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 $x = b, y = 0, z = 0$, whereas particle 2 is at $x = 0, y = 0, z = a$ (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 $\tau$ 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 $\tau$ and your expression for the electric field $\vec{E}$ at particle 1 due to particle 2 as a function of $t$, estimate the distance $\delta$ that particle 1 moves during the duration $\tau$ of its encounter with particle 2. Express $\delta$ 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 $\delta E$ 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 $P = 2q^2 |\vec{v}|^2 / 3c^3$ (Gaussian units) or $P = q^2 |\vec{v}|^2 / 6\pi\varepsilon_0 c^3$ (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 $\delta E_{\text{rad}}$ radiated by particle 1 during its encounter with particle 2.