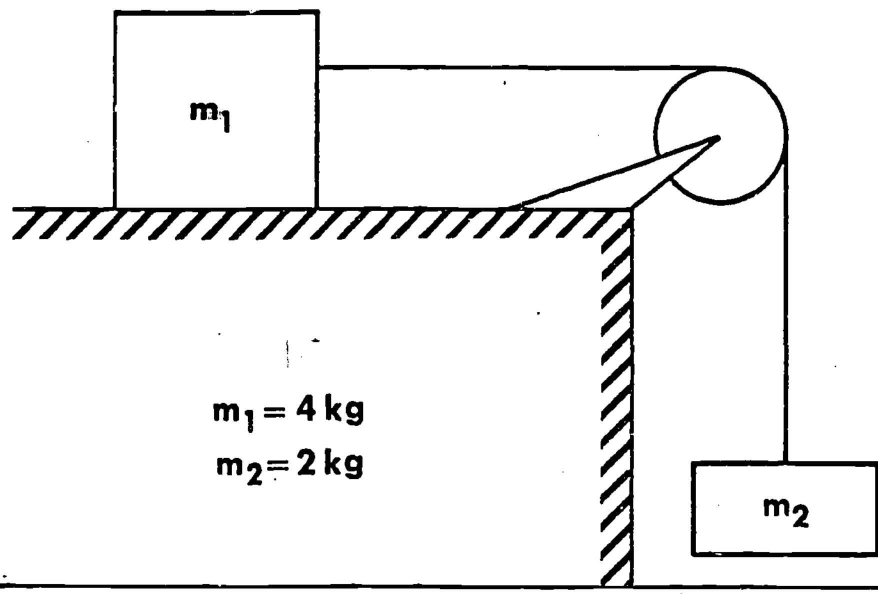
Schaum: Ch 5, No 14

SEGMENT 5

LINEAR MOTION; FRICTION

Problem 2: Newton's Laws of Motion

2. Referring to the figure, what is the acceleration of m_1? Assume the idealized conditions of a frictionless table and massless pulley and cord. Be sure to draw a free-body diagram and to use a consistent sign convention.



Reading Assignment:

Halliday and Resnick:	Ch 5, Sect 10 ex 6
Semat and Blumenthal:	Vol I, Ch 4, Fr 20-22
Joseph and Leahy:	Part I, Ch 3, Sect 10, Fr 85-89

Related Problems:

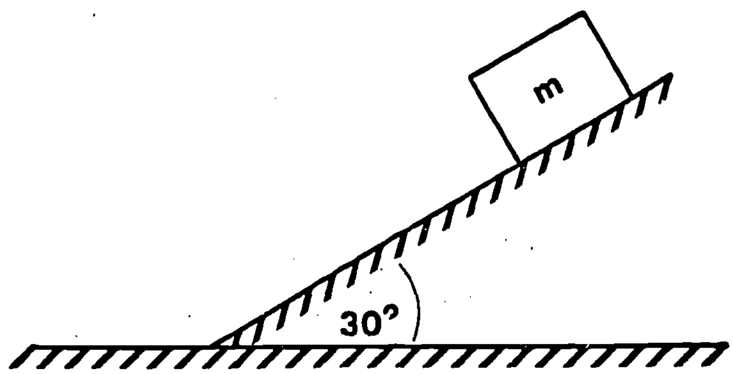
Schaum:	Ch 5, No 21

SEGMENT 5

LINEAR MOTION; FRICTION

Problem 5: Coefficients of Friction

5. In the diagram, you can see a 30 lb block on an inclined plane with coefficient of kinetic friction $\mu_k = 0.40$ and coefficient of static friction $\mu_s = 0.60$. What will the block do when released from rest?



A. remain at rest
B. slide with constant velocity down the plane
C. accelerate down the plane

Reading Assignment:

Halliday and Resnick: Ch 6, Sect 1, 2

Related Problems:

Schaum: Ch 5, Nos 18, 20

SEGMENT 5

LINEAR MOTION; FRICTION

Problem 10: Friction on an Inclined Plane

10. Refer to the diagram in problem 5. The block slides down the plane inclined at 30° with constant velocity. What is the coefficient of kinetic friction?

Reading Assignment:

Halliday and Resnick: Ch 6, Sect 1, 2

Related Problems:

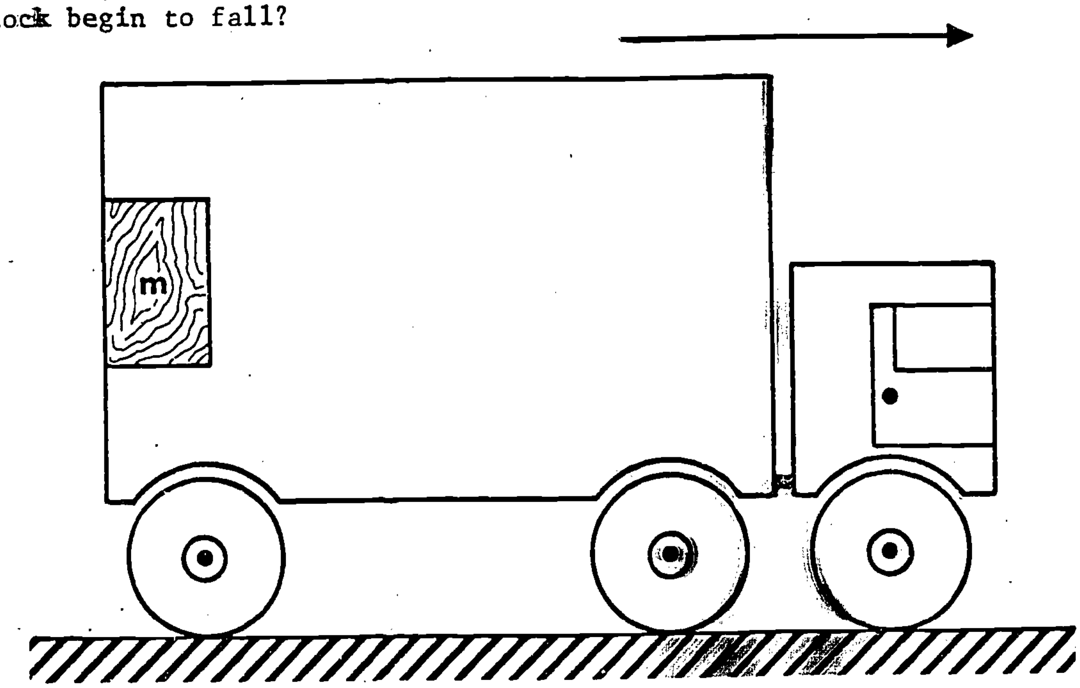
Schaum: Ch 5, Nos 18, 20

SEGMENT 5

LINEAR MOTION; ~~FRICTION~~

Problem 11: Friction on ~~a Vertical~~ Plane

11. The truck shown in the diagram ~~accelerates at~~ 30 m/sec^2 with a 20-kg block stuck to the back door as ~~a result of~~ the friction between it and the door. The coefficients of ~~static and~~ kinetic friction are 0.5 and 0.5 respectively for all surfaces ~~inside~~ the truck. If the truck begins to reduce its acceleration, ~~at what acceleration~~ will the block begin to fall?



Reading Assignment:

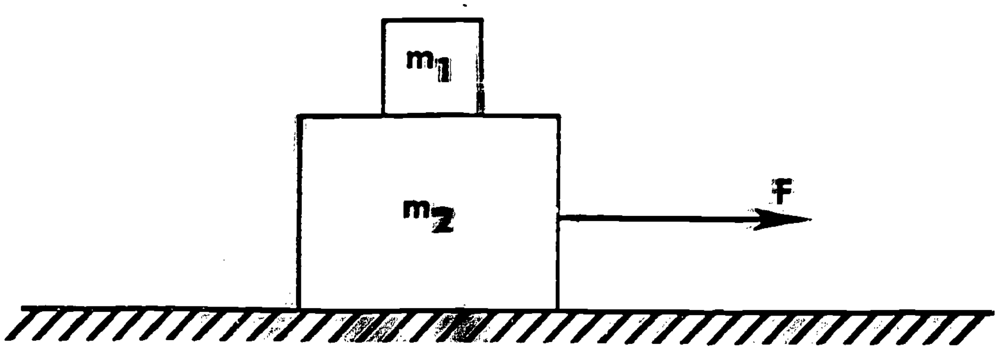
Halliday and Resnick:	Ch 6, Sect 1, 2
Semat and Blumenthal:	Vol I, Ch 4, Fr 26-29, 31-33
Joseph and Leahy:	Part I, Ch 3, Sect 7, Fr 17, 18, 26-30

SEGMENT 5

LINEAR MOTION; FRICTION

Problem 12: Friction on a Horizontal Plane

12.



In the diagram, a force F of 136 nt pulls two blocks along a horizontal surface (m_1 = 10 kg, m_2 = 20 kg). The coefficients of static and kinetic friction for all surfaces are μ_s = 0.055 and μ_k = 0.040.

True or false? Block one will *move to the left* relative to block two.

Reading Assignment:

Halliday and Resnick: Ch 6, Sect 1, 2

Related Problems:

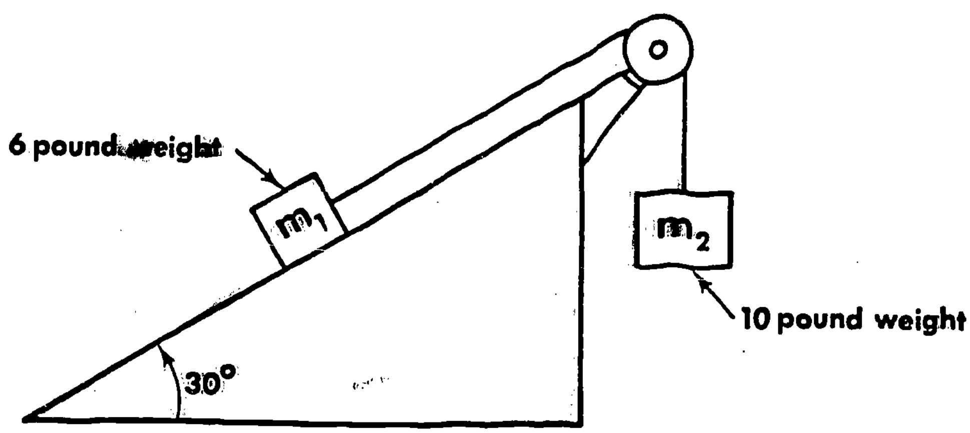
Schaum: Ch 5, Nos 15, 16

SEGMENT 5

LINEAR MOTION; FRICTION

Problem 13: Friction on an Inclined Plane

13. As shown in the figure, a 6-pound weight on the inclined plane (coefficient of kinetic friction between the weight and the surface is $\mu_k = 0.2$) is connected by a light inextensible string to a 10-lb weight. The string passes over an ideal frictionless, massless pulley. What is the magnitude and direction of the acceleration of the 10-lb weight?



A. 8.7 ft/sec^2 upward
B. 15. ft/sec^2 upward
C. 16. ft/sec^2 downward
D. 7.4 ft/sec^2 downward

Reading Assignment:

Halliday and Resnick:	Ch 6, Sect 1, 2
Semat and Blumenthal:	Vol I, Ch 4, Fr 31-33
Joseph and Leahy:	Part I, Ch 3, Sect 7, Fr 26-30

Related Problems:

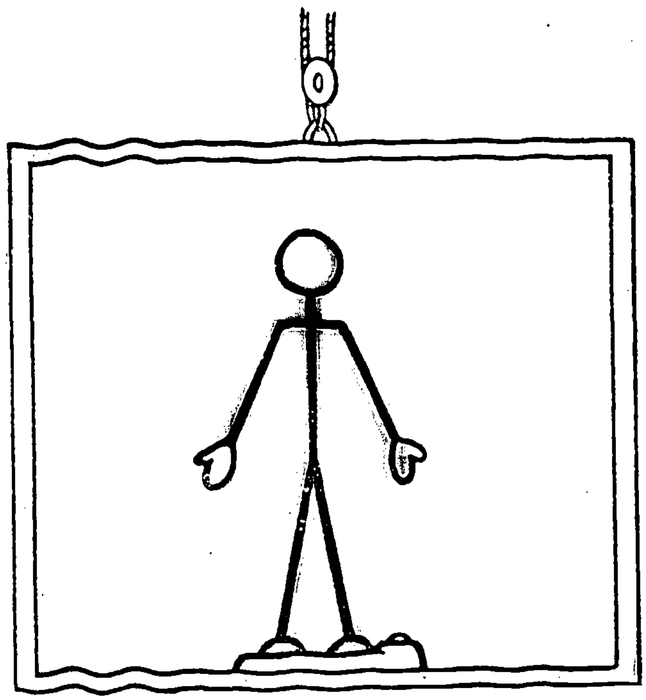
Schaum:	Ch 5, Nos 19, 21, 22

SEGMENT 5

LINEAR MOTION; FRICTION

Problem 18: Accelerated Vertical Motion

18. In the figure below, a man is standing in an elevator which is initially stationary. The weight scale under the man reads 160 lb. The elevator then accelerates upward at 5 ft/sec^2. What is the new reading on the scale?



Reading Assignment:

Halliday and Resnick: Ch 5, Sect 10 ex 8

Semat and Blumenthal: ---------

Joseph and Leahy: Part I, Ch 3, Sect 9, Fr 38, 39, 52

Related Problems:

Schaum: Ch 5, No 11

SEGMENT 6

UNIFORM CIRCULAR MOTION

Problem 1: Relation Between Linear and Angular Quantities

1. The rim of a rotating bicycle wheel has a tangential velocity of 30 m/sec. If 0.5 m is the radius of the rotating wheel, how many revolutions per minute (rev/min) would be recorded by a tachometer? (A tachometer is an instrument used to measure revolutions per minute).

Reading Assignment:

Halliday and Resnick: Ch 4, Sect 4; Ch 11, Sect 5

Related Problems:

Schaum: Ch 9, Nos 2, 3, 4

SEGMENT 6

UNIFORM CIRCULAR MOTION

Problem 2: Characteristics of Uniform Circular Motion

2. A particle moves at constant speed in a circular path of radius r. The particle makes one complete revolution every second. Calculate the acceleration of the particle if r = 0.5 m.

A. 19.8 m/sec
B. 12.6 m/sec^2
C. 19.8 m/sec^2
D. 1.98 m/sec^2

Reading Assignment:

Halliday and Resnick:	Ch 4, Sect 4
Semat and Blumenthal:	Vol I, Ch 6, Fr 1-3
Joseph and Leahy:	Part I, Ch 5, Sect 3, Fr 1-36

Related Problems:

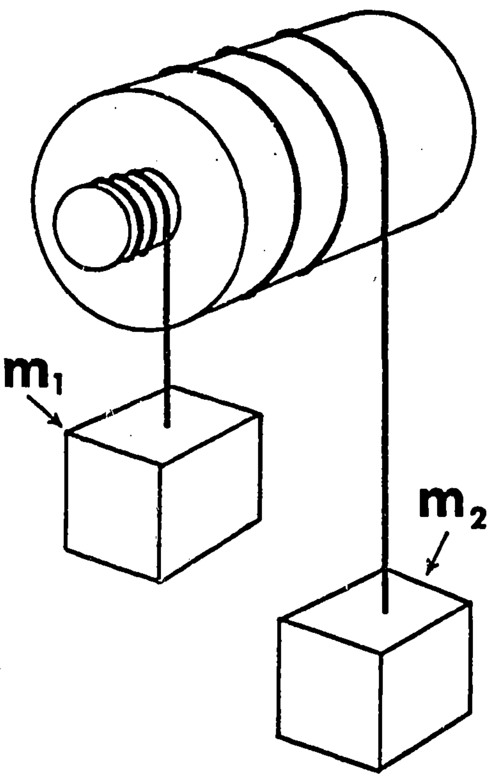
Schaum:	Ch 10, No. 1

SEGMENT 6

UNIFORM CIRCULAR MOTION

Problem 8: Circular Motion

8. Two blocks are lowered by a winch made of two concentric cylinders. The smaller cylinder has a radius of 0.04 m, and the larger cylinder has a radius of 1 m. If the winch turns at 3 rev/min, what are the vertical velocities of block one and block two (v_1 and v_2)?



Reading Assignment:

Halliday and Resnick:	Ch 4, Sect 4, Ch 11, Sect 5
Semat and Blumenthal:	Vol I, Ch 7, Fr 1-16
Joseph and Leahy:	Part I, Ch 5, Sect 3, Fr 1-10

Related Problems:

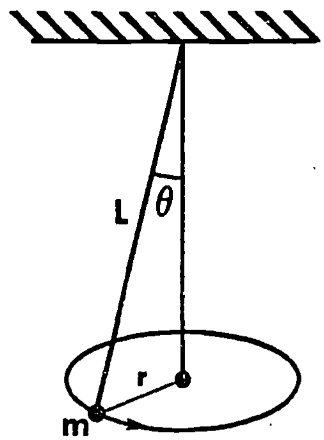
Schaum:	Ch 9, Nos 2, 3, 4

SEGMENT 6

UNIFORM CIRCULAR MOTION

Problem 9: Centripetal Force in a Horizontal Plane

9. The figure shows a mass m = 2 kg revolving in a horizontal circle. The mass is suspended from a string 98 cm in length. The motion of the string traces out a cone. If the string makes an angle of 30° with the vertical, how long does it take for the mass to make one revolution?



