Name:	Signature:
Surname:	Student ID Number:

PHYS 101 General Physics I – Midterm 2

December 3, 2014 Wednesday 19:00 -20:50

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.

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1	2	3	4	Total

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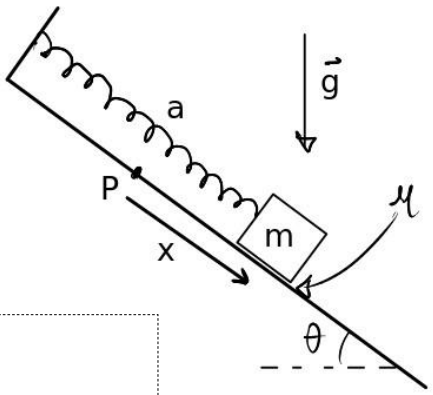
1-(25 Points) A spring-block system is placed on a plane with inclination angle θ and coefficient of friction μ ($\mu_S=\mu_K$). The spring *does not obey Hooke's Law*: when extended by a distance *x*, the restoring force exerted by the spring has magnitude ax^3. P denotes the position of the block when the spring is unstreched. The mass of the block is *m* and the gravitational acceleration is downward with magnitude *g*.

We strech the spring by a length x_0 and release the attached block from rest. We observe that the block moves upward and comes to rest at *P*, never passing the point *P*.

(a) Calculate the work done on the block by the spring in terms of x_0 and given constants.

ANSWER:



(b) Calculate the work done on the block by the gravitational force in terms of x_0 and given constants.

ANSWER:

(c) Calculate the work done on the block by the frictional force in terms of x_0 and given constants.

ANSWER:

(d) Find x_0.

ANSWER:

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

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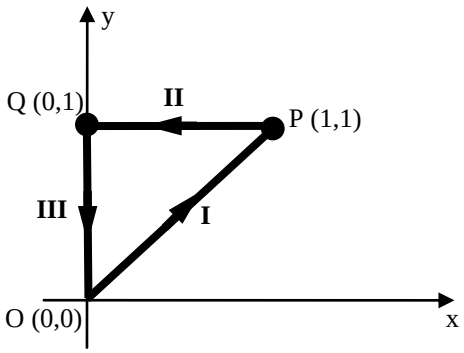
2-(25 Points) A particle is subject to a position dependent force given by $\vec{F} = A\left(By^2\hat{i} + 4xy\hat{j}\right)$ where *A* and *B* are constants. *B* is dimensionless.

(a) Do a dimension analysis and determine the unit of *A* in the SI unit system.

ANSWER:



(b) Calculate the work done by the force as the particle moves around a triangular path, shown in the diagram. Particle starts from the origin (0,0) goes to the point (1,1) along the straight line x=y. Then from (1,1) horizontally left to (0,1). Finally from (0,1) vertically down to the origin (0,0). Your answer must depend on both A and B.

ANSWER:

(c) Show that $\vec{F}$ is conservative when *B*=2. Write down the corresponding potential energy function.

ANSWER:

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

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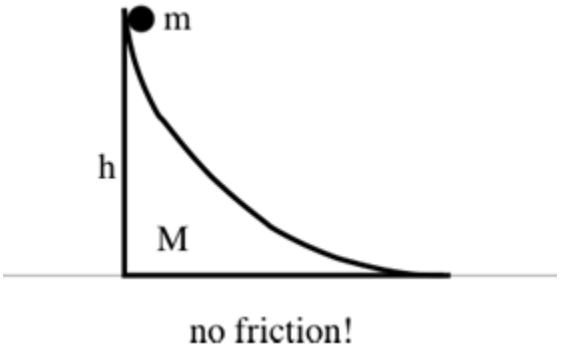
3-(25 Points) A point mass *m* and a platform with mass *M* and height *h* are initially held at rest as shown in the figure. At *t = 0*, the system is given a net positive impulse *J > 0* in the *+x* direction, and the point mass is released at the same instant. Assume there is no friction anywhere in the system including the interface between the platform and the ground, and further assume that the possible collisions are elastic.



(a) Find the final (terminal) velocity of the point mass.

ANSWER:

(b) Find the final velocity of the platform.

ANSWER:

(c) Discuss the *x*-component of the center of mass of the system as a function of time.

ANSWER:

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

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4-(25 Points) Suppose that on Equator, you observe a satellite pass from east to west directly overhead in the sky at 12:00 p.m. and at 18:00 p.m. in the same day. Assume that Earth is spherical and ignore the inclination angle of Earth's rotation axis.
(m: Satellite's mass, m_E: Earth's mass, R_E: Earth's radius, m_M: Moon's mass, R_M: Moon's radius, d: distance from Earth's center to Moon's center)
(a) Determine the total mechanical energy of the satellite.

ANSWER:

(b) What happens with the orbit of the satellite if its total mechanical energy suddenly becomes zero? Determine the maximum value the radius of orbit can take in this case.

ANSWER:

(c) (You can solve this part without solving (a) and (b)) Which takes more fuel?: Sending the satellite from its orbit to moon or bringing it from moon back to its orbit around Earth? Explain and prove your answer by physical equations.

ANSWER:

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