Study Guide 4

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  /                  Objective 13     The Biot-Savart Law                  \
 /                                                                          \
 /     a) Calculate the contribution made to the magnetic field at a        \
 /        specified point by a current element, given the current, location,\
 /        and orientation of the element.                                   \
 /                                                                          \
 /     b) Use the Biot-Savart law to calculate the net magnetic field       \
 /        produced at a point by a combination of wires containing both     \
 /        straight and circular sections.                                   \
 /                                                                          \
 /     c) Calculate the magnetic force between two parallel conductors       \
 /                                                                          \
 /     d) Use the superposition principle to calculate the total magnetic   \
 /        field at a point due to a combination of current carrying wires    \
 /        and externally applied magnetic fields.                           \
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Suggested Study Procedures

Read Sec. 28-2, paying particular attention to the units and constants
which are introduced. Study Sec. 28-3, which is an important
application of the Biot-Savart Law. While the mathematics is somewhat
complicated, pay attention to the direction of the field at P (in Fig.
28.5) due to the current element, the fact that the distances of the
current elements to P change as one moves along the wire, and that the
field produced by a very long wire reduces to a simple expression. We
will use this result frequently, and later derive it in another way.
Study Examples 28-3 and 28-4, in which the superposition principle is
used to determine the total magnetic field.

Study Sec. 28-4, in which the force between two current carrying wires is
derived. This force is the basis for the definition of the ampere. Study
Example 28-5.

Suggested Problems Related to Objective 13:

Chapter 28: Problems 12, 22, 23, 36, 37, 61, 67, 69, 74, 78

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/                       Objective 14    Ampere's Law                        \
/                                                                           \
/   a) Describe the meaning of the line integral (sometimes called          \
/      the circulation) of B around a closed path.                          \
/                                                                           \
/   b) Given two or more wires carrying specified current, determine the    \
/      circulation of B on a given closed path.                             \
/                                                                           \
/   c) Use Ampere's Law to determine the magnetic field distribution for    \
/      wires and coaxial cables having cylindrical symmetry.                \
/                                                                           \
/   d) Know how to calculate the magnietic field of a solenoid and          \
/      understand its features                                              \
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  Suggested Study Procedures

  Study Secs. 28-6 and 28-7. Examples 28-7 and 28-8 use Ampere's Law
  to derive the magnetic field inside and outside a long straight
  current-carrying wire. This same type of analysis can also be applied
  to any problem with circular symmetry. Example 28-9 illustrates
  another important application of Ampere's law, that of a solenoid.

  Suggested Problems Related to Objective 14:

  Chapter 28: Problems 42, 45 (also consider r<a, b<r<c), 46, 49, 51

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/                       Objective 15    Magnetic Flux                       \
/                                                                           \
/      a) Define magnetic flux                                              \
/                                                                           \
/      b) Define an area as a vector                                        \
/                                                                           \
/      c) Calculate the magnetic flux through an area positioned in a       \
/         magnetic field                                                    \
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  Suggested study Procedure

  Study Sec. 27-3 and Example 27-2. Review Sec. 22-2 on pages 729-730
  to recall how an area can be represented by a vector. Note
  also that although the definition of flux implies something passing
  through an area and having a direction, flux is defined explicitly as a
  scalar quantity. Note that the definition of magnetic flux is similar
  to our previous definition of electric flux. Look again at Figure 22.6,
  imagining now that the object is in a uniform magnetic field. Although
  it is an abstract concept, magnetic flux plays a crucial role in
  understanding Faraday's law of induction, which in turn is the basis for
  many practical devices such as electric generators.

Suggested Problems Related to Objective 15:

  Chapter 27: Problems 11, 14

  More calculations of flux will be encountered in the problems assigned
  under Objective 16.


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/                 Objective 16   Faraday's Law and Lenz's Law               \
/                                                                           \
/   Given a circuit in a magnetic field where                              \
/                                                                           \
/     a) the B-field changes with time; or                                 \
/                                                                           \
/     b) the area of the circuit changes with time, or                     \
/                                                                           \
/     c) the orientation of the circuit in the B-field changes with time;  \
/         determine:                                                        \
/                                                                           \
/       i) the flux of the magnetic field intercepted by the circuit at a  \
/           specified instant;                                             \
/      ii) the emf induced in the circuit;                                 \
/     iii) the current in the circuit (assuming the resistance is known).  \
/                                                                           \
/   For the situations above, use Lenz's Law to determine the directions of \
/   the induced currents.                                                   \
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  Suggested Study Procedures

  Study Secs. 29-1 to 29-3. In this course, we will determine the
  direction of induced emf mostly using Lenz's law, rather than by
  the sign convention implicit in Eq. 29.3. We will generally use Eq. 29.3
  without the minus sign, for the magnitude of emf, and use Lenz's law to
  get the direction.

