# Midterm Exam No. 01 (2021 Spring)

**PHYS 205A-001: UNIVERSITY PHYSICS**

*Department of Physics, Southern Illinois University–Carbondale*

Date: 2021 Feb 15

*Honor Pledge: I affirm that I will not give or receive any consultation during this examination.*

____________________ (Name) ____________________ (Signature)

## Instructions

- There are 10 questions in this exam.
- To be considered for partial credit present your work in detail and organize it clearly.
- This is a timed exam, from 12:00 PM to 12:50 PM on Monday 2021 Feb 15. This time includes the time required for downloading the exam and uploading the solutions.
- Please submit a single PDF file on D2L. Note that D2L will not allow submissions after 12:50 PM.
- In case of technical issues contact me by email at the earliest. Accommodations will be made after fairness to other students is taken into consideration.
- This is an open book and open resource examination, and use of Internet is allowed. However, consultation is prohibited.

0. (**0 points.**) Write the Honor Pledge on your answer sheet. You do not have to attach the cover sheet with your submission.

## Conceptual questions

1. (**5 points.**) The position of an object moving along a straight line as a function of time is plotted in Figure 1. The slope of the curve in the position-time graph at 3.0 hours is zero. Thus, the velocity of the object at 3.0 hours is zero. Is the acceleration of object at 3.0 hours zero? If so, explain. If not, why not?

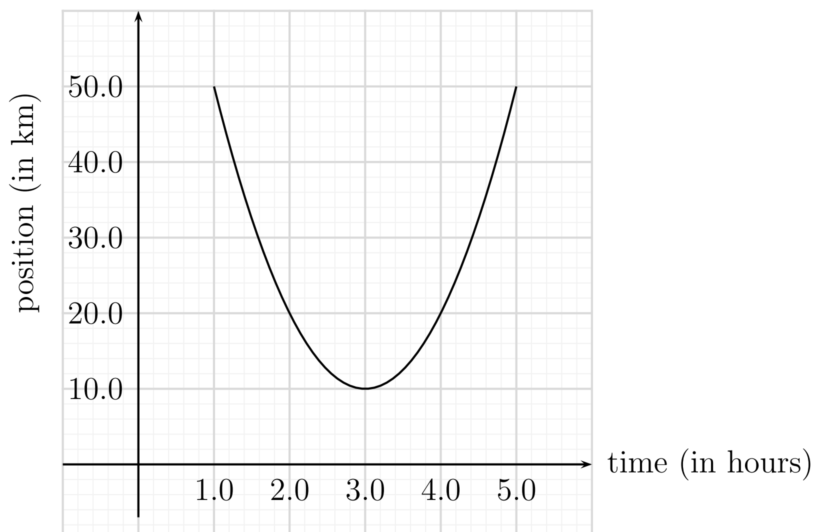


Figure 1: Problem 1.

2. (**5 points.**) An object starts from rest and uniformly accelerates in both the horizontal and the vertical direction such that the positions $x$ and $y$ as a function of time are described by the equations

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

$$y = \frac{1}{2} a_y t^2, \tag{1b}$$

where $a_x$ and $a_y$ are the respective accelerations in the horizontal and vertical directions. Determine the curve that describes the trajectory of the object in the $x$-$y$ plane.

3. (**5 points.**) A car is moving with uniform velocity. A passenger in the car tosses an orange vertically upwards with respect to him. Will the orange return to his hands? If so, explain. If not, why not? Assume no air resistance.

4. (**5 points.**) In a room devoid of air a stuntman is released from rest. During the fall, the stuntman throws a ball vertically upwards. Describe the motion of the ball as perceived by the stuntman.

## Problems

5. (**10 points.**) A square surrounds a circle such that the circumference of the circle is tangent to all four sides of the square. What is the ratio of the area of the square to area of the circle?

6. (**10 points.**) Consider the mathematical expression

$$x = \frac{1}{7!} b t^7 + \frac{1}{8!} c t^8, \tag{2}$$

where $x$ is measured in units of distance and $t$ is measured in units of time. Determine the dimension of the physical quantity represented by the ratio $\frac{b}{c}$. That is, given

$$\left[\frac{b}{c}\right] = M^\alpha L^\beta T^\gamma, \tag{3}$$

determine $\alpha$, $\beta$, and $\gamma$.

7. (**10 points.**) A fish is dropped by a pelican that is descending steadily at a speed 4.0 m/s. Determine the time taken for the fish to reach the water 15.0 m below. (Caution: This is slightly different from the homework problem.)

8. (**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 $\alpha$ and $\tau$ are constants. Determine the magnitude of the acceleration of the particle when it momentarily stops in terms of $\alpha$ and $\tau$.

9. (**10 points.**) Given that vector $\vec{\mathbf{A}}$ has magnitude $A = |\vec{\mathbf{A}}| = 15\,\text{m}$ and direction $\theta_A = 30.0^\circ$ counterclockwise w.r.t $+x$-axis, and that vector $\vec{\mathbf{B}}$ has magnitude $B = |\vec{\mathbf{B}}| = 20.0\,\text{m}$ and direction $\theta_B = 40.0^\circ$ counterclockwise w.r.t $+y$-axis. Determine the magnitude and direction of the sum of the vectors.

10. (**10 points.**) A package is dropped from an aeroplane while it is moving horizontally with a speed of 45 m/s at a height of 75 m from the ground. What is the speed of the package right before it hits the ground?