Homework No. 15 (Spring 2025)

PHYS 205A-001: UNIVERSITY PHYSICS

School of Physics and Applied Physics, Southern Illinois University–Carbondale

Due date: Friday, 2025 May 02, Noon, on D2L

Instructions

- You are encouraged to use any of the resources to complete this homework. However, the extent to which you depend on resources while doing this homework is a measure of how much extra work you need to put in to master the associated concepts. Solutions should be the last resource.
- Links to solutions are provided.
- Variations of homework problems and additional problems with hyperlinks to old exams are available in Lecture Notes. These serve as practice problems.
- Describe your thought process in detail and organize it clearly. Make sure your answer has units and right number of significant digits.
- After completion, scan the pages as a single PDF file, and submit the file on D2L (under Assesments → Assignments). You can replace your PDF file as many times as you like, only the last file is graded. The deadline has an (undisclosed) buffer period, so do not hesitate to try submissions after the deadline.

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.

   [**Solution**]

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 $2a$.

   [**Solution**]

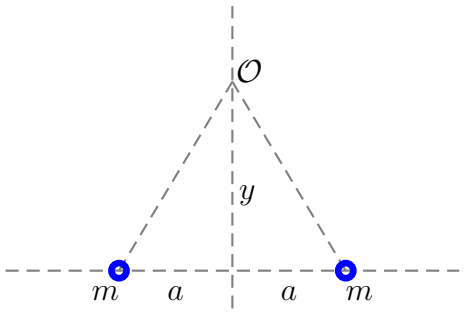

Figure 1: Problem 2

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?

   [**Solution**]

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.

   [**Solution**]