Solutions to Problems for Chapter 1
Introduction

Antenna Theory and Design
THIRD EDITION

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1.3-1 Show that the decay of power density for a wave radiated by an antenna ($1/r^2$) results from the increase in the area of a sphere centered on the antenna and the fact that the total radiated power is conserved.

Solution:

Radiated power density, S, with units of Watts per meter squared varies with distance away from the radiator, r, as $S=K/r^2$.

The area of the sphere surrounding the antenna is $A_{sph}= 4\pi r^2$, which increases as r^2.

Thus, the total power radiated through a sphere of radius r is

$$P = SA_{sph} = (K/r^2)\, 4\pi r^2 = 4\pi K \sim r^0$$

Therefore, the total power radiated remains constant with radius.

As the radius increases, the area of the sphere increases as r^2. But the power remains constant, so the power density decreases as $S = P/A_{sph} = P/4\pi\, r^2$, or $1/r^2$.

1.3-2 Consider an ideal dipole of length $L << \lambda$. If charge carriers actually moved along the full length of the wire in half cycle, $T/2$, show that the speed of the charges is much less than the speed of light, i.e. $v << c$.

Solution:

Charge disturbance moves from the top of the dipole to the bottom in a half cycle, $T/2$.

The corresponding distance is

$$L = v(T/2)$$

So

$$V = 2L/t = 2Lf \quad \text{using the well known relation between period and frequency: } T = 1/f.$$

From this, if $L << \lambda$, then $\underline{v << c}$.

1.4-1 *Project: Antenna hunt.* (a) Locate one representative antenna for each of the four major antenna type categories. Preferably the antennas are in your community and being actively used. Take a photograph, or make a sketch, of the antenna and its surroundings. If you cannot find an example in your community, you can use other sources such as a catalog, magazine, or the Internet. (b) Prepare a brief report that shows each of the four antennas and includes information about the antenna such as: the type of antenna, operating frequency, purpose and use, and any other information you can determine.

The instructor can provide suggestions as to where students can go in the local area to find interesting antennnas. However, students usually get interested in the project and do quite well on their own.
