Version Quiz #5 Form #511 Name:____________________

A

Physics 2211 BCD Spring 2013 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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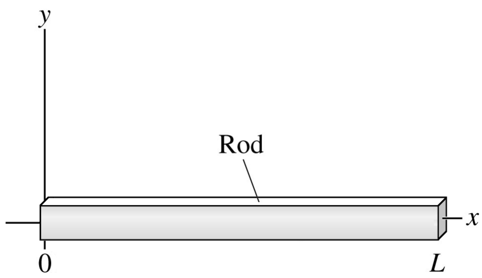
g Magnitude of Free Fall Acceleration G Gravitational Constant

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.

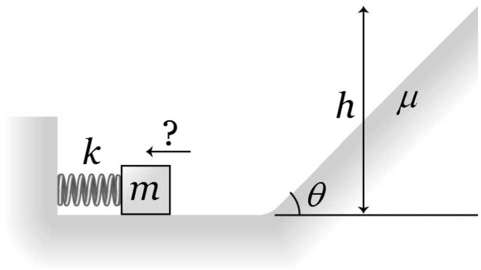
I. (16 points) A thin rod of mass M and length L lies on the x axis, as shown. Its linear mass density (mass per unit length), λ, depends on position, x, according to

$$\lambda = \lambda_0 \left(\frac{L}{x}\right)$$

where λ_0 is a constant. Find the location of the rod's center of mass, in terms of parameters defined in the problem, and physical or mathematical constants.



II. (16 points) The spring in the figure has a spring constant of k. It is compressed and then launches a block of mass m. The horizontal surface is frictionless, but the block's coefficient of kinetic friction with the incline is μ. This incline rises a height h at an angle θ above the horizontal. What distance must the spring be compressed if the block is to come to a stop at the very top of the incline? Express your answer in terms of parameters defined in the problem, and physical or mathematical constants. *On Earth.*

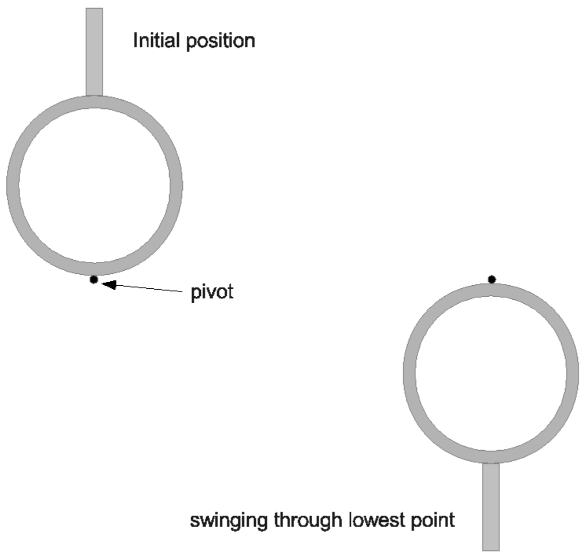


1. (5 points) The block stops at a height h above the horizontal surface in the problem above. If the angle of the incline were reduced to $\theta/2$, the block stops at a height h' above that horizontal surface. Compare the heights h and h'.

   (a) $h' < h$
   (b) $h' > h$
   (c) $h' = h$
   (d) No comparison between h' and h can be made with the information provided.

2. (5 points) A thin ring with mass M and radius R is pivoted about an axle through it's edge, and perpendicular to its face. Exactly opposite the pivot point, a thin rod of mass M and length R is attached, as shown. What is the moment of inertia of this combined object about the axle?

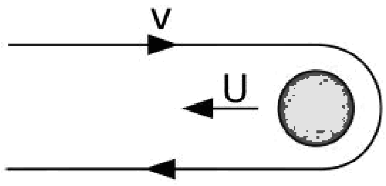
(a) $I = (13/3)\, MR^2$
(b) $I = (25/3)\, MR^2$
(c) $I = (37/12)\, MR^2$
(d) $I = (4/3)\, MR^2$
(e) $I = (13/12)\, MR^2$



III. (16 points) In the problem above, the axle is parallel to the ground. The object is initially at rest with the rod directly above the axle as shown. A small disturbance caused the object to rotate clockwise, as shown. What is the speed of the end of the rod farthest from the axle, at the moment it is directly below the axle? Express your answers in terms of parameters defined in the problem, and physical or mathematical constants. You may use "I" to represent the moment of inertia found in the problem above. *On Earth.*

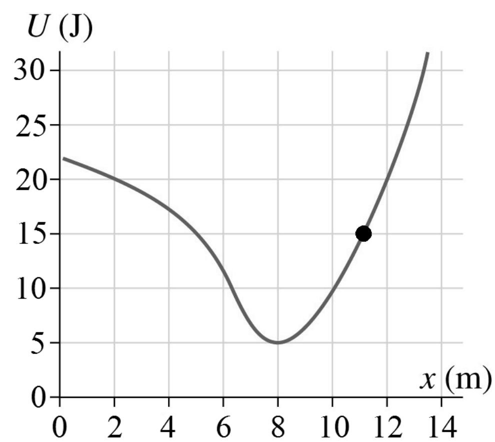
3. (7 points) George P. Burdell has attempted to be the first human being to perform a gravitational slingshot around Mars. The initial speed of the spaceship as seen from a stationary observer is v. The same observer sees Mars moving in the opposite direction with speed U. After the collision, the spaceship and Mars are moving in the same direction, and we can assume the collision to be perfectly elastic. What is the speed of Burdell's spaceship after the collision?

