

Instructor(s): *Hirschfeld/Matcheva*PHYSICS DEPARTMENT
Exam 3

April 13, 2009

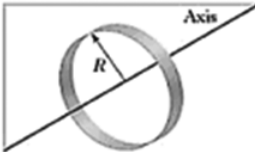
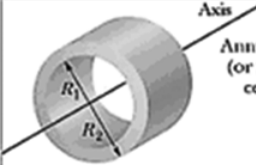
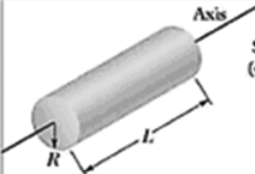
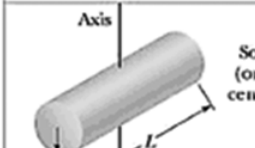
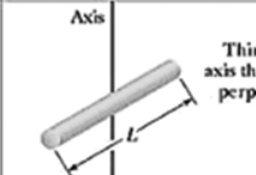
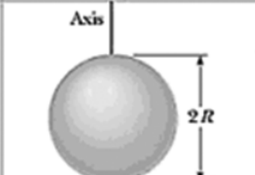
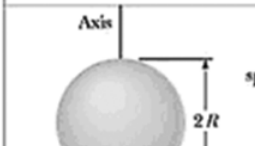
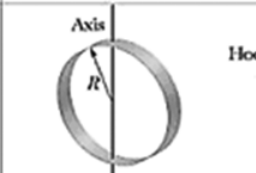
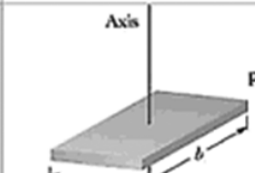
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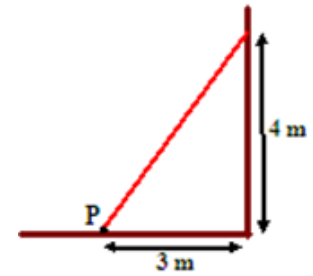
*On my honor, I have neither given nor received unauthorized aid on this examination.***YOUR TEST NUMBER IS THE 5-DIGIT NUMBER AT THE TOP OF EACH PAGE.**

- (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 $g = 9.80 \text{ m/s}^2$

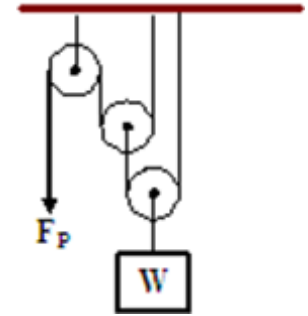
 <p>Hoop about central axis</p> <p>$I = MR^2$ (a)</p>	 <p>Annular cylinder (or ring) about central axis</p> <p>$I = \frac{1}{2}M(R_1^2 + R_2^2)$ (b)</p>	 <p>Solid cylinder (or disk) about central axis</p> <p>$I = \frac{1}{2}MR^2$ (c)</p>
 <p>Solid cylinder (or disk) about central diameter</p> <p>$I = \frac{1}{4}MR^2 + \frac{1}{12}ML^2$ (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. 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) 150 N·m (2) 100 N·m (3) 500 N·m (4) 66.7 N·m (5) 75 N·m

2. 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 rotate without friction and without the rope slipping, what is the ideal mechanical advantage of the combination of pulleys shown in the figure?

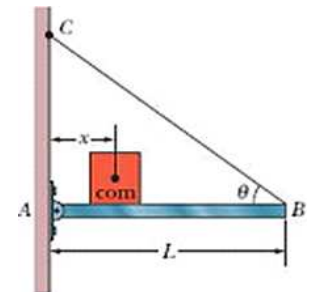


- (1) 4 (2) 1 (3) 2 (4) 3 (5) 8

3. A 160-N child sits on a light swing and is pulled back and held with a horizontal force of 120 N. The magnitude of the tension force of each of the two supporting ropes is:

- (1) 100 N (2) 60 N (3) 120 N (4) 160 N (5) 200 N

4. In the figure, the uniform bar has length L and a weight of 200 N. Also, the block has weight $W = 300$ N and the angle $\theta