Homework No. 12 (Spring 2021)

PHYS 205A: University Physics

Due date: Friday, 2021 Apr 30, 11:59 PM, on D2L

Instructions

- Describe your thought process in detail and organize it clearly. Make sure your answer has the correct units and the right number of significant digits.
- After completion, scan the pages as a single PDF file, and submit the file on D2L (under Assesments → Assignments).

Problems

1. (**10 points.**) Three identical stars, each of mass m, are positioned at the corners of a square of edge length L.
   (a) Find the magnitude and direction of the gravitational field at the vacant corner of the square due to the three stars.
   (b) Find the magnitude and direction of the gravitational force a planet of mass M would experience if it is placed in the vacant corner.
   (c) Find the magnitude and direction of the gravitational field at the center of the square.
2. (**10 points.**) Determine the expression for the gravitational field at point $\mathcal{O}$ in Figure 1, along the bisector of the line segment connecting two identical stars, masses $m_1 = m_2 = m$, that are separated by distance $2a$.
3. (**10 points.**) Four identical stars, each of mass m, are positioned at the corners of a square of edge length L.
   (a) Find the gravitational potential at a distance very far away from the square, that is, at infinity.
   (b) Find the gravitational potential at the center of the square.
   (c) Find the gravitational potential at the center of one of the edges of the square.
   (d) How much work is done by the gravitational forces when a mass M is moved from infinity to the center of the square?

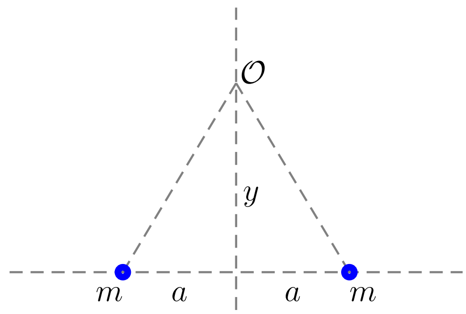

Figure 1: Problem 2

4. (**10 points.**) Three identical stars, of mass m each, are positioned at the corners of an equilateral triangle of edge length a. Find the expression for the gravitational potential energy of this three-body configuration up to a constant.

5. (**10 points.**) At the surface of Earth a rocket is launched in the radially outward direction with a speed equal to the orbital speed of the International Space Station ($\sim 7.7\,\mathrm{km/s}$). Neglecting the gravitational influence of the Sun and other planets, and air resitance, determine how far the rocket would go. Compare this distance to the Earth-Moon distance. Next, derive the escape velocity of Earth.