Reading Assignment:

Halliday and Resnick: Ch 6, Sect 3

Related Problems:

Schaum: Ch 10, No 4

SEGMENT 6

UNIFORM CIRCULAR MOTION

Problem 14: Centripetal Force

14. A copper penny is placed 4 inches from the center of a hi-fi record. The record plus penny are then placed on a phonograph turntable (33 1/3 rev/min) and the switch is turned on. The coefficient of static and kinetic friction are 0.1 and 0.05 respectively. At what angular velocity will the penny begin to slide?

Reading Assignment:

Halliday and Resnick:	Ch 6, Sect 3, Ch 11, Sect 5
Semat and Blumenthal:	Vol I, Ch 6, Fr 1-5
Joseph and Leahy:	Part I, Ch 5, Sect 4, Fr 1-10, 18-23

Related Problems:

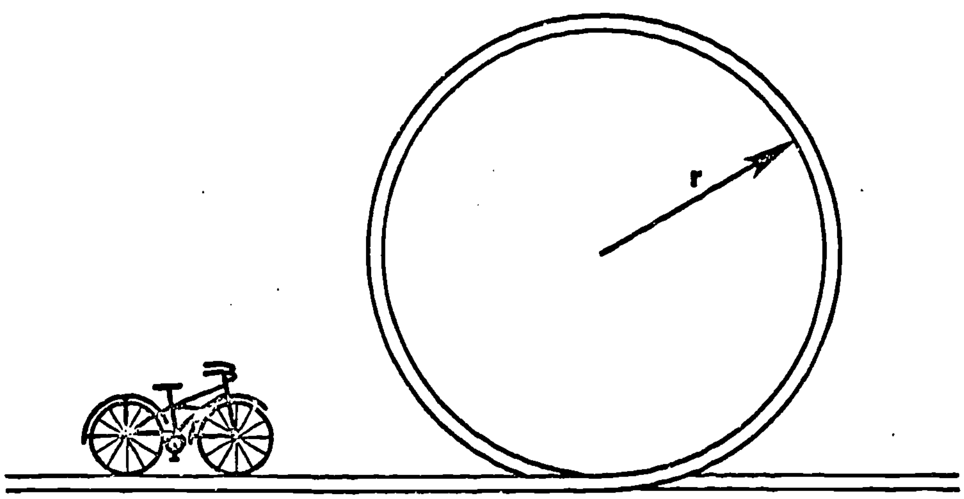
Schaum:	Ch 10, Nos 1, 2

SEGMENT 6

UNIFORM CIRCULAR MOTION

Problem 15: Centripetal Force in a Vertical Plane

15. A man plans to perform the loop-the-loop with his bicycle at the county fair (see the diagram below). The radius r is equal to 10 ft. What is the minimum speed at which he can safely perform the stunt?



A. depends on the man's mass
B. 12.2 mi/hr
C. 20 ft/sec
D. 9.6 mi/hr

Reading Assignment:

Halliday and Resnick: Ch 6, Sect 3

Related Problems:

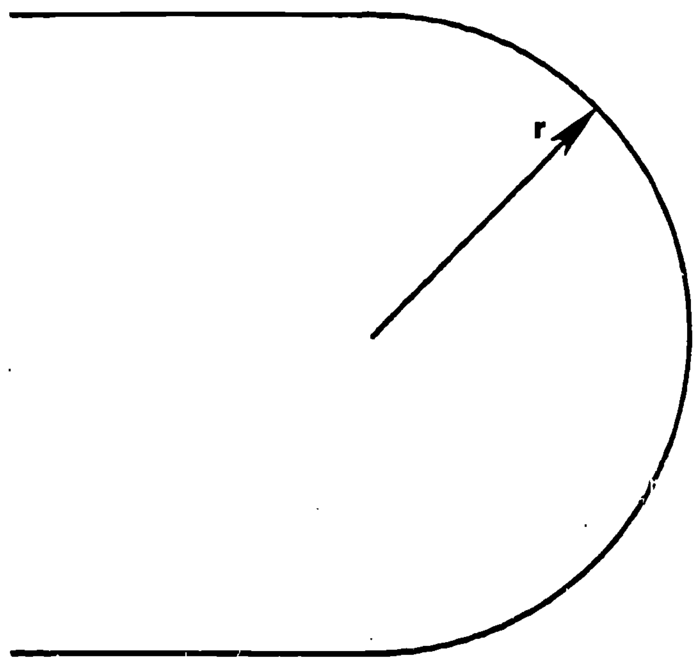
Schaum: Ch 10, No. 5

SEGMENT 6

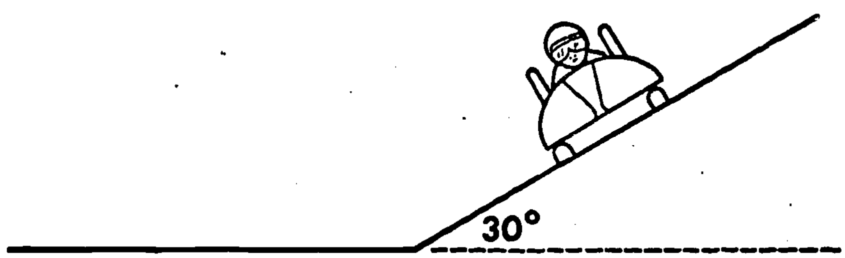
UNIFORM CIRCULAR MOTION

Problem 16: Centripetal Force

16. A bobsled speeds around the curve shown in the figure below. The curve has been well iced and can be considered frictionless. The sled moves in a circular arc of radius = 100 m and banking angle of 30°; what is its speed?



Curve view from the top



Bobsled on banked curve

Reading Assignment:

Halliday and Resnick:	Ch 6, Sect 3
Semat and Blumenthal:	Vol I, Ch 6, Fr 7-9
Joseph and Leahy:	Part I, Ch 5, Sect 4, Fr 1-10, 14-17

Related Problems:

Schaum:	Ch 10, No. 3

SEGMENT 7

WORK AND ENERGY

Problem 1: Definition of Work

1. A 2-kg particle is moving in a circle with an angular velocity of 10 rad/sec. The diameter of the circle is 1 m. How much work is done on the particle by the centripetal force during one revolution?

   A. 400π j
   B. 200π j
   C. 100π j
   D. Zero j

Reading Assignment:

Halliday and Resnick:	Ch 7, Sect 1, 2
Semat and Blumenthal:	Vol I, Ch 5, Fr 1-6
Joseph and Leahy:	Part I, Ch 7, Sect 1, Fr 1-13, 19, 24-41; Sect 3, Fr 1-13

Related Problems:

Schaum:	Ch 6, Nos. 4, 5

SEGMENT 7

WORK AND ENERGY

Problem 2: Work Done by a Constant Force

> 2. A safe having a mass of 2 slugs is moved up a 30° frictionless inclined plane for a distance of 15 ft. Calculate the work done on the safe.

Reading Assignment:

Halliday and Resnick:	Ch 7, Sect 1, 2
Semat and Blumenthal:	Vol I, Ch 5, Fr 1-6
Joseph and Leahy:	Part I, Ch 7, Sect 1, Fr 24-41

Related Problems:

Schaum:	Ch 6, No. 5

SEGMENT 7

WORK AND ENERGY

Problem 5: Work Done by a Varying Force

5. A mass m = 2 kg moves in the direction of an applied force varying with displacement according to the equation

$$F = m(\alpha + \beta x^2)$$

where $\alpha = 5\ m/sec^2$, $\beta = 15\ m^{-1}\ sec^{-2}$, and x is the displacement. Find the work done on the mass during the first 2 m of its journey.

A. 260 j
B. 130 j
C. 100 j
D. 20 j

Reading Assignment:

Halliday and Resnick: Ch 7, Sect 3

SEGMENT 7

WORK AND ENERGY

Problem 10: Power Expended by an Escalator

10. An escalator, inclined at 37° from the horizontal, has a motor that can deliver a maximum power of 10 hp. If the escalator is moving with a constant speed of 2 ft/sec, what is the maximum number of passengers, with an average weight of 150 lb, that the escalator can handle?

A. 30
B. 18
C. 41
D. 31

Reading Assignment:

Halliday and Resnick: Ch 7, Sect 7

Related Problems:

Schaum: Ch 6, No 18

SEGMENT 7

WORK AND ENERGY

Problem: 15: Projectile Motion and Kinetic Energy

15. A 2-kg particle is projected from ground level with an initial velocity of 20 m/sec, at 60° above the horizontal. Find the kinetic energy of the particle when it reaches its highest altitude; i.e., where the vertical component of the velocity is zero. (Neglect air resistance.)

Reading Assignment:

Halliday and Resnick: Ch 4, Sect 3; Ch 7, Sect 5

Related Problems:

Schaum: Ch 4, Nos. 11, 16, 18; Ch 6, No. 8

SEGMENT 7

WORK AND ENERGY

Problem 18: The Work-Energy Theorem

18. A block is projected with an initial speed of 8 m/sec, down a frictionless plane inclined 45° from the horizontal. Find the speed of the block after it has traveled for a distance of 2.6 m along the incline. (Use the work-energy theorem in your solution.)

Reading Assignment:

Halliday and Resnick:	Ch 7, Sect 5, 6
Semat and Blumenthal:	Vol I, Ch 5, Fr 10-11
Joseph and Leahy:	Part I, Ch 8, Sect 1, Fr 1-27

Related Problems:

Schaum:	Ch 6, Nos. 13, 14

SEGMENT 7

WORK AND ENERGY

Problem 24: Composite Problem Involving Work, Energy, and Projectile Motion

24. A 30-gm bullet, fired with a speed of 300 m/sec, passes through a telephone pole 30 cm in diameter at a point 2 m above ground. The bullet's path through the pole is horizontal and along a diameter. While in the pole the bullet experiences an average force of 2500 nt. If air resistance is neglected, at what horizontal distance from the pole will the bullet hit the ground?

Reading Assignment:

Halliday and Resnick: Ch 4, Sect 3, Ch 7, Sect 5

Related Problems:

Schaum: Ch 4, Nos.16, 17; Ch 6, No. 11

SEGMENT 7

WORK AND ENERGY

Problem 27: Composite Problem Involving Work and Energy

> 27. A constant horizontal force $\vec{F}$, of magnitude 120 nt, is used to move a 10-kg block up a plane inclined at 37° from the horizontal. If the block starts from rest, and the coefficient of kinetic friction between the block and the plane is 0.200, what is the speed of the block after it has traveled 10 m along the plane?
>
> A. 6.56 m/sec
> B. 9.55 m/sec
> C. 12.8 m/sec
> D. 3.76 m/sec

Reading Assignment:

Halliday and Resnick:	Ch 7, Sect 2, 5
Semat and Blumenthal:	Vol I, Ch 5, Fr 1-6, 10, 11
Joseph and Leahy:	Part I, Ch 8, Sect 1, Fr 18-27, 37-43

Related Problems:

Schaum:	Ch 6, Nos. 13, 15

SEGMENT 8

CONSERVATION OF ENERGY

Problem 1: Work Done by Conservative Forces

1. The work-energy theorem states that the work done by the resultant force on a particle is equal to the change in kinetic energy of the particle, $W = \Delta K$. *If* the resultant force is conservative, we also know that the total energy of the particle does not change, $\Delta K + \Delta U = 0$. In this case, which of the following statements is correct?

The work done by the resultant conservative force is equal to

A. the change in the potential energy of the particle, $W = \Delta U$

B. the change in the total energy of the particle, $W = \Delta E$

C. the negative of the change in the total energy of the particle, $W = -\Delta E$

D. the negative of the change in the potential energy of the particle, $W = -\Delta U$

Reading Assignment:

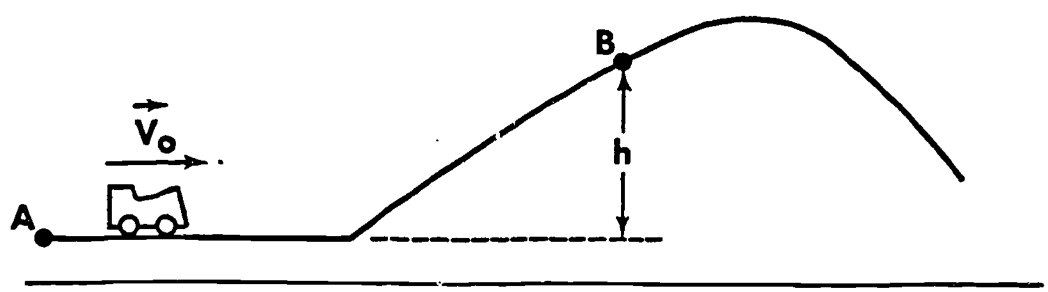
Halliday and Resnick: Ch 8, Sect 1, 2, 3

SEGMENT 8

CONSERVATION OF ENERGY

Problem 5: Conservation of Energy

5. A roller coaster moves at point A with speed v_o. At point B, the coaster moves with speed (1/2) v_o. Assuming no frictional losses, what is the height of point B above point A?



A. $3 v_o^2/8g$

B. $7 v_o^2/8g$

C. $v_o^2/4g$

D. $5 v_o^2/8g$

Reading Assignment:

Halliday and Resnick:	Ch 8, Sect 3, 4
Semat and Blumenthal:	Vol I, Ch 5, Fr 12-24
Joseph and Leahy:	Part I, Ch 8, Sect 3, Fr 1-29

Related Problems:

Schaum:	Ch 6, Nos. 9, 14

SEGMENT 8

CONSERVATION OF ENERGY

Problem 9: Potential Energy and the Related Force Function

9. For a force

$$F = -ky$$

where k is a constant, and for the choice $U = 0$ at $y = y_o$, what is the potential energy $U(y)$ of a particle located at an arbitrary point y?

Reading Assignment:

Halliday and Resnick: Ch 8, Sect 3, 4

SEGMENT 8

CONSERVATION OF ENERGY

Problem 13: Energy in Springs

13. A ball of mass m is dropped from rest onto a spring with spring constant k. The maximum compression of the spring is x. Find the height above the uncompressed spring from which the ball was dropped, assuming no friction at the time of impact.

A. $(kx^2/2mg) - x$

B. $(kx^2/2mg) + x$

C. $(kx^2/mg) - x$

D. kx^2/mg

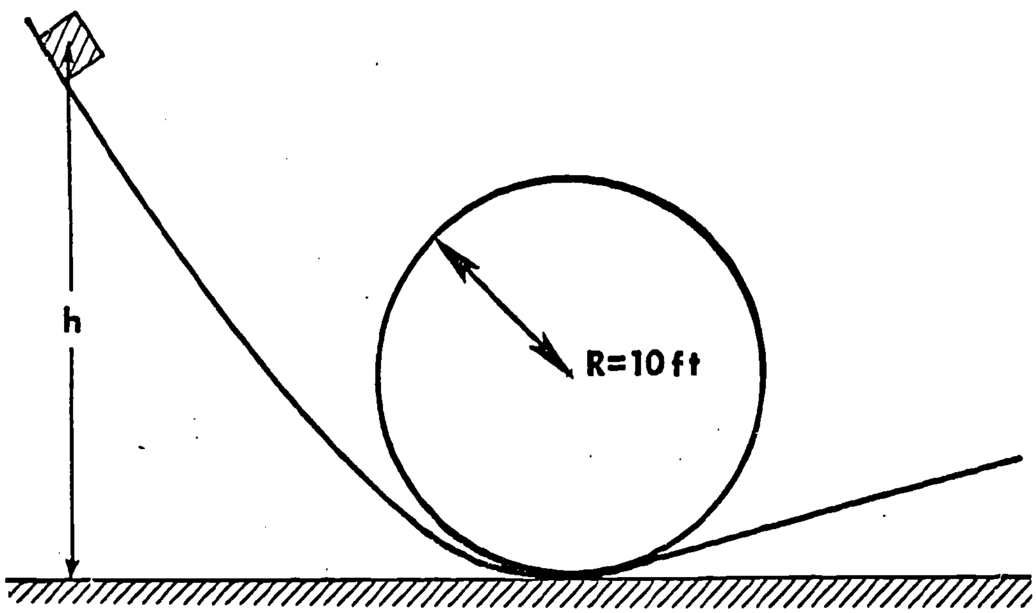
Reading Assignment:

Halliday and Resnick:	Ch 8, Sect 4
Semat and Blumenthal:	Vol I, Ch 5, Fr 17-20, 25-29
Joseph and Leahy:	Part I, Ch 8, Sect 2, Fr 30-36; Sect 3, Fr 26-29

CONSERVATION OF ENERGY

Problem 18: A Composite Problem Using Conservation of Energy

18.



Compute the minimum height h from which a 10-lb block can be released, in order that it will go around the loop without losing contact with the track. Assume a frictionless track.

