# Final Exam (2024 Spring)

## PHYS 205A-001: UNIVERSITY PHYSICS

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

Date: 2024 May 10

(Name) (Signature)

## Instructions

1. Seating direction: Please be seated on seats with seat-numbers divisible by 3.
2. Total time = 120 minutes.
3. There are 4 conceptual questions and 3 problems in this exam.
4. Equation sheet is provided separately.
5. To be considered for partial credit you need to present your work in detail and organize it clearly.
6. A simple calculator (with trigonometric functions) is allowed.
7. Use of smart devices, including smart watches, is strictly prohibited. They should stay out of reach during the exam.
8. Restroom breaks are allowed. Under questionable circumstances this might lead up to a Makeup Exam.
9. Academic misconduct will lead to a failing grade in the course.

1. (**5 points.**) The equation

$$x = 3At^2 + 5Bt^4 \tag{1}$$

describes the motion of an object, with $x$ having the dimension of length and $t$ having the dimension of time. Determine the dimension of

$$\frac{A}{B}. \tag{2}$$

(Use $L$ for the dimension of length and $T$ for the dimension of time.)

2. (**5 points.**) What is the direction of the acceleration of an object when it is moving in a circle of radius 65 m with uniform speed?

3. (**5 points.**) Identify the physical quantity associated with the integral of the product of mass times acceleration, along the path of the particle,

$$\int_i^f m\mathbf{a} \cdot d\mathbf{r}? \tag{3}$$

4. (**5 points.**) A sphere rolls perfectly (without sliding or slipping) on the surface of an incline that makes an angle of 30° with the horizontal. Determine the torque (about the axis of rotation of the sphere) exerted by the normal force (on the sphere) while it is rolling.

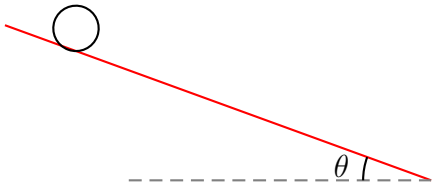


Figure 1: Problem 4.

5. (**10 points.**) Your mass is 75 kg. How much will you weigh on a bathroom scale (designed to measure the normal force in Newtons) inside an elevator that is moving upward at constant speed?

6. (**10 points.**) An object in the shape of a cylindrical disc, (with $I = \frac{1}{2}MR^2$ when the axis of rotation passes through the center of disc,) rolls perfectly (without sliding or slipping) on the surface of an incline that makes an angle 30° with the horizontal. Determine the acceleration of the disc?

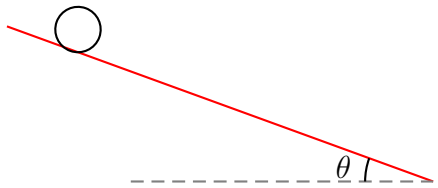


Figure 2: Problem 6.

7. (**10 points.**) Derive the expression for escape velocity of Earth. Then, evaluate the numerical value for escape velocity of Earth. Given mass of Earth is $6.0 \times 10^{24}\,\text{kg}$ and radius of Earth is $6.4 \times 10^{6}\,\text{m}$.