

**Physics 5A, Fall 2017**  
**Homework Set 5**

KK Ch 4: 4.9, 4.13, 4.16, 4.20, 4.26

KK Ch 5: 5.1, 5.5, 5.10

S 4.1 Two stars, one with mass  $m_1$  and one with mass  $m_2$ , orbit about each other. The position of  $m_1$  with respect to an arbitrary reference frame is  $\vec{r}_1$ , while the position of  $m_2$  is  $\vec{r}_2$ .

- (a) What is the center of mass  $\vec{R}$  of the double-star system?
- (b) We define the center of mass coordinates to be

$$\vec{R}_1 = \vec{r}_1 - \vec{R}, \quad \vec{R}_2 = \vec{r}_2 - \vec{R}. \quad (1)$$

Show that

$$m_1 \vec{R}_1 + m_2 \vec{R}_2 = 0. \quad (2)$$

- (c) Both stars rotate about the center of mass of the system. Find the time  $T_1$  (called the period) that it takes  $m_1$  to orbit about the center of mass, and show that it equals the period  $T_2$  for  $m_2$  to orbit about the center of mass.

*Comments:*

- In problem 4.20, assume that the reflected stream of particles does not collide with the incoming stream.
- For problem 4.26, by elastically KK means that the speed of the particle after the collision equals that of the particle before the collision.
- For problem 5.10, you will have to use energy as well as change of momentum.