

## Homework No. 01 (Spring 2024)

### PHYS 205A-001: UNIVERSITY PHYSICS

*School of Physics and Applied Physics, Southern Illinois University–Carbondale*

Due date: Monday, 2024 Jan 22, 12:00 PM, on D2L

### Instructions

- You are encouraged to use any of the resources to complete this homework. However, the extent to which you depend on resources while doing this homework is a measure of how much extra work you need to put in to master the associated concepts. Solutions should be the last resource.
- Links to solutions are provided. Further, links to few variations of the problem are provided that serve as practice problems.
- Describe your thought process in detail and organize it clearly. Make sure your answer has units and right number of significant digits.
- After completion, scan the pages as a single PDF file, and submit the file on D2L (under Assesments → Assignments). You can replace your PDF file, only the last file is graded.

### Problems

1. (**10 points.**) The corners of a square lie on a circle of radius  $R$ . Find the area of the square as a function of  $R$ .

[[Solution, 2021S MT-01 P05](#)]

2. (**10 points.**) What can you deduce about the physical quantity  $c$  in the famous equation

$$E = mc^2, \tag{1}$$

if the energy  $E$  has the dimensions  $ML^2T^{-2}$  and mass  $m$  has the dimension  $M$ . In particular, what is the dimension of  $c$ ? That is, given

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

determine  $\alpha$ ,  $\beta$ , and  $\gamma$ .

[[Solution, 2023F MT-01 P01](#)]

3. (10 points.) Consider the mathematical expression

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

where  $x$  is measured in units of distance and  $t$  is measured in units of time. Determine the dimension of the physical quantity represented by the symbol  $b$ . That is, given

$$[b] = M^\alpha L^\beta T^\gamma, \quad (4)$$

determine  $\alpha$ ,  $\beta$ , and  $\gamma$ .

[**Solution**, 2023S MT-01 P01, 2022S MT-01 P01, 2021S MT-01 P06, 2018S MT-01 P01, 2018S FE P01, 2017F-001 MT-01 P01, 2017F-002 MT-01 P01, 2016F MT-01 P01, 2014F MT-01 P01]

4. (10 points.) Consider the mathematical expression

$$x = Ae^{-\omega t}, \quad (5)$$

where  $x$  is measured in units of distance and  $t$  is measured in units of time. Evaluate  $\frac{dx}{dt}$ . Then, determine the dimension of  $\omega A$ . That is, given

$$[\omega A] = M^\alpha L^\beta T^\gamma, \quad (6)$$

determine  $\alpha$ ,  $\beta$ , and  $\gamma$ .

[**Solution**, 2022F MT-01 P01, 2015F MT-01 P01]

5. (10 points.) Complete the operations and express your answer in scientific notation with correct number of significant digits.

(a)  $345 \times 72$

(b)  $55 \div 11$

(c)  $34.3456 + 42.1$

(d)  $46.32 - 56.92345$

(e)  $15600 - 12$

[**Solution**]