(a) $2U + v$
(b) v
(c) $2U + 2v$
(d) $U + 2v$
(e) $U + v$



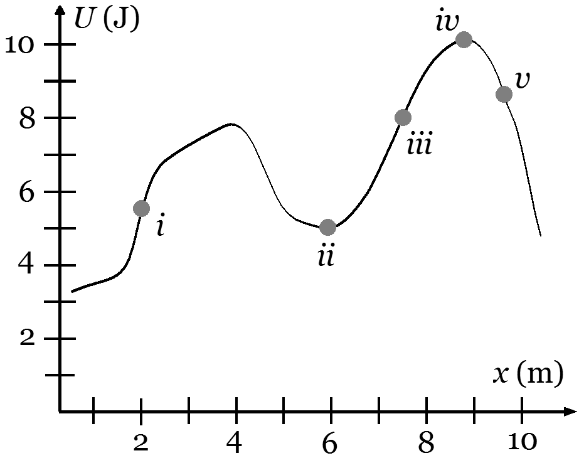
4. (7 points) The potential energy of a system depends on the location of an object within it, according to the graph. What is the force acting on an object when it is at $x = 11\,\text{m}$?

(a) $-1\frac{4}{11}$ N (b) $+5$ N (c) -15 N (d) $+1\frac{4}{11}$ N (e) -5 N



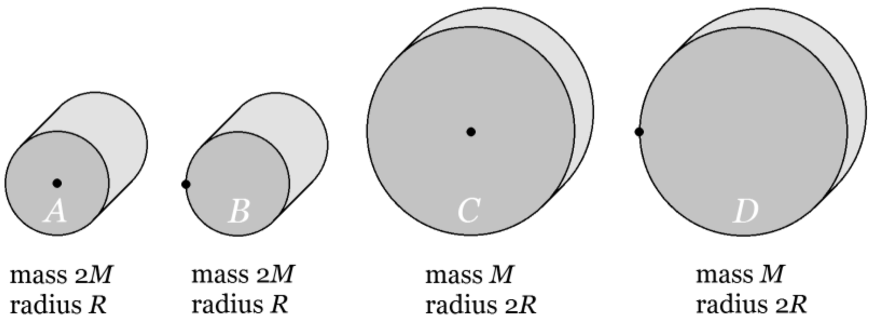
5. (7 points) The potential energy of a system depends on the location of an object within it, according to the graph. At which location, *i*–*v*, does the maximum positive force act on the object?

(a) Position *iv*.
(b) Position *iii*.
(c) Position *v*.
(d) Position *i*.
(e) Position *ii*.



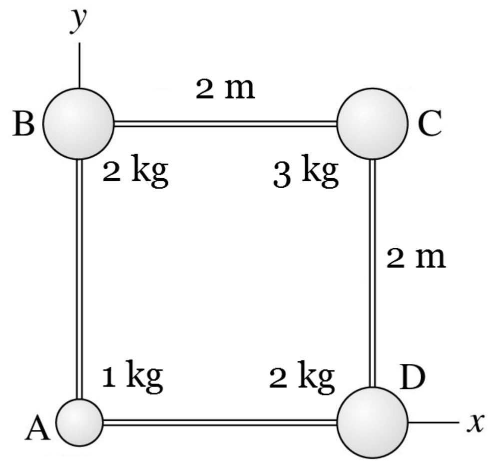
6. (7 points) Uniform solid cylinders A and B have mass $2M$ and radius R. Uniform solid cylinders C and D have mass M and radius $2R$. Cylinders A and C rotate on a axis perpendicular to the page that passes through their centers. Cylinders B and D rotate on a axis perpendicular to the page that passes through their edges. Rank the moments of inertia of the cylinders about their axes, from greatest to least.

(a) $I_D > I_B > I_C > I_A$
(b) $I_D = I_B > I_C > I_A$
(c) $I_D > I_C = I_B > I_A$
(d) $I_D = I_C > I_B = I_A$
(e) $I_D = I_B > I_C = I_A$



7. (7 points) Four point masses, $m_A = 1\,\text{kg}$, $m_B = 2\,\text{kg}$, $m_C = 3\,\text{kg}$, and $m_D = 2\,\text{kg}$, are located at the vertexes of a massless square with 2 m edges, as shown. What is the moment of inertia of this object about the x axis?