Reading Assignment:

Halliday and Resnick:	Ch 6, Sect 3; Ch 8, Sect 4
Semat and Blumenthal:	Vol I, Ch 6, Fr 1-4, 10-13; Ch 5, Fr 12-18
Joseph and Leahy:	Part I, Ch 5, Sect 4, Fr 1-10; Ch 8, Sect 3, Fr 26-29

Related Problems:

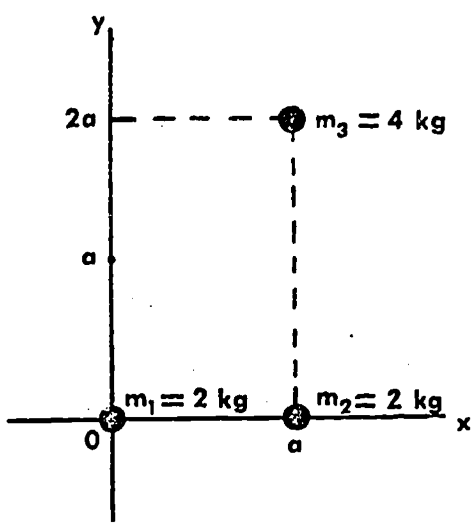
Schaum:	Ch 6, Nos. 7, 9; Ch 10, No. 5

SEGMENT 9

MOTION OF THE CENTER OF MASS

Problem 1: Calculation of Center of Mass

1. The coordinates of the center of mass of the system shown in the figure are



A. x = a; y = 1.33 a
B. x = 0.25 a; y = a
C. x = a; y = 0.75 a
D. x = 0.75 a; y = a

Reading Assignment:

Halliday and Resnick: Ch 9, Sect 1

Semat and Blumenthal: ------

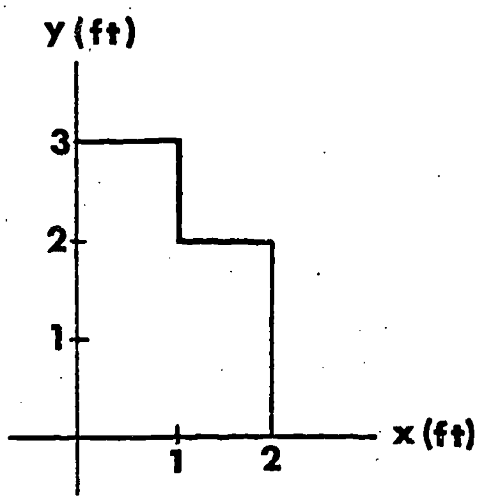
Joseph and Leahy: ------

SEGMENT 9

MOTION OF THE CENTER OF MASS

Problem 4: Calculation of Center of Mass

4. A piece of 3/4 inch plywood has been cut into the shape shown. If uniform mass density and thickness are assumed for this piece of wood, then the center of mass is located at the point



A. (0.9, 1.0)
B. (1.3, 1.3)
C. (0.9, 1.3)
D. (1.0, 1.3)

Reading Assignment:

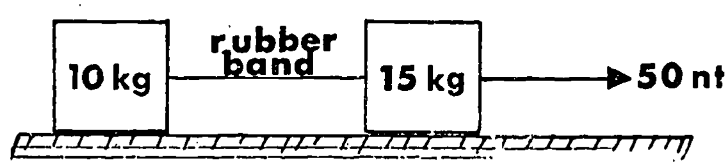
Halliday and Resnick: Ch 9, Sect 1

SEGMENT 9

MOTION OF THE CENTER OF MASS

Problem 6: Movement of Center of Mass

6. Two masses on a table are connected by a rubber band. A constant force of 50 nt is applied to the right mass as shown. The coefficient of kinetic friction between each mass and the table is $\mu = 0.2$. The left mass is 10 kg and the right mass is 15 kg. What is the acceleration of the center of mass when both masses are moving to the right?



Reading Assignment:

Halliday and Resnick: Ch 9, Sect 2

Semat and Blumenthal: ---------

Joseph and Leahy: ---------

SEGMENT 10

LINEAR MOMENTUM

Problem 1: The Momentum of a Particle

1. A 2-kg block slides along the frictionless track shown in the figure. If the block's speed at point A is 10 m/sec, what is the momentum in kg-m/sec of the block at point B?

Reading Assignment:

Halliday and Resnick: Ch 8, Sect 4; Ch 9, Sect 3

Semat and Blumenthal: Vol I, Ch 5, Fr 12-18, Ch 4, Fr 37

Joseph and Leahy: Part I, Ch 8, Sect 3, Fr 26-29, Ch 6, Sect 2, Fr 9-15

Related Problems:

Schaum: Ch 8, Nos 1,2,3

Problem 5: Momentum of a System of Particles

5. Two particles of mass 2 kg and 3 kg respectively, are moving with a speed of 10 m/sec due east. A third particle of mass 2 kg is moving with a speed of 25 m/sec due north. Determine the velocity of the center of mass, $\vec{v}_{cm}$, of the system of three particles.

A. 10.1 m/sec at 45° N of E
B. 20.2 m/sec at 37° N of E
C. 10.1 m/sec at 37° N of E
D. 20.2 m/sec at 45° N of E

Reading Assignment:

Halliday and Resnick:	Ch 9, Sect 4
Semat and Blumenthal:	------
Joseph and Leahy:	------

SEGMENT 10

LINEAR MOMENTUM

Problem 10: Newton's Second Law in Terms of Momentum

> 10. The total mass of a system is 3 kg and the magnitude of the system's momentum is changing at the rate of 15 kg-m/sec^2. What is the magnitude of the net external force exerted on the system?

Reading Assignment:

Halliday and Resnick:	Ch 9, Sect 3, 4
Semat and Blumenthal:	Vol I, Ch 4, Fr 37-38
Joseph and Leahy:	Part I, Ch 6, Sect 3, Fr 45-56

SEGMENT 10

LINEAR MOMENTUM

Problem 13: Conservation of Momentum

13. An 8-ton, open-top freight car is coasting at a speed of 5 ft/sec along a frictionless horizontal track. It suddenly begins to rain hard, the raindrops falling vertically with respect to ground. Assuming the car to be deep enough, so that the water does not spatter over the top of the car, what is the speed of the car after it has collected 4.5 tons of water?

Reading Assignment:

Halliday and Resnick:	Ch 9, Sect 5, 6
Semat and Blumenthal:	Vol I, Ch 4, Fr 41-44
Joseph and Leahy:	Part I, Ch 6, Sect 8, Fr 28-35, 54-58

Related Problems:

Schaum:	Ch 8, Nos 3, 6

SEGMENT 11

IMPULSE AND COLLISIONS

Problem 1: Definition of Impulse

1. An impulsive force proportional to time is applied to a block. The constant of proportionality is k, and the total time during which the force is applied is T. Assume that at time t = 0, F = 0. What is the magnitude of the total impulse?

A. $(\frac{1}{2})kT^2$
B. FT
C. kT^2
D. $(\frac{1}{2})(T^2/k)$

Reading Assignment:

Halliday and Resnick:	Ch. 10, Sect. 2
Semat and Blumenthal:	Vol. I, Ch. 4, Fr 38-40
Joseph and Leahy:	Part I, Ch. 6, Sect 1, Fr 1-31

Related Problems:

Schaum:	Ch. 8, No. 4

SEGMENT 11

IMPULSE AND COLLISIONS

Problem 5: Impulse and Momentum

5. A baseball is thrown by a pitcher at 90 mi/hr toward the strike zone. The batter hits a line drive, reversing the original direction of the ball's motion. If the ball weighs 4 oz., is in contact with the bat for 0.01 sec., and leaves the bat at 150 mi/hr, what is the magnitude of the average force on the ball during the time of contact?

Reading Assignment:

Halliday and Resnick:	Ch. 10, Sect. 2, 3
Semat and Blumenthal:	Vol. I, Ch. 4, Fr 38-40
Joseph and Leahy:	Part I, Ch. 6, Sect. 3, Fr 1-55

Related Problems:

Schaum:	Ch. 8, No. 4

SEGMENT 11

IMPULSE AND COLLISIONS

Problem 11: Conservation of Linear Momentum

11. A machine gunner on the bow of a boat fires his gun horizontally. The gun is firing 600 rounds per minute. Each shell weighs 2 ounces and has a muzzle speed of 3200 ft/sec. The combined weight of the boat, gunner, machine gun, etc., is one ton. Neglecting friction and assuming the boat to be initially at rest, what is its speed after five seconds of continuous firing?

A. 80 ft/sec
B. 10 ft/sec
C. 5 ft/sec
D. 2 ft/sec

Reading Assignment:

Halliday and Resnick:	Ch. 9, Sect. 5, 6
Semat and Blumenthal:	Vol. I, Ch. 4, Fr 41-45
Joseph and Leahy:	Part I, Ch. 6, Sect. 4, Fr 6-38

Related Problems:

Schaum:	Ch. 8, No. 5

SEGMENT 11

IMPULSE AND COLLISIONS

Problem 15: Inelastic Collision in One-Dimension

15. A railroad car of mass 1000 kg is rolling down a track at 3 m/sec. It strikes a stationary car of mass 2000 kg. If the two cars couple together, what is the speed of the combination after the collision? (neglect friction)

A. 1 m/sec
B. 0 m/sec
C. 3 m/sec
D. 2 m/sec

Reading Assignment:

Halliday and Resnick:	Ch. 10, Sect. 3, 4
Semat and Blumenthal:	Vol. I, Ch. 4, Fr 41-43
Joseph and Leahy:	Part I, Ch. 6, Sect. 7, Fr 14-33

Related Problems:

Schaum:	Ch. 8, Nos. 1, 2

SEGMENT 11

IMPULSE AND COLLISIONS

Problem 18: Elastic Collision in One-Dimension

18. A steel ball of 2-kg mass (m_1), moving to the right along a horizontal frictionless surface at a speed of 40 m/sec., collides head-on with another 2-kg steel ball (m_2) moving to the left at 20 m/sec. After the collision, m_1 recoils and moves to the left at 20 m/sec. Assuming the collision to be perfectly elastic, in which direction and with what speed will m_2 move after the collision?

Reading Assignment:

Halliday and Resnick:	Ch. 10, Sect. 3, 4
Semat and Blumenthal:	Vol. I, Ch. 4, Fr 41-43
Joseph and Leahy:	Part I, Ch. 6, Sect. 8, Fr 43-46

Related Problems:

Schaum	Ch. 8, No. 8

SEGMENT 12

COLLISIONS IN TWO DIMENSIONS

Problem 1: Elastic Collision in One Dimension

1. In a one-dimensional elastic collision between two objects, mass m_2 is initially at rest. If $u_1 = 1$ km/sec. and $m_1 = 2m_2$, what is the final velocity of m_1?

Reading Assignment:

Halliday and Resnick:	Ch. 10, Sect. 3, 4
Semat and Blumenthal:	Vol. I, Ch. 4, Fr 41-42
Joseph and Leahy:	Part I, Ch. 8, Sect. 9, Fr 9-11

Related Problems:

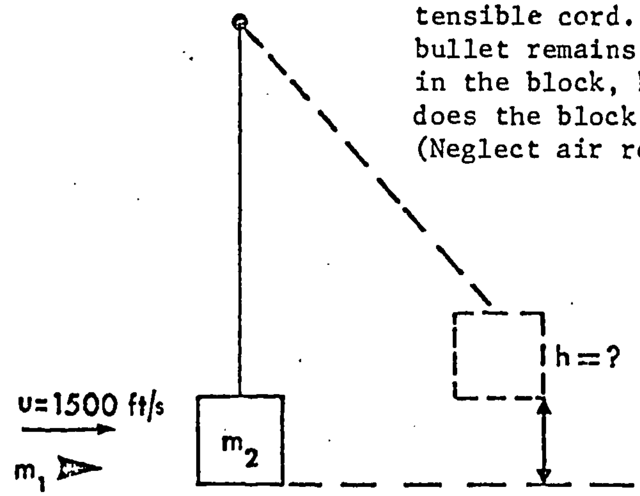
Schaum:	Ch. 8, No. 8

SEGMENT 12

COLLISIONS IN TWO DIMENSIONS

Problem 6: The Ballistic Pendulum

6. A 1/2-ounce bullet traveling horizontally with a muzzle speed of 1500 ft/sec strikes a 5-pound block suspended from a fixed point with 5-foot, massless, inextensible cord. If the bullet remains embedded in the block, how high does the block rise? (Neglect air resistance.)



A. 5.00 ft
B. 2.18 ft
C. 1.36 ft
D. 1.00 ft

Reading Assignment:

Halliday and Resnick:	Ch. 10, Sect. 4
Semat and Blumenthal:	Vol. I, Ch. 4, Fr 41-43
Joseph and Leahy:	Part I, Ch. 8, Sect. 8, Fr 1-25

Related Problems:

Schaum:	Ch. 8, Nos. 1, 3

SEGMENT 12

COLLISIONS IN TWO DIMENSIONS

Problem 10: Elastic Collision in Two Dimensions

10. A mass m_1 collides perfectly elastically with a stationary mass m_2. After the collision the two masses move at right angles to one another. What is the ratio m_2/m_1? (HINT: Choose $\vec{v}_1$ along the x-axis and $\vec{v}_2$ along the y-axis.)

Reading Assignment:

Halliday and Resnick: Ch. 10, Sect. 4, 6

Related Problems:

Schaum: Ch. 8, No. 8

SEGMENT 12

COLLISIONS IN TWO DIMENSIONS

Problem 14: Inelastic Collision in Two Dimensions

14. A 1000-kg auto moving north at 60 km/hr collides perfectly inelastically with a 2000-kg truck moving east at 40 km/hr. How much mechanical energy is dissipated during the collision?

Reading Assignment:

Halliday and Resnick: Ch. 10, Sect. 4, 6

Related Problems:

Schaum: Ch. 8, Nos. 2, 6

SEGMENT 13

GRAVITATION

Problem 1: Gravitational Force Between Point Masses

> 1. In the Bohr picture of the hydrogen atom, the electron revolves about the proton in a circular orbit of radius 5.3×10^{-11} m and period 1.5×10^{-16} sec. The mass of the electron is $m_e = 9.1 \times 10^{-32}$ kg, and that of the proton is $m_p = 1.7 \times 10^{-27}$ kg. Calculate the gravitational force of the proton on the electron.

Reading Assignment:

Halliday and Resnick:	Ch. 16, Sect. 2, 3
Semat and Blumenthal:	Vol. I, Ch. 4, Pr 46-47

SEGMENT 13

GRAVITATION

Problem 4: Acceleration Due to Gravity

4. If a Martian were working on the law of universal gravitation by considering that Mars acted as a particle attracting a Martian apple and a Martian moon according to the same law, he could calculate the distance of that moon from Mars on the assumption that the gravitational attraction falls off as the inverse square of the distance from the center of Mars. From measurements made on Mars he obtains $g = 3.8 \text{ m/sec}^2$ for the acceleration of a falling apple, $R = 3.4 \times 10^6$ m for the radius of Mars and $T = 2.76 \times 10^4$ sec for the period of Phobos (the larger of Mars' two moons). What value would he obtain for the radius of Phobos' orbit about Mars? (assumed circular)

A. 1,580 km
B. 9,500 km
C. 16,000 km
D. 17,500 km

Reading Assignment:

Halliday and Resnick:	Ch. 16, Sect. 2, 3
Semat and Blumenthal:	Vol. I, Ch. 4, Pr 46-49

Related Problems:

Schaum:	Ch. 5, No. 25

SEGMENT 13

GRAVITATION

Problem 10: Inertial and Gravitational Mass

10. Inertial and gravitational masses are conceptually distinct, although experimentally the same. We use one symbol, m, to denote both kinds of masses. In which of the following equations does m stand for gravitational mass?

1. $\vec{F} = m\vec{a}$
2. $\vec{p} = m\vec{v}$
3. $K = \frac{1}{2} mv^2$
4. $F = \frac{mv^2}{r}$
5. $F = \frac{GMm}{r^2}$
6. $g = \frac{Gm}{R_e^2}$
7. $U = mgh$
8. $T = 2\pi\sqrt{m/k}$

A. All of them
B. Numbers 3, 5, and 7
C. Numbers 5, 6, and 7
D. None of them

Reading Assignment:

Halliday and Resnick: Ch. 16, Sect. 4, 13

Joseph and Leahy: Part I, Ch. 4, Sect. 1, Fr 1-23

SEGMENT 13

GRAVITATION

Problem 11: Weight on a Rotating Planet

11. For a perfectly spherical Earth of radius 6.37×10^6 with its axis through both poles, how much more (or less) would a 70-kg man weigh at either pole than he would on the equator? (Assume the weighing to be done with a "massless" spring balance.)

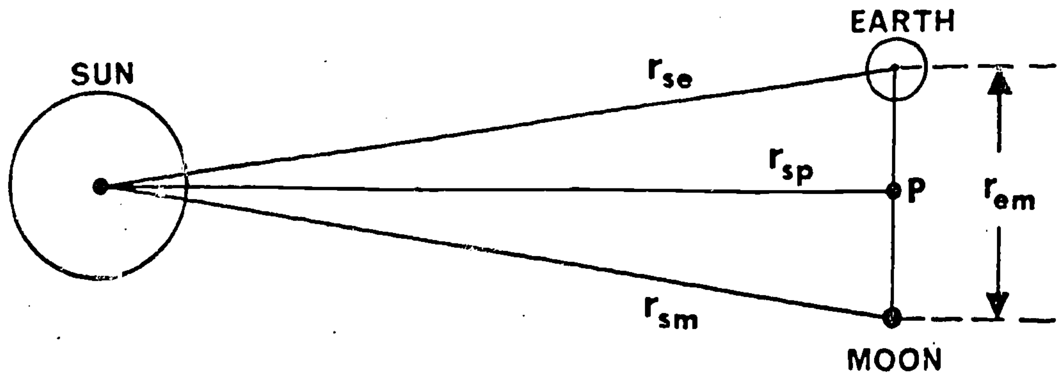
A. he would weigh the same
B. 3.62 nt more
C. 2.36 nt more
D. 2.36 nt less

Reading Assignment:

Halliday and Resnick: Ch. 16, Sect. 5

Problem 15: Gravitational Field Strength

15.



