Instructor(s): *Acosta, Matcheva, Rinzler*

PHYSICS DEPARTMENT

PHY 2048, Spring 2016 Final Exam April 23, 2016

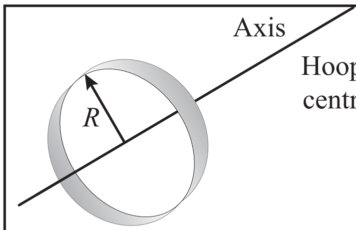
Name (print, last first): ______________________________ Signature: ______________________________

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.

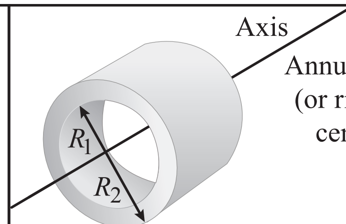
(1) **Code your test number on your answer sheet (use lines 76–80 on the answer sheet for the 5-digit number)**. Code your name on your answer sheet. **DARKEN CIRCLES COMPLETELY**. Code your UFID number on your answer sheet.
(2) Print your name on this sheet and sign it also.
(3) Do all scratch work 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. If you believe that no listed answer is correct, leave the form blank.**
(6) Hand in the answer sheet separately.

Where needed use $g = 9.81$ m/s^2



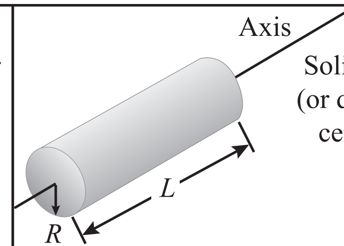
Hoop about central axis

$I = MR^2$



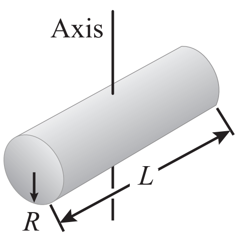
Annular cylinder (or ring) about central axis

$I = \frac{1}{2}M(R_1^2 + R_2^2)$



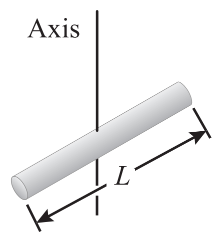
Solid cylinder (or disk) about central axis

$I = \frac{1}{2}MR^2$



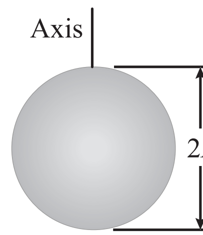
Solid cylinder (or disk) about central diameter

$I = \frac{1}{4}MR^2 + \frac{1}{12}ML^2$



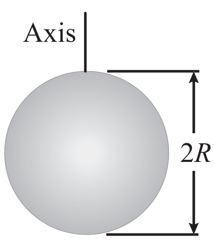
Thin rod about axis through center perpendicular to length

$I = \frac{1}{12}ML^2$



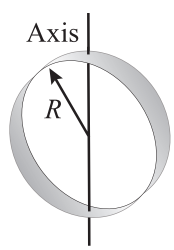
Solid sphere about any diameter

$I = \frac{2}{5}MR^2$



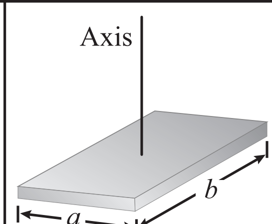
Thin spherical shell about any diameter

$I = \frac{2}{3}MR^2$



Hoop about any diameter

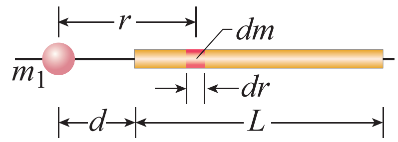
$I = \frac{1}{2}MR^2$



Slab about perpendicular axis through center

$I = \frac{1}{12}M(a^2 + b^2)$

1. In the figure, a particle of mass $m_1 = 1.0$ kg is a distance $d = 2.0$ m from one end of a uniform rod with length $L = 6.0$ m and mass $M = 2.0$ kg. What is the magnitude of the gravitational force $\vec{F}$ on the particle from the rod? ($G = 6.674 \times 10^{-11}$ N m^2/kg^2)



(1) 8.3×10^{-12} N (2) 1.1×10^{-11} N (3) 2.8×10^{-12} N (4) 3.3×10^{-11} N (5) 5.3×10^{-10} N

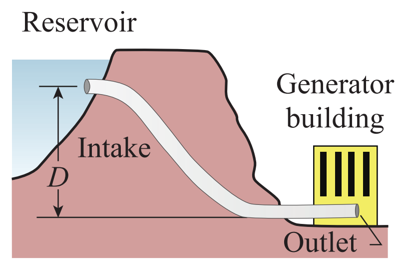
2. What is the orbital speed of the Earth as it orbits our sun? The mass of the sun is 2.0×10^{30} kg, the mass of the Earth is 6.0×10^{24} kg, and the distance between the Earth and sun is 1.5×10^{11} m. ($G = 6.674 \times 10^{-11}$ N m^2/kg^2)

