Homework No. 09 (Spring 2025)

PHYS 205A-001: UNIVERSITY PHYSICS

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

Due date: Wednesday, 2025 Mar 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.**) The velocity of a 25 kg object changes from $\vec{\mathbf{v}}_i = (4.0\,\hat{\mathbf{i}} + 3.0\,\hat{\mathbf{j}})\,\mathrm{m/s}$ to $\vec{\mathbf{v}}_f = (6.0\,\hat{\mathbf{i}} + 8.0\,\hat{\mathbf{j}})\,\mathrm{m/s}$ while it traverses along a path. What is the total work done by all the forces acting on the object during this change in velocity.

   [**Solution**]

2. (**10 points.**) The force acting on a particle varies as shown in the Figure 1. Find the work done by the force on the particle as it moves from $x = 10\,\mathrm{m}$ to $x = 30\,\mathrm{m}$.

   [2017F MT-03 P01]

3. (**10 points.**) A mass of $m = 25.0\,\mathrm{kg}$ slides down a frictionless incline that makes an angle of $\theta = 30.0^\circ$ with the horizontal. Assume that the mass starts from rest. The two forces acting on the mass during the slide are the normal force and the force of gravity. The mass slides $d = 10.0\,\mathrm{m}$ along the incline.

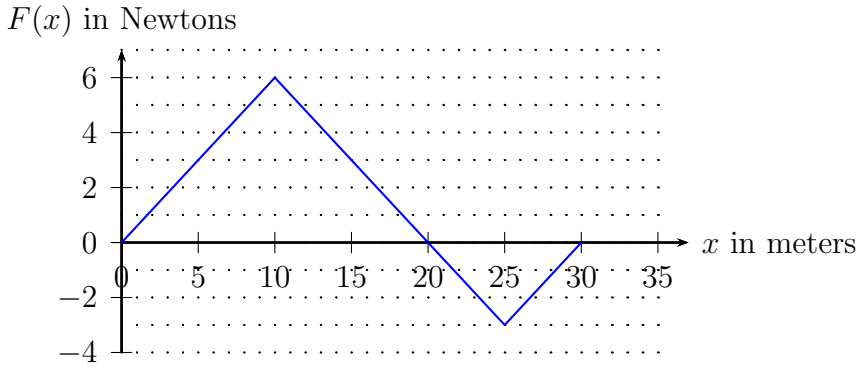

Figure 1: Problem 2.

(a) Determine the work done by the force of gravity.

(b) Determine the work done by the normal force.

(c) Determine the change in the gravitational potential energy of the mass.

(d) Determine the change in the kinetic energy of the mass.

[**Solution**]

4. (**10 points.**) A 25 kg mass slides down a surface, see Figure 2. Determine the work done by the force of friction while it falls a vertical height of $h = 3.0\,\text{m}$ and gains a speed of $4.0\,\text{m/s}$ starting from rest.

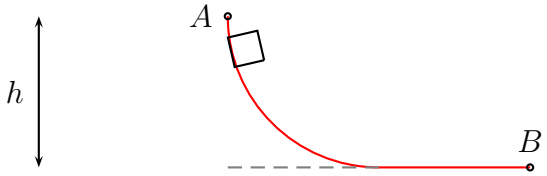

Figure 2: Problem 4.

[**Solution**]

5. (**10 points.**) A 25 kg mass slides down a frictionless surface, see Figure 3, from point A to point B starting from rest. Determine the speed at point B if it falls a vertical height of $h = 10.0\,\text{m}$.

[2023S MT-03 P05]

6. (**10 points.**) A roller coaster of mass $m = 500.0\,\text{kg}$ moves on the curve described in Figure 4. Assume frictionless surface. It starts from rest, $v_A = 0\,\text{m/s}$ at point A height at $h_A = 40.0\,\text{m}$.

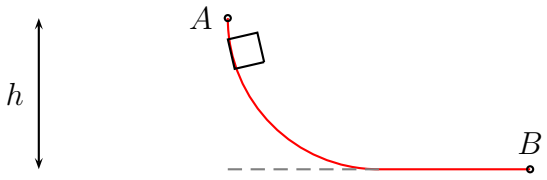

Figure 3: Problem 5.

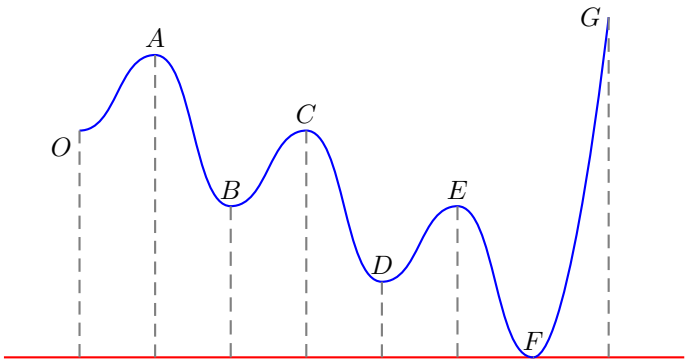

Figure 4: Problem 6.

(a) What is the work done by the normal force?

(b) Determine the velocity of the mass at point E, given $h_E = 20.0\,\text{m}$.

(c) How does your result depend on the mass.

[**Solution**]

7. (**10 points.**) Figure 5 shows a pendulum of length $L = 3.0\,\text{m}$ and mass $m = 5.0\,\text{kg}$. It starts from rest at angle $\theta = 30.0°$. Determine the velocity of the mass when $\theta = 0$.

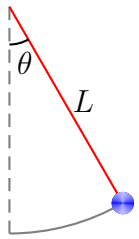

Figure 5: Problem 7.

[**Solution**]

8. (**10 points.**) A mass $m = 20.0\,\text{kg}$ slides down a frictionless incline starting from rest at point A at height $h = 1.0\,\text{m}$. After sliding down the incline it moves horizontally on a frictionless surface before coming to rest by compressing a spring of spring constant $k = 2.0 \times 10^4\,\text{N/m}$ by a length x. See Figure 6.

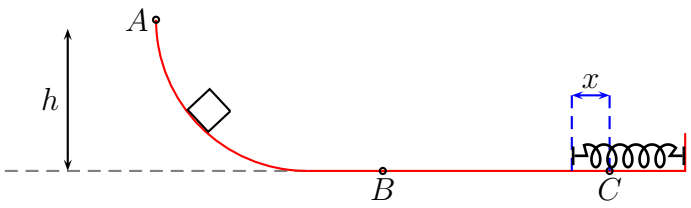

Figure 6: Problem 8.

(a) Determine the velocity of the mass at point B.

(b) Determine the maximum compression x in the spring.

[**Solution**]

9. (**10 points.**) A $3.0 \times 10^2\,\text{kg}$ mass slides down a frictionless incline, starting from rest at point A. The incline makes an angle of $30°$ with respect to the horizontal. After sliding down a distance $L = 2.0\,\text{m}$ (along the incline) it hits a spring of spring constant $4.0 \times 10^4\,\text{N/m}$ at point B. The mass is brought to rest at point C when the spring is compressed by length x. See Figure 7. Determine the compression x.

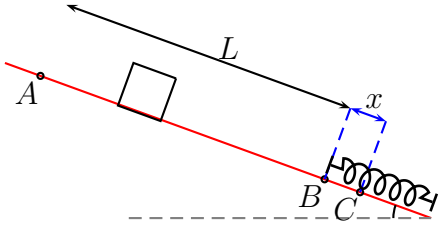

Figure 7: Problem 9.

[**Solution**]