Objective 4  Electrical Potential (Uniform Field)

i) Define electric potential. Calculate the potential difference between two points in a uniform electric field.

ii) Calculate the work one must do against electrical forces in moving a point charge between two points in a uniform electric field.

ii) Calculate the potential difference between two points, given the value of a charge and the work involved in transporting it between the two points.

iii) Determine the motion of a charged particle accelerated through a known potential difference in a uniform electric field.

Suggested Study Procedures

Study Sec. 23-1 and 23-2 (uniform E). Please note that in defining electric potential, we will emphasize the work that you do against the electric force, while your textbook emphasizes the work done by the electrical force. One is the negative of the other. Potential difference can be defined as: the work that you do against electric forces in moving a positive test charge (+q) at constant speed from point a to point b, divided by +q.

\[
W \text{ (by you)} = +q \left( V_b - V_a \right)
\]

Study carefully Example 23-3. Note that the formula \( W = Fd \) only applies for a constant force, which is the case in this example.

Suggested Problems related to Objective 4:

Chapter 23, Problems: 13, 15, 25, 38, 39, 65
Objective 5  Electric Potential (nonuniform field)

i) Calculate the potential (relative to $\infty$) that exists at a specified location in space due to:
   a) a stationary point charge, given its value and location
   b) two or more stationary point charges, given their respective values and locations.

ii) Calculate the work one must do against electrical forces in moving a point charge between two points in the vicinity of another point charge.

iii) Calculate the work one must do in assembling a given arrangement of two or more charges.

iv) Apply conservation of energy (kinetic and electrical potential) to problems involving charged particles moving in electrostatic fields.

Suggested Study Procedures

Study Sec. 23-1 and 23-2 (point charges), and sec. 23-3. It is important to note that only potential difference is physically meaningful. For point source charges, when we talk about the potential at a point we mean implicitly the potential with respect to infinity.


Suggested Problems Related to Objective 5:

Chapter 23, Problems: 1, 5, 9, 16, 19, 23, 25

Objective 6  Potential and Electric Field

Be able to relate an electric field to its corresponding potential. Given an electric field configuration be able to construct equipotential lines and given a configuration of equipotential lines, be able to construct electric field lines associated with the equipotentials.

Suggested Study Procedures

Study Sec. 23-4. Look over Sec. 23-5. We will emphasize one-dimensional or radially symmetric potential variations in this course, so $E_x = -\frac{dV}{dx}$ or $E_r = -\frac{dV}{dr}$.

Suggested Problems Related to Objective 6:

Chapter 23, Problems: 44, 48, 49
Objective 7  Capacitance

a) Define capacitance

b) Given a set of capacitors in a series-parallel configuration, connected to a voltage source:
   i) calculate the equivalent capacitance of the set;
   ii) explain how charge is distributed among the capacitors, and how the potential changes across each capacitor;
   iii) calculate the charge stored on each and the potential drop across each capacitor.

Suggested Study Procedures

Study Sec. 24-1 and 24-2 giving particular attention to Examples 24-2, 24-5 and 24-6. Look over Example 24-4, which will be discussed in lecture; however, you can ignore Example 24-3.

Suggested Problems Related to Objective 7:

Chapter 24, Problems: 1, 2, 6, 12, 17, 20, 54, 56

Objective 8  Capacitors and Energy, Electric-Field Energy

a) Calculate the electrostatic energy stored in charged capacitors.

b) Calculate the final electrostatic energy in capacitors which have been initially independently charged and then connected together.

c) Calculate the energy density in an electric field.

Suggested Study Procedures

Study Sec. 24-3. The derivation leading to the expressions (24.9) is important. Make sure you can do problems similar to Example 24-7. Look over Sec. 24-4 and 24-5 if you'd like to learn a bit more about capacitors than we are covering in this course.

Suggested Problems Related to Objective 8:

Chapter 24, Problems: 24, 28, 29, 30
HOMEWORK ASSIGNMENTS FOR STUDY GUIDE 2

Homework Assignment #5 - due by 5:00 pm Monday, March 30

Just as with Assignment #4, this assignment is to be submitted via the web. In your web browser, go to www.masteringphysics.com. Then login using the username and password you have chosen.

IF YOU ARE USING A USED OR BORROWED MASTERING PHYSICS ACCOUNT: go to the course website and click on the link for “Mastering Physics information” for information about enrolling, or go to the direct URL at users.wpi.edu/~physics/ph1120d15/mp.html

After logging in, click on Assignment List and select Assignment #5. In the Mastering Physics problems, you will get 10 chances to submit a correct answer. If your first answer is incorrect, you should consider making use of the hints, and/or getting help. There is no penalty for opening a hint, and no penalty for giving a wrong answer to a hint. However, if you request an answer to a hint, you will lose some points. Also note that requesting the answer to a part of the problem results in no points for that part, so avoid doing this unless all other options have been exhausted.

Homework Assignment #6 - due in lecture Wednesday, April 1

1. The electric potential in a region of space varies only in the x direction, as given by the graph. (a) Calculate the electric field in the four regions 0<x<3, 3<x<7, 7<x<10, and 10<x<15 cm, and sketch a graph of E_x(x) for 0<x<15 cm with properly labeled and scaled axes. (b) Determine the force on a charge q = -3.5 nC placed at x = 9 cm. [express your answer in i j notation.] (c) Determine the work required by an external force to move a charge q = -3.5 nC at constant speed from x = 2 cm to x = 13 cm.

2. Three point charges are located as follows: charge A (-10 nC) at the origin, charge B (15 nC) at [x=0, y=6 cm], and charge C (9 nC) at [x=8 cm, y=0]. Find the electric potential at point P with coordinates [x=8 cm, y=6 cm].
Homework Assignment #7 - due in lecture Friday, April 3

1. A point charge $q_1 = -5.80 \ \mu C$ (1 $\mu C = 10^{-6}$ C) is held stationary at the origin. A second point charge $q_2 = 4.30 \ \mu C$ moves from the point $A$ [$x=26 \ \text{cm}, y=0$] to the point $B$ [$x=38 \ \text{cm}, y=0$]. (a) How much work is done by the electric force on $q_2$? (b) If the charge $q_2$ is now released with zero initial speed, and with charge $q_1$ still held stationary at the origin, what is the kinetic energy of charge $q_2$ when it returns to point $A$?

2. Determine the amount of work required to assemble the following three charges at the designated points, starting with the charges at infinity:

+2$q$ at $(x=0, y=0)$
$-q$ at $(x=-a, y=0)$
$-q$ at $(x=a, y=0)$

Homework Assignment #8 - due at 5:00 pm Monday, April 6

This assignment is to be submitted via the web. In your web browser, go to www.masteringphysics.com. Then login using the username and password you have chosen.

IF YOU ARE USING A USED OR BORROWED MASTERING PHYSICS ACCOUNT: go to the course website and click on the link for "Mastering Physics information" for information about enrolling, or go to the direct URL at users.wpi.edu/~physics/ph1120d15/mp.html

After logging in, click on Assignment List and select Assignment #8. In the Mastering Physics problems, you will get 10 chances to submit a correct answer. If your first answer is incorrect, you should consider making use of the hints, and/or getting help. There is no penalty for opening a hint, and no penalty for giving a wrong answer to a hint. However, if you request an answer to a hint, you will lose some points. Also note that requesting the answer to a part of the problem results in no points for that part, so avoid doing this unless all other options have been exhausted.