Midterm Exam No. 03 (2021 Spring)

PHYS 205A-001: UNIVERSITY PHYSICS

Department of Physics, Southern Illinois University–Carbondale

Date: 2021 Apr 9

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

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(Name)   (Signature)

Instructions

- There are 8 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 12:00 PM to 12:50 PM on Friday 2021 Apr 9. 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 12:50 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.**) You climb up a stair and return back to where you started. What is the work done by the gravitational force acting on you during the round trip?

2. (**5 points.**) The total energy E of a system is the sum of kinetic energy K and a potential energy U, given by
$$E = K + U, \tag{1}$$
where the potential energy as a function of distance $r > 0$ is shown in Figure 1. Determine if there is a restriction on the amount of total energy the system can have. In particular, determine the maximum and minimum total energy the system could have? Explain.
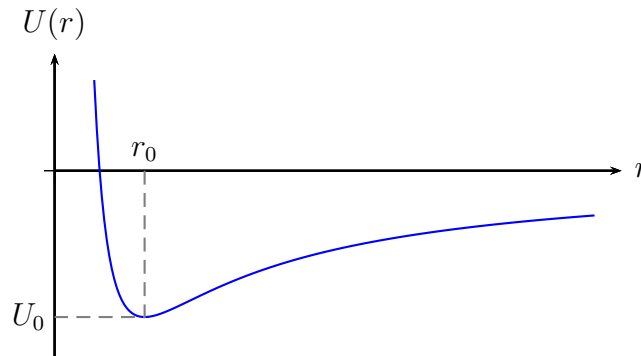

Figure 1: Problem 2.

3. (**5 points.**) Given the expression
$$P = \kappa J, \tag{2}$$
where P is momentum and J is impulse. What is the dimension of κ?

4. (**5 points.**) The object in Figure 2 is constructed by cutting out a disc of diameter R out of a circular disc of diameter $2R$. Assume uniform density of material (shown in blue). Is the center of mass of the object above height R from the baseline shown, or below height R?
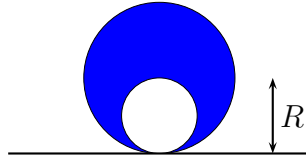
Figure 2: Problem 4.

Problems

5. (**10 points.**) Determine the work done by the force of gravity when a person first lifts a 3.0 kg block a vertical height of 10.0 m (along the vertical direction) and then carries the block a horizontal distance of 50.0 m (along the horizontal direction).

6. (**10 points.**) A 25 kg mass slides down an inclined plane. Determine the work done by the force of friction while it falls a vertical height of $h = 10.0$ m and gains a speed of 5.0 m/s starting from rest.
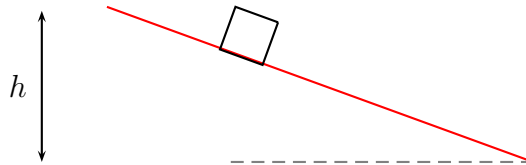

Figure 3: Problem 6.

7. (**10 points.**) A car of mass $m_1 = 3000.0$ kg is moving at speed $v_{1i} = 25.0$ m/s towards West. A truck of mass $m_2 = 7000.0$ kg is moving at speed $v_{2i} = 15.0$ m/s towards South. They collide at an intersection and get entangled (complete inelastic collision). What is the magnitude and direction of the final velocity of the entangled automobiles?

8. (**10 points.**) A mass $m_1 = 1.0$ kg moving with speed v_{1i} (elastically) collides with another mass $m_2 = 2.0$ kg initially at rest. After the collision mass m_2 moves with speed $v_{2f} = 3.0$ m/s. Determine the initial speed v_{1i}.