Name:	Signature:
Surname:	Number:

KOÇ UNIVERSITY

College of Sciences
PHYS 101 General Physics 1
Fall Semester 2016
Final Exam
January 11, 2017 Wednesday, 09:00-10:40

Please read.

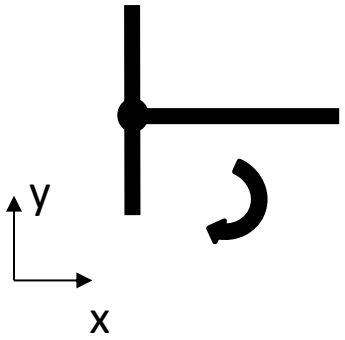
- Count to make sure that there are 5 pages in this question booklet
- Check your **name, number, on front page, and student ID on each page.**.
- This examination is conducted with closed books and notes.
- Put all your personal belongings underneath your seat and make sure that pages of books or notebooks 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.
- Make sure that you include units in your results.
- Make sure that you label the axis and have units in your plots.
- You are not allowed to use calculators during this exam.
- Turn off your mobile phones, and put away.
- 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.

P101_Index:

1	2	3	4	Total

Exam Room:	P101_Index:
Student ID Number:	Signature:

Q1-(25 pts) Two rods each of length l and mass m are joined center to end to form a T-shaped object. The object is free to rotate around a pivot that is located where the rods are joined. The object is initially in the position in the figure and then released. Express your answers in terms of l, m and the gravitational acceleration g.



(a) Calculate the moment of inertia of the object around the pivot. The moment of inertia of a rod of length l and mass m around its center of mass is $\frac{1}{12}ml^2$.

(b) Calculate the distance of the center of mass of the object to the pivot.

(c) What is the angular acceleration of the object immediately after we release it?

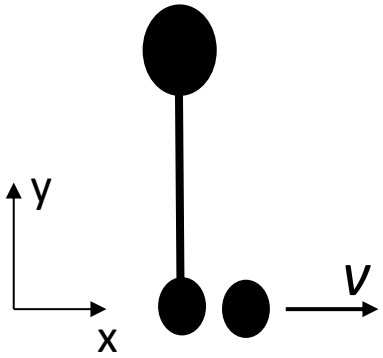
(d) What is the maximum angular velocity of the object?

(e) What are the x and y components of the force the pivot exerts on the object when it has maximal angular velocity?

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

Exam Room:	P101_Index:
Student ID Number:	Signature:

Q2-(25 pts) We can model a molecule as two point-like atoms, each of mass m, connected by a massless rigid rod of length l. Initially the molecule has no motion, but suddenly one of the atoms goes through a nuclear reaction and splits into two equal pieces. One piece stays a part of the molecule while the other is observed to fly away with speed v in the $+x$ direction. The molecule and the split piece are isolated in space having no external interactions, and there is no gravity. Answer the following in terms of m, l and v.



(a) What is the moment of inertia of the molecule after the split for rotating around an axis in the z direction going through its center of mass?

(b) What is the center of mass velocity of the molecule after the split? Give the x and y components.

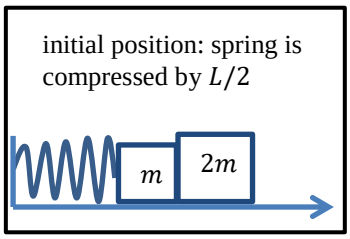
(c) What is the direction and magnitude of the molecule's angular velocity around its center of mass?

(d) What are the linear velocities of each atom of the molecule right after the split? Give the x and y components.

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

Exam Room:	P101_Index:
Student ID Number:	Signature:

Q3-(25 pts) A block of mass $\boldsymbol{m}$ is attached to an ideal spring with rest (equilibrium) length $\boldsymbol{L}$ and spring constant $\boldsymbol{k}$ on the $\boldsymbol{x}$ axis. The other end of the spring is fixed to a wall. Initially, the spring is compressed by an amount $\boldsymbol{L/2}$ and another block of mass $\boldsymbol{2m}$ is placed in front of the first block (they are not attached). The system is released at $\boldsymbol{t = 0}$ from rest. Ignore friction and the sizes of the blocks.



a) At what time after release do the blocks pass from the equilibrium point?

t =

b) Where do the blocks start to move separately (give the value of x) and why? (Think simple: if two objects move separately which physical quantity differs for them?) What is the new amplitude and frequency of oscillation of the block attached to the spring after the blocks are separated?

amplitude:

frequency:

c) Show that the total mechanical energy of the system (blocks+spring) is conserved before $t = 0$ and after the blocks move separately. Why is it conserved?

d) Show that the total momentum of the system (blocks) is not conserved before $t = 0$ and after the blocks move separately. Why is it not conserved?

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

Exam Room:	P101_Index:
Student ID Number:	Signature:

Q4-(25 pts) Two identical stars with mass *M* orbit around their center of mass. Each orbit is circular and has radius *R*, so that the two stars are always on the opposite sides of the circle.

(a) Find the gravitational force of one star on the other.

(b) Find the orbital speed of each star and the period of the orbit.

(c) How much energy would be required to separate the two stars to infinity?

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