Name: «Name_»	**Signature:**
Surname: «Surname_»	**Student ID Number: «Student_ID»**

PHYS 101 General Physics I – Final Exam

January 5 , 2015 Monday, 11:45 - 13:45

Please read!

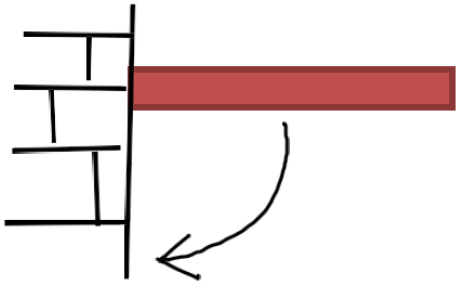
- Count to make sure that there are 5 pages in the question booklet
- Check your name and surname on front page, and student ID number on each page, and sign each page.
- This examination is conducted with closed books and notes.
- Put all your personal belongings underneath your seat and make sure that 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.

P101_Index: «Index»

1	2	3	4	Total

Exam Room: «Exam_Room»	P101_Index: «Index»
Student ID Number: «Student_ID»	Signature:

1-(25 Points) A 30 cm long, 100 g uniform thin rod is hinged at one end and connected to a wall. It is held out horizontally, then released.



(Hint: $\int x^n dx = \frac{x^{n+1}}{n+1}$)

(i) Derive the moment of inertia of the rod about an axis passing through its center of mass.

ANSWER :

(ii) Using parallel axes theorem, derive the moment of inertia of the rod about an axis passing through one of its ends.

ANSWER :

(iii) What is the angular velocity of the center of mass of the rod as it hits the wall?

ANSWER :

(iv) What is the speed of the center of mass of the rod as it hits the wall?

ANSWER :

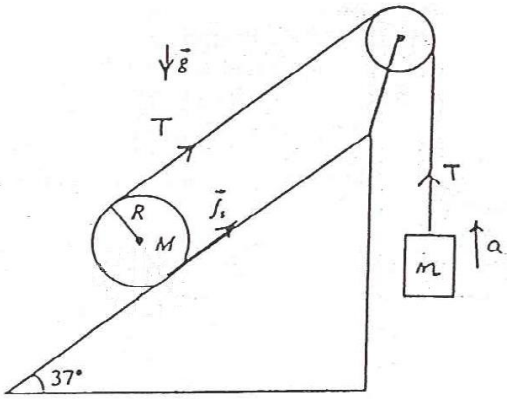
(v) What are the angular velocity and the speed of the end of the rod as it hits the wall?

ANSWER :

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

Exam Room: «Exam_Room»	P101_Index: «Index»
Student ID Number: «Student_ID»	Signature:

2-(25 Points) A uniform solid cylinder of mass M=14 kg and radius R=10 cm has a massless cord wound around it. The cord passes over a massless, frictionless fixed pulley and is attached to a block, hanging vertically. The plane on which the cylinder moves is inclined 37^o to the horizontal. The cylinder starts from rest and rolls without slipping down the incline. The (linear) acceleration of the cylinder's center of mass is measured to be $2\,m/s^2$.
(The rotational inertia of the cylinder about its central axis is $\frac{1}{2}MR^2$. Take $g = 10 m/s^2$, $\sin 37^o$ =3/5, $\cos 37^o$ =4/5.)



a.) Find the acceleration of the hanging block.

ANSWER :

b.) Find the mass of the hanging block.

ANSWER :

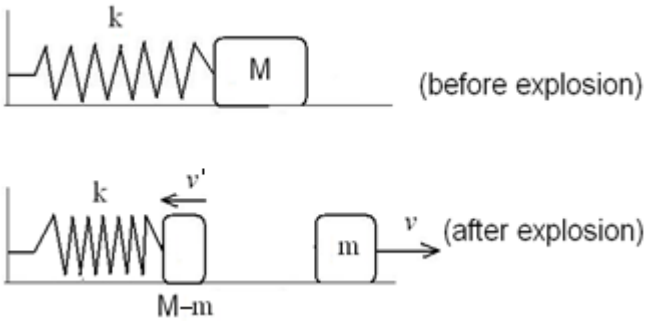
c.) To maintain rolling without slipping, what should be the minimum value of the coefficient of static friction μ_s between the incline and the cylinder?

ANSWER :

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

Exam Room: «Exam_Room»	P101_Index: «Index»
Student ID Number: «Student_ID»	Signature:

3-(25 Points) A body of mass M attached to an ideal spring of spring constant k is initially lying at rest on a horizontal, frictionless surface. The body explodes into two pieces at time $t = 0$. The piece with mass "m" moves right with a constant speed v, while the other piece that remains attached to the spring moves left and performs a simple harmonic oscillation.



a.) What is the period T of the simple harmonic oscillator?

ANSWER :

b.) Determine the amplitude A of the simple harmonic oscillator in terms of M, m, k, and v.

ANSWER :

c.) Write down an expression for the displacement x(t) for the simple harmonic oscillator, taking the coordinate origin as the equilibrium point of the oscillator.

ANSWER :

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

Exam Room: «Exam_Room»	P101_Index: «Index»
Student ID Number: «Student_ID»	Signature:

4-(25 Points) Vertically vibrating segment of a guitar string of length $L=50\ cm$ is stretched horizontally between $x=0$ and $x=L$. The string carries a standing wave with the lowest possible frequency . It generates an A (La) sound at 440 Hz, while the antinode oscillates with an amplitude of 1.0 mm.

(a) Find the numerical value of the wavelength of the sinusoidal waves in the standing wave.

ANSWER :

(b) Find the numerical value of the speed (phase velocity) of the travelling mechanical waves on the string?

ANSWER :

(c) Write down a possible wave function $y(x, t)$ for the standing wave. Specify the values of all the constants in your expression.

ANSWER :

(d) Find the numerical value of the maximum vertical speed of the string. At which point is it realized?

ANSWER :

Make sure that you show your work. *No points will be given to answers without supporting calculations.*

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