## Home Work 8

8-1 In Fig. 28-34, a conducting rectangular solid of dimensions $d_{x}=5.00 \mathrm{~m}, d_{y}=3.00$ m , and $d_{z}=2.00 \mathrm{~m}$ moves at constant velocity $\mathbf{v}=(20.0 \mathrm{~m} / \mathrm{s}) \mathbf{i}$ through a uniform magnetic field $\mathbf{B}=(30.0 \mathrm{mT}) \mathbf{j}$. What are the resulting (a) electric field within the solid, in unit-vector notation, and (b) potential difference across the solid?


Figure 28-34 Problems 15.


Figure 28-53Problem 76.

8-2 Bainbridge's mass spectrometer, shown in Fig. 28-53, separates ions having the same velocity. The ions, after entering through slits, $S_{1}$ and $S_{2}$, pass through a velocity selector composed of an electric field produced by the charged plates P and $\mathrm{P}^{\prime}$, and a magnetic field $\mathbf{B}$ perpendicular to the electric field and the ion path. The ions that then pass undeviated through the crossed $\mathbf{E}$ and $\mathbf{B}$ fields enter into a region where a second magnetic field $\mathbf{B}^{\prime}$ exists, where they are made to follow circular paths. A photographic plate (or a modern detector) registers their arrival. Show that, for the ions, $q / m=$ $E / r B B^{\prime}$, where $r$ is the radius of the circular orbit.

8-3 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?

8-4 A positron with kinetic energy 2.00 keV is projected into a uniform magnetic field $\mathbf{B}$ of magnitude 0.100 T , with its velocity vector making an angle of $89.0^{\circ}$ with $\mathbf{B}$.
Find (a) the period, (b) the pitch $p$, and (c) the radius $r$ of its helical path.
27.90 ... The Electromagnetic

Pump. Magnetic forces acting on conducting fluids provide a convenient means of pumping these fluids. For example, this method can be used to pump blood without the damage to the cells that can be caused by a mechanical pump. A horizontal tube with rectangular cross section (height $h$, width $w$ ) is placed at right angles to a uniform magnetic field with magnitude $B$ so that a length $l$ is in the field (Fig. P27.90). The tube is filled with a

Figure P27.90
 conducting liquid, and an electric current of density $J$ is maintained in the third mutually perpendicular direction. (a) Show that the difference of pressure between a point in the liquid on a vertical plane through $a b$ and a point in the liquid on another vertical plane through $c d$, under conditions in which the liquid is prevented from flowing, is $\Delta p=J l B$. (b) What current density is needed to provide a pressure difference of 1.00 atm between these two points if $B=2.20 \mathrm{~T}$ and $l=35.0 \mathrm{~mm}$ ?

## 8-6

$27.91 \ldots$... CP A Cycloidal Path. A particle with mass $m$ and positive charge $q$ starts from rest at the origin shown in Fig. P27.91. There is a uniform electric field $\overrightarrow{\boldsymbol{E}}$ in the $+y$-direction and a uniform magnetic field $\overrightarrow{\boldsymbol{B}}$ directed out of the page. It is shown in more advanced books that the path is a cycloid whose radius of curvature at the top points is twice the $y$-coordinate at that level. (a) Explain why the path has this general shape and why it is repetitive. (b) Prove that the speed at any point is equal to $\sqrt{2 q E y / m}$. (Hint: Use energy conservation.) (c) Applying Newton's second law at the top point and taking as given that the radius of curvature here equals $2 y$, prove that the speed at this point is $2 E / B$.

Figure P27.91