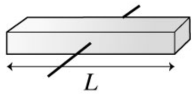
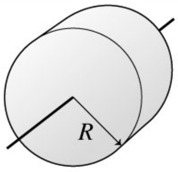
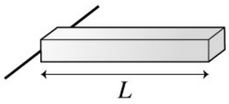
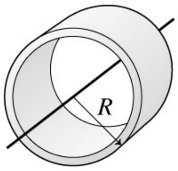
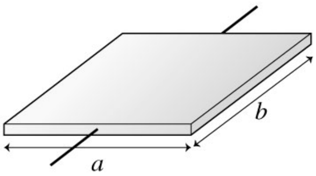
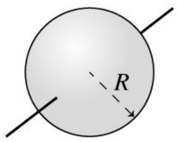
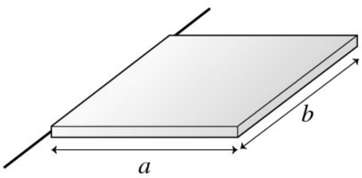
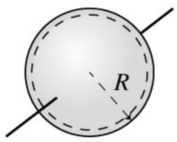
(a) $10\,\text{kg}{\cdot}\text{m}^2$
(b) $40\,\text{kg}{\cdot}\text{m}^2$
(c) $32\,\text{kg}{\cdot}\text{m}^2$
(d) $16\,\text{kg}{\cdot}\text{m}^2$
(e) $20\,\text{kg}{\cdot}\text{m}^2$

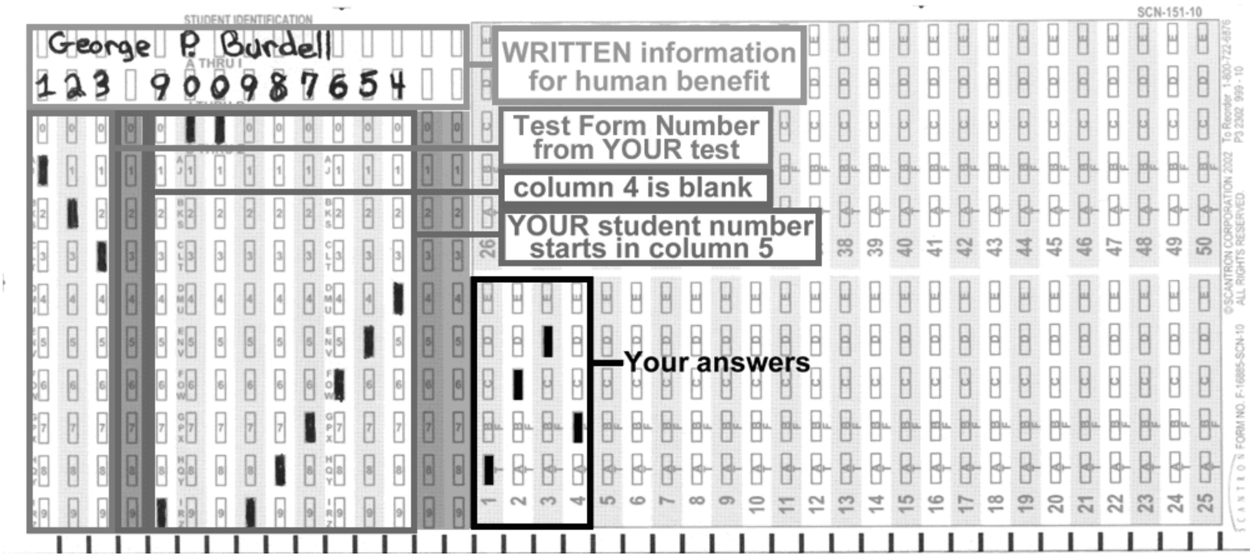


8. (7 points) When solidly built German Porsche is traveling at a speed of 360 km/h, its engine provides an accelerating force of 4 kN. How much power does the engine deliver in this situation?

(a) 1440 kW (b) 11 W (c) 40 W (d) 400 kW (e) 1440 MW

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 Buffardi, Luke		B05 Tennenbaum, Michael		C05 Ding, Kan
3:05 – 3:55 pm	B02 Buffardi, Luke			C02 Tennenbaum, Michael	
4:05 – 4:55 pm	B06 Buffardi, Luke	C01 Tennenbaum, Michael			
Tuesday					
2:05 – 2:55 pm	C03 Chen, Elton	D02 Tennenbaum, Michael **Note: Meets in Howey S-106!!**			
3:05 – 3:55 pm	B04 Chen, Elton			C07 London, Lionel	
4:05 – 4:55 pm	B03 Ding, Kan			B08 London, Lionel	C04 Tennenbaum, Michael
5:05 – 5:55 pm	C08 Ding, Kan			D04/D08 London, Lionel	C09 Tennenbaum, Michael
Wednesday					
1:05 – 1:55 pm	B09 London, Lionel				
2:05 – 2:55 pm	D01/D05 London, Lionel				
3:05 – 3:55 pm					
4:05 – 4:55 pm	D06 London, Lionel			C06 Kharbouch, Adel	
5:05 – 5:55 pm					
6:05 – 6:55 pm		B10/D10 Kharbouch, Adel			
Thursday					
3:05 – 3:55 pm	B07 Chen, Elton	D07 Ding, Kan			
4:05 – 4:55 pm				D03 Ding, Kan	
5:05 – 5:55 pm					
6:05 – 6:55 pm		C10 Ding, Kan	D09 Kharbouch, Adel		