Midterm Exam 01 (2020 Fall)<br>PHYS 203A-002: College Physics<br>Department of Physics, Southern Illinois University-Carbondale<br>Date: 2020 Sep 8

## Instructions

- There are 12 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 12:35 PM to $01: 50$ PM on Tuesday 2020 Sep 8. 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 01:50 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.


## 1 Conceptual questions

1. (5 points.) Give an example of a physical quantity that has units of $\mathrm{cm}^{3}$. If this quantity is measured to be $13 \mathrm{~m}^{3}$, express it in $\mathrm{cm}^{3}$.
2. ( 5 points.) A feather and a bowling ball are projected up with the same initial speed in a room devoid of air. Will the feather or the bowling ball go higher?
3. (5 points.) A vehicle is moving in a straight line with a uniform speed of 70 miles/hour. Imagine the inside part of the vehicle to be devoid of air. A passenger in such a vehicle throws an orange vertically up. Will the orange return to his hands? If so, explain. If not, why not?
4. (5 points.) In a room devoid of air a stuntman and a bullseye (target) are released from rest from the same height simultaneously. During the fall, the stuntman throws a ball horizontally towards the target. Is the ball expected to hit the target? If yes, explain. If not, why not?

## 2 Problems

5. (10 points.) The famous equation $E=m c^{2}$ in a textbook appears in the form

$$
\begin{equation*}
E=\sqrt{p^{2} c^{2}+m^{2} c^{4}} \tag{1}
\end{equation*}
$$

If energy $E$ has the dimensions $M L^{2} T^{-2}$ and mass $m$ has the dimension $M$, deduce the dimensions of $c$ and $p$.
6. (10 points.) Find the components of vector A whose magnitude is 10.0 m and its direction is $30.0^{\circ}$ counterclockwise with respect to the positive $y$ axis.
7. ( $\mathbf{1 0}$ points.) Given that vector $\mathbf{A}$ has magnitude 10.0 m and direction $30.0^{\circ}$ counterclockwise w.r.t. $+y$ axis, and that vector $\mathbf{B}$ has magnitude 20.0 m and direction $135^{\circ}$ clockwise w.r.t. $+x$ axis. Determine the magnitude and direction of the sum of the vectors.
8. (10 points.) Standing on the ground you throw a stone vertically up. Neglect air resistance.
(a) What is the velocity of the stone when it is at the highest point?
(b) Is the stone accelerating when it is at the highest point?
9. ( $\mathbf{1 0}$ points.) A ball is thrown vertically upward at a speed of $15 \mathrm{~m} / \mathrm{s}$. How high above does the stone reach? Neglect air resistance.
10. ( $\mathbf{1 0}$ points.) A speeder is moving in a straight line with uniform speed of $40.0 \mathrm{~m} / \mathrm{s}$. The speeder passes a police car that is moving at $30.0 \mathrm{~m} / \mathrm{s}$. The police car starts the chase with a uniform acceleration of $3.0 \mathrm{~m} / \mathrm{s}^{2}$ immediately after the speeder passes. How much time does it take for the police to catch up with the speeder?
11. ( $\mathbf{1 0}$ points.) A small fish is dropped by a pelican that is descending steadily at $6.0 \mathrm{~m} / \mathrm{s}$ when it is 12.0 m above the ground. How much time later does the fish hit the water?
12. (10 points.) A rifle is aimed at a bullseye. The muzzle speed of the bullet is $750 \mathrm{~m} / \mathrm{s}$. 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?

