Version Quiz #5 Form #511 Name:________________________

A

Physics 2211 BCD Spring 2014 Recitation Section:________________________

- Print your name, quiz form number (3 digits at the top of this form), and student number (9 digit Georgia Tech ID number) in the section of the answer card labeled "Student Identification."
- Bubble the Quiz Form Number in columns 1–3, skip column 4, then bubble your Student Number in columns 5–13.
- Free-response questions are numbered I–III. For each, make no marks and leave no space on your card. Show all your work clearly, including all steps and logic. Box your answer.
- Multiple-choice questions are numbered 1–9. For each, select the answer most nearly correct, circle this answer on your quiz, and bubble it on your answer card. Do not put any extra marks on the card.
- Turn in your quiz and answer card as you leave. Your score will be posted when your quiz has been graded. Quiz grades become final when the next quiz is given.
- You may *not* use any aids, including a calculator or other electronic device.

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g	Magnitude of Free Fall Acceleration	G	Universal Gravitation Constant

Unless otherwise directed, drag should be neglected, and all ropes and pulleys are ideal.
Any integrals in free-response problems must be evaluated. Questions about magnitudes will state so explicitly.

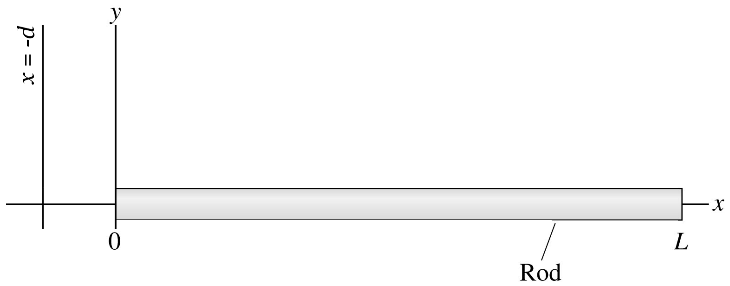
I. (16 points) An object of mass m is to be launched from the surface of a planet with mass M. The planet has radius R and an atmosphere with thickness R_a. This atmosphere exerts a constant drag force D on the object, for as long as the object is in the atmosphere. With what initial speed must the object be launched, if it is never to return to the planet? Express your answer in terms of parameters defined in the problem, and physical or mathematical constants.

II. (16 points) A non-uniform thin rod lies on the $+x$ axis, with one end at the origin, as shown. It has mass M, length L, cross-sectional area A, and a density ρ that varies with position x according to

$$\rho = \rho_0 \left(\frac{x^2}{L^2} - \frac{x^3}{L^3} \right)$$

where ρ_0 is a positive constant. What is the rod's moment of inertia about the y axis? Express your answer in terms of parameters defined in the problem, and physical or mathematical constants.

1. (6 points) Let the moment of inertia found in the problem above be I. Describe the rod's moment of inertia I' about an axis along the line $x = -d$.
   (a) $I' = I + Md^2$
   (b) $I' > I + Md^2$
   (c) $I < I' < I + Md^2$
   (d) $I' < I$
   (e) $I' = I$



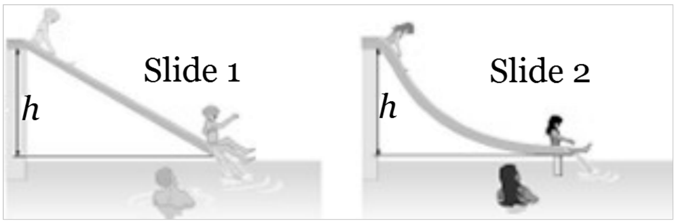
2. (6 points) A bullet with mass m is shot into a block with mass M, at rest on a frictionless horizontal surface. The bullet remains lodged in the block. The block moves into an ideal spring with Hooke's Law constant K, and compresses it by a distance d. What physical principle can you use to relate the speed of the bullet before it hits the block, to the speed of the bullet-block combination before it hits the spring?

(a) Conservation of *kinetic* energy in the bullet-block system.
(b) Newton's Second Law and constant-acceleration kinematics.
(c) Conservation of energy in the bullet-block system.
(d) Conservation of *mechanical* energy in the bullet-block system.
(e) Conservation of linear momentum in the bullet-block system.

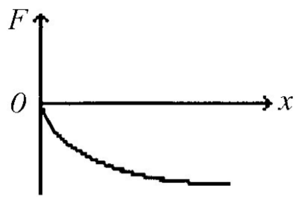
III. (16 points) In the problem above, what was the speed of the bullet before it hit the block? Express your answer in terms of parameters defined in the problem, and physical or mathematical constants.

