Homework No. 02 (Spring 2026)

PHYS 205A-001: UNIVERSITY PHYSICS

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

Due date: Monday, 2026 Jan 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.
- Practice problems are available at Binapani Academy. It is a free service and requires a one-time registration. (Code: SIUC2025)
- 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 Assessments → 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.**) Motion of an object moving with uniform velocity is described by the equation

$$x = vt, \tag{1}$$

where x is the position of the object, v is the velocity of the object, and t is time.

   (a) Plot x versus t for $v = 3.0\,\mathrm{m/s}$. Give a real life example that is described by this scenario.

   (b) Plot x versus t for $v = -3.0\,\mathrm{m/s}$. Give a real life example that is described by this scenario.

   (c) What is the acceleration of the object for these cases?

   [**Solution**]

2. (**10 points.**) Motion of an object moving with uniform acceleration, with intial velocity v_0, is described by the equation

$$x = v_0 t + \frac{1}{2} a t^2, \tag{2}$$

where x is the position of the object, a is the acceleration of the object, and t is time.

   (a) Plot x versus t for $v_0 = 0$ and $a = 2.0\,\mathrm{m/s^2}$. Give a real life example that is described by this scenario.

   (b) Plot x versus t for $v_0 = 0$ and $a = -2.0\,\mathrm{m/s^2}$. Give a real life example that is described by this scenario.

   (c) Plot x versus t for $v_0 = +1.0\,\mathrm{m/s}$ and $a = 2.0\,\mathrm{m/s^2}$. Give a real life example that is described by this scenario.

   (d) Plot x versus t for $v_0 = +1.0\,\mathrm{m/s}$ and $a = -2.0\,\mathrm{m/s^2}$. Give a real life example that is described by this scenario.

   (e) Plot x versus t for $v_0 = -1.0\,\mathrm{m/s}$ and $a = 2.0\,\mathrm{m/s^2}$. Give a real life example that is described by this scenario.

   (f) Plot x versus t for $v_0 = -1.0\,\mathrm{m/s}$ and $a = -2.0\,\mathrm{m/s^2}$. Give a real life example that is described by this scenario.

   [**Solution**]

3. (**10 points.**) A particle's velocity is given by

$$v(t) = v_0 + a_0 t + \frac{1}{2} b_0 t^2. \tag{3}$$

   (a) Determine the particle's acceleration as a function of time.

   (b) Determine the particle's rate of change of acceleration as a function of time.

   (c) Given the particle starts from rest at $t = 0$, determine the velocity of the particle when the instantaneous acceleration of the particle is zero.

   [**Solution**]

4. (**10 points.**) The position of a particle x as a function of time t is given by

$$x(t) = 3\alpha t - \frac{\alpha}{\tau^2} t^3, \tag{4}$$

   where α and τ are constants. Determine the magnitude of the acceleration of the particle when it momentarily stops.

   [2021S MT-01 P08]

5. (**10 points.**) While standing on a 50.0 m tall building you throw a stone straight upwards at a speed of 15 m/s.

(a) How long does the stone take to reach the ground?

(b) How high above the building does the stone reach?

[Solution]

6. (**10 points.**) A fish is dropped by a pelican that is rising steadily at a speed 4.0 m/s. Determine the time taken for the fish to reach the water 15.0 m below. How high above the water is the pelican when the fish reaches the water?

   [Solution]

7. (**10 points.**) A car is traveling at 10.0 m/s, and the driver sees a traffic light turn red. After 0.500 s (the reaction time), the driver applies the brakes, and the car decelerates at 8.00 m/s^2. What is the stopping distance of the car, as measured from the point where the driver first sees the red light?

   [Solution]

8. (**10 points.**) A speeding car is moving at a constant speed of $v = 80.0$ miles/hour (35.8 m/s). A police car is initially at rest. As soon as the speeder crosses the police car the cop starts chasing the speeder at a constant acceleration of $a = 2.0\,\mathrm{m/s^2}$. Determine the time it takes for the cop to catch up with the speeder. Determine the distance traveled by the cop in this time.

   [Solution]

9. (**10 points.**) A key falls from a bridge that is 50.0 m above the water. It falls directly into a boat that is moving with constant velocity, that was 10.0 m from the point of impact when the key was released. What is the speed of the boat?

   [Solution]

10. (**10 points.**) Imagine that a man is running at a uniform speed $v = 7.0\,\mathrm{m/s}$ to catch a bus that is stopped at a traffic light. When he is still a distance $d = 10.\,\mathrm{m}$ from the bus, the bus starts to move away with a constant acceleration $a = 2.0\,\mathrm{m/s^2}$. How long after the bus starts to move will the man catch the bus? Assume that the motion of the man and the bus is along a straight road. The cross in Figure 1 illustrates the point where the man catches the bus.

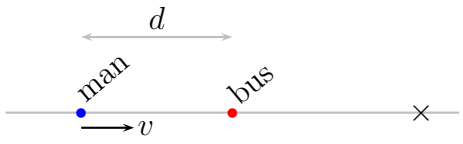

Figure 1: Problem 10.

[Solution]