## Homework for Chapter 28

(Due 11/3/22)

Questions: 4, 6, 10
Exercises \& Problems: 4, 11, 17, 33, 36, 47, 49, 51, 60, 74

## Question 4

Figure 28-25 shows the path of a particle through six regions of uniform magnetic field, where the path is either a half-circle or a quarter-circle. Upon leaving the last region, the particle travels between two charged, parallel plates and is deflected toward the plate of higher potential. What is the direction of the magnetic field in each of the six regions?


## Question 6

Figure 28-26 shows crossed uniform electric and magnetic fields $\vec{E}$ and $\vec{B}$ and, at a certain instant, the velocity vectors of the 10 charged particles listed in Table 28-3. (The vectors are not drawn to scale.) The speeds given in the table are either less than or greater than $E / B$ (see Question 5). Which particles will move out of the page toward you after the instant shown in Fig. 28-26?



| Table 28-3 |  |  |  |  |  |
| :--- | :---: | :---: | :---: | :---: | :---: |
| Question 6 |  |  |  |  |  |
| Particle Charge Speed Particle Charge Speed <br> 1 + Less 6 - Greater <br> 2 + Greater 7 + Less <br> 3 + Less 8 + Greater <br> 4 + Greater 9 - Less <br> 5 - Less 10 - Greater |  |  |  |  |  |$.$

## Question 10

Particle roundabout. Figure 28-29 shows 11 paths through a region of uniform magnetic field. One path is a straight line; the rest are half-circles. Table 28-4 gives the masses, charges, and speeds of 11 particles that take these paths through the field in the directions shown. Which path in the figure corresponds to which particle in the table? (The direction of the magnetic field can be determined by means of one of the paths, which is unique.)


| Table 28-4 |  |  |  |
| :---: | :---: | :---: | :---: |
| Question 10 |  |  |  |
| Particle | Mass | Charge | Speed |
| 1 | $2 m$ | $q$ | $v$ |
| 2 | $m$ | $2 q$ | $v$ |
| 3 | $m / 2$ | $q$ | $2 v$ |
| 4 | $3 m$ | $3 q$ | $3 v$ |
| 5 | $2 m$ | $q$ | $2 v$ |
| 6 | $m$ | $-q$ | $2 v$ |
| 7 | $m$ | $-4 q$ | $v$ |
| 8 | $m$ | $-q$ | $v$ |
| 9 | $2 m$ | $-2 q$ | $3 v$ |
| 10 | $m$ | $-2 q$ | $8 v$ |
| 11 | $3 m$ | 0 | $3 v$ |

## Problem 4

An alpha particle travels at a velocity $\vec{v}$ of magnitude $550 \mathrm{~m} / \mathrm{s}$ through a uniform magnetic field $\vec{B}$ of magnitude 0.045 T . (An alpha particle has a charge of $+3.2 \times 10^{-19} \mathrm{C}$ and a mass of $6.6 \times 10^{-27} \mathrm{~kg}$.) The angle between $\vec{v}$ and $\vec{B}$ is $52^{\circ}$. What is the magnitude of (a) the force $\vec{F}_{B}$ acting on the particle due to the field and (b) the acceleration of the particle due to $\vec{F}_{B}$ ? (c) Does the speed of the particle increase, decrease, or remain the same?

## Problem 11

An ion source is producing 6 Li ions, which have charge $+e$ and mass $9.99 \times 10^{-27} \mathrm{~kg}$. The ions are accelerated by a potential difference of 10 kV and pass horizontally into a region in which there is a uniform vertical magnetic field of magnitude $B=1.2 \mathrm{~T}$. Calculate the strength of the smallest electric field, to be set up over the same region, that will allow the 6Li ions to pass through undeflected.

## Problem 17

An alpha particle can be produced in certain radioactive decays of nuclei and consists of two protons and two neutrons. The particle has a charge of $q=+2 e$ and a mass of 4.00 u , where u is the atomic mass unit, with $1 \mathrm{u}=1.661 \times 10^{-27} \mathrm{~kg}$. Suppose an alpha particle travels in a circular path of radius 4.50 cm in a uniform magnetic field with $B=1.20 \mathrm{~T}$. Calculate (a) its speed, (b) its period of revolution, (c) its kinetic energy, and (d) the potential difference through which it would have to be accelerated to achieve this energy.

## Problem 33

A positron with kinetic energy 2.00 keV is projected into a uniform magnetic field $B$ of magnitude 0.100 T , with its velocity vector making an angle of $89.0^{\circ}$ with $\vec{B}$. Find (a) the period, (b) the pitch $p$, and (c) the radius $r$ of its helical path.

## Problem 36

A cyclotron with dee radius 53.0 cm is operated at an oscillator frequency of 12.0 MHz to accelerate protons. (a) What magnitude $B$ of magnetic field is required to achieve resonance? (b) At that field magnitude, what is the kinetic energy of a proton emerging from the cyclotron? Suppose, instead, that $\mathrm{B}=1.57 \mathrm{~T}$. (c) What oscillator frequency is required to achieve resonance now? (d) At that frequency, what is the kinetic energy of an emerging proton?

## Problem 47

A 1.0 kg copper rod rests on two horizontal rails 1.0 m apart and carries a current of 50 A from one rail to the other. The coefficient of static friction between rod and rails is 0.60 . What are the (a) magnitude and (b) angle (relative to the vertical) of the smallest magnetic field that puts the rod on the verge of sliding?

## Problem 49

Figure 28-44 shows a rectangular 20-turn coil of wire, of dimensions 10 cm by 5.0 cm . It carries a current of 0.10 A and is hinged along one long side. It is mounted in the $x y$ plane, at angle $\theta=30^{\circ}$ to the direction of a uniform magnetic field of magnitude 0.50 T . In unit-vector notation, what is the torque acting on the coil about the hinge line?


## Problem 51

Figure 28-45 shows a wood cylinder of mass $m=0.250 \mathrm{~kg}$ and length $L=0.100 \mathrm{~m}$, with $N=$ 10.0 turns of wire wrapped around it longitudinally, so that the plane of the wire coil contains the long central axis of the cylinder. The cylinder is released on a plane inclined at an angle $\theta$ to the horizontal, with the plane of the coil parallel to the incline plane. If there is a vertical uniform magnetic field of magnitude 0.500 T , what is the least current i through the coil that keeps the cylinder from rolling down the plane?


## Problem 60

Figure 28-48 shows a current loop $A B C D E F A$ carrying a current $i=5.00 \mathrm{~A}$. The sides of the loop are parallel to the coordinate axes shown, with $A B=20.0 \mathrm{~cm}, B C=30.0 \mathrm{~cm}$, and $F A=10.0$ cm . In unit-vector notation, what is the magnetic dipole moment of this loop? (Hint: Imagine equal and opposite currents $i$ in the line segment $A D$; then treat the two rectangular loops $A B C D A$ and $A D E F A$.)


## Problem 74

A particle with charge 2.0 C moves through a uniform magnetic field. At one instant the velocity of the particle is $\left(2.0 \mathrm{i}^{\wedge}+4.0 \mathrm{j}^{\wedge}+6.0 \mathrm{k}^{\wedge}\right) \mathrm{m} / \mathrm{s}$ and the magnetic force on the particle is $\left(4.0 \mathrm{i}^{\wedge}-20 \mathrm{j}^{\wedge}+\right.$ $\left.12 \mathrm{k}^{\wedge}\right) \mathrm{N}$. The $x$ and $y$ components of the magnetic field are equal. What is $\vec{B}$ ?

