your name(s) KEY

*Physics 321 Quiz #9 - Friday, November 9 2018*

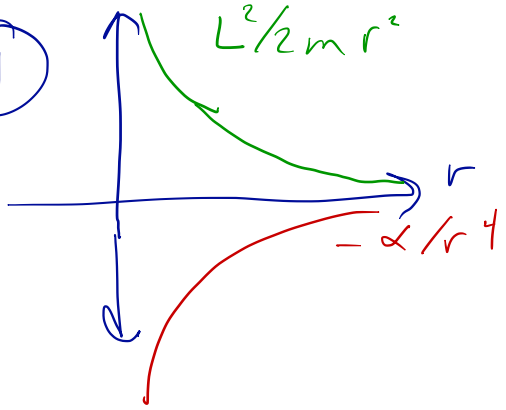
Work in groups of 2 or 3. This is open-book, open-note, open-mouth.
Consider a particle of mass $m$ moving in a radially symmetric attractive potential,

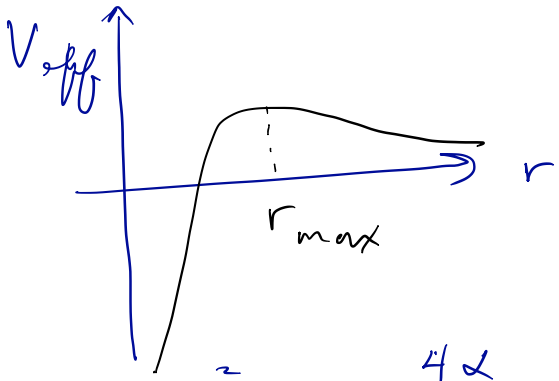
$$V(r) = -\frac{\alpha}{r^4}.$$

If the particle makes it all the way to $r = 0$, it will be absorbed. A beam of such particles with energy $E$ are shot toward the target.

1. (10 pts) For a trajectory with angular momentum $L$, sketch the potential $V(r)$, the centrifugal potential $L^2/(2mr^2)$ and the effective potential, $V_{\text{eff}} = V(r) + L^2/(2mr^2)$.
2. (10 pts) For a fixed energy $E$, find the angular momentum $L_{\text{crit}}$ such that particles with $L < L_{\text{crit}}$ are absorbed whereas particles with $L > L_{\text{crit}}$ are not.
3. (5 pts) What is the cross section for absorption.

(1)




(2) Find $r_{max}$, $\frac{\partial V_{eff}}{\partial r} = 0 = \frac{-L^2}{m r_{max}^3} + \frac{4\alpha}{r_{max}^5}$

$r_{max}^2 = \frac{4m\alpha}{L^2}$, $E = \frac{L^2}{2m r_{max}^2} - \frac{\alpha}{r_{max}^4}$

$= \frac{L^2 \cdot L^2}{2m \cdot 4m\alpha} - \frac{\alpha L^4}{16 m^2 \alpha^2} = \frac{L^4}{16 m^2 \alpha}$

$L^4 = 16 m^2 \alpha E$, $L = 2 m^{1/2} (\alpha E)^{1/4}$

(3) $\sigma = \frac{\pi L^2}{p^2} = \frac{\pi L^2}{2mE} = 2\pi\sqrt{\alpha/E}$