Referring to the diagram, point P is midway along the line from the Earth to the moon. This line is normal to the radius vector from the sun to P, so the Earth and the moon are equidistant from the sun. Neglecting the effects of other members of the solar system, compute the gravitational field strength at P.

A. 1.25×10^{-2} nt/kg; at an angle of 28° to the left of the line going from P to the sun

B. 1.25×10^{-2} nt/kg; at an angle of 62° above the line going from P to the moon

C. 5.9×10^{-3} nt/kg; directly toward the sun

D. 5.9×10^{-3} nt/kg; directly away from the sun

Reading Assignment:

Halliday and Resnick: Ch. 16, Sect. 8

Joseph and Leahy: Part I, Ch. 4, Sect. 3, Fr 1-58

SEGMENT 13

GRAVITATION

Problem 19: Gravitational Effects of Spherically Symmetric Mass Distribution

19. Consider a sphere of radius R and total mass M, having uniform mass density. Calculate the gravitational field associated with this sphere as a function of r, the distance of the field point from the center of the sphere.

A. $\gamma = -\frac{GM}{r^2}$ everywhere

B. $\gamma = 0$ for $r < R$; $\gamma = -\frac{GM}{r^2}$ for $r > R$

C. $\gamma = -\frac{GM}{R^3} r$ for $r < R$; $\gamma = -\frac{GM}{r^2}$ for $r > R$

D. $\gamma = -\frac{GM}{R^2}$ for $r < R$; $\gamma = -\frac{GM}{r^2}$ for $r > R$

Reading Assignment:

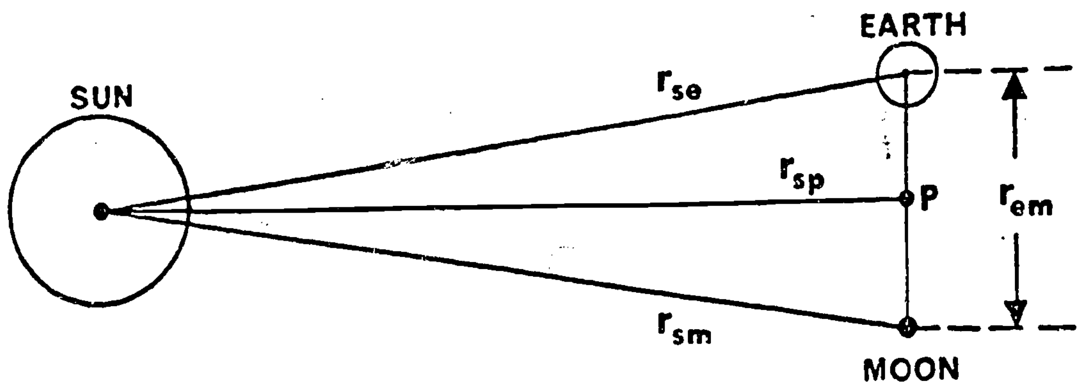
Halliday and Resnick: Ch. 16, Sect. 6

SEGMENT 14

GRAVITATIONAL POTENTIAL ENERGY

Problem 1: Gravitational Potential Energy

1.



Referring to the diagram, what is the work required to bring a spaceship of mass m to the position P (halfway between the Earth and moon) from infinity? Assume that the Earth, moon, and sun are stationary.

A. $-Gm\left(\frac{M_s}{r_{sp}} + \frac{M_e}{r_{em}} + \frac{M_m}{r_{em}}\right)$

B. $-Gm\left(\frac{M_s}{r_{sp}} + \frac{2M_e}{r_{em}} + \frac{2M_m}{r_{em}}\right)$

C. $-Gm\left(\frac{2M_s}{r_{sp}} + \frac{2M_e}{r_{em}} + \frac{2M_m}{r_{em}}\right)$

D. $-Gm\left(\frac{2M_s}{r_{sp}} + \frac{2M_e}{r_{em}} + \frac{M_m}{r_{em}}\right)$

Reading Assignment:

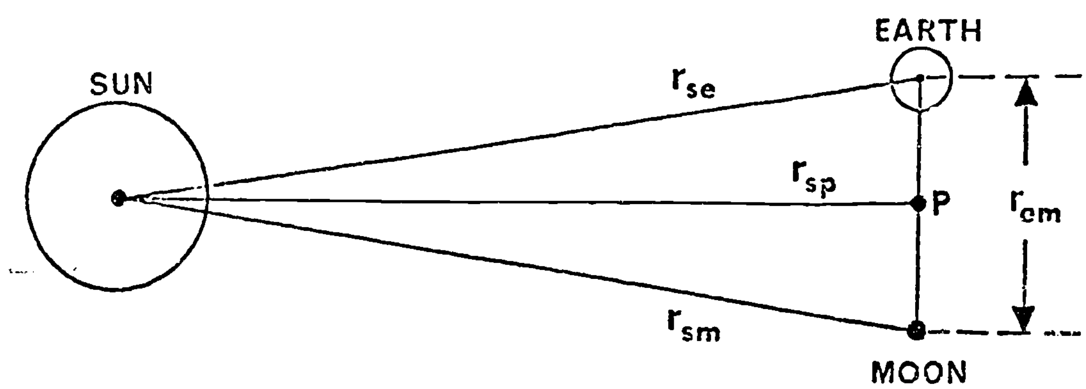
Halliday and Resnick: Ch. 16, Sect. 9, 10

SEGMENT 14

GRAVITATIONAL POTENTIAL ENERGY

Problem 6: Gravitational Potenial

6. What is the gravitational potential at the point P (halfway between the Earth and moon) in the diagram?



A. $-G\left[\frac{M_s}{r_{sp}} + \frac{M_e}{r_{em}} + \frac{M_m}{r_{em}}\right]$

C. $-G\left[\frac{2M_s}{r_{sp}} + \frac{2M_e}{r_{em}} + \frac{2M_m}{r_{em}}\right]$

B. $-G\left[\frac{M_s}{r_{sp}} + \frac{2M_e}{r_{em}} + \frac{2M_m}{r_{em}}\right]$

D. $-G\left[\frac{2M_s}{r_{sp}} + \frac{2M_e}{r_{em}} + \frac{M_m}{r_{em}}\right]$

Reading Assignment:

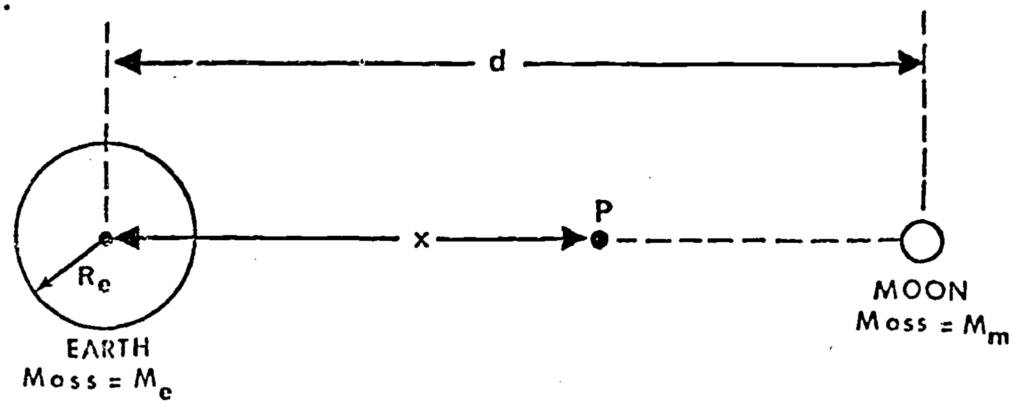
Halliday and Resnick: Ch. 16, Sect. 9

SEGMENT 14

GRAVITATIONAL POTENTIAL ENERGY

Problem 10: Conservation of Energy in the Gravitational Field

10. In the figure below, the gravitational field at point P is zero; hence, a spaceship placed there would experience no force and would remain there indefinitely if the Earth-moon system were a rigid body. (A rigid body is a body whose parts have a fixed location with respect to each other.) Suppose that the Earth-moon system were a rigid body and that the effects of all other celestial bodies were negligible; with what speed would a rocket, aimed directly toward the moon, have to leave the surface of the Earth in order that it would be "captured" at point P. Express your answer in terms of the symbols in the diagram below.



Reading Assignment:

Halliday and Resnick: Ch. 8, Sect. 3,8; Ch. 16, Sect. 9, 10

SEGMENT 14

GRAVITATIONAL POTENTIAL ENERGY

Problem 14: Escape Velocity

14. At what altitude above the Earth's surface is the escape velocity (speed) from the Earth equal to 10 km/sec? (Take the Earth's radius equal to 6400 km and its mass equal to 6×10^{24} kg.)

Reading Assignment:

Halliday and Resnick: Ch. 16, Sect. 9

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

SEGMENT 19

ELECTRIC CHARGE AND COULOMB'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:

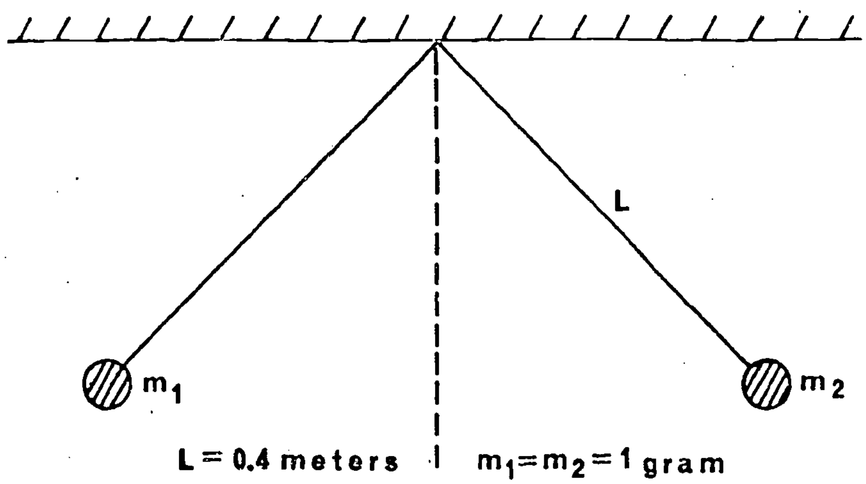
Schaum:	Ch. 22, No. 1, 2, 3

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

Problem 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

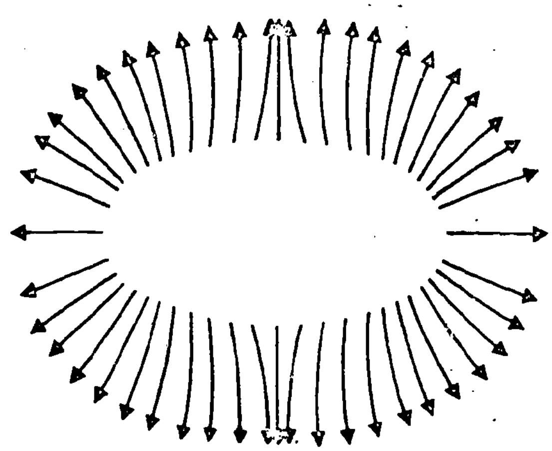
SEGMENT 20

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 field?

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



Reading Assignment:

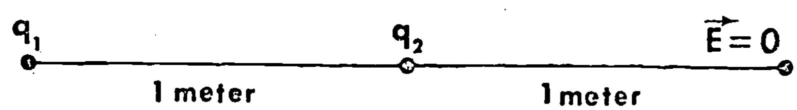
Halliday and Resnick:	Ch. 27, Sect. 3
Semat and Blumenthal:	Vol 3, Ch. 20 Fr. 34-36
Joseph and Leahy:	Part II, Ch. 2, Sect. 2, Fr. 25-30

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:

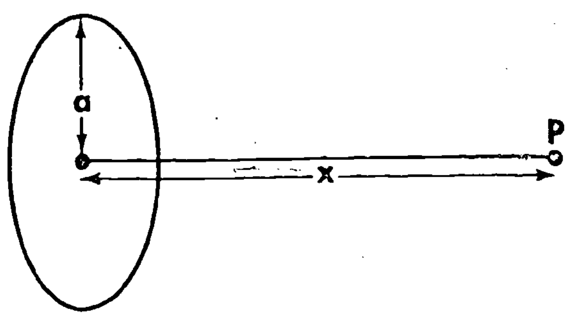
Schaum: Ch. 22, Nos. 6, 7

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

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:

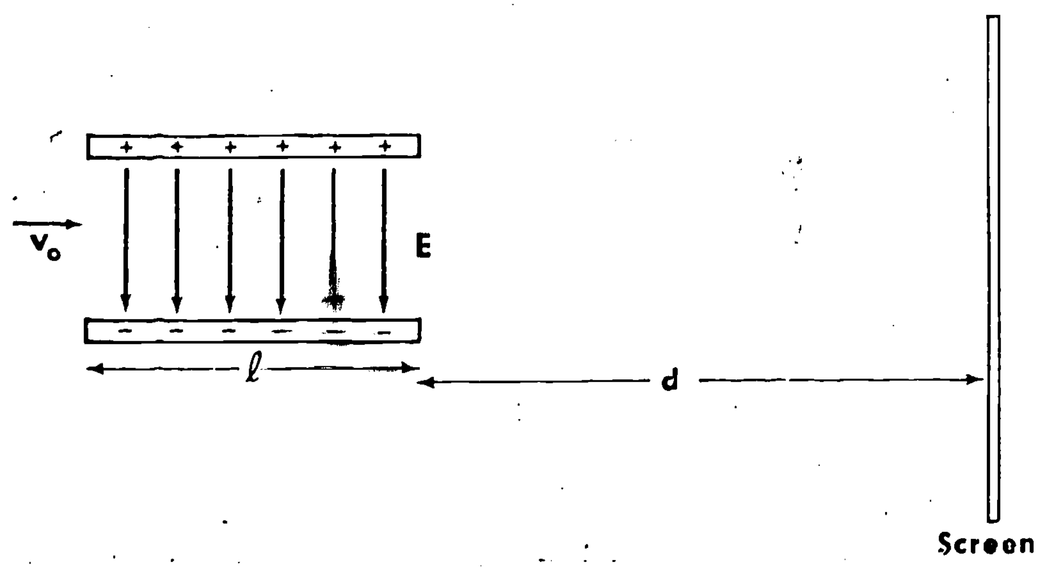
Schaum: Ch. 22, Nos. 8, 13, 15

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

ELECTR'' DIPOLES AND ELECTRIC FLUX

Problem 1: D' ction 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:

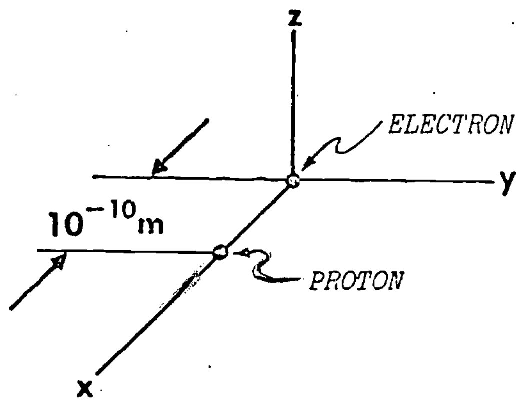
Halliday and Resnick:	Ch. 27, Sect. 4, 6
Sears and Zemansky	Ch. 26, Sect. 7

SEGMENT 22

ELECTRIC DIPOLES AND ELECTRIC FLUX

Problem 4: Electric Dipole Moment

4.



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

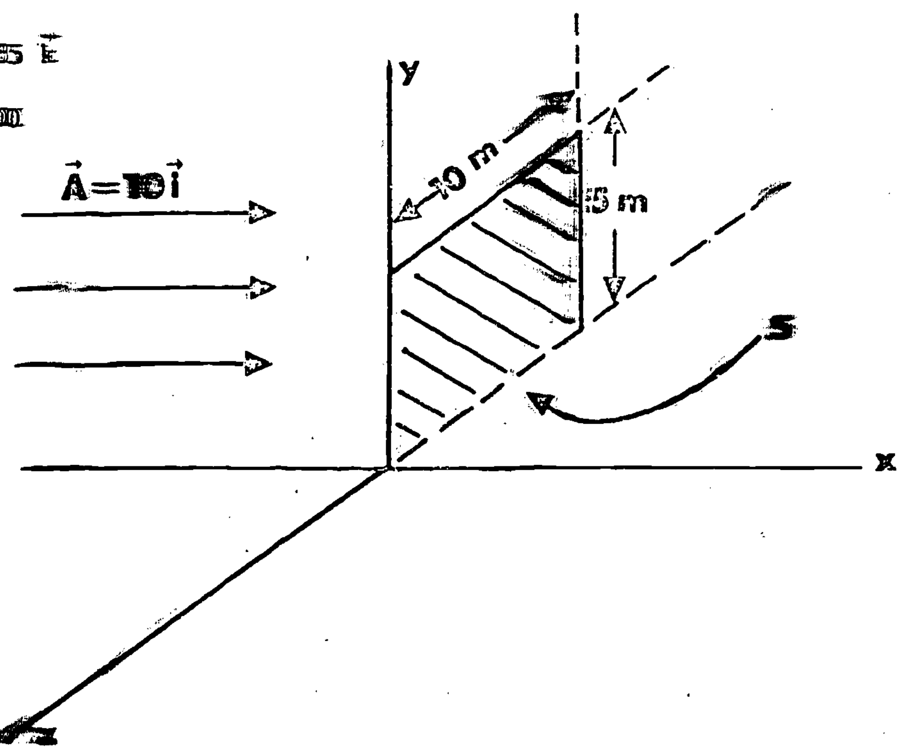
5. The vector field $\vec{A}$ shown in the diagram has a constant magnitude and direction at every point in space. The direction of $\vec{A}$ is always parallel to the x axis. What is the *flux* of the vector A through the surface S shown in the diagram?

