Name:	Student ID Number:
Surname:	Exam Room:

KOÇ UNIVERSITY
College of Sciences
PHYS 101 General Physics 1
Spring Semester 2022
Final Exam
June 3, 2022 Friday, 15:00-17:00

Please read.

- Count to make sure that there are 5 pages in this question booklet
- Check your **name, number, on front page, and student ID on each page.**.
- This examination is conducted with closed books and notes.
- Put all your personal belongings underneath your seat and make sure that pages of books or notebooks are not open.
- Absolutely no talking or exchanging anything (like rulers, erasers) during the exam.
- You must show all your work to get credit; you will not be given any points unless you show the details of your work (this applies even if your final answer is correct).
- Write neatly and clearly; unreadable answers will not be given any credit.
- If you need more writing space, use the backs of the question pages and put down the appropriate pointer marks.
- You are not allowed to use calculators during this exam.
- You are not allowed to leave the class during the first 15 minutes, and last 15 minutes.
- Write your final answers into the boxes. No points will be given to unjustified answers. Incomplete calculations will not be graded.

I hereby certify that I have completed this exam on my own without any help from anyone else.

Signature

P101_Index:

1	2	3	4	Total

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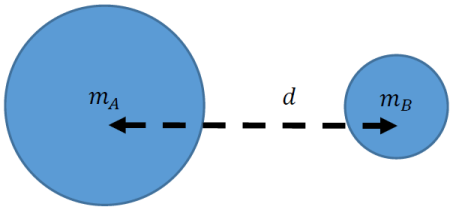
Q1-(25 pts) Assume that two spherical stars of mass m_A and m_B form a binary star system by circling around their common center of mass. The distance between the centers of the stars is d.

a) What is the period of rotation for this system? (15 pts)



b) What is the speed of star A with respect to the common center of mass? (5 pts)

c) What would be the magnitude of the gravitational force a small mass m feels if it is placed at the common center of mass of the stars? (5 pts)

Solution continues on the back side of the page **Yes** □ **No** □

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Q2-(25 pts) The motion of a point particle of mass m is described by the position vector

$\vec{r}(t) = [R\cos(\omega t)]\,\hat{\imath} + [R\sin(\omega t)]\,\hat{\jmath} - R\hat{k}$, where R and ω are constants.

a) Find the force acting on the particle. (8 pts)

b) Find the angular momentum of the particle with respect to the origin. (10 pts)

c) What is the torque acting on the particle with respect to the origin? (7 pts)

Solution continues on the back side of the page **Yes** □ **No** □

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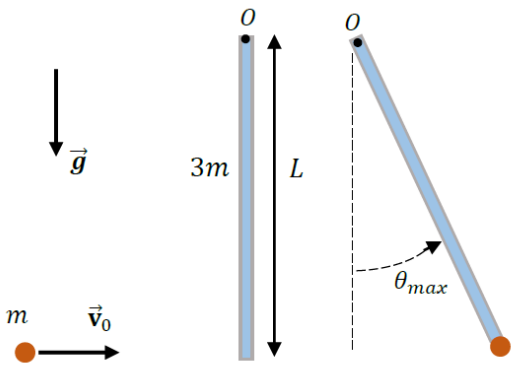
Q3-(25 pts) A thin uniform rod of mass $3m$ and length L is pivoted at its top end with a frictionless axle, and is at rest hanging vertically. A small object with mass m and initial velocity v_0 collides with the rod, and sticks to the free end, as shown in the figure. After the collision, the rod swings up until it makes a maximum angle θ_{max} with the vertical. (The moment of inertia of a rod with mass M and length L about its center of mass is $I_{CM}=ML^2/12$.)



a) Which of the physical quantities below are conserved during the collision? (5 pts)

Angular momentum with respect to the pivot.
Linear momentum on the horizontal.
Total mechanical energy

b) What is the angular speed of the rod immediately after the collision? (8 pts)

c) Following the collision, the rod-mass system will be oscillating about the axle without any friction. Write the equation of motion and find the period of small oscillations. (12 pts)

Solution continues on the back side of the page **Yes** □ **No** □

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Q4-(25 pts) Two uniform, solid cylinders of radius R and total mass M are connected along their common axis by a short, light rod and rest on a horizontal table top. A frictionless ring at the rod's center is attached to a spring of force constant k; the spring's other end is fixed. The cylinders are pulled to the left a distance x, stretching the spring, then released from rest. Due to the friction between the tabletop and the cylinders, the cylinders roll without slipping as they oscillate. (For a single cylinder of mass m and radius R, $I_{cm}=mR^2/2$)

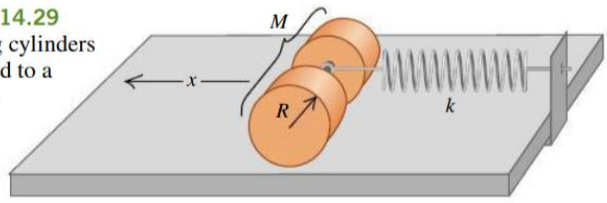

Figure 14.29
Rolling cylinders attached to a spring.

a) Show that the motion of the center of mass of the cylinders is simple harmonic. (15 pts)

b) Find the period of the simple harmonic motion. (10 pts)

Solution continues on the back side of the page **Yes** □ **No** □