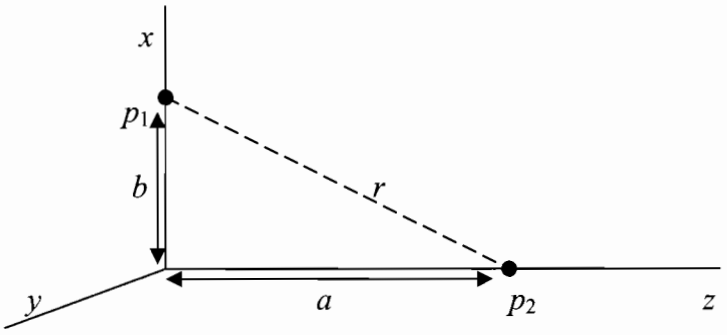
Consider the time-dependent coulomb interaction of two particles. Assume particle 1 has charge q_1 and mass m_1, whereas particle 2 has charge q_2 and mass m_2. Assume further that in a Cartesian coordinate system with coordinates x, y, z, particle 1 is at $x = b$, $y = 0$, and $z = 0$, whereas particle 2 is at $x = 0$, $y = 0$, and $z = a$ (see the figure below).



(a) What is the electric field $\vec{E}$ at particle 1 due to particle 2? Express your answer in terms of q_2, a, and b.

(b) Assume now that particle 1 remains fixed in the coordinate system of part (a) whereas particle 2 moves along the z axis from $-\infty$ to $+\infty$ with constant speed $v \ll c$ and that particle 2 is closest to particle 1 at time $t = 0$. (i) What is the electric field $\vec{E}$ at particle 1 due to particle 2 as a function of t? Express your answer in terms of q_2, b, v, and t. (ii) Sketch the nonzero components of the electric field $\vec{E}$ at particle 1 due to particle 2 as a function of t.

(c) Using your expression for the electric field $\vec{E}$ at particle 1 due to particle 2 as a function of t, (i) estimate the time interval τ over which the electric field $\vec{E}$ at particle 1 due to particle 2 exceeds half its peak value. (ii) What is the maximum force on particle 1 due to particle 2 during their encounter? Express your answer in terms of q_1, q_2, and b.

(d) Assume now that particle 1 is free to move. Using your estimate of τ and your expression for the electric field $\vec{E}$ at particle 1 due to particle 2 as a function of t, estimate the distance δ that particle 1 moves during the duration τ of its encounter with particle 2. Express δ in terms of q_1, q_2, m_1, and v.

(e) Assume that particle 1 is free to move but that $\delta \ll b$. (i) What is the total impulse $\delta\vec{I}$ given to particle 1 during its encounter with particle 2? (ii) What is the total energy δE given to particle 1? Express your answers in terms of q_1, q_2, m_1, m_2, b, and v.

(f) Using the formula $P = 2q^2|\dot{v}|^2/3c^3$ (Gaussian units) or $P = q^2|\dot{v}|^2/6\pi\varepsilon_0 c^3$ (SI units) for the power radiated by a nonrelativistic accelerating electrical charge, estimate the peak power radiated by particle 1 during its encounter with particle 2.

(g) Using the peak power estimated in part (f), estimate the total energy δE_{rad} radiated by particle 1 during its encounter with particle 2.