Midterm Exam No. 01 (2022 Spring)

PHYS 205A-001: UNIVERSITY PHYSICS

Department of Physics, Southern Illinois University–Carbondale

Date: 2022 Feb 7

(Name) (Signature)

Instructions

- Seating direction: Please be seated on seats with seat numbers divisible by 2.
- Total time = 50 minutes.
- There are 7 questions in this exam.
- Equation sheet is provided separately.
- To be considered for partial credit present your work in detail and organize it clearly.
- A simple calculator (with trigonometric functions) is allowed.
- Use of mobile phones is strictly prohibited. It should stay out of reach during the exam.

1. (**5 points.**) Given the expression

$$E = \sqrt{m^2c^4 + p^2c^2}, \tag{1}$$

where it is known that m is measured in units of mass and $[c] = LT^{-1}$. Determine the dimension of the quantity represented by the symbol p. That is, given

$$[p] = M^{\alpha}L^{\beta}T^{\gamma}, \tag{2}$$

determine α, β, and γ.

2. (**5 points.**) The position of an object moving in a straight line, as a function of time, is plotted in Figure 1. Estimate the velocity of the object at 3.0 hours.

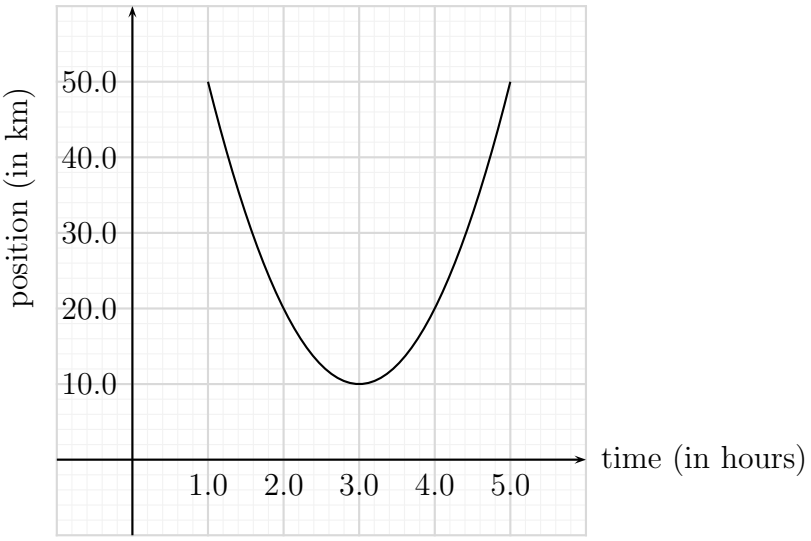

Figure 1: Problem 2.

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? Illustrate using a diagram. Assume no air resistance.

4. (**10 points.**) Starting at time $t = 0$, an object moves along a straight line. Its coordinate in meters is given by

$$x(t) = 75\,t - 1.0\,t^3, \tag{3}$$

where t is in seconds. Determine the acceleration of the object at time $t = 0$. More accurately, the numbers in the above equation should include units, which is achieved by the replacements $75 \to 75\,\mathrm{m/s}$ and $1.0 \to 1.0\,\mathrm{m/s^3}$.

5. (**10 points.**) While standing on the ground you throw a ball straight upwards. It returns to your hand after 2.0 s. How high did the ball go?

6. (**10 points.**) An explorer walks along a straight path a distance $d = 5.0\,\text{km}$ at an angle 60° North of East. Then, he turns right (ninety degree turn) and walks another distance d. Determine the magnitude and direction of the final position of the explorer with respect to the initial position.

7. (**10 points.**) A rifle is aimed at a bullseye. The muzzle speed of the bullet is 750 m/s. The gun is pointed directly at the center of the bullseye, but the bullet strikes the target 0.25 m below the center. What is the horizontal distance between the end of the rifle and the bullseye?