[3] **(25 points)** Two object of mass m_1 and m_2 and negligible size interact through a model potential $V(r) = \frac{a^2}{4r^4} - \frac{b^2}{3r^3}$ where a and b are constants with the appropriate units. $r = |\vec{r}|$ is the distance between the two objects and $\vec{r}$ is along the line connecting the centers of each object. In a particular reference frame, the Lagrangian for this isolated system can be written $L = \frac{1}{2}\mu|\dot{\vec{r}}|^2 - V(r)$.

a) Specify the reference frame in which L has this form.
b) What is the equation determining μ?
c) Briefly explain why the angular momentum, l, must be conserved in this system.

Because angular momentum is conserved, we can assume the motion is in a plane and use polar coordinates, so that $L = \frac{1}{2}\mu\dot{r}^2 + \frac{l^2}{2\mu r^2} - V(r)$

d) What is the maximum angular momentum at which the masses can move in stable circular orbits around each other?
e) What is the relative separation r in a circular orbit with angular momentum infinitesimally below the breakup value?
f) Find the equilibrium separation of the objects in the case where they don't rotate around each other, and compare to the result in (e).