Homework No. 01 (Fall 2020)

PHYS 203A: COLLEGE PHYSICS

Department of Physics, Southern Illinois University–Carbondale

Due date: Tuesday, 2020 Aug 25, 12.30pm, on D2L

Instructions

- Describe your thought process in detail and organize it clearly. Make sure your answer has the correct units and the right number of significant digits.
- After completion, scan the pages as a single PDF file, and submit the file on D2L (Assesments → Assignments).

Questions

1. (**10 points.**) The corners of a square lie on a circle of radius $R = 1.0\,\text{cm}$. Find the length L of the square.

2. (**10 points.**) Consider the mathematical expression

$$x = vt + \frac{1}{2!}at^2 + \frac{1}{3!}bt^3 + \frac{1}{4!}ct^4, \tag{1}$$

where x is measured in units of distance and t is measured in units of time. Determine the dimension of the physical quantities represented by the symbols v, a, b, and c.

3. (**10 points.**) What can you deduce about the physical quantity c in the famous equation

$$E = mc^2, \tag{2}$$

if the energy E has the dimensions ML^2T^{-2} and mass m has the dimension M.

4. (**10 points.**) (Weyl expansion.) The list of overtones (frequencies of vibrations) of a drum is completely determined by the shape of the drumhead. Is the converse true? That is, what physical quantities regarding the shape of a drum can one infer, if the complete list of overtones is given. This is popularly stated as ‘Can one hear the shape of a drum?’ Weyl expansion, that addresses this question, is

$$E = \frac{A}{\delta^3} + \frac{C}{\delta^2} + \frac{B}{\delta} + a_0 + a_1\delta + a_2\delta^2 + \dots, \tag{3}$$

where E is measured in units of inverse length, and δ is measured in units of length. Deduce that the physical quantities A and C have the dimensions of area and circumference, respectively.

5. (**10 points.**) Find the components of vector $\mathbf{A}$ whose magnitude is $20.0\,\mathrm{m}$ and its direction is $30.0°$ counterclockwise with respect to the positive x-axis.

6. (**10 points.**) Given that vector $\mathbf{A}$ has magnitude $A = |\mathbf{A}| = 15\,\mathrm{m}$ and direction $\theta_A = 30.0°$ counterclockwise w.r.t x-axis, and that vector $\mathbf{B}$ has magnitude $B = |\mathbf{B}| = 20.0\,\mathrm{m}$ and direction $\theta_B = 45.0°$ counterclockwise w.r.t x-axis. Determine the magnitude and direction of the sum of the vectors.

7. (**10 points.**) An explorer is caught in a whiteout (in which the snowfall is so thick that the ground cannot be distinguished from the sky) while returning to base camp. He was supposed to travel due north for $4.4\,\mathrm{km}$, but when the snow clears, he discovers that he actually traveled $7.8\,\mathrm{km}$ at $54°$ north of due east.

   (a) How far must he now travel to reach base camp?

   (b) In what direction must he travel?

8. (**10 points.**) A golfer takes two strokes to putt a golf ball into a hole. On the first stroke, the ball moves $5.0\,\mathrm{m}$ at an angle $60°$ West of North. On the second, it moves $3.0\,\mathrm{m}$ at an angle $70°$ South of West. If the golfer had instead hit the ball directly into the hole on the first stroke, what would have been the magnitude and direction of the ball's displacement?