

Instructor(s): *Hirschfeld/Matcheva*PHYSICS DEPARTMENT
Exam 2

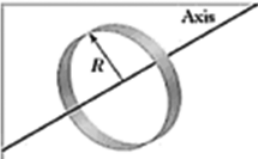
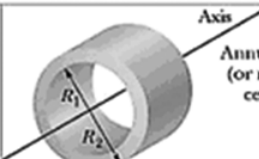
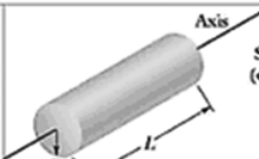
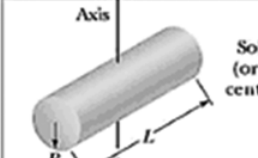
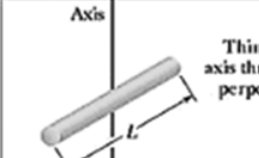
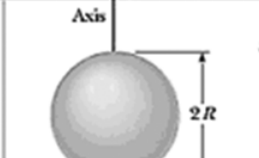
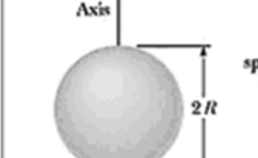
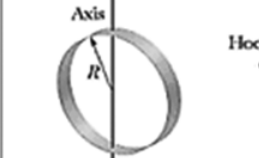
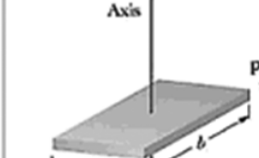
March 16, 2009

Name (print, last first): _____ Signature: _____

*On my honor, I have neither given nor received unauthorized aid on this examination.***YOUR TEST NUMBER IS THE 5-DIGIT NUMBER AT THE TOP OF EACH PAGE.**

- (1) **Code your test number on your answer sheet (use lines 76–80 on the answer sheet for the 5-digit number).** Code your name on your answer sheet. **DARKEN CIRCLES COMPLETELY.** Code your UFID number on your answer sheet.
- (2) Print your name on this sheet and sign it also.
- (3) Do all scratch work anywhere on this exam that you like. **Circle your answers on the test form.** At the end of the test, this exam printout is to be turned in. No credit will be given without both answer sheet and printout.
- (4) **Blacken the circle of your intended answer completely, using a #2 pencil or blue or black ink.** Do not make any stray marks or some answers may be counted as incorrect.
- (5) The answers are rounded off. Choose the closest to exact. There is no penalty for guessing.
- (6) **Hand in the answer sheet separately.**

Where needed use $g = 9.80 \text{ m/s}^2$

 <p>Hoop about central axis</p> <p>$I = MR^2$ (a)</p>	 <p>Annular cylinder (or ring) about central axis</p> <p>$I = \frac{1}{2}M(R_1^2 + R_2^2)$ (b)</p>	 <p>Solid cylinder (or disk) about central axis</p> <p>$I = \frac{1}{2}MR^2$ (c)</p>
 <p>Solid cylinder (or disk) about central diameter</p> <p>$I = \frac{1}{4}MR^2 + \frac{1}{12}ML^2$ (d)</p>	 <p>Thin rod about axis through center perpendicular to length</p> <p>$I = \frac{1}{12}ML^2$ (e)</p>	 <p>Solid sphere about any diameter</p> <p>$I = \frac{2}{3}MR^2$ (f)</p>
 <p>Thin spherical shell about any diameter</p> <p>$I = \frac{2}{3}MR^2$ (g)</p>	 <p>Hoop about any diameter</p> <p>$I = \frac{1}{2}MR^2$ (h)</p>	 <p>Slab about perpendicular axis through center</p> <p>$I = \frac{1}{12}M(a^2 + b^2)$ (i)</p>

1. Which of the following has the largest kinetic energy? An object with:
 - (1) Mass $2M$ and speed $3V$
 - (2) Mass $3M$ and speed V
 - (3) Mass $3M$ and speed $2V$
 - (4) Mass M and speed $4V$
 - (5) Mass $40M$ and speed $V/2$

2. A 0.50-kg object moves in a horizontal circular track with a radius of 2.5 m . An external force of 3.0 N , always tangent to the track, causes the object to speed up as it goes around. The work done by the external force as the mass makes one revolution is about:
 - (1) 47 J
 - (2) 24 J
 - (3) 59 J
 - (4) 94 J
 - (5) 120 J

