Instructor(s): *Hirschfeld/Matcheva*

PHYSICS DEPARTMENT

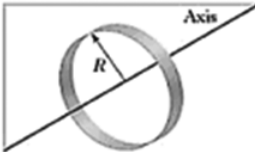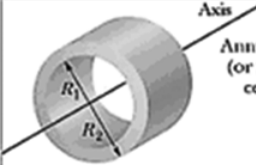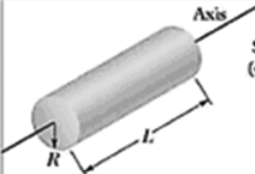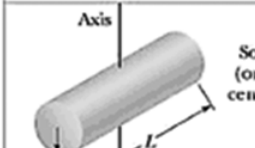PHY 2048   Final Exam   April 25, 2009
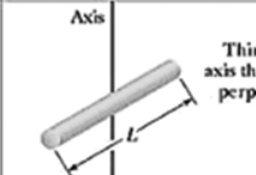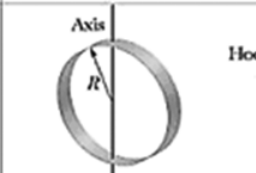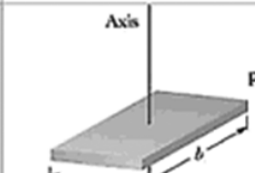
Name (print, last first): _____   Signature: _____

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.
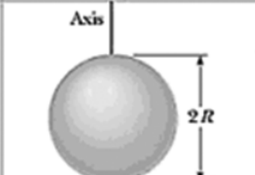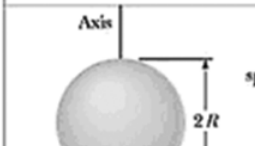(4) **Blacken the circle of your intended answer completely, using a #2 pencil or <u>blue</u> or <u>black</u> ink**. Do not make any stray marks or some answers may be counted as incorrect.
(5) The answers are rounded off. Choose the closest to exact. There is no penalty for guessing.
(6) **Hand in the answer sheet separately.**

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

1. Near the surface of the earth, a startled armadillo leaps upward at time $t = 0$. At time $t = 1$ s it is a height of 2 m above the ground. What is the speed and the direction of motion of the armadillo at this time (*i.e.*, at $t = 1$ s)?

   (1) 2.9 m/s downward (2) 2.9 m/s upward (3) 2.0 m/s downward (4) 2.0 m/s upward (5) 4.9 m/s downward

2. In the figure, a car is driven at a constant speed v over a circular hill and then into a circular valley with the same radius by a driver with mass M. If at the top of the hill the normal force on the driver from the car seat is zero, what is the magnitude of the normal force on the driver from the seat when the car passes through the bottom of the valley?
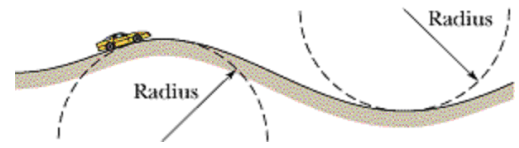
   (1) 2 Mg (2) 5 Mg (3) Mg (4) 0.5 Mg (5) zero

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 t^2, its kinetic energy is proportional to:

   (1) t^6 (2) t (3) t^2 (4) $1/t^2$ (5) t^4

4. 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 at the center of the disk, what is the new angular velocity of the mouse-disk system?

   (1) $3\omega/2$ (2) ω (3) $\omega/2$ (4) 2ω (5) $4\omega/3$

5. A 100-N uniform plank leans against a frictionless wall as shown. The magnitude of the torque (about the point P) applied to the plank by the wall is:
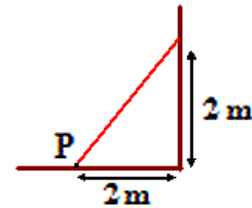
   (1) 100 N·m (2) 150 N·m (3) 500 N·m (4) 66.7 N·m (5) 75 N·m

6. An object hangs from a spring balance. The balance indicates 30 N in air and 15 N when the object is entirely submerged in water and 10 N when entirely submerged in an unknown liquid with density ρ. What is the ratio of the density of the unknown liquid to the density of water (*i.e.*, ρ/ρ_{water})?

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

7. A motorist drives along a straight road at a constant speed of 60 m/s. Just as she passes a parked motorcycle police officer, the officer starts to chase her at a constant acceleration. If the officer maintains this constant value of acceleration, what is the speed of the police officer when he reaches the motorist?