A. 200 $\vec{j}$

B. 75

C. 25 $\vec{k}$

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

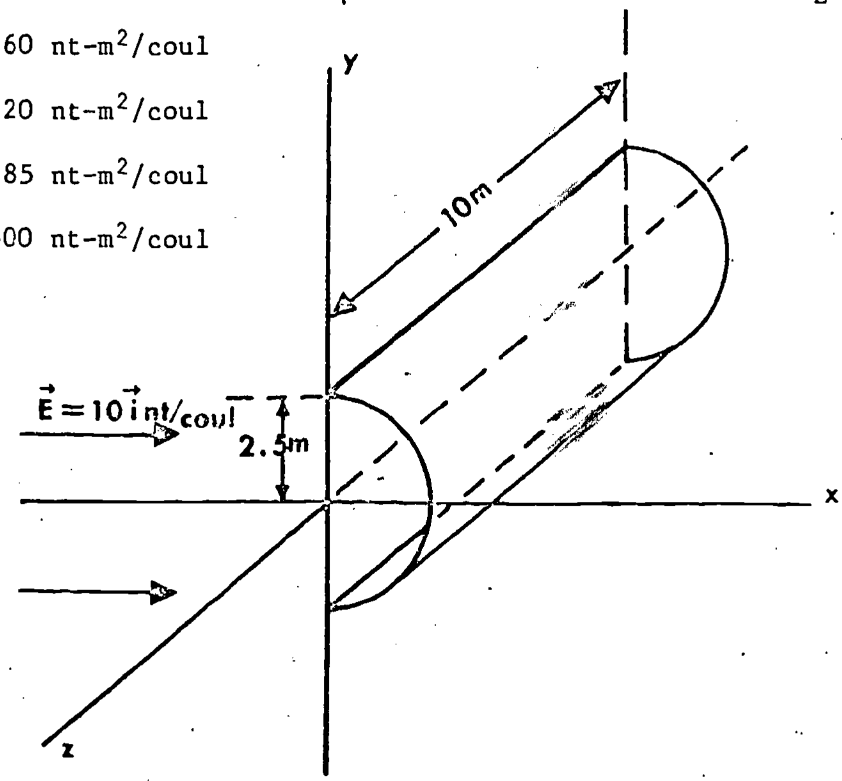
9. In the accompanying figure, a shell is shown which consists only of half a cylinder with no end surfaces. What is the value of Φ_E?

A. 360 nt-m^2/coul

B. 420 nt-m^2/coul

C. 785 nt-m^2/coul

D. 500 nt-m^2/coul



Reading Assignment:

Halliday and Resnick: Ch. 28, Sect. 1

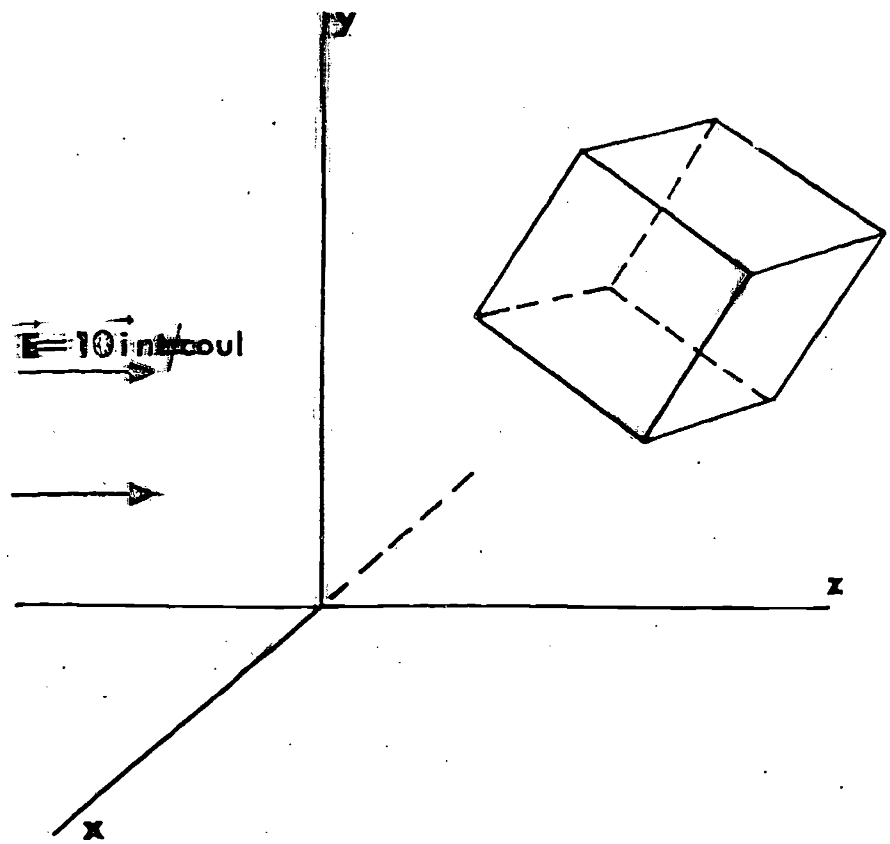
Sears and Zemansky: Ch. 25, Sect. 4

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

Problem 1: Distribution of Charge in Conducting and Non-Conducting Bodies

1. A non-conducting uniformly charged sphere (ρ = +3 coul/m^3) has a radius of one meter. The sphere is plunged into a very cold solution (temperature = 1° K) and becomes a conductor. What is the surface charge, σ, of the sphere?

   A. 1 coul/m^2
   B. 3.78 coul/m^2
   C. 0.025 coul/m^2
   D. 3 coul/m^3

Reading Assignment:

Halliday and Resnick:	Ch. 28, Sect. 4
Semat and Blumenthal:	Vol. 3, Ch. 20, Fr. 48
Joseph and Leahy:	Part II, Ch. 2, Sect. 2, Fr. 2

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

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

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

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

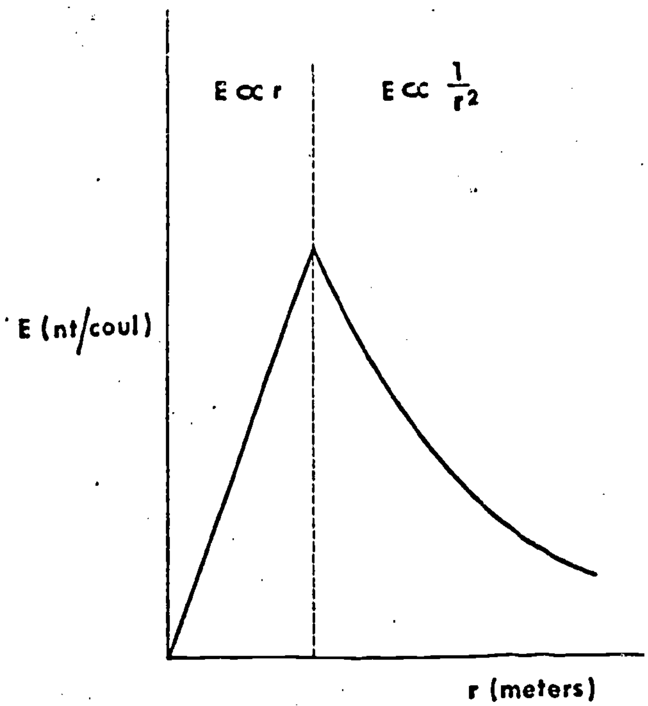
SEGMENT 23

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 shpere
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. $E = \frac{\lambda}{2\pi\varepsilon_o a}$

B. $E = \frac{\lambda}{4\pi\varepsilon_o r2}$

C. $E = \frac{\lambda}{2\pi\varepsilon_o}$

D. $E = \frac{\lambda}{2\pi\varepsilon_o r}$

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

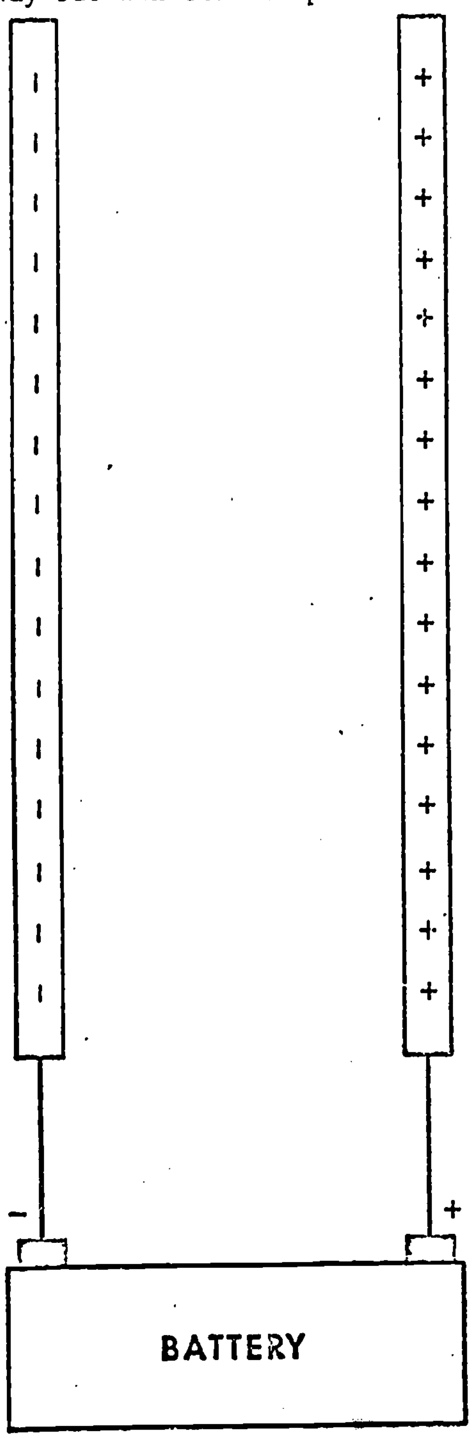
Sears and Zemansky: Ch. 25, Sect. 5, Par. 6

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:

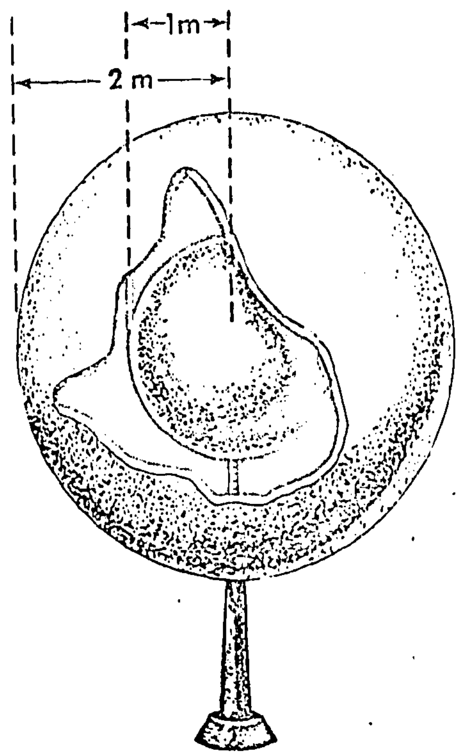
Ch. 25, Sect. 5, Par. 7

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

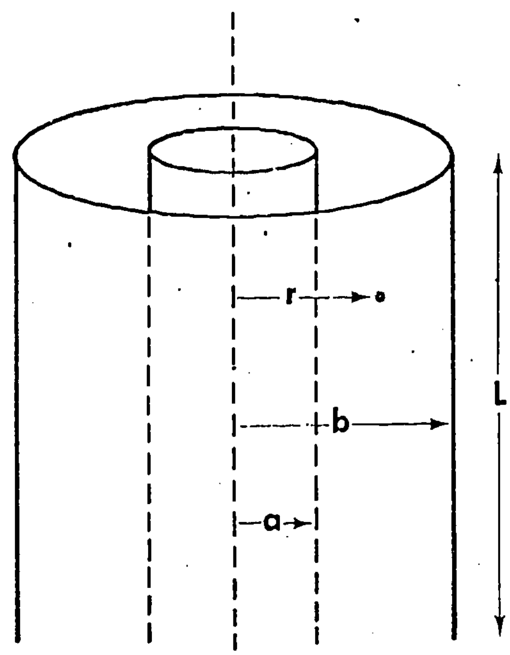
25. Two coaxial hollow metal cylinders of length L with radii a and b ($b > a$) carry charges $+q$ and $-q$ respectively. The magnitude of the electric field (neglecting edge effects) at a point $a < r < b$, measured from the common axis is

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

ECTRIC POTENTIAL

Problem 1: Wor Electric Field

1. A particular elect eld can be described by the following equation:

$$\vec{E} = \text{-}$$

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

Reading Assignment:

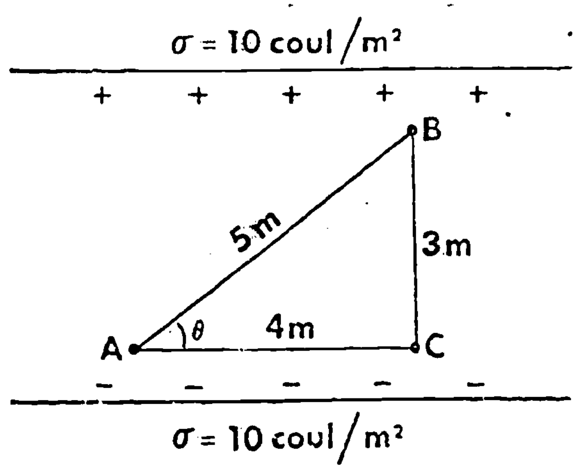
Halliday and Resnick: Ch. 29, Sect. 1, 2

SEGMENT 24

ELECTRIC POTENTIAL

Problem 6: Potential Difference in a Uniform Electric Field

6. Two parallel plates each with a surface charge density $\sigma = 10\ \text{coul/m}^2$ 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. $V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}$

B. $V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$

C. $V = \frac{1}{4\pi\varepsilon_0} qr$

D. $V = \frac{1}{4\pi\varepsilon_0} r^2$

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:

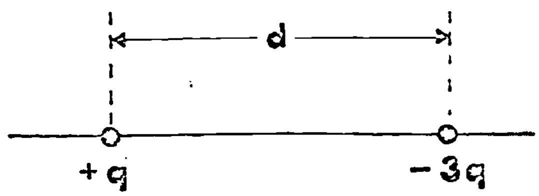
Schaum:	Ch. 22, No. 9

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 where 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.

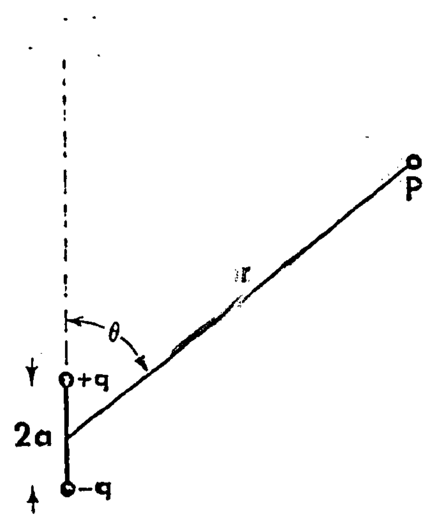
What is the y component of the electric field E_y at P?

