Midterm Exam No. 01 (2017 Fall)

PHYS 205A-002: University Physics

Date: 2017 Sep 15

(Name) (Signature)

Instructions

1. Seating direction: Please be seated on seats with seat-numbers divisible by 3.
2. Total time = 50 minutes.
3. There are 7 questions in this exam.
4. Equation sheet is provided separately.
5. To be considered for partial credit you need to show your work in detail and organize it clearly.
6. A simple calculator (with trigonometric functions) is allowed.
7. Use of mobile phones is strictly prohibited. It should stay out of reach during the exam.

1. (**10 points.**) The Einstein field equation

$$R - \frac{D}{2}R + D\Lambda = \frac{8\pi G}{c^4}\mathcal{E} \tag{1}$$

model concepts like black holes and dark energy. Here D is the spacetime dimension of our universe, which is a dimensionless quantity. Further, $\mathcal{E}$ is energy density with dimensions

$$\big[\mathcal{E}\big] = \frac{M}{LT^2}, \tag{2}$$

and the fundamental constants G and c have the dimensions

$$\big[G\big] = \frac{L^3}{MT^2} \quad \text{and} \quad \big[c\big] = \frac{L}{T}. \tag{3}$$

The variable Λ is the cosmological constant. Using dimensional analysis deduce the dimension of the cosmological constant.
Note: To be eligible for partial credit please explain your reasoning clearly. A prior knowledge of the special words used in this question is not necessary to complete this problem.

2. (**10 points.**) Starting at time $t = 0$, an object moves along a straight line. Its coordinate in meters is given by

$$x(t) = 75\,t - 1.0\,t^3, \tag{4}$$

where t is in seconds. What is its acceleration when it momentarily stops?

3. (**10 points.**) A truck covers 44.0 m in 8.20 s while smoothly slowing down to final speed of 2.50 m/s. Find its acceleration.

4. (**10 points.**) A baseball is hit so that it travels straight upward after being struck by the bat. A fan observes that it takes 3.00 s for the ball to reach its maximum height. Find the height it reaches.

5. (**10 points.**) A ball is thrown vertically downward from the top of a 36.6 m tall building. The ball passes the top of a window that is 12.2 m above the ground 2.00 s after being thrown. What is the speed of the ball as it passes the top of the window?

6. (**10 points.**) A vector has an x component of -40.0 units and a y component of 30.0 units. Find the magnitude and direction of this vector.

7. (**10 points.**) Consider the vectors:

$$\vec{\mathbf{A}} = 4.00\,\hat{\mathbf{i}} + 2.00\,\hat{\mathbf{j}}, \tag{5a}$$

$$\vec{\mathbf{B}} = -5.00\,\hat{\mathbf{i}} + 3.00\,\hat{\mathbf{j}}. \tag{5b}$$

Draw the vector $\vec{\mathbf{C}} = \vec{\mathbf{A}} + \vec{\mathbf{B}}$. Determine the magnitude and direction of vector $\vec{\mathbf{C}}$.