First Year Electricity & Magnetism **Problem Sheet 6** **20 February 2008**

Magnetic Fields and Forces

Numbers in italics refer to the Exercise number in the 12th Edition of Young & Freedman's "University Physics". Answers to odd-numbered questions are at the back of the book.

1. [*27.12*] The magnetic field **B** in a certain region is 0.128 T, and its direction is that of the $+z$-axis shown in the figure. (a) What is the magnetic flux across the surface *abcd* in the figure? (b) What is the magnetic flux across the surface *befc*? (c) What is the magnetic flux across the surface *aefd*? (d) what is the net flux through all five surfaces that enclose the shaded volume?

2. [*27.25*] An electron in the beam of a TV picture tube is accelerated by a potential difference of 2.00 kV. Then it passes through a region of transverse magnetic field, where it moves in a circular arc with radius 0.180 m. (a) What is the magnitude of the field? (b) Sketch this configuration and show clearly the direction of the magnetic field and the resulting electron motion.

3. [*27.35*] A long wire carrying 4.50 A of current makes two 90° bends, as shown in the Figure. The bent part of the wire passes through a uniform 0.240 T magnetic field directed out of the page as shown in the figure and confined to a limited region of space. Find the magnitude and direction of the force that the magnetic field exerts on the wire.

4. [*27.45*] A uniform rectangular coil of total mass 210 g and dimensions 0.500 m × 1.00 m is oriented perpendicular to a uniform 3.00 T magnetic field, as shown in the figure. A current of 2.00 A is suddenly started in the coil. (a) About which axis, A_1 or A_2, will the coil begin to rotate? Why? (b) Find the initial angular acceleration of the coil just after the current is started.

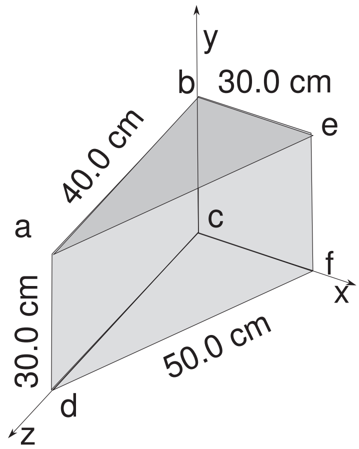

Figure from Q27.12

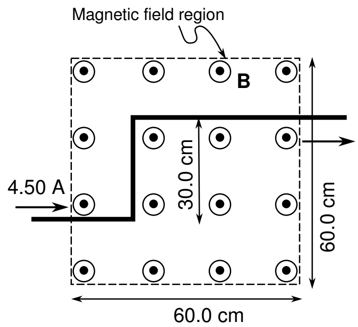

Figure from Q27.35

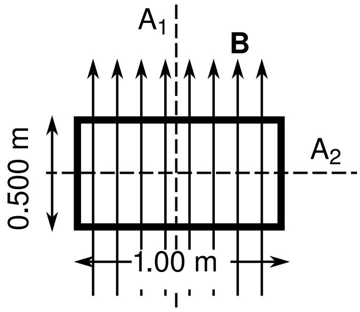

Figure from Q27.45

Some possibly useful information and formulae:

$$\oiint \mathbf{B}\cdot d\mathbf{A} = \oiint \mathbf{B}\cdot\hat{\mathbf{n}}\, dA = 0$$

$$\mathbf{F} = q\mathbf{v}\times\mathbf{B}$$

$$R = \frac{mv}{|q|B}$$

$$\mathbf{F} = I\boldsymbol{\ell}\times\mathbf{B}$$

$$\boldsymbol{\mu} = I\mathbf{A}$$

$$\boldsymbol{\tau} = \boldsymbol{\mu}\times\mathbf{B}$$

$$I_{inertia} = \sum m_i r_i^2$$

$$I_{inertia} = mL^2/12$$

$$m_e = 9.11\times10^{-31}\ \text{kg}$$

$$e = 1.60\times10^{-19}\text{C}$$

Steve Schwartz, 20 February 2008