(1) 30 km/s (2) 0.05 km/s (3) 8 km/s (4) 42 km/s (5) 7.3×10^{13} km/s

3. A slab of ice floats on a freshwater lake. What minimum volume must the slab have for a 44 kg woman to be able to stand on it without getting her feet wet (*i.e.,* her feet are at the level of the lake surface)? The density of water is 1000 kg/m^3 and the density of ice is 920 kg/m^3.

(1) 0.55 m^3 (2) 0.25 m^3 (3) 0.05 m^3 (4) 5.5 m^3 (5) 0.75 m^3

4. A water intake at a pump storage reservoir (see figure) has a cross-sectional area of 1.0 m^2. The water flows in at a speed of 1.0 m/s. At the generator building, at distance $D = 10$ m below the intake point, the cross-sectional area is smaller than at the intake and the water flows out at 7 m/s. What is the difference in pressure between the outlet and inlet? The density of water is 1000 kg/m^3.



(1) 74,000 Pa (2) 24,000 Pa (3) 98,000 Pa (4) 122,000 Pa (5) 50,000 Pa

5. A block with mass m = 0.5 kg is attached to one end of an ideal spring and moves on a horizontal frictionless surface. The other end of the spring is attached to a wall. The block is at $x = 0$ when it is at rest. When the block is at $x = +1.0$ m, its acceleration is $a_x = -8.0$ m/s^2 and its velocity is $v_x = +4.0$ m/s. What is the maximum speed of the block during its motion?

(1) 4.9 m/s (2) 1.7 m/s (3) 6.0 m/s (4) 4.0 m/s (5) 2.8 m/s

6. Suppose that a simple pendulum consists of a small 5 kg bob at the end of a cord of negligible mass. If the angle θ between the cord and the vertical is given by: $\theta(t) = (0.25\,\text{rad})\cos[(4.4\,\text{rad/s})t + \phi]$, what is the pendulum's length?

(1) 0.51 m (2) 2.0 m (3) 20 m (4) 1.0 m (5) 0.25 m

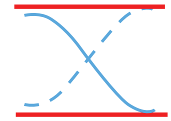
7. The transverse displacement along a string from a traveling wave has the form $y(x,t) = y_m \sin(kx - \omega t)$, where y_m is 0.5 cm, k is 100 m^{-1}, and ω is $20,000$ rad/s^{-1}. What is the maximum *transverse* speed of any particular point along the string?

(1) 100 m/s (2) 200 m/s (3) $10,000$ m/s (4) 2×10^6 m/s (5) 5×10^{-3} m/s

8. A cellist tunes the C-string of her instrument to a fundamental frequency of 65 Hz. The vibrating portion of the string is 0.60 m long and has a mass of 15 g. With what tension must she stretch it?

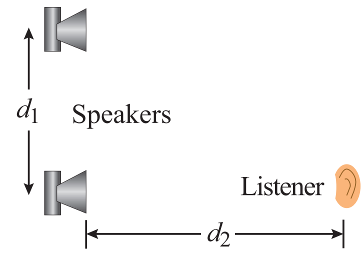
(1) 150 N (2) 1.2 N (3) 0.025 N (4) 6100 N (5) 40 N

9. A pipe in a pipe organ is 2.0 m long. What is the frequency of the note corresponding to the fundamental mode if the pipe is open at both ends? See the figure for a sketch of this sound wave at two different times. (Take the speed of sound to be 340 m/s.)



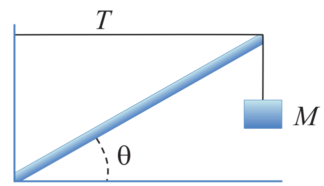
(1) 85 Hz (2) 170 Hz (3) 340 Hz (4) 44 Hz (5) 0.5 Hz

10. In the figure, two loudspeakers, separated by a distance of $d_1 = 3.0$ m, are in phase. Assume the amplitudes of the sound from the speakers are approximately the same at the position of a listener, who is $d_2 = 4.0$ m directly in front of one of the speakers. Consider the audible range for normal hearing, 20 Hz to 20 kHz. What is the lowest frequency that gives the minimum signal (destructive interference) at the listener's ear? (Take the speed of sound to be 340 m/s.)



