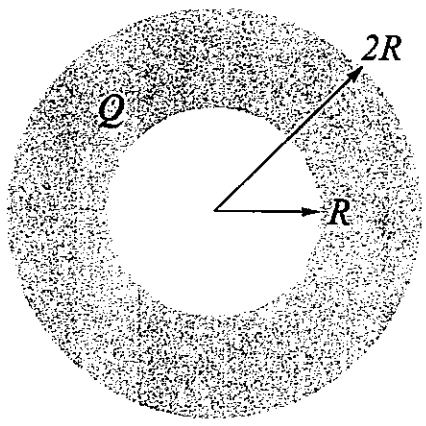
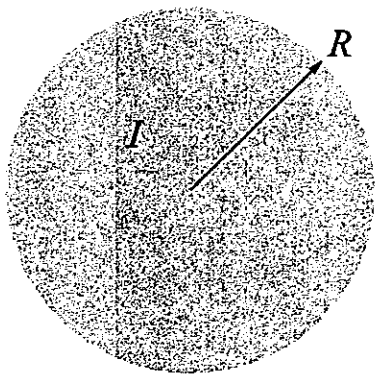
1. (25%) A total charge Q is uniformly distributed over a spherical shell of inner radius R and outer radius $2R$, as shown in the figure. Let r be the distance from the center of the spherical shell and the reference point be at the infinity.
   (a) Find the electric potential $V(r)$ for $0<r<R$. (10%)
   (b) Find the electric potential $V(r)$ for $R<r<2R$. (10%)
   (c) Find the electric potential $V(r)$ for $r>2R$. (5%)



2. (25%) A line current I is uniformly distributed over an infinite long circular cylinder of radius R, as shown in the figure. Let r be the distance from the axis of the cylinder.
   (a) Find the magnetic field magnitude $|\mathbf{B}(r)|$ for $0<r<R$. (15%)
   (b) Find the magnetic field magnitude $|\mathbf{B}(r)|$ for $r>R$. (10%)



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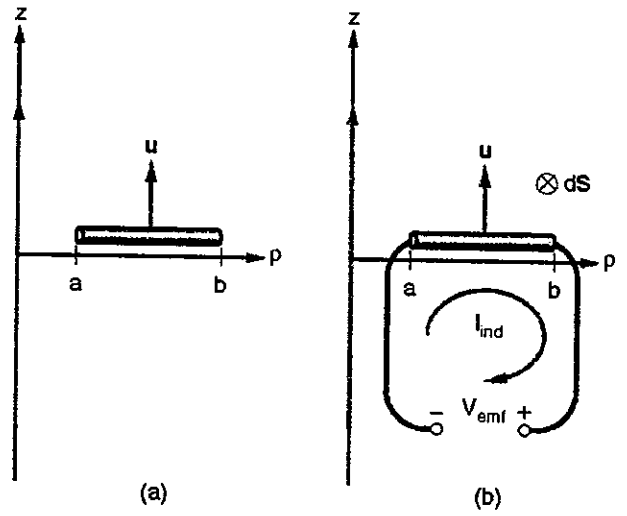
3. (25%) Consider the conductive bar moving with a speed **u** in the positive z direction at a fixed distance (one end at distance a and the other end at distance b from the z-axis) from an infinite length line of current I on the z-axis, as show in the figure below. Please find the potential difference between the ends of the bar as well as the bar's polarity.



(a) Conductive bar moving in the field from a line of current. (b) A virtual loop is added for calculating a V_{emf}.

4. (25%) A (physical) electric dipole consists of two equal and opposite charges +q and –q, which are separated by a distance *d*. Please derive the approximate potential at points far from the dipole

$$V(\vec{r}) = \frac{1}{4\pi\varepsilon_0}\frac{qd\cos\theta}{r^2}$$

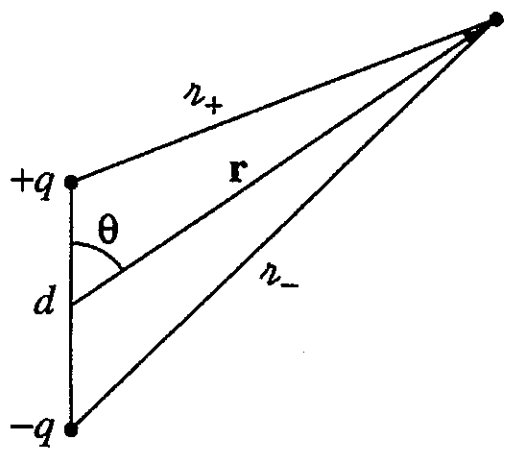


Figure 3.26

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