# Homework No. 07 (Spring 2025)

## PHYS 205A-001: UNIVERSITY PHYSICS

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

Due date: Wednesday, 2025 Feb 26, 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.**) 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.

   [**Solution**]

2. (**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 $20\,\text{N}$. Determine the reading on the scale.

   [**Solution**]

3. (**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?

[**Solution**]

4. (**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 Figure 1.

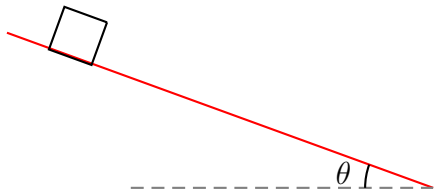


Figure 1: Problem 4.

(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.

(d) Determine the time taken by the student to reach the bottom of the ramp.

[**Solution**]

5. (**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 $m_1$.

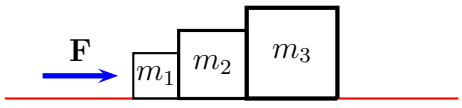


Figure 2: Problem 5.

(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 $C_{12}$. Let $F = 180\,\mathrm{N}$.

[**Solution**]

6. (**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 3.

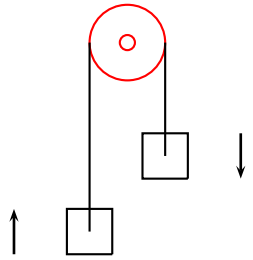

Figure 3: Problem 6

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

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

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

[**Solution**]

7. (**10 points.**) A mass is held above ground using two ropes as described in Figure 4. Let $m = 20.0\,\text{kg}$, $\theta_1 = 30.0°$, and $\theta_2 = 45.0°$.

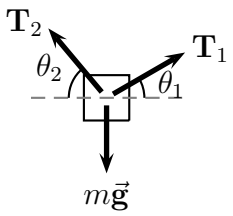


Figure 4: Problem 7.

(a) Identify the forces acting on the masses.

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

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

[**Solution**]

8. (**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 5. Surfaces are frictionless.

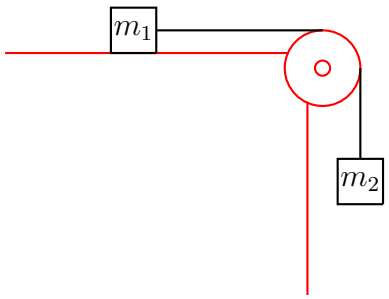


Figure 5: Problem 8

(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.

[**Solution**]