3. A particle starts from rest at time $t = 0$ and moves along the x axis. If the net force on it is proportional to the time t , its kinetic energy is proportional to:
 - (1) t^4
 - (2) t
 - (3) t^2
 - (4) $1/t^2$
 - (5) none of these answers

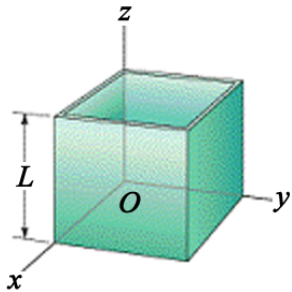
4. A particle moves through an xyz coordinate system while a force acts on the particle. When the particle has the position vector $\vec{r} = (2m)\hat{i} - (3m)\hat{j} + (2m)\hat{k}$, the force is $\vec{F} = F_x\hat{i} + (7N)\hat{j} - (6N)\hat{k}$, and the corresponding torque about the origin is $\vec{\tau} = (4N \cdot m)\hat{i} + (2N \cdot m)\hat{j} - (1N \cdot m)\hat{k}$. What is the x -component of the force, F_x ?
 - (1) $-5N$
 - (2) $5N$
 - (3) $-10N$
 - (4) $10N$
 - (5) $-1N$

5. A single force acts on a particle located on the positive x axis a distance d from the origin (i.e. at the point $P = (x,y,z) = (d,0,0)$). The torque about the origin is non-zero and points in the negative y direction. The force must be:
 - (1) in the positive z direction
 - (2) in the negative z direction
 - (3) in the positive x direction
 - (4) in the negative x direction
 - (5) in the positive y direction

6. A 0.5-kg particle moves along the x axis under the influence of a conservative force. The potential energy is given by $U(x) = (8J/m^2)x^2 + (2J/m^4)x^4$, where x is the coordinate of the particle in meters. If the particle has a speed of 5 m/s when it is at $x = 1\text{ m}$, its speed when it is at the origin is:
 - (1) 8.1 m/s
 - (2) 0 m/s
 - (3) 5.0 m/s
 - (4) 6.3 m/s
 - (5) 65 m/s

7. A particle moves along the x -axis under the influence of a conservative force. The potential energy is given by $U(x) = (3J/m^2)x^2 - (12J/m)x + 12J$, where the particle. If the total mechanical energy is 12 J , the limits of motion are:
 - (1) $0\text{ m}; 4\text{ m}$
 - (2) $0\text{ m}; 2\text{ m}$
 - (3) $-4\text{ m}; 4\text{ m}$
 - (4) $-4\text{ m}; 0\text{ m}$
 - (5) $-2\text{ m}; 0\text{ m}$

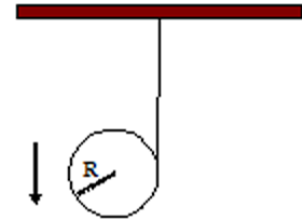
8. A particle moves along the x -axis under the influence of a conservative force. The potential energy is given by $U(x) = (3J/m^2)x^2 - (12J/m)x$, where the particle. At what value of the position x is the force on the particle equal to zero?
 - (1) $x = 2m$
 - (2) $x = 4m$
 - (3) $x = 6m$
 - (4) $x = 0$
 - (5) The force is not zero at any value of x

