

# Final Exam (2021 Spring)

## PHYS 205A-001: UNIVERSITY PHYSICS

*Department of Physics, Southern Illinois University–Carbondale*

Date: 2021 May 6

*Honor Pledge: I affirm that I will not give or receive any consultation during this examination.*

\_\_\_\_\_  
(Name)

\_\_\_\_\_  
(Signature)

### Instructions

- There are 10 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 2:45 PM to 4:45 PM on Thursday 2021 May 6. 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 4:45 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.

0. (0 points.) Write the Honor Pledge on your answer sheet. You do not have to attach the cover sheet with your submission.

## Conceptual questions

1. (5 points.) Is the acceleration of an object zero when it momentarily stops? Explain.
2. (5 points.) An object is dropped from rest from the roof of a building. Neglect air resistance. While falling freely under gravity the object explodes into two identical pieces. Is the linear momentum conserved in this explosion? Explain.
3. (5 points.) What is the dimension of torque? How is it different from the dimension of energy?
4. (5 points.) Escape velocity is the minimum speed needed for an object at the surface of a planet to escape from the gravitational influence of the planet. Is it necessary for the this velocity to be directed radially outward? That is, would it escape if the object were launched at an arbitrary angle?

## Problems

5. (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?
6. (10 points.) A particle has a circular path of radius 2.0 m. If it makes 30 revolutions per minute, what is the centripetal acceleration of the particle?
7. (10 points.) A mass of  $m = 25.0$  kg slides down a frictionless incline that makes an angle of  $\theta = 30.0^\circ$  with the horizontal. Assume that the mass starts from rest. The two forces acting on the mass during the slide are the normal force and the force of gravity. The mass slides  $d = 10.0$  m along the incline. Determine the change in the kinetic energy of the mass.
8. (10 points.) A motorcycle accelerates uniformly from rest and reaches a linear speed of 24.0 m/s in a time of 8.00 s. The radius of each tire is 0.300 m. What is the angular displacement of a point on the rim of the tire in this time interval?
9. (10 points.) Five balls of masses  $m_1 = 1.0$  kg,  $m_2 = 2.0$  kg,  $m_3 = 3.0$  kg,  $m_4 = 4.0$  kg, and  $m_0 = 5.0$  kg, are connected by massless rods of length  $a = 10.0$  cm and  $b = 20.0$  cm, as shown in Figure 1. This configuration is rotated about an axis coming out of the plane containing the five masses and passing through the mass  $m_4$ . The inertia associated with

this rotational motion is quantified by the moment of inertia. Compute the moment of inertia.

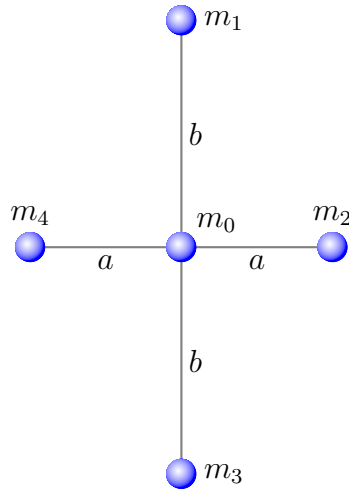


Figure 1: Problem 9.

10. (10 points.) Two identical stars, each of mass  $m$ , are positioned at diagonally opposite corners of a square of edge length  $L$ . See Figure 2. Find the magnitude and direction of the gravitational field at one of the vacant corner of the square marked  $\mathcal{O}$ .

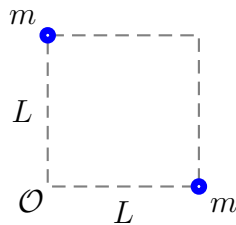


Figure 2: Problem 10