End Semester Exam-April 2022

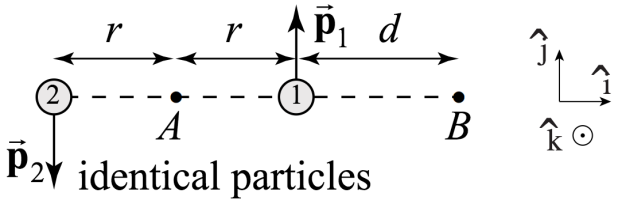
PH1101: Mechanics-I

Attempt any five questions

Time: 2:30 hour *(10:00AM to 12:30PM, April, 4th, 2022)* Maximum Marks: 50

1. Let's consider a spring with spring force ($F_{spring} = -kx$) moving in positive x direction. Derive the total energy of the spring? [10]

2. Two identical particles form a system, at the instant shown in the below figure the particles have equal and opposite momentums ($p_1 = -p_2 = p$). Determine a vector expression for the angular momentum of the system about the point A, B and compare?

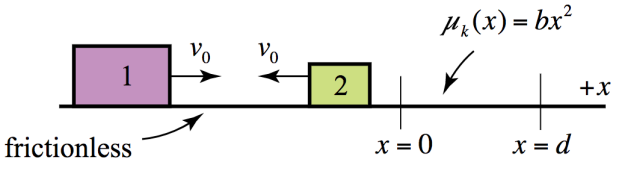


[10]

3. Derive the moment of inertia of sphere? [10]

4. Derive the potential energy of of gravity near the surface of the earth? [10]

5. Block 1 of mass $3m$ is sliding along a frictionless horizontal table to the right with speed v_0. Block 1 collides with block 2 of mass m that is moving to the left with speed v_0. After the collision, the two blocks stick together and the blocks enter a rough surface at $x = 0$ with a coefficient of kinetic friction that increases with distance as $\mu(x) = bx^2$ for $0 \leq x \leq d$ for , where b is a positive constant. The blocks come to rest at $x = d$. The downward gravitational acceleration has magnitude (g). Determine an expression for the initial speed v_0 of the blocks.



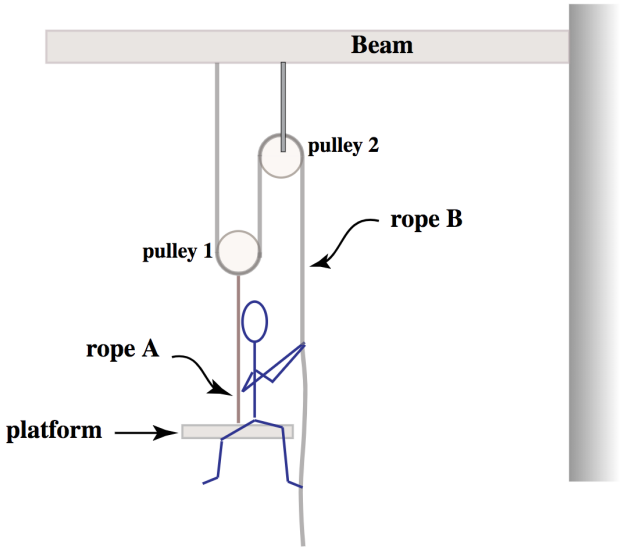
[10]

6. Define center of mass (CM) and estimate the center of mass of a uniform rod. [10]

7. What is the difference between inertial and non-inertial reference frames?support your answer? [10]

8. A window washer of mass m is sitting on a horizontal platform of negligible mass. The platform is held up by the two pulleys and the two ropes (A and B) shown in the figure. The person is able to pull Rope B downwards in such a way that the platform accelerates upwards with an acceleration of magnitude a . Assume the ropes and pulleys to be massless. Calculate the force exerted by the window washer on rope B?

Student's name: Please go on to the next page...



[10]

9. Expand $\sin x, \cos x$ and e^x using Taylor series expansion?. [10]

10. A bead moves along the spoke of a wheel at constant speed u meters per second. The wheel rotates with uniform angular velocity $\dot{\theta} = \omega$ radians per second about an axis fixed in space. At $t = 0$ the spoke is along the x axis, and the bead is at the origin. Find the bead's velocity and acceleration in polar coordinates at time t, and sketch the trajectory of the bead? [10]