9. The figure shows a cubical box with each side consisting of a uniform metal plate of negligible thickness. Each of the four sides have mass, M , and the bottom has mass $2M$. The box is open at the top (at $z = L$) and has edge length L . What is the z -coordinate of the center-of-mass?
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- (1) $z = L/3$ (2) $z = L/2$ (3) $z = L/4$ (4) $z = L/6$ (5) $z = 2L/3$
10. A 75-kg man is riding in a 25-kg cart at 2.5 m/s along a frictionless horizontal surface. He jumps off in such a way as to land on the ground with no horizontal velocity. What is the new speed of the cart?
- (1) 10 m/s (2) 7.5 m/s (3) zero (4) 2.5 m/s (5) 5 m/s
11. A uniform solid cylinder rolls without sliding along the floor. If its translational kinetic energy is equal to 20 J, what is its rotational kinetic energy about the rotation axis through its center of mass (*i.e.*, the central axis of the cylinder)?
- (1) 10 J (2) 5 J (3) 20 J (4) 40 J (5) 60 J
12. A horizontal force of magnitude 35 N pushes a block of mass 4 kg across a floor where the coefficient of kinetic friction is 0.6. What is the increase in the kinetic energy of the block when the block slides through a displacement of 5 m across the floor?
- (1) 57.4 J (2) 117.6 J (3) 175 J (4) 196 J (5) 28.7 J
13. A 0.2 kg rubber ball is dropped from rest a height of 30 m above the surface of the Earth. It strikes the sidewalk below and rebounds up to a maximum height of 15 m. The magnitude of the impulse due to the collision with the sidewalk is:
- (1) 8.3 N·s (2) 3.4 N·s (3) 4.8 N·s (4) 1.4 N·s (5) 16.6 N·s
14. An astronaut is being tested in a centrifuge. The centrifuge has a radius R and, in starting from rest at $t = 0$, rotates according to $\theta(t) = (0.125\text{rad/s}^2)t^2$. At what time $t > 0$ is the magnitude of the tangential acceleration equal to the magnitude of the radial acceleration.
- (1) $t = 2s$ (2) $t = 1s$ (3) $t = 0.5s$ (4) never (5) need to know the radius R
15. An stone of mass M sits at rest on a spring near the surface of the Earth. If the spring is compressed a distance, d , by the weight of the stone, what is the spring constant k ?
- (1) Mg/d (2) $2Mg/d$ (3) $2mg/d^2$ (4) Mgd (5) none of these answers
16. A mouse of mass M lies on the rim of a uniform disk of mass $4M$ that can rotate freely about its center like a merry-go-round. Initially the mouse and disk rotate together with an angular velocity of ω . If the mouse walks to a new position that is halfway to the center of the disk what is the new angular velocity of the mouse-disk system?
- (1) $4\omega/3$ (2) ω (3) $\omega/2$ (4) 2ω (5) $3\omega/4$

17. A ball of mass m , at one end of a string of length L , rotates in a vertical circle just fast enough to prevent the string from going slack at the top of the circle. The speed of the ball at the bottom of the circle is:

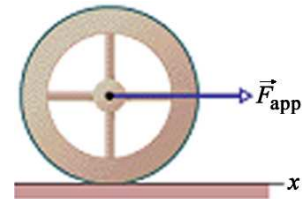
(1) $\sqrt{5gL}$ (2) $\sqrt{2gL}$ (3) $\sqrt{3gL}$ (4) $\sqrt{7gL}$ (5) $2\sqrt{gL}$

18. A massless cloth tape is wound around the outside of a uniform solid cylinder (mass M , radius R) and fastened to the ceiling as shown in the figure. The cylinder is held with the tape vertical and then released from rest. What is the acceleration of the center-of-mass of the cylinder?



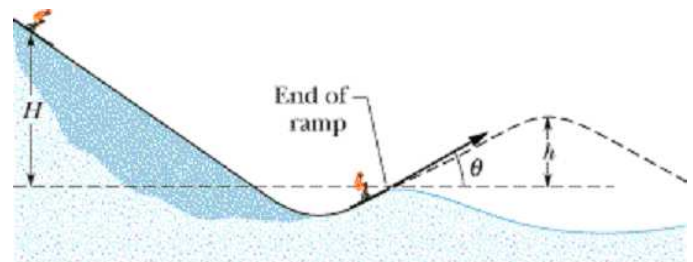
(1) $2g/3$ (2) g (3) $g/2$ (4) $3g/4$ (5) $g/3$

19. A constant horizontal force \vec{F}_{app} of magnitude 20 N is applied to a wheel of mass 20 kg and radius 0.5 m as shown in the figure. The wheel rolls without slipping on the horizontal surface, and the acceleration of its center of mass has magnitude 0.5 m/s^2 . What is the rotational inertia of the wheel about the rotation axis through its center of mass?



(1) $5 \text{ kg}\cdot\text{m}^2$ (2) $10 \text{ kg}\cdot\text{m}^2$ (3) $2.5 \text{ kg}\cdot\text{m}^2$ (4) $25 \text{ kg}\cdot\text{m}^2$ (5) $40 \text{ kg}\cdot\text{m}^2$

20. A skier starts from rest at height H above the end of a ski-jump ramp. As the skier leaves the ramp, his velocity makes an angle of θ with the horizontal as shown in the figure. Neglect the effects of air resistance and assume the ramp is frictionless. If the maximum height h of his jump above the end of the ramp is equal to $H/4$, what is the angle θ ?



(1) 30° (2) 45° (3) 14.5° (4) 60° (5) Need to know H