NAME _____ DATE _____

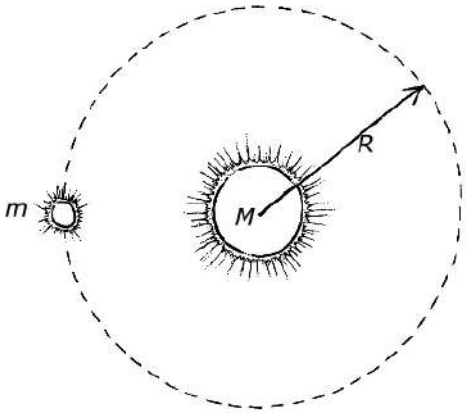
Scenario

A small star of mass m makes a circular orbit around a large star of mass M. The radius of the orbit is R, and the large star has much more mass than the small star.

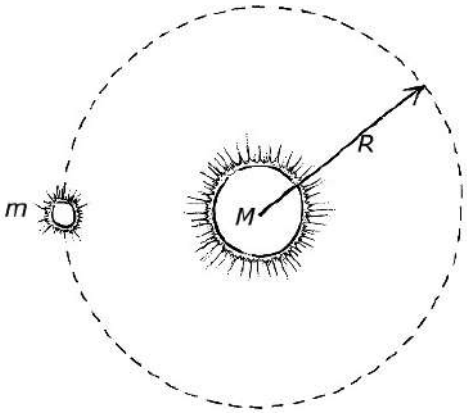
Using Representations

PART A: The two diagrams below show the small star at one specific point in its orbit. Assume that the small star orbits counterclockwise and draw and label the vectors indicated.

i. Draw and label the forces exerted on the small star at this instant.



ii. Draw a vector labeled v representing the velocity of the small star and a vector labeled a representing the acceleration of the small star, at this instant.



Quantitative Analysis

PART B: Derive an expression for the kinetic energy of the small star as it orbits the large star in terms of M, m, R, and fundamental constants.

PART C: Suppose instead that the small star has four times as much kinetic energy but is kept in the circular orbit of the same radius because both stars have equal magnitudes of net charge Q.

i. Do the stars have same sign or opposite sign charges? Explain your reasoning.

ii. Derive an expression for Q in terms of M, m, R, and fundamental constants.