   (1) 120 m/s (2) 60 m/s (3) 180 m/s (4) 100 m/s (5) need to know the officers acceleration

8. Three blocks (A,B,C), each having mass M, are connected by strings on a horizontal frictionless surface as shown in the figure. Block C is pulled to the right by a horizontal force of magnitude F that causes the entire system to accelerate. What is the magnitude of the net horizontal force acting on block B due to the strings?

   (1) $F/3$ (2) $F/2$ (3) $2F/3$ (4) zero (5) F

9. A 5.0 g bullet moving at 600 m/s strikes a 400 g wooden block at rest on a frictionless surface. The bullet becomes embedded in the block and the block-bullet system then travels together at speed V. How much thermal energy was generated in the heating up of the block and the bullet during this collision?

(1) 889 J   (2) 900 J   (3) 11 J   (4) 600 J   (5) 0 J

10. A block of mass m is attached to a cord that is wrapped around the rim of a flywheel of radius R and mass M, hangs vertically as shown in the figure. The rotational inertia of the flywheel is $I = MR^2/2$. If $m = M/2$, when the block is released and the cord unwinds, the acceleration of the block is:

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

11. A particle is 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 angular momentum about the origin is non-zero and points in the negative y direction. The velocity of the particle 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

12. The coefficient of static friction between a solid spherical ball with radius R and a horizontal floor (x-axis) is 0.40. What is the magnitude of the maximum acceleration in the x-direction the ball can have without sliding?

(1) g   (2) 0.1g   (3) 0.2g   (4) 0.4g   (5) 0.8g

13. A picture P of weight W is hung by two strings as shown. The magnitude of the tension force of each string is T and the angle of each string with the horizontal is θ. The total upward pull of the strings on the picture is:

(1) W (2) $2W\cos\theta$ (3) $T\sin\theta$ (4) $T\cos\theta$ (5) $2T\cos\theta$

14. To measure the mass of a planet with the same radius as Earth, an astronaut drops an object from rest (relative to the planet) from an altitude of one radius above the surface. When the object hits the surface of the planet (neglecting air resistance), its speed is 2 times what it would be if the same experiment were carried out for Earth. If M_E is the mass of the Earth, the mass of the planet is:

(1) $4M_E$ (2) $2M_E$ (3) $16M_E$ (4) $8M_E$ (5) $32M_E$

15. The density of water is 1.0 g/cm^3 and oil does not mix with water. The density of the oil in the left column of the U-tube shown in the figure is:

(1) 0.80 g/cm^3 (2) 0.20 g/cm^3 (3) 1.0 g/cm^3 (4) 1.3 g/cm^3 (5) 5.0 g/cm^3

16. The sound intensity 5.0 m from an isotropically radiating point source is 0.50 W/m^2. The power output of the source is:

    (1) 157 W (2) 39 W (3) 266 W (4) 320 W (5) 628 W

17. The figure shows four isotropic point sources of sound that are uniformly spaced on the x-axis. The sources emit sound at the same wavelength λ and the same amplitude s_m, and they emit in phase. A point P is shown on the x-axis. Assume that as the sound waves travel to the point P, the decrease in their amplitude is negligible. What is the amplitude of the net wave at P if $d = \lambda$?
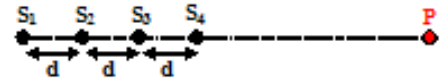
    (1) $4s_m$ (2) s_m (3) $2s_m$ (4) $3s_m$ (5) zero

18. Sound with a 40 cm wavelength travels rightward from a source and through a tube that consists of a straight portion and a half-circle as shown in the figure. Part of the sound wave travels through the half-circle and then rejoins the rest of the wave, which goes directly through the straight portion. This rejoining results in interference. What is the smallest radius r that results in an intensity minimum at the detector?

    (1) 17.5 cm (2) 35.0 cm (3) 8.75 cm (4) 12.3 cm (5) 21.5 cm

19. A stationary motion detector sends sound waves of frequency of 800 Hz toward a truck that is travelling away from the detector. If the frequency of the waves reflected back to the detector is 600 Hz, what is the speed of the truck? (Take the speed of sound to be 343 m/s.)

    (1) 49.0 m/s (2) 19.1 m/s (3) 68.6 m/s (4) 85.8 m/s (5) 38.1 m/s

20. The function $y(x, t) = A \cos(kx - \omega t)$ describes a wave on a taut string with the x-axis parallel to the string. If the phase velocity of the wave is 2 m/s in the x-direction and if the wavelength $\lambda = \pi$ cm and $A = 15$ cm, what is the magnitude of the transverse velocity for a point on the string at an instant when the point has a displacement $y = 12$ cm?

    (1) 48 m/s (2) 24 m/s (3) 12 m/s (4) 60 m/s (5) 2 m/s