Homework No. 02 (Fall 2023)

PHYS 205A-002: UNIVERSITY PHYSICS

School of Physics and Applied Physics, Southern Illinois University–Carbondale
Due date: Friday, 2023 Sep 1, 2:00 PM, 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.

- Describe your thought process in detail and organize it clearly. Make sure your answer has units and the right number of significant digits.

- After completion, scan the pages as a single PDF file, and submit the file on D2L (under Assesments → Assignments).

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
$$x = v_0 t + \frac{1}{2}at^2, \tag{2}$$
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 $a = 2.0\,\mathrm{m/s^2}$.

(b) Plot x versus t for $v_0 = 0$ and $a = -2.0\,\mathrm{m/s^2}$.

(c) Plot x versus t for $v_0 = +1.0\,\mathrm{m/s}$ and $a = 2.0\,\mathrm{m/s^2}$.

(d) Plot x versus t for $v_0 = +1.0\,\mathrm{m/s}$ and $a = -2.0\,\mathrm{m/s^2}$.

(e) Plot x versus t for $v_0 = -1.0\,\mathrm{m/s}$ and $a = 2.0\,\mathrm{m/s^2}$.

(f) Plot x versus t for $v_0 = -1.0\,\mathrm{m/s}$ and $a = -2.0\,\mathrm{m/s^2}$.

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.**) 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

5. (**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

6. (**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/s². What is the stopping distance of the car, as measured from the point where the driver first sees the red light?

Solution

7. (**10 points.**) A speeding car is moving at a constant speed of $v = 80.0\,\mathrm{miles/hour}$ (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

8. (**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