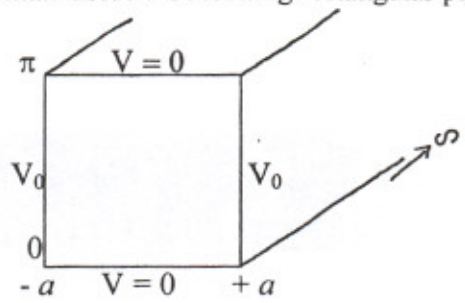
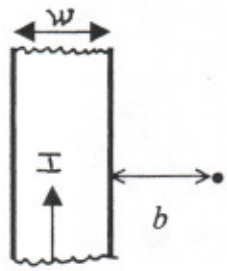
(1) Two metal plates infinitely long in the z-direction are grounded at y = 0 and y = π and connected at x = ±*a* by metal strips maintained at a potential V_0 (a thin sliver of insulation at each corner prevents them from shorting out). Find the potential inside the resulting rectangular pipe. (30 points)

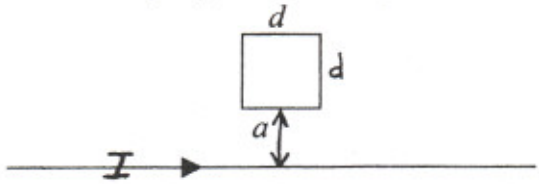


(2) A conducting sphere of radius *R* floats half submerged in a liquid dielectric medium of permittivity ε_L. The region above the liquid is a gas of permittivity ε_G. The total free charge on the sphere is *Q*. Find the electric field that satisfies all the boundary conditions and determine the free, bound, and total charge densities at all point on the surface of the sphere. (22 points)

(3) Consider a thin strip of metal of width *w* and very long. The current in the strip is along its length; the total current is *I*. Find the magnetic field in the plane of the strip at a distance *b* from the nearer edge. (18 points)



(4) A square loop of wire of side *d* lies on a table near a very long straight wire carrying a current *I* as shown. (a) Find the flux of **B** through the loop; (b) If the loop is now pulled directly away from the wire, at speed *v*, what *emf* is generated? In what direction (clockwise or counterclockwise) does the current flow? (c) What if the loop is pulled to the right at the same speed *v*? (30 points)



Possibly useful integrals: $\int \frac{\sin\alpha}{\sqrt{1-\cos\alpha}} = 2\sqrt{1-\cos a}\,;$ $\int \frac{dx}{x+a} = \ln\frac{x+a}{a}$

$$\int_0^{\pi} \sin(ky)\sin(qy)dy = \begin{cases} 0 \text{ if } k \neq q \\ \pi/2 \text{ if } k = q \end{cases}$$