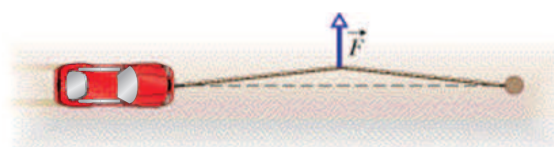
(1) 170 Hz (2) 340 Hz (3) 85 Hz (4) 115 Hz (5) 250 Hz

11. The system depicted in the figure is in equilibrium. A block of mass $M = 500$ kg hangs from the end of a massless strut which is fixed to the ground at the other end and makes an angle $\theta = 30°$ with respect to the horizontal. Find the tension T in the massless, horizontal cable attaching the strut to the wall.



(1) 8500 N (2) 4900 N (3) 2800 N (4) 9800 N (5) 5700 N

12. In the figure, a man is trying to get his car out of mud on the shoulder of a road. He ties one end of a rope tightly around the front bumper and the other end tightly around a utility pole 12 m away. He then pushes sideways on the rope at its midpoint with a force of 600 N, displacing the center of the rope 0.10 m from its previous position, and the car barely moves. What is the magnitude of the force on the car from the rope? (The rope stretches somewhat.)



(1) 18,000 N (2) 36,000 N (3) 600 N (4) 1800 N (5) 12,000 N

13. A hot air balloon is ascending at a rate of 10 m/s and is 120 m above the ground when a package is dropped over the side. How long does it take for the package to reach the ground?

(1) 6 s (2) 4 s (3) 5 s (4) 7 s (5) 2 s

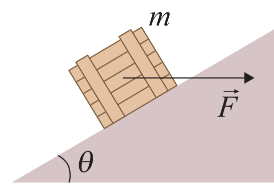
14. Find the interior angle between the vectors $\vec{a}$ and $\vec{b}$ if $\vec{a} = \hat{\imath} + 2\hat{\jmath} + 3\hat{k}$ and $\vec{b} = 3\hat{\imath} + 2\hat{\jmath} + \hat{k}$.

(1) 44° (2) 135° (3) 0° (4) 75° (5) 22°

15. During a tennis match a tennis player serves the ball at 33.0 m/s with the center of the ball leaving the racquet horizontally 2.37 m above the court surface. The net is 12 m away and 0.9 m high. What is the distance between the center of the ball and the top of the net when the ball flies over the net?

(1) 0.82 m (2) 1.70 m (3) 0.65 m (4) 0.25 m (5) 0.40 m

16. A 200 N crate is pushed up a frictionless incline with a constant speed by a constant horizontal force $\vec{F}$ as shown in the figure. The angle of the slope is $\theta = 60°$. What is the force with which the crate acts on the hill?

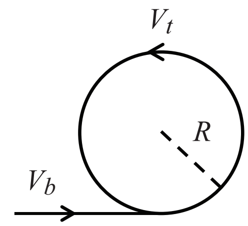


(1) 400 N (2) 800 N (3) 550 N (4) 200 N (5) 260 N

17. A block is moving without friction, up an incline of 30° under the force of gravity when it encounters a section in which the coefficient of kinetic friction is 0.16. Measured along the incline, that section is 2 m long. When the block first enters that section it has a speed up the incline of 6 m/s. When the block leaves that 2 m long section, its speed is (in m/s):

(1) 3.3 (2) 2.8 (3) 2.3 (4) 1.8 (5) mass of the block is needed to calculate

18. A roller coaster is to go through a vertical loop as shown. What is the minimum speed (in m/s) at the bottom of the loop (V_b) necessary so that the cars do not fall off of the track at the top of the loop if the radius of the loop is $R = 7.0$ m? Treat a roller coaster car as a point mass going through the loop.

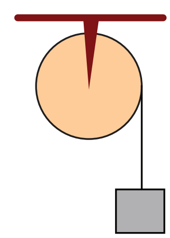


(1) 18.5 (2) 16.5 (3) 8.0 (4) 12.0 (5) 500

19. A 0.20 kg rubber ball is dropped from the window of a building. It strikes the horizontal sidewalk below at 15.0 m/s and rebounds straight back upwards at 10.0 m/s. The fall took 3.0 seconds and the ball is in contact with the sidewalk for 4.0 ms. The magnitude of the average force on the ball during the collision with the sidewalk was (in N):

(1) 1250 (2) 6250 (3) 1.67 (4) 8.3 (5) 250

20. A 16 kg block is attached to a rope that is wrapped many times around the rim of a flywheel of diameter 0.80 m and rotational inertia of 1.0 kg·m^2. The block hangs vertically, as shown in the figure. When the block is released and the rope unspools without slipping, the acceleration of the block (in m/s^2) is:



(1) 7.0
(2) 4.0
(3) 6.0
(4) 5.0
(5) 8.0