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. $V_r - V_R = \frac{q}{4\pi\varepsilon_0}\left(\frac{1}{R} - \frac{1}{r}\right)$

B. $V_r - V_R = \frac{q}{4\pi\varepsilon_0}\left(\frac{1}{r} - \frac{1}{R}\right)$

C. $V_r - V_R = 0$

D. $V_r - V_R = \frac{1}{4\pi\varepsilon_0}\frac{2q}{r}$

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 III, 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_0, plate area, and distance between plates, then select the correct answer:

A. $C = \frac{d}{\varepsilon_0 A}$

B. $C = \frac{\varepsilon_0 A}{d}$

C. $C = \varepsilon_0 Ad$

D. $C = \varepsilon_0 d$

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)

SEGMENT 26

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

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

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

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

Reading Assignment:

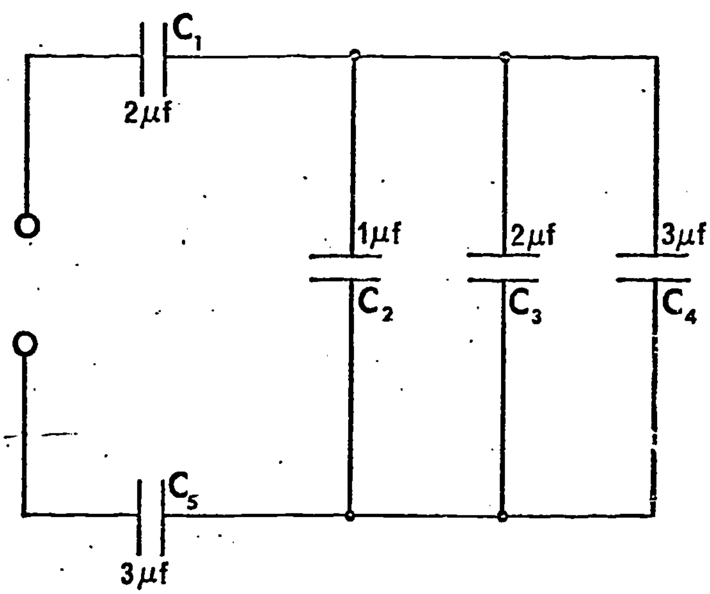
Halliday and Resnick: Ch. 30, Sect. 2

SEGMENT 26

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:

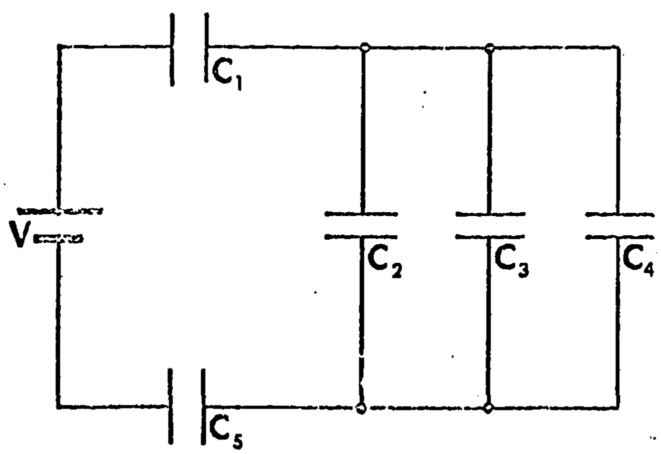
Schaum: Ch. 22, Nos. 20, 21

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

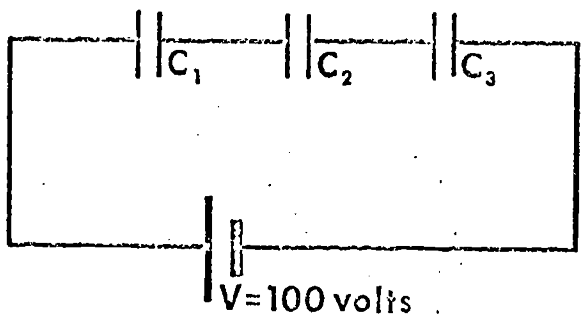
Schaum:	Ch. 22, Nos. 19, 22

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

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

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

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

Reading Assignment:

Halliday and Resnick: Ch. 30, Sect. 5

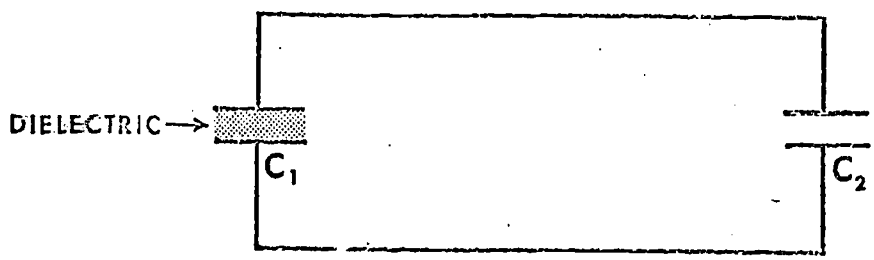
Semat and Blumenthal: Vol. 3, Ch. 21, Fr. 6-9

SEGMENT 27

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, Fr. 21-25

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

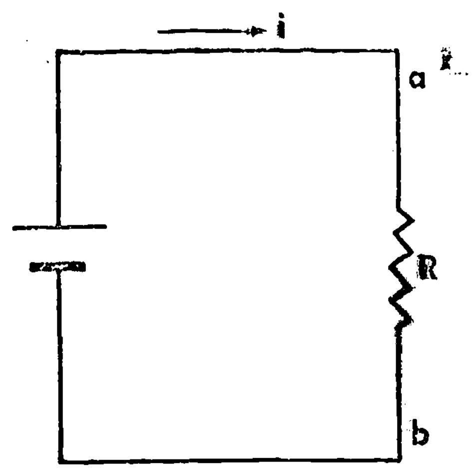
Schaum:	Ch. 23, No. 4; Ch. 25, No. 1

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 's 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:

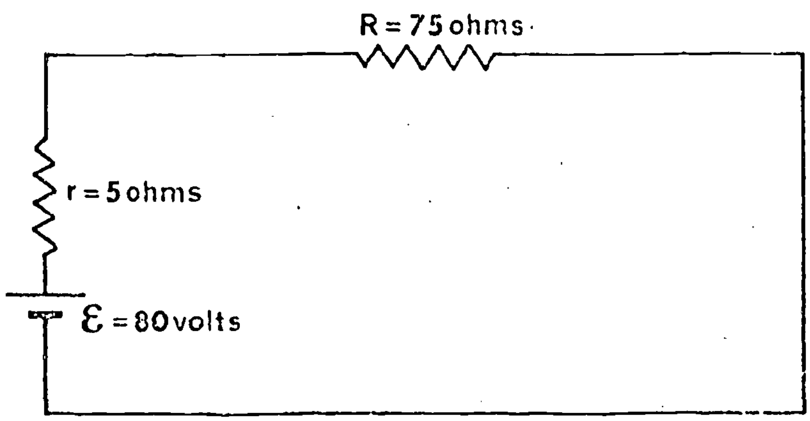
Halliday and Resnick:	Ch. 32, Sect. 1
Joseph and Leahy:	Part II, Ch. 2, Sect. 7, Fr. 1-22

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

Reading Problems:

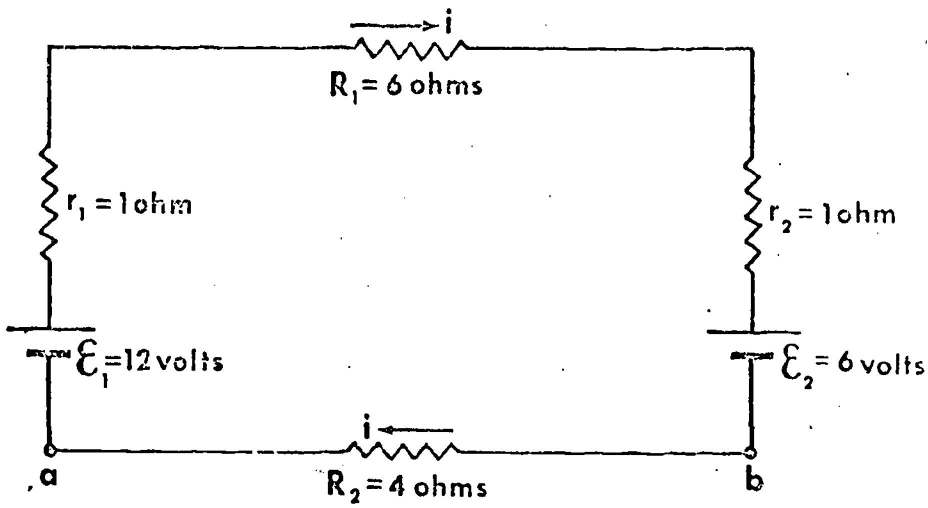
Schaum:	Ch. 24, Nos. 4, 6

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:

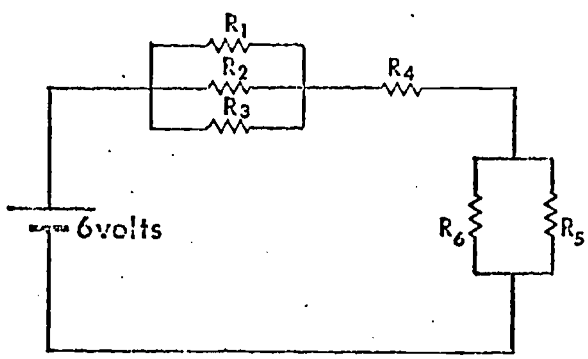
Halliday and Resnick: Ch. 32, Sect. 5

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

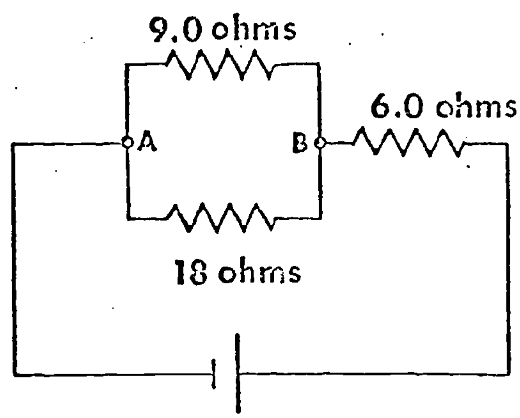
10. In this circuit, the voltage drop across the 6.0-ohm resistor is

A. equal to V_{AB}

B. greater than V_{AB}

C. smaller than V_{AB}

D. zero



Reading Assignment:

Halliday and Resnick:	Ch. 32, Sect. 4, 5
Semat and Blumenthal:	Vol. 3, Ch. 22, Fr. 26,27
Joseph and Leahy	Part II, Ch. 3, Sect. 8, Fr. 1-8

Related Problems:

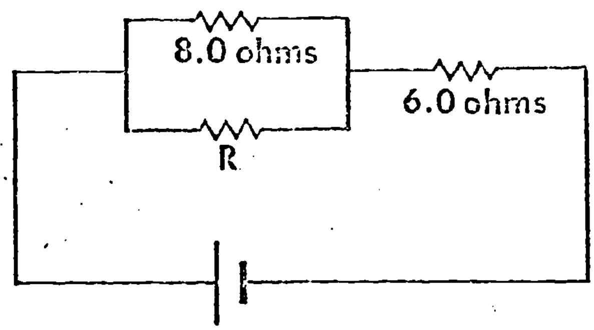
Schaum:	Ch. 25, Nos. 12, 13

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

SEGMENT 30

CIRCUITS AND KIRCHHOFF'S RULES

Problem 19: Kirchhoff's First Rule

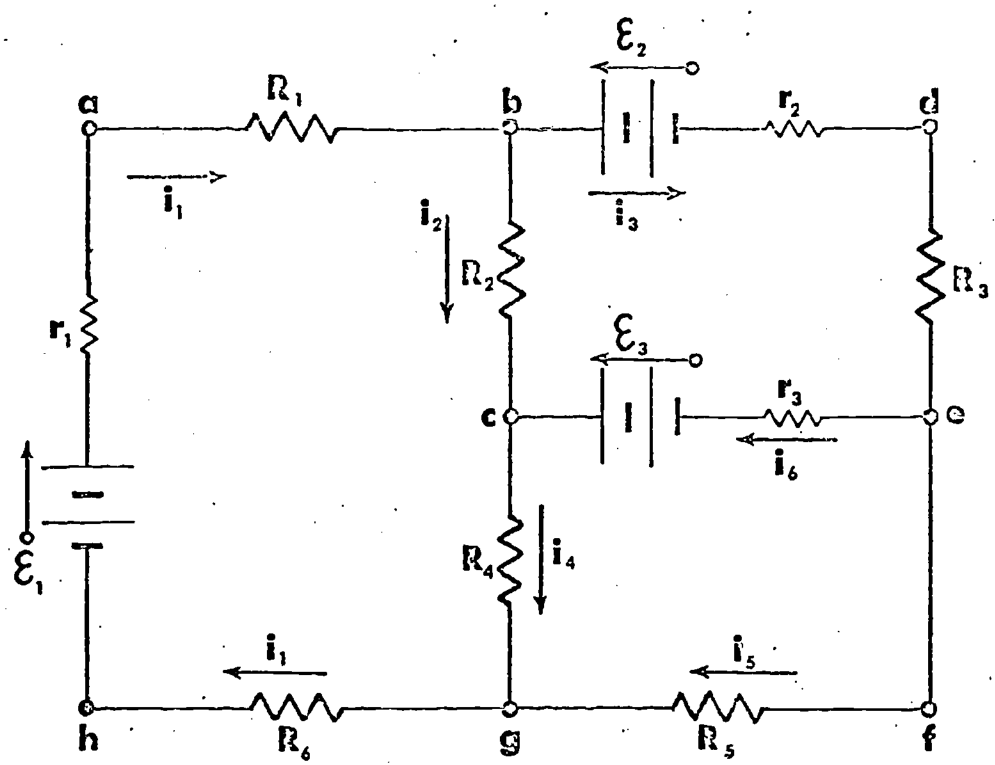
19. The current equations for the three branch points b, c, g in the accompanying circuit are, respectively

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

Related Problems:

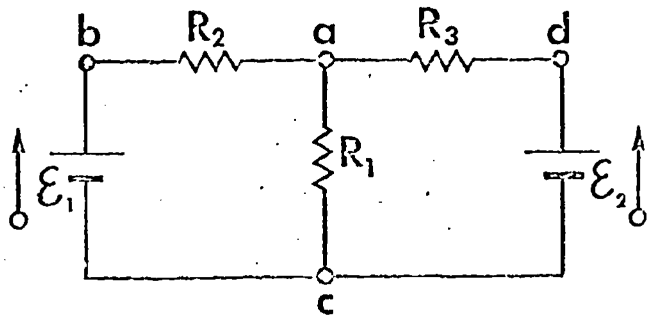
Schaum Ch. 25, Nos. 25, 26

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:

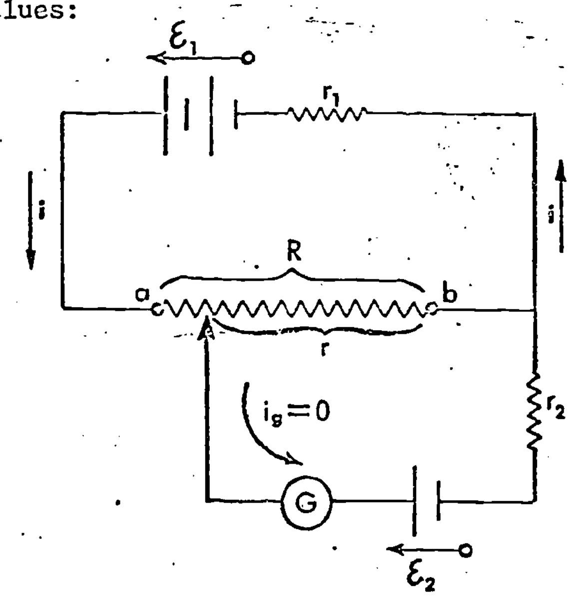
Schaum:	Ch. 29, Nos. 3,4

SEGMENT 31

AMMETERS AND VOLTMETERS

Problem 11: The Potentiometer

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



$R = 100$ ohms $\varepsilon_1 = 9$ volts

$r = 68$ ohms $\varepsilon_2 = ?$

$r_1 = r_2 = 2$ ohms

Calculate the value of ε_2.

Reading Assignment:

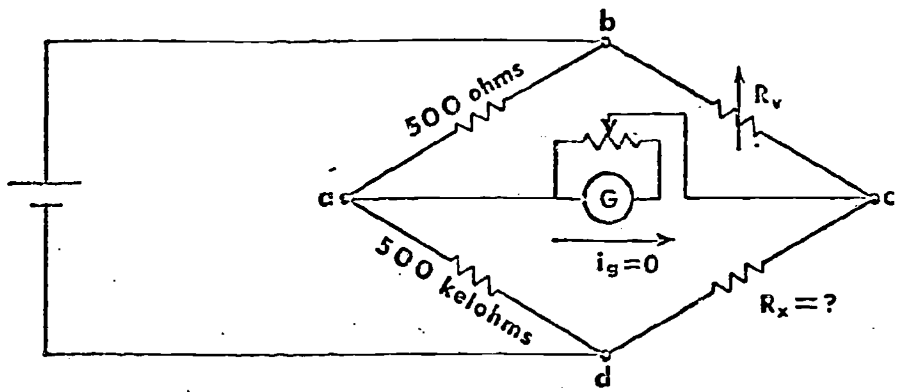
Halliday and Resnick:	Ch. 32, Sect. 7
Sears and Zemansky:	Ch. 29, Sect. 6
Semat and Blumenthal:	Vol. 3, Ch. 23, Fr. 28-29

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

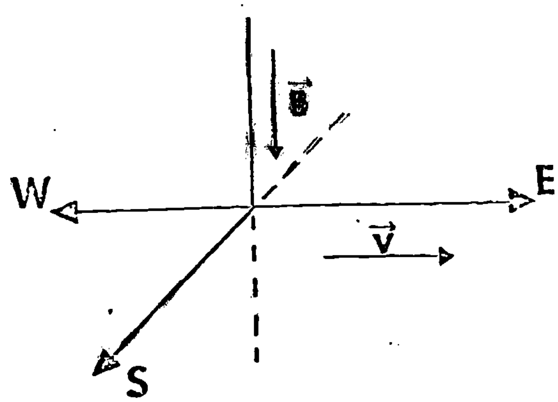
Semat and Blumenthal: Vol. 3, Ch. 22, Fr. 30-33

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, 15-22

Related Problems:

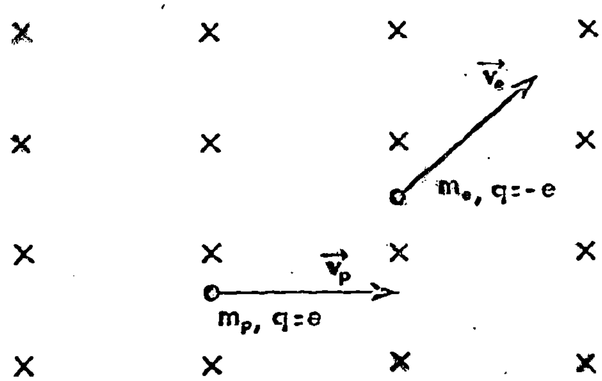
Schaum:	Ch. 27, No. 12

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:

