Homework No. 04A (Fall 2020)

PHYS 203A: COLLEGE PHYSICS

Department of Physics, Southern Illinois University–Carbondale

Due date: Thursday, 2020 Sep 17, 12:30pm, 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 (Assessments → Assignments).

Questions

1. (**10 points.**) Mass of Jupiter is 320 times larger than that of Earth. If you are given that the acceleration due to gravity on Jupiter is 2.4 times larger than that on Earth, then what can you conclude about the radius of Jupiter. (Radius of Earth is 6.4×10^6 m.)

2. (**10 points.**) Three particles have their positions on a straight line, far away from any other objects. See Fig. 1. The masses of these particles are $m_1 = 300\,\text{kg}$, $m_2 = 500\,\text{kg}$, and $m_3 = 200\,\text{kg}$. The distances are $r_{12} = 50\,\text{m}$ and $r_{23} = 25\,\text{m}$. Find the magnitude and direction of the net gravitational force acting on mass m_1.

Figure 1: Problem 2

3. (**10 points.**) A body of mass $m = 10.0\,\text{kg}$ rests on a weighing scale on a horizontal table.
   (a) Determine the magnitude of the normal force acting on the mass.
   (b) Determine the magnitude of the normal force acting on the mass while you pull on it vertically upwards with a force of 20 N. Determine the reading on the scale.

4. (**10 points.**) Your mass is 75 kg. How much will you weigh on a bathroom scale (designed to measure the normal force in Newtons) inside an elevator that is

(a) at rest?

(b) moving upward at constant speed?

(c) slowing down at $2.0\,\mathrm{m/s^2}$ while moving upward?

5. (**10 points.**) A student is skateboarding down a ramp that is 6.0 m long and inclined at 15° with respect to the horizontal. The initial speed of the skateboarder at the top of the ramp is 3.0 m/s. Neglect friction. See Fig. 2.

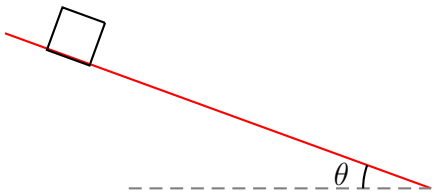

Figure 2: Problem 5.

(a) Identify the forces acting on the student. Choose a coordinate system such that the acceleration is along one of the axis. Draw a force diagram. That is, identify the forces.

(b) Determine the acceleration of the student.

(c) Find the speed of the student at the bottom of the ramp.

6. (**10 points.**) Three masses $m_1 = 10.0\,\mathrm{kg}$, $m_2 = 20.0\,\mathrm{kg}$, and $m_3 = 30.0\,\mathrm{kg}$, are stacked together on a frictionless plane. A force $\mathbf{F}$ is exerted on m_1.

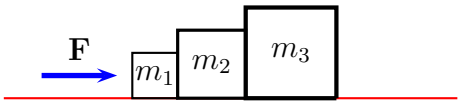

Figure 3: Problem 6.

(a) Identify the forces acting on each of the three masses.

(b) Using Newton's law determine the equations of motion for all three masses. If C_{ij} are contact forces acting on mass i by mass j, determine C_{12}.

7. (**10 points.**) The Atwood machine consists of two masses m_1 and m_2 connected by a massless (inextensible) string passing over a massless pulley. See Figure 4.

(a) Identify the forces acting on each of the two masses.

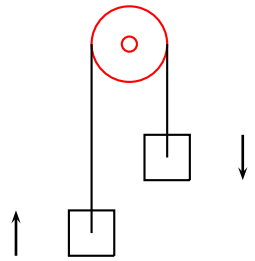

Figure 4: Problem 7

(b) Using Newton's law determine the equations of motion for all the masses.

(c) Determine the expression for the tension in the string.

8. (**10 points.**) A mass is held above ground using two ropes as described in Figure 5. Let $m = 20.0\,\text{kg}$, $\theta_1 = 30.0°$, and $\theta_2 = 45.0°$.

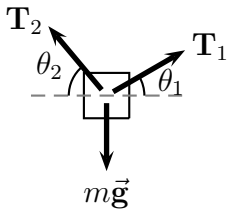

Figure 5: Problem 8.

(a) Identify the forces acting on the masse.

(b) Using Newton's law determine the equations of motion for the mass.

(c) Find the tension in each of the strings.

9. (**10 points.**) A mass $m_2 = 2.0\,\text{kg}$ is connected to another mass $m_1 = 1.0\,\text{kg}$ by a massless (inextensible) string passing over a massless pulley, as described in Figure 6. Surfaces are frictionless.

(a) Identify the forces acting on both the masse.

(b) Using Newton's law determine the equations of motion for each of the masses.

(c) Determine the acceleration of the masses.

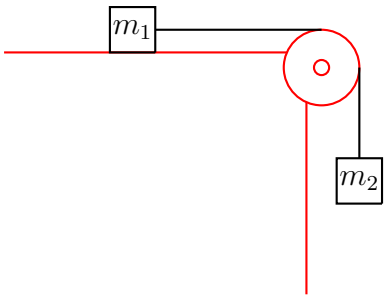

Figure 6: Problem 9