  Examples 29-1 and 29-2 involve a magnetic field changing in time, while
  Examples 29-5 and 29-6 involve a changing area. Similar examples will be
  discussed in lecture. In each case, make sure that you understand
  how to determine the induced current direction using Lenz's Law.

  Examples 29-3 and 29-4 illustrate an important application of Faraday's
  law of induction. Electric generators develop an emf because of the
  changing angle between the area of a loop and the magnetic field. In this
  case, it is helpful to use the sign convention discussed on p. 962 to
  determine the induced current direction, rather than Lenz's law.

  Suggested Problems Related to Objective 16:

  Chapter 29: Problems 2, 5, 6, 15, 17, 18, 28, 54, 57, 71, 77[*]

   [*](a challenge)
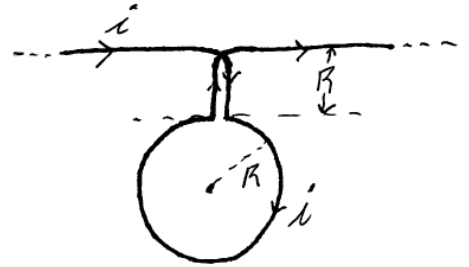
Homework Assignment #13 – due in lecture Friday, April 24

1. Two wires carrying currents i_1 = 1.2 A and
    i_2 = 6 A are bent as shown into arcs of a
    circle of radius R = 3.2 cm, with the
    straight sections heading toward or away
    from the center of the circle at (x=0,
    y=0). Calculate the contribution of the
    current element of length 0.15 mm at (x=R,
    y=0) to the B-field at the following points
    (express as a vector):
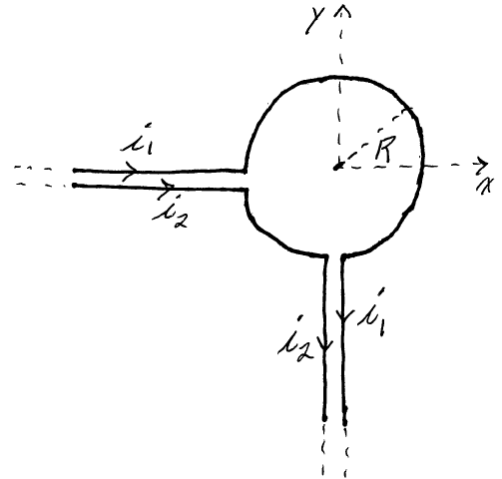
    a) x=0, y=0
    b) x=2R, y=0
    c) x=R, y=R

    d) Determine the total magnetic field
    (magnitude and direction) at (x=0, y=0)

2. A long wire carrying a current i = 1.7 A is
    bent into straight sections and circular
    sections of radius R = 25 mm as shown.
    Determine the magnitude and direction of the
    magnetic field at the center of the loop. (you
    can assume that the vertical straight sections
    are directly over and in line with the center
   of the circle.)

Homework Assignment #14 – due in lecture Monday, April 27

1. A hollow metal pipe of inner radius a and
    outer radius b is carrying current i_2 out of
    the page, and a thin wire along the axis of
    the pipe is carrying current i_1 into the page
    as shown. Determine the magnitude (and sketch
    the direction) of the magnetic field produced
    in the regions:
        a) r < a
        b) a < r < b
        c) r > b
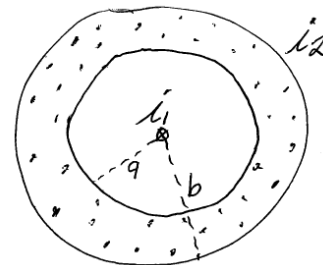
2. Three long, parallel wires are oriented in the same
    plane as shown, carrying currents of the same
    magnitude I in the directions indicated. Determine:
    (a) The magnetic field at the location of each wire
    due to the currents in the other two, and (b) The
    force per unit length on each wire.
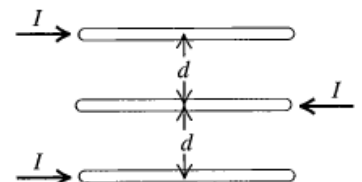
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   Homework Assignment #15 – due at 5:00 pm Wednesday, April 29
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This assignment is to be submitted via the web. In your web browser, go to www.masteringphysics.com.
Then login using the username and password you have chosen.

After logging in, click on Assignment List and select Homework #15. If you need any review, you can always
do that by repeating Assignment 0, a brief, noncredit tutorial on how to enter answers in Mastering Physics.

In Homework #15, you will get 10 chances to submit a correct answer for each problem. If your first answer
is incorrect, you should consider making use of the hints. 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.

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   Homework Assignment #16 – due at 5:00 pm Friday, May 1
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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.

After logging in, click on Assignment List and select Homework #16. If you need any review, you can always
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