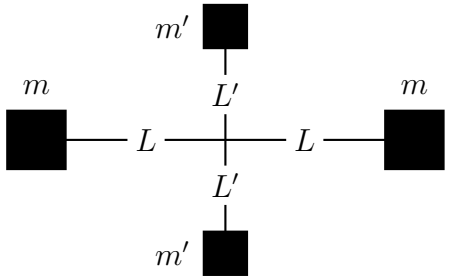
Angular Momentum

Question 1 *2005 Paper.* The following system of four interconnected particles, of masses m and m' as shown on the diagram,



is rotating around its centre. Then, the distance L is reduced by a factor of 2. Using conservation of angular momentum, determine how L' needs to be changed to ensure that the angular velocity of the system remains the same as before.

Question 2 *2006 Paper.* Consider a system of 3 particles of masses m_1, m_2, and m_3, with position vectors $\mathbf{r}_1$, $\mathbf{r}_2$, and $\mathbf{r}_3$, interacting with forces $\mathbf{F}_{1,2}$, $\mathbf{F}_{2,1}$, ..., $\mathbf{F}_{3,2}$. Prove that the angular momentum of the system with respect to the origin is conserved.

Question 3 *2009 Paper.* Consider a closed system of two particle of masses m_1 and m_2 located at $\mathbf{r}_1$ and $\mathbf{r}_2$ respectively. We suppose that the particles are moving (i.e. $\mathbf{r}_1$ and $\mathbf{r}_2$ depend on time t).

(a) Write the momentum $\mathbf{P}$ of the system in terms of m_1, m_2, $\dot{\mathbf{r}}_1$, and $\dot{\mathbf{r}}_2$.

(b) Show that $\mathbf{P}$ does not depend on time.

(c) Write the angular momentum $\mathbf{A}_M$ of the system with respect to a fixed point M located at $\mathbf{r}_M$ of the system in terms of m_1, m_2, $\mathbf{r}_M$, $\mathbf{r}_1$, $\mathbf{r}_2$, $\dot{\mathbf{r}}_1$, and $\dot{\mathbf{r}}_2$.

(d) Supposing that the inter-particle interaction are parallel to the straight line going though the particles, show $\mathbf{A}_M$ does not depend on time.