NOTE: Problems are graded at 10 pts. each, unless indicated otherwise.

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(31) [Jackson Prob. (14.2)]. Using the Larmor formulas for the nonrelativistic motion of a point charge q, find the time-averaged quantities: $\langle dP/d\Omega \rangle$ = power radiated per unit solid angle, and $\langle P \rangle$ = total power radiated, when q moves as follows...

(A)... along the z-axis with instantaneous position: $z(t) = R\cos\omega_0 t$ (R & ω_0 = cnsts);

(B)... in a circle of radius R in the xy plane, at ∡ frequency ω_0 (R & ω_0 = cnsts).

In each case, sketch the angular distribution of the radiation. Is there a significant difference in $\langle P \rangle$ for the linear motion vs. the circular motion?

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(32) [Jackson Prob. (14.3)]. A nonrelativistic particle of mass m, charge ze, and initial kinetic energy K collides head-on with a fixed central force field. The interaction is repulsive, and is specified by a potential $V(r)$: $V(r)$ increases as the separation r decreases, and $V(r) > K$ for all $r < r_0$ (so r_0 = "closest distance of approach").

(A) Show that the total energy radiated by ze during this encounter is...

$$\boxed{\Delta W = \frac{4}{3c}\left(\frac{ze}{mc}\right)^2 \sqrt{\frac{m}{2}} \int_{r_0}^{\infty} \left|\frac{dV}{dr}\right|^2 \frac{dr}{\sqrt{V(r_0) - V(r)}}} .$$

(B) Let the potential be Coulombic: $V(r) = zZe^2/r$. If v_0 is the velocity of ze at infinity, show the radiated energy is: $\boxed{\Delta W = \frac{16}{45}(z/Z)(v_0/c)^3 K \ll K}$.

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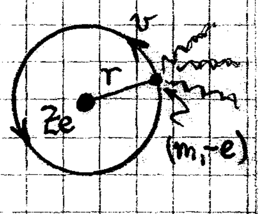
(33) An electron (mass m, charge $(-)e$), in a hydrogenlike atom (stationary nucleus of charge Ze), moves in a circular orbit of radius r. Treat the system classically, and assume the electron velocity $v \ll c$.



(A) Find an expression for the electron's total orbit energy E in terms of r alone.

(B) Assume the electron radiates energy $\Delta E \ll |E|$, per orbit. Find the radiated power P in terms of r alone. Equate P to the rate of loss of orbital energy, to obtain a differential eqtn for the decrease in orbit radius r due to radiation.

(C) Calculate the elapsed time for the electron to spiral into the nucleus if it starts from $r = a_0$. Set $Z=1$, $a_0 = 0.53$ Å (Bohr radius). Calculate a number for the collapse time.