Instructor(s): *Korytov/Matcheva*

PHYSICS DEPARTMENT

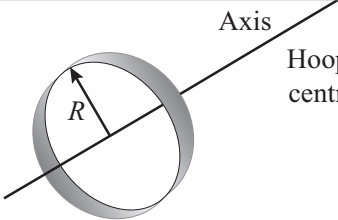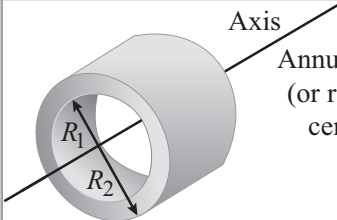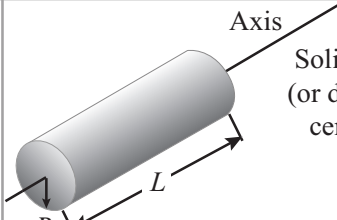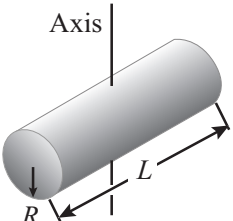PHY 2048   Exam 2   October 30, 2013
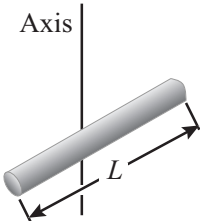
Name (print, last first): _____   Signature: _____

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.
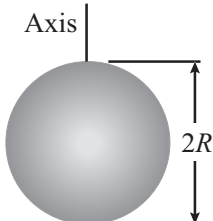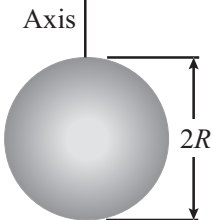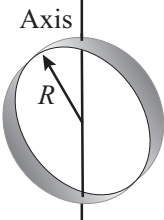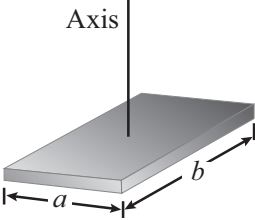(2) Print your name on this sheet and sign it also.
(3) Do all scratch work anywhere on this exam that you like. **Circle your answers on the test form.** At the end of the test, this exam printout is to be turned in. No credit will be given without both answer sheet and printout.
(4) **Blacken the circle of your intended answer completely, using a #2 pencil or <u>blue</u> or <u>black</u> 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. If you believe that no listed answer is correct, leave the form blank.**
(6) Hand in the answer sheet separately.
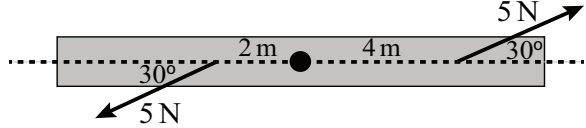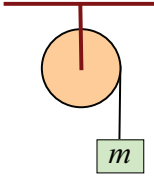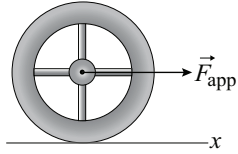
Where needed use $g = 9.80 \text{ m/s}^2$

Axis — Hoop about central axis $I = MR^2$	Axis — Annular cylinder (or ring) about central axis $I = \frac{1}{2} M(R_1^2 + R_2^2)$	Axis — Solid cylinder (or disk) about central axis $I = \frac{1}{2} MR^2$

Hoop about central axis
$$I = MR^2$$

Annular cylinder (or ring) about central axis
$$I = \frac{1}{2} M(R_1^2 + R_2^2)$$

Solid cylinder (or disk) about central axis
$$I = \frac{1}{2} MR^2$$

Solid cylinder (or disk) about central diameter
$$I = \frac{1}{4} MR^2 + \frac{1}{12} ML^2$$

Thin rod about axis through center perpendicular to length
$$I = \frac{1}{12} ML^2$$

Solid sphere about any diameter
$$I = \frac{2}{5} MR^2$$

Thin spherical shell about any diameter
$$I = \frac{2}{3} MR^2$$

Hoop about any diameter
$$I = \frac{1}{2} MR^2$$

Slab about perpendicular axis through center
$$I = \frac{1}{12} M(a^2 + b^2)$$

1. 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^2 (3) t (4) $1/t^2$ (5) none of these

2. An object attached to a cord is moving in a circular path of radius 0.5m on a horizontal frictionless surface. The cord will break if its tension exceeds 16 N. The maximum kinetic energy the object can have is:

   (1) 4 J   (2) 8 J   (3) 16 J   (4) 32 J   (5) 64 J

3. 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:

   (1) 47 J   (2) 24 J   (3) 59 J   (4) 94 J   (5) 0 J

4. The potential energy of a body of mass m is given by $U = -mgx + kx^2/2$. The corresponding force is:

   (1) $mg - kx$ (2) $-mg + kx$ (3) $-mg + kx/2$ (4) $mgx^2/2 - kx^3/6$ (5) $-mgx^2/2 + kx^3/6$

5. A 4-kg particle moves along the x axis under the influence of a conservative force. The potential energy is given by $U(x) = (1.0 \text{ J/m}^3)x^3$ where x is in meters. If the velocity of the particle at $x = -2$ m is 2 m/s, how far to the right along x $(x > 0)$ does the particle reach?

