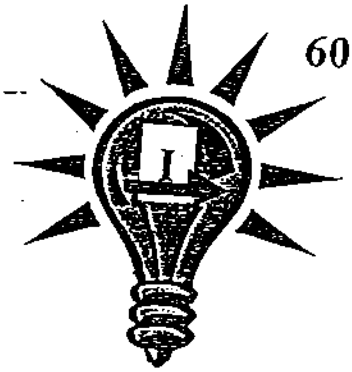
Physics 100 HW 8 (Due 3/9/07; Friday) Name S. Olsen



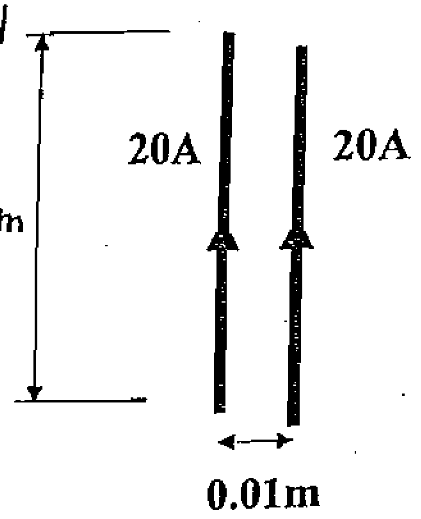
60W

1. How much current flows through a 60 Watt light bulb that is powered by a 110 Volt power source?

$$\text{Power} = IV \qquad I = \frac{\text{Power}}{V} = \frac{60\,W}{110\,V} = 0.55\,A$$

2. i) A 20 Ampere current flows through each of two, one-meter long parallel wires that are separated by 0.01 m. What is the magnetic force between the wires?

$$F_M = k\frac{I_1 I_2 \ell}{d} = 2\times10^{-7}\frac{N}{A^2}\,\frac{(20A)(20A)\cdot 1m}{0.01m} = 8\times10^{-3}\,N$$



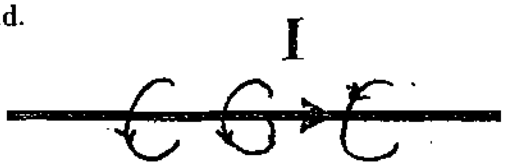
ii) What is the electrical force between two 20 Coulomb charges separated by a distance of 0.01 m?

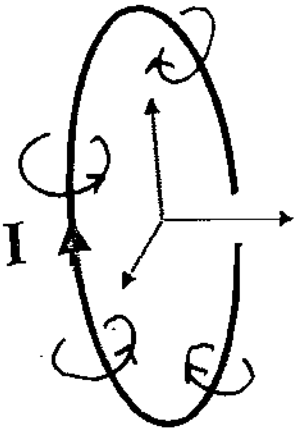
$$F_C = k\frac{Q_1 Q_2}{d^2} = 9\times10^{9}\frac{Nm^2}{C^2}\,\frac{(20C)^2}{(.01m)^2} = 3.6\times10^{16}\,N$$

iii) Which of these two forces is bigger, and by what factor?

Electric Force; by a factor $\frac{F_c}{F_M} = 4.5\times10^{18}$

3. Sketch the magnetic fields produced by
a) a circular loop of current carrying wire and
b) a straight current-carrying wire.
Be sure to indicate the direction of the field, and which part of the field line is in front of the wire and which part is behind.



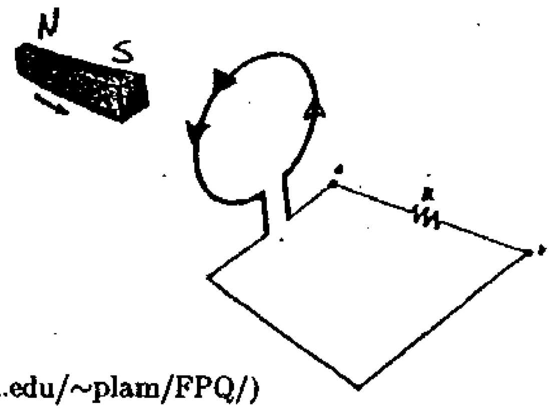


4. List some differences between gravitational, electrical and magnetic fields.

1) Grav. Field lines start at ∞ & end on mass.
B-field lines never end
E-field lines start on + charge & end on − charge

2) B-field lines come out of N-pole & go into S-pole
B-field lines are produced by electric currents

5. Suppose a magnet is inserted through a loop of wire as shown. Indicate the direction of the induced current in the loop.



6. (You can find a discussion of this problem at www2.hawaii.edu/~plam/FPQ/)

Io, the innermost large moon of the planet Jupiter, has an orbital period of 42 hours and 8 minutes. This means that every 42 hours and 8 minutes, Io disappears behind (i.e. is "eclipsed" by) Jupiter. Astronomers use precise measurements of the time between successive eclipses to determine this orbital period. However, when the Earth is moving towards Jupiter, the light from an eclipses has a shorter distance to travel than the light from the previous eclipse, thereby making measurements of Io's period systematically shorter—the opposite effect occurs when the Earth is moving away from Jupiter. In the late 17th century, Ole Roemer noticed these differences and used them to infer that light traveled at a finite speed and make the first measurements of that speed. For the following questions you need to know the speed of light: $c = 3\times10^8 m/s$; and the speed of the Earth in its orbit around the Sun: $v_E = 3.1 \times 10^4 m/s$.

a) How far does the Earth move in its orbit around the Sun during the time between successive eclipses of Io? 42 hrs + 8 min = 1.5×10^5 s

$$d_E = V_E t = 3.1\times10^4 \text{ m/s} \times 1.5\times10^5 \text{ s} = 4.7\times10^9 \text{ m}$$

b) How long does it take light to travel this distance?

$$t_{light} = \frac{d_E}{c} = \frac{4.7\times10^9 \text{ m}}{3\times10^8 \text{ m/s}} = 15.6 \text{ s}$$

c) What is the difference in the time observed for successive eclipses of Io between the time of year when the Earth is moving directly toward Jupiter and when it is moving directly away from Jupiter? 2×15.6 s