Midterm Exam 01 (2020 Fall)

PHYS 203A-002: College Physics

Department of Physics, Southern Illinois University–Carbondale 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 cm^3 . If this quantity is measured to be $13 m^3$, express it in 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 $E = mc^2$ in a textbook appears in the form

$$E = \sqrt{p^2 c^2 + m^2 c^4}.$$
 (1)

If energy E has the dimensions ML^2T^{-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° counterclockwise with respect to the positive y axis.
- 7. (10 points.) Given that vector **A** has magnitude 10.0 m and direction 30.0° counterclockwise w.r.t. +y axis, and that vector **B** has magnitude 20.0 m and direction 135° 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. (10 points.) A ball is thrown vertically upward at a speed of 15 m/s. How high above does the stone reach? Neglect air resistance.
- 10. (10 points.) A speeder is moving in a straight line with uniform speed of 40.0 m/s. The speeder passes a police car that is moving at 30.0 m/s. The police car starts the chase with a uniform acceleration of 3.0 m/s^2 immediately after the speeder passes. How much time does it take for the police to catch up with the speeder?
- 11. (10 points.) A small fish is dropped by a pelican that is descending steadily at 6.0 m/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 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?