Worksheet 18: Angular Momentum

1. Two matching space stations of mass m are tethered by a cable to be a distance $d_1 = 800$ m apart. They rotate about their mutual center of mass with a period of $T_1 = 40.0$ s.

   a. What is the moment of inertia I_1 of the pair of space stations? Express in terms of m and their radius of rotation r_1. Treat them as point masses.

   b. What is their angular speed ω_1? Express in terms of T_1.

   c. What is their centripetal acceleration a_1? Express in terms of ω_1 and r_1.

   d. What is their angular momentum L_1? Express in terms of I_1 and ω_1.

   e. What is their kinetic energy K_1? Express in terms of I_1 and ω_1.

   f. How would your answers to parts a and e change if you did not approximate the space stations as point masses, but took their center-of-mass moments of inertia into account?

2. The tether connecting the space stations of question 1 is lengthened to 5/4 of its initial length, 1000 m.

   a. What is the new radius of rotation r_2 of the space stations? Express in terms of r_1.

   b. What is the new moment of inertia I_2 of the pair? Express in terms of I_1. Continue to treat them as point masses.

   c. What is their new angular momentum L_2? Express in terms of L_1.

d. What is their new angular speed ω_2? Express in terms of ω_1.

e. What is their new centripetal acceleration a_2? Express in terms of a_1.

f. What is their new kinetic energy K_2? Express in terms of K_1.

3. The tether connecting the space stations of question 1 is shortened to 4/5 of its initial length, 640 m.

   a. What is the new radius of rotation r_3 of the space stations? Express in terms of r_1.

   b. What is the new moment of inertia I_3 of the pair? Express in terms of I_1. Continue to treat them as point masses.

   c. What is their new angular momentum L_3? Express in terms of L_1.

   d. What is their new angular speed ω_3? Express in terms of ω_1.

   e. What is their new centripetal acceleration a_3? Express in terms of a_1.

   f. What is their new kinetic energy K_3? Express in terms of K_1.