   (1) 0 m   (2) 1 m   (3) 2 m   (4) -1 m   (5) 4 m

6. A stone of mass M rests on an elastic spring which is compressed a distance of 1 cm by the weight of the stone. The stone is pushed down an additional distance of 3 cm and then released. What is the maximum height reached by the stone relative to the release point?

   (1) 8 cm   (2) 16 cm   (3) 4 cm   (4) 12 cm   (5) need to know the spring constant k

7. With a help of a winch, one attempts to raise a 6-ton block vertically up by 1 m by sliding it along a frictionless incline that makes an angle of 20 degrees with the horizon. If the task is to be accomplished in 5 min, what is the minimal power requirement for the winch?

   (1) 200 W   (2) 300 W   (3) 400 W   (4) 500 W   (5) 600 W

8. 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?

   (1) $z = L/3$
   (2) $z = L/2$
   (3) $z = L/4$
   (4) $z = L/6$
   (5) $z = 2L/3$
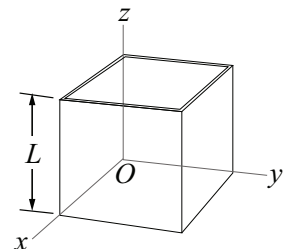
9. A 75-kg man is riding in a 30-kg cart at 2.0 m/s. He jumps off in such a way as to land on the ground with no horizontal velocity. The resulting *change* in speed of the cart is:

   (1) 5 m/s   (2) 7 m/s   (3) zero   (4) 2 m/s   (5) 3 m/s

10. A firefighter puts down fire. He holds a hose ejecting 400 liters of water per minute through a nozzle of 1 cm in diameter. What is the force exerted by the hose on the firefighter? The water density is 1 g/cm^3; 1 liter is 10^{-3}m^3.

   (1) 600 N   (2) 400 N   (3) 200 N   (4) 100 N   (5) 900 N

11. An astronaut is being tested in a centrifuge. The centrifuge has a radius R and, when 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

12. The rotational inertia of a solid uniform sphere about a diameter is $(2/5)MR^2$, where M is its mass and R is its radius. If the sphere is pivoted about an axis that is tangent to its surface, its rotational inertia is:

   (1) $(7/5)MR^2$ (2) $(2/5)MR^2$ (3) $(3/5)MR^2$ (4) $(5/2)MR^2$ (5) MR^2

13. A rod is pivoted about its center. A 5-N force is applied 4 m from the pivot and another 5-N force is applied 2 m from the pivot, as shown. The magnitude of the total torque about the pivot (in N·m) is:

   (1) 15 N·m   (2) 5 N·m   (3) 8.7 N·m   (4) 26 N·m   (5) 0 N·m

14. A 16-kg block is attached to a cord that is wrapped around the rim of a flywheel of diameter 0.40 m and hangs vertically, as shown. The rotational inertia of the flywheel is 0.50 kg·m^2. When the block is released and the cord unwinds, the acceleration of the block is:

   (1) 5.5 m/s^2 (2) 1.5 m/s^2 (3) 8.2 m/s^2 (4) 9.8 m/s^2 (5) 12.7 m/s^2

15. A thin-walled hollow tube rolls without sliding along the floor. The ratio of its translational kinetic energy to its rotational kinetic energy (about an axis through its center of mass) is:

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

16. 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 kg·m^2 (2) 10 kg·m^2 (3) 2.5 kg·m^2 (4) 25 kg·m^2 (5) 40 kg·m^2

17. 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) $3\omega/4$

18. The ideal mechanical advantage is defined to be the ratio of the weight W to the force of the pull F_P for equilibrium (*i.e.*, W/F_P in equilibrium). Assuming that the pulleys are massless and there is no friction in the system, what is the ideal mechanical advantage of the combination of pulleys shown in the figure?
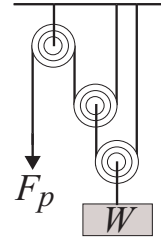
(1) 4
(2) 1
(3) 2
(4) 3
(5) 8

19. A 960-N block is suspended on a rope attached to point B as shown. The beam AB is weightless and is hinged to the wall at A. The tension force of the cable attached to points C and B has magnitude:
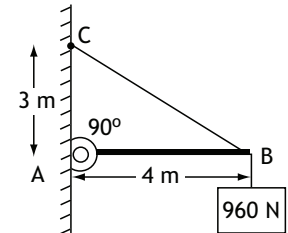
(1) 1600 N
(2) 720 N
(3) 1200 N
(4) 1280 N
(5) 960 N

20. A certain wire stretches 0.90 cm when outward forces with magnitude F are applied to each end. The same forces are applied to a wire of the same material but with three times the diameter and three times the length. The second wire stretches:

(1) 0.30 cm   (2) 0.10 cm   (3) 0.90 cm   (4) 2.7 cm   (5) 8.1 cm