1. An electron is “wiggling” in one dimension such that its position is \( x(t) = A \cos(\omega t) \). What is the average power radiated by the particle? Note how it scales with the wiggle frequency \( \omega \)?

2. The classical Larmor’s formula for radiation from an accelerated charged particle implies that the electron orbiting a proton in a hydrogen atom will radiate away its kinetic energy in a small fraction of a second, and the atom will collapse. This striking failure was one of the problems in classical physics that led to the development of quantum mechanics. A classical hydrogen atom consists of an electron in a circular orbit around a proton, with the centrifugal force \( m_e v_e^2/r_0 \) balancing the Coulomb force \( e^2/r_0^2 \). Here \( r_0 = 5.3 \times 10^{-9} \) cm is the orbital radius, called the Bohr radius. The classical radiative lifetime \( t \) of such an atom is the electron kinetic energy \( E \) divided by the Larmor power radiated when \( r = r_0 \). Estimate \( t \).

3. A convenient parameter for specifying the sensitivity of a radio telescope is its sensitivity in units of K/Jy; that is, the number of Kelvins of antenna temperature \( T_A \) produced by an unpolarized point source whose flux density is 1 Jy. (a.) What is the effective collecting area \( A_e \) of a radio telescope whose sensitivity is 1 K/Jy? (b.) The 2.3 GHz feed at Arecibo illuminates an elliptical aperture 225 m by 200 m in size, and the aperture efficiency \( \eta_A \) over this ellipse is \( \eta_A \approx 0.70 \). What is the sensitivity of this system in K/Jy? (c.) The same feed is used with a 1 megawatt transmitter at 2.3 GHz for planetary radar. What is the on-axis power gain \( G_{\text{max}} \) of this radar system?