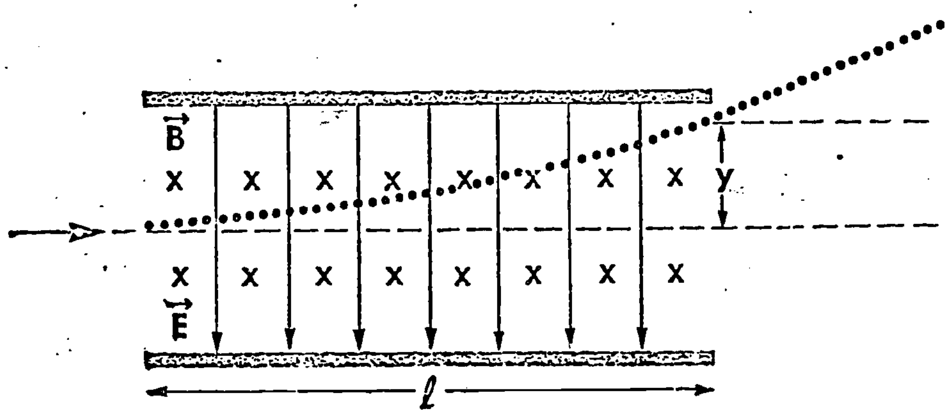
Schaum:	Ch. 27, No. 16

SEGMENT 32

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:

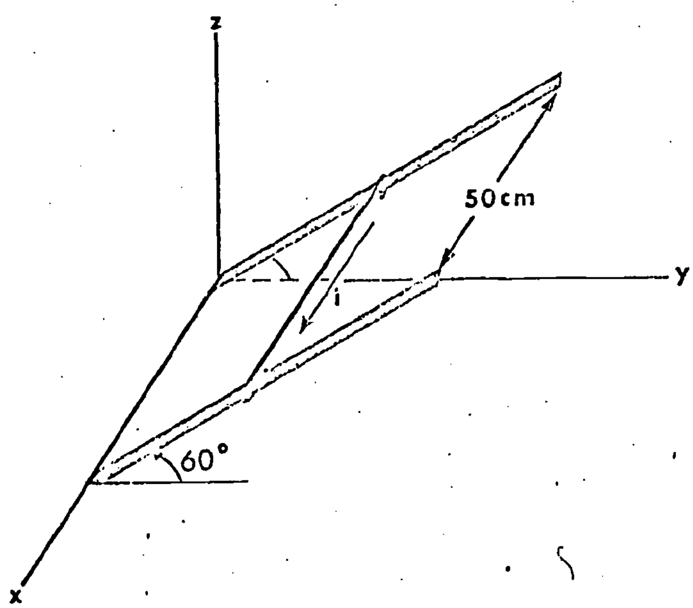
Schaum:	Ch. 27, No. 13

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

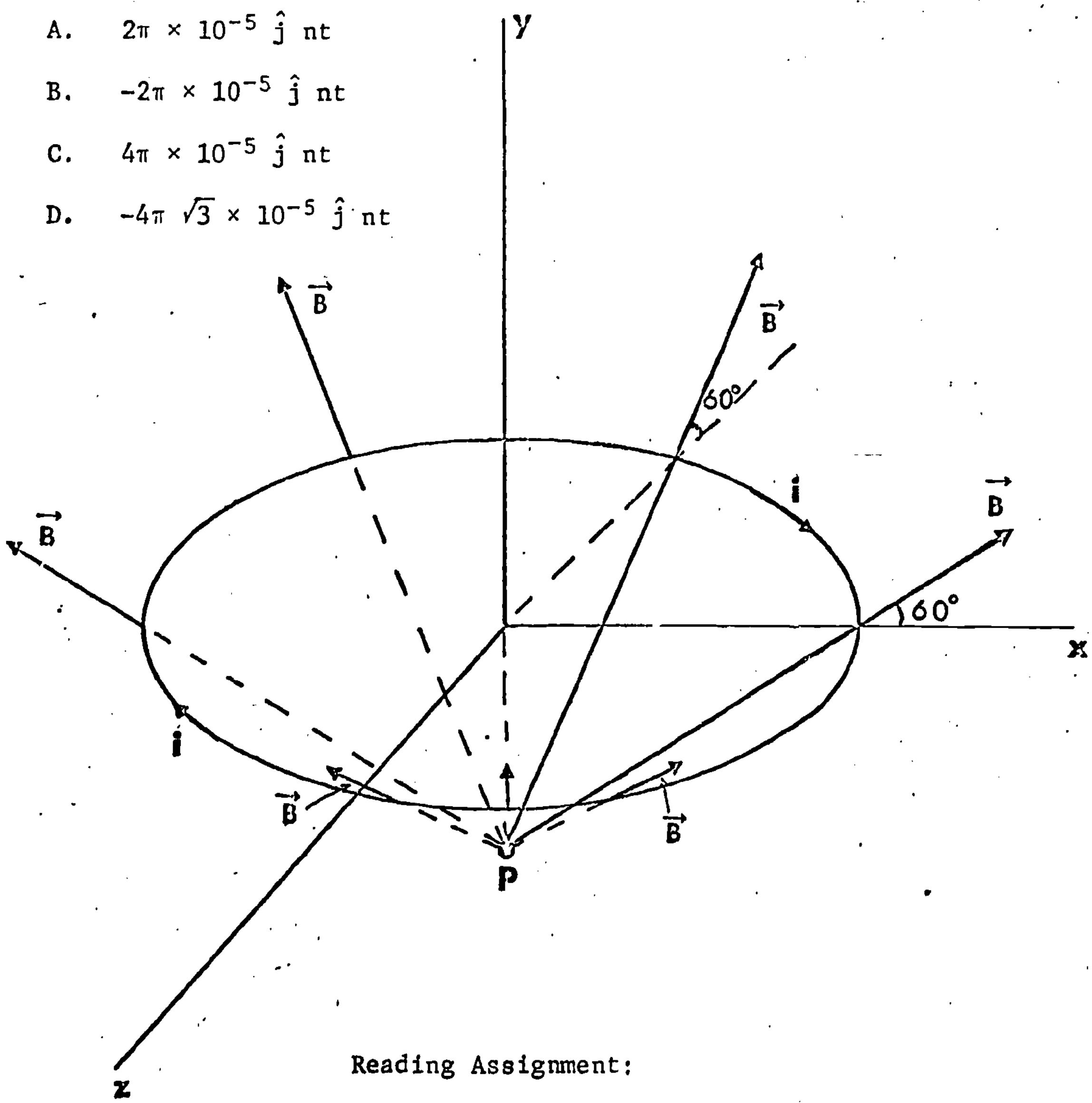
5. A circular loop of radius 40 cm carries a current of 1 milliampere in the sense shown in the diagram. The loop is placed in a symmetrically diverging magnetic field such that $\vec{B}$ is everywhere perpendicular to the loop itself and makes an angle of 60° with the plane of the loop (the plane of 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. $-4\pi\sqrt{3} \times 10^{-5}\ \hat{j}$ nt



Reading Assignment:

Halliday and Resnick: Ch. 33, Sect. 3

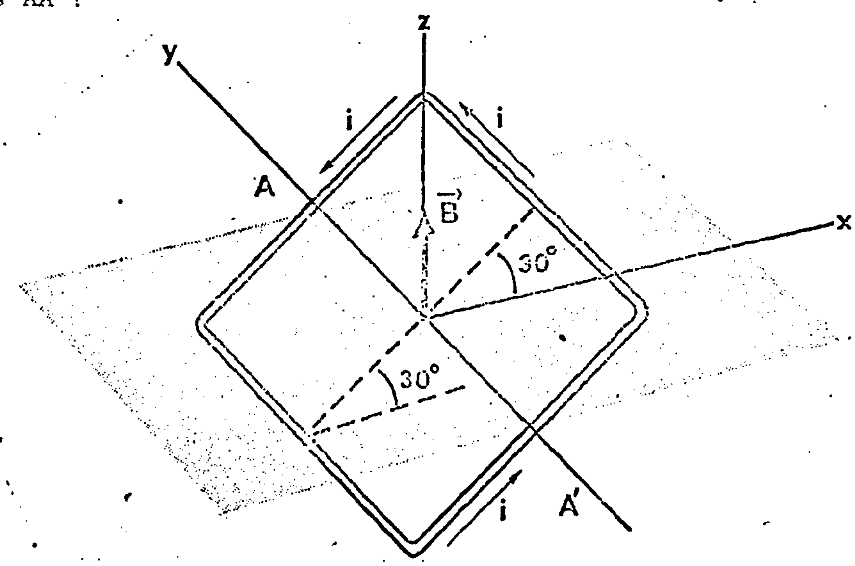
Sears and Zemansky: Ch. 31, Sect. 1, 3

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:

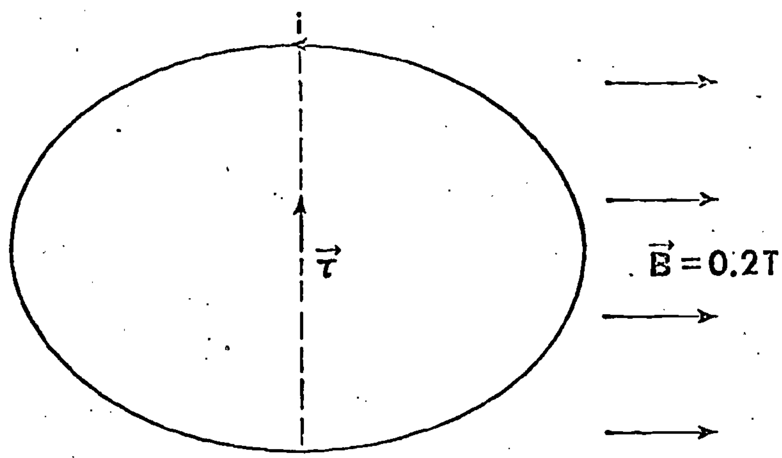
Schaum: Ch. 27, No. 9

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:

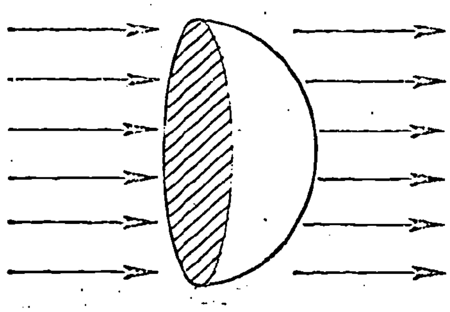
Halliday and Resnick: Ch. 33, Sect. 4

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), 1
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 unifo[illegible] 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

AMPERE'S 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:

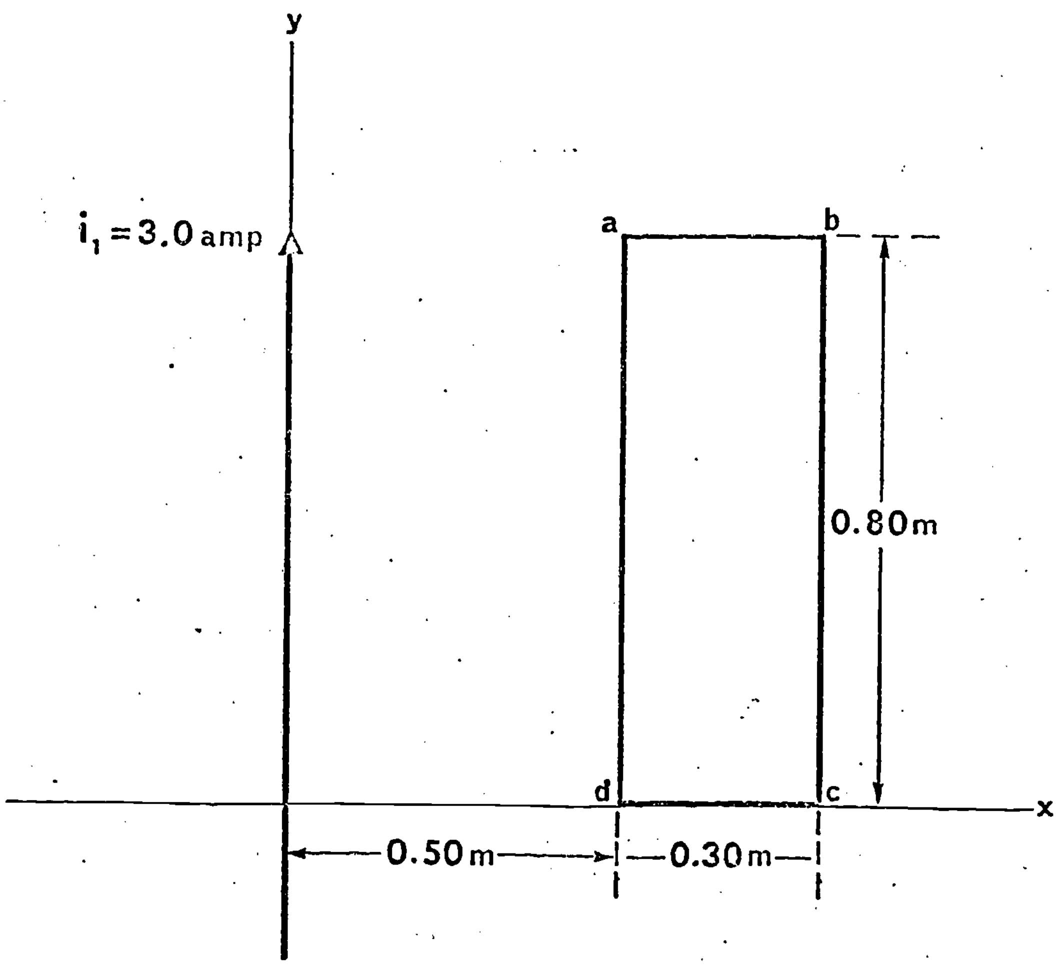
Schaum:	Ch. 27, Nos. 7,8

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:

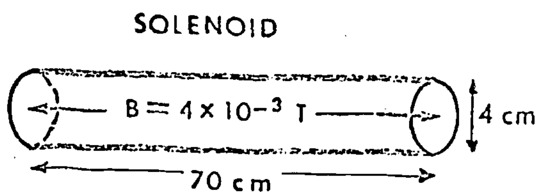
Schaum:

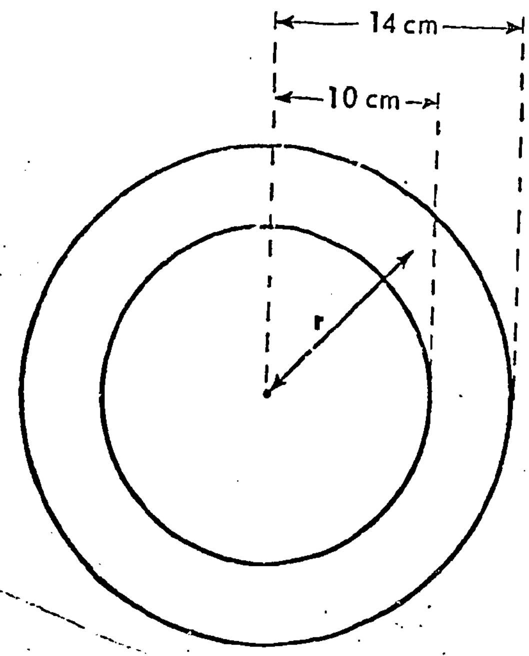
SEGMENT 36

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:

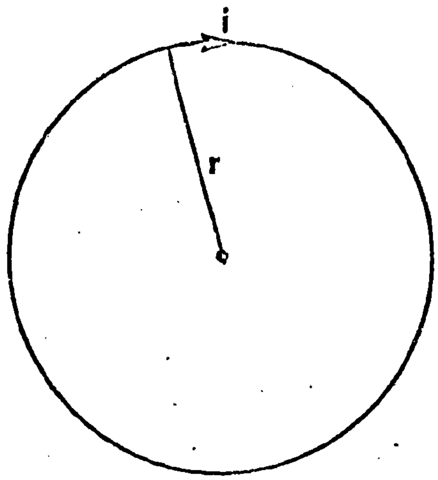
Halliday and Resnick:	Ch. 34, Sect. 5
Sears and Zemansky:	Ch. 32, Sect. 6

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. $B = \frac{\mu_0 i}{2\pi r}$

B. $B = \frac{\mu_0 i}{2r}$

C. $B = \frac{\mu_0 i}{2r^2}$

D. $B = \frac{\mu_0 i}{4\pi r^2}$

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:

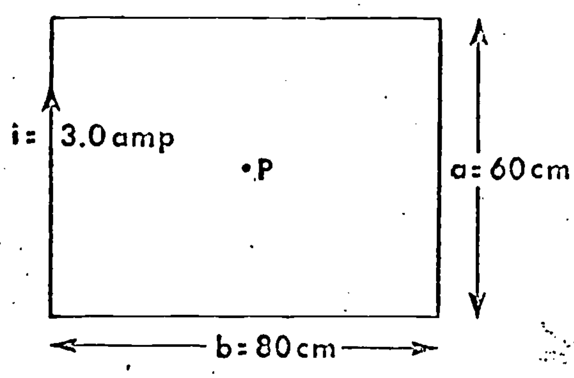
Schaum:	Ch. 27, Nos. 2,4

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:

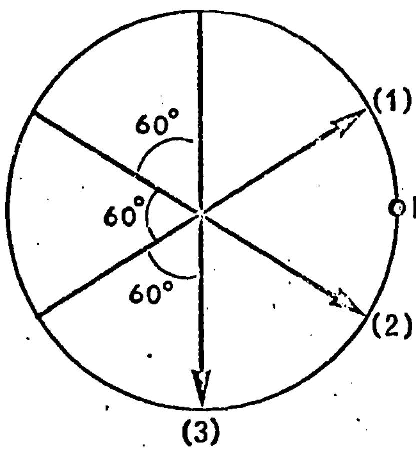
Halliday and Resnick: Ch. 34, Sect. 6

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:

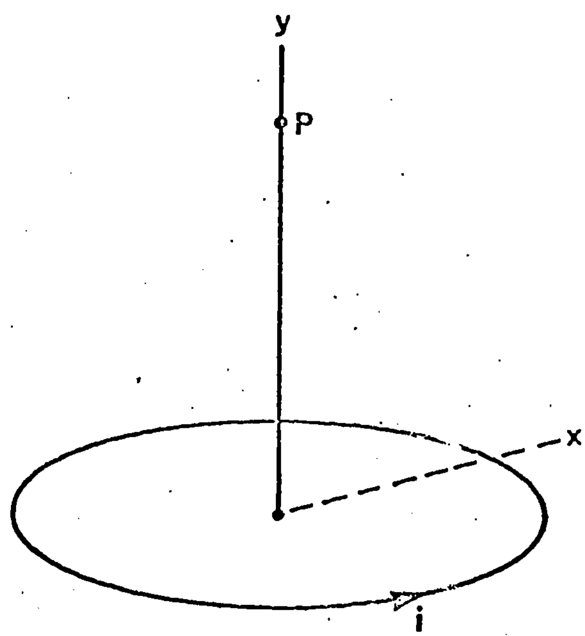
Halliday and Resnick:	Ch. 34, Sect. 6
Sears and Zemansky:	Ch. 32, Sect. 1, 2

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

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

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

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

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:

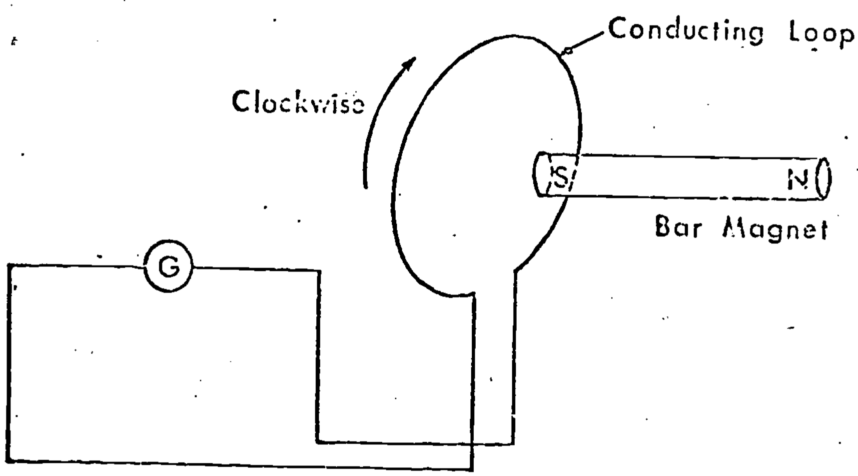
Schaum:	Ch. 30, No. 2

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:

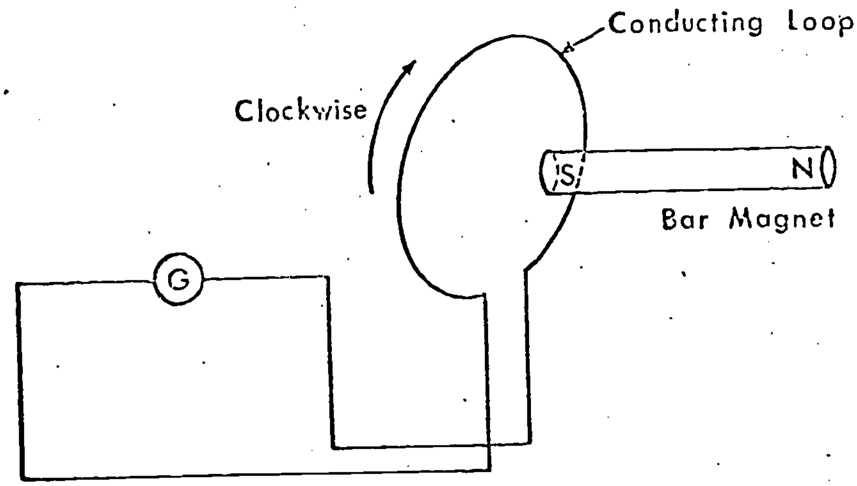
Schaum: Ch. 30, No. 5

SEGMENT 37

FARADAY'S LA[illegible] [illegible]DUCTION

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

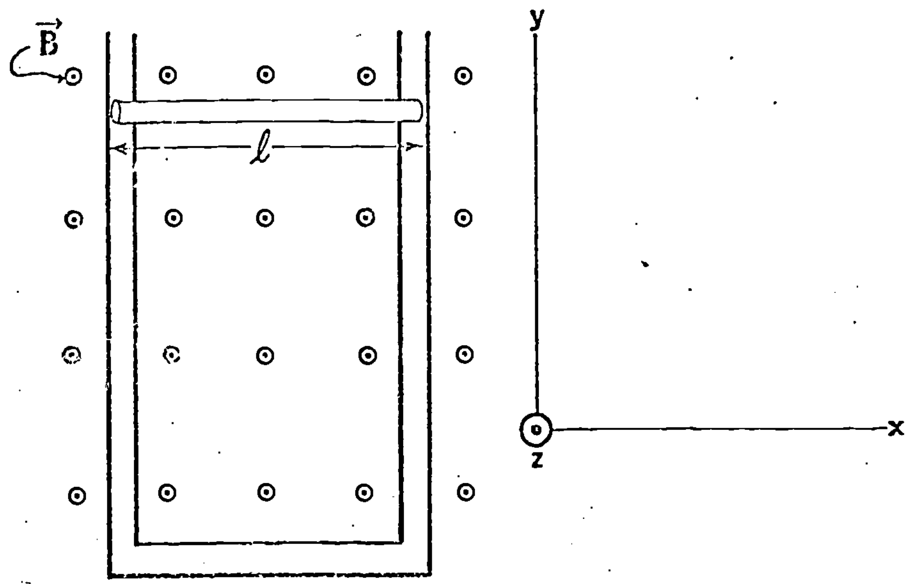
14. A wire of length ℓ, mass m and resistance R slides without friction vertically downward along parallel conducting rails of negligible resistance as shown in the diagram. The rails are connected to each other at the bottom by a conductor of negligible resistance. The wire and the rails form a closed 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:

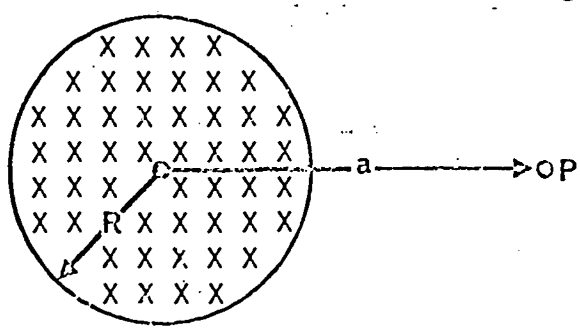
Schaum: Ch. 30, No. 1

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 $\mu_0 N i/(\pi a + \pi b)$, find the self-inductance.

A. $(1/4)\ \mu_0 N\ (b - a)^2/(b + a)$

B. $(1/4)\ \mu_0 N^2\ (b - a)^2/(b + a)$

C. $\mu_0 N b^2/(b + a)$

D. $\mu_0 N^2 b^2/(b + a)$

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 Sto[illegible] 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. $\frac{\mu_o i^2}{8\pi^2 r^2}$

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

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

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

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

SEGMENT 40

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

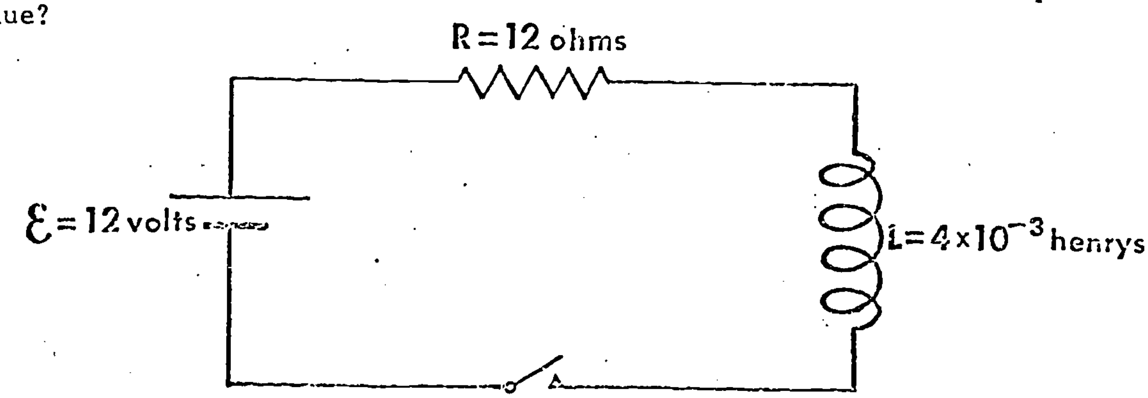
Sears and Zemansky: Ch. 33, Sect. 12

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

RATIONALES FOR

SEQUENCING OBJECTIVES

Abstract: This document contains the criteria for subject matter sequencing in the design of the multimedia physics course.

CRITERIA FOR SUBJECT MATTER SEQUENCING

The sequencing for a majority of topics was dictated by the fact that the concepts of techniques contained in one topic are often prerequisite to the treatment of a second topic. In behavioral terms, the terminal objectives of an earlier topic are enabling objectives for succeeding topics. We will refer to those subject matter sequences which are mandated by this condition as "Subject matter constrained sequences" (SMCS). The broad SMCS are shown in the accompanying figures.

The remaining ordering of the material (within the constraints imposed by the subject matter) is established according to the criteria of "inclusion" and student difficulty. The inclusion criterion requires that when Topic B has most of the terminal objectives of Topic A as enabling objectives, then Topic B must immediately follow Topic A. This criterion receives the highest priority in subject matter sequencing, because evidence indicates that forgetting is a function of intervening learning rather than a function of elapsed time (1) and immediate use of prior terminal objectives tends to reinforce them.

The following are sequences established by the inclusion criterion:

Kinematics → Relative motion

Work and energy → Potential energy and conservation of energy

Conservation of momentum → Collisions

Circular motion (kinematics) → Circular motion (dynamics)

Charge and Coulomb's Law → Electric field → Gauss's Law

Currents and Ohm's Law → Kirchhoff's Rules

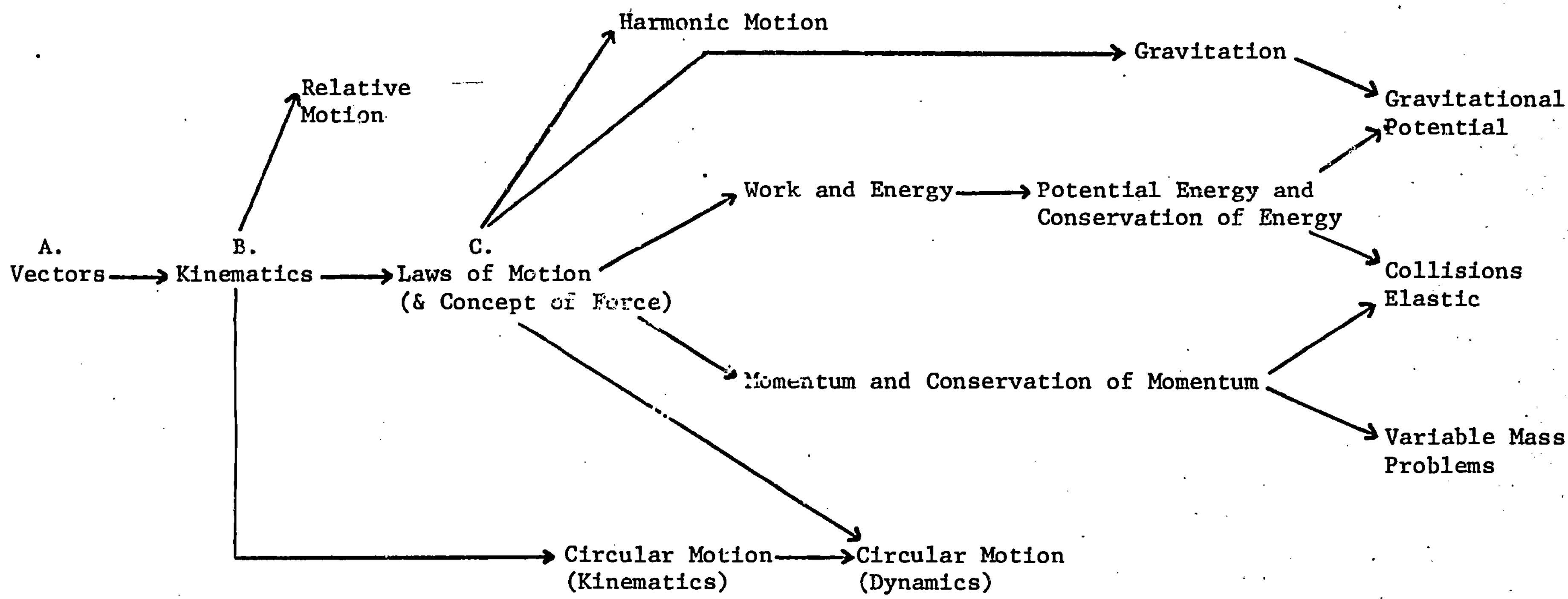
Student difficulty is employed as a sequencing criterion so that those topics which, in the experience of the teaching physicists, are most difficult for students are placed nearest the end of the course. This rule is based upon the assumption that a student gains maturity (facility in mathematical manipulations and rapid recognition of the principles and techniques involved) and sophistication (a backlog of concepts to rely upon) as the course progresses. Since new material should be less difficult for the more mature and sophisticated physics student, the difficult topics should be put toward the end of a sequence.

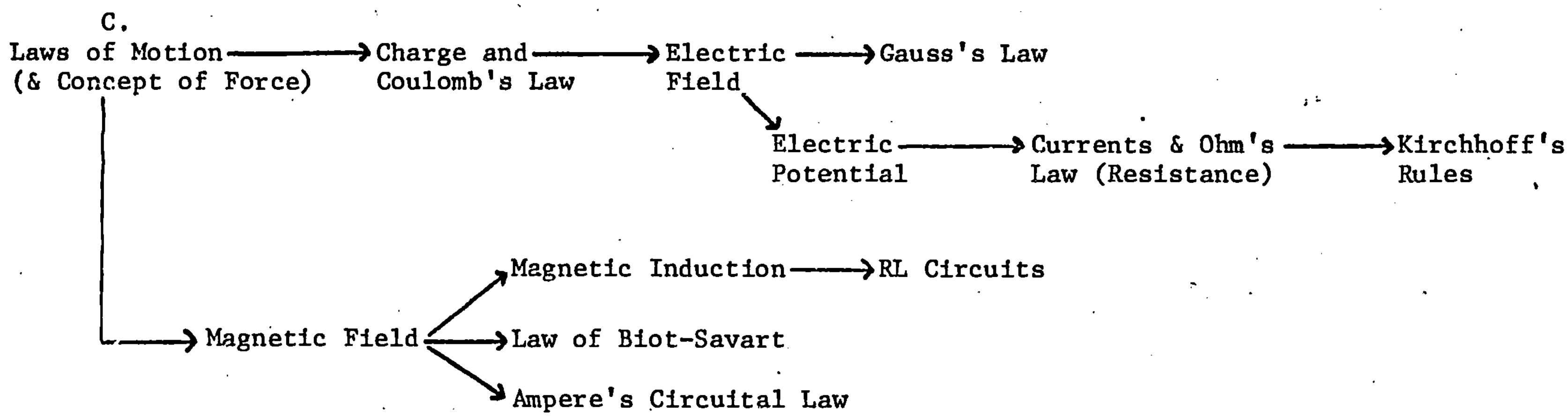
The student difficulty criterion was sufficient to dictate the remaining topic sequencing as it is contained in the Problem Books. The major decision based on student difficulty was to treat all of mechanics before treating any electricity and magnetism.

References

[1]B.J. Underwood, Psychological Review, 64, 1957, p.49.

[2]H. Kruglak, American Journal of Physics, 33, 1965, p.255.


A.
Vectors
B.
Kinematics
Relative Motion
C.
Laws of Motion (& Concept of Force)
Harmonic Motion
Gravitation
Gravitational Potential
Work and Energy
Potential Energy and Conservation of Energy
Collisions Elastic
Momentum and Conservation of Momentum
Variable Mass Problems
Circular Motion (Kinematics)
Circular Motion (Dynamics)


C.
Laws of Motion (& Concept of Force)
Charge and Coulomb's Law
Electric Field
Gauss's Law
Electric Potential
Currents & Ohm's Law (Resistance)
Kirchhoff's Rules
Magnetic Field
Magnetic Induction
RL Circuits
Law of Biot-Savart
Ampere's Circuital Law