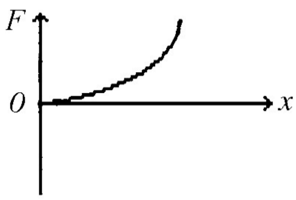
3. (7 points) Swimmers at a water park have a choice of two frictionless water slides as shown in the figure. Although both slides drop over the same height h, Slide 1 is straight while Slide 2 is curved, dropping quickly at first and then leveling out. If it can be determined, how does the speed v_1 of a swimmer reaching the end of Slide 1 compare with v_2, the speed of a swimmer reaching the end of Slide 2? *(On Earth.)*

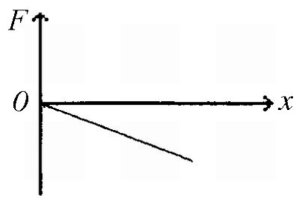
(a) The relationship cannot be determined without knowing the curvature of Slide 2.
(b) The relationship cannot be determined without knowing the masses of the swimmers.
(c) $v_1 > v_2$
(d) $v_1 = v_2$
(e) $v_1 < v_2$

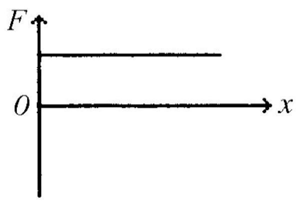


4. (6 points) Which of the graphs represents a spring that gets less stiff the more it is stretched?

(a)


(b)


(c)


(d)


5. (7 points) Jacques and George have met in their canoes at the middle of a lake. They stopped, and when they are ready to leave, Jacques pushes George's canoe with a force $\vec{F}$ to separate the two canoes. As the canoes drift apart, what is true about the momentum and kinetic energy of the system consisting of Jacques, George, and the two canoes, if we can neglect any resistance due to the water? *(On Earth.)*

(a) The momentum is in the direction of Jacques' push $\vec{F}$, and the kinetic energy is positive.
(b) The momentum is in the direction of Jacques' push $\vec{F}$, and the kinetic energy is zero.
(c) The momentum is zero, but the kinetic energy is positive.
(d) The momentum is opposite the direction of Jacques' push $\vec{F}$, and the kinetic energy is positive.
(e) The momentum is zero, and the kinetic energy is zero.

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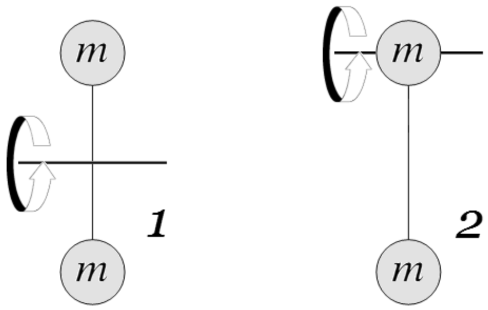
6. (7 points) A dumbbell-shaped object is composed by two equal masses m, connected by a rod of negligible mass and length r. If I_1 is the moment of inertia of this object with respect to an axis passing through the center of the rod and perpendicular to it, and I_2 is the moment of inertia with respect to an axis passing through one of the masses ...

(a) $I_1 = I_2$ because the axes in this question have been carefully chosen to accomplish that.
(b) $I_1 = I_2$ because I for this particular object does not depend on the axis chosen.
(c) $I_1 = I_2$ because I for an object never depends on the axis chosen.
(d) $I_1 < I_2$
(e) $I_1 > I_2$



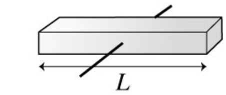
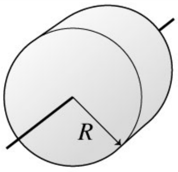
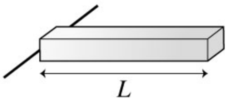
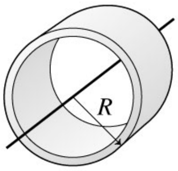
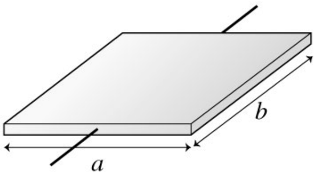
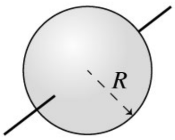
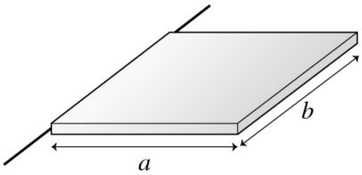
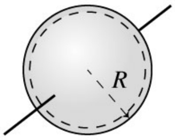
7. (6 points) An athlete holds a ball in her hand. *(On Earth.)* The torque she must apply about her shoulder joint to hold the ball straight out to her side is ...

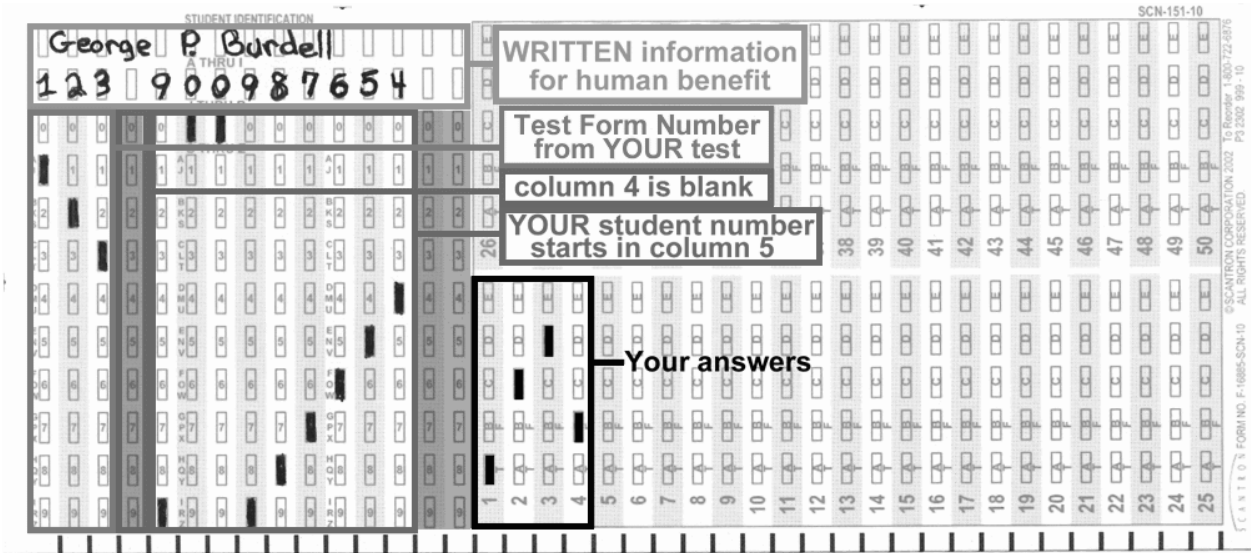
   (a) **the same as** the torque she must apply to hold the ball 45° below the horizontal.
   (b) **greater than** the torque she must apply to hold the ball 45° below the horizontal.
   (c) **less than** the torque she must apply to hold the ball 45° below the horizontal.

8. (7 points) A uniform solid sphere of mass M and radius R rotates with an angular speed ω about an axis through its center. A uniform solid cylinder of mass M, radius R, and length $2R$ rotates through an axis running through the central axis of the cylinder. What must be the angular speed of the cylinder so it will have the same rotational kinetic energy as the sphere?

   (a) $2\omega/5$
   (b) $2\omega/\sqrt{5}$
   (c) $\omega\sqrt{2/5}$
   (d) $\omega/\sqrt{5}$
   (e) $4\omega/5$

TABLE 12.2 Moments of inertia of objects with uniform density

Object and axis	Picture	I	Object and axis	Picture	I
Thin rod, about center		$\frac{1}{12}ML^2$	Cylinder or disk, about center		$\frac{1}{2}MR^2$
Thin rod, about end		$\frac{1}{3}ML^2$	Cylindrical hoop, about center		MR^2
Plane or slab, about center		$\frac{1}{12}Ma^2$	Solid sphere, about diameter		$\frac{2}{5}MR^2$
Plane or slab, about edge		$\frac{1}{3}Ma^2$	Spherical shell, about diameter		$\frac{2}{3}MR^2$



YOUR form number is **511**

Recitation Sections

	Clough 123	Clough 125	Clough 127	Clough 131	Clough 325
Monday					
2:05 – 2:55 pm	B01 Berman, Simon		B05 Li, Gande	C05 Spitz, Stephen	
3:05 – 3:55 pm	B02 Berman, Simon			C02 Spitz, Stephen	
4:05 – 4:55 pm	B06 Berman, Simon	C01 Spitz, Stephen			
Tuesday					
2:05 – 2:55 pm	C03 Liberi, Brandon			D02 Steahr, Alexander	
3:05 – 3:55 pm	B04 Liberi, Brandon			C07 Berman, Simon	
4:05 – 4:55 pm	B03 Liberi, Brandon			B08 Berman, Simon	C04 Steahr, Alexander
5:05 – 5:55 pm	C08 Liberi, Brandon			C09 Berman, Simon	D04 Steahr, Alexander
Wednesday					
1:05 – 1:55 pm	B09 Crowley, Chris				
2:05 – 2:55 pm	D01 Crowley, Chris	D05 Buffardi, Luke			
3:05 – 3:55 pm					
4:05 – 4:55 pm	C06 Crowley, Chris	D06 Buffardi, Luke			
5:05 – 5:55 pm					
6:05 – 6:55 pm	B10/D10 Crowley, Chris				
Thursday					
3:05 – 3:55 pm		B07/D07 Spitz, Stephen			
4:05 – 4:55 pm	D03 Spitz, Stephen				D08 Crowley, Chris
5:05 – 5:55 pm					
6:05 – 6:55 pm	C10 Spitz, Stephen	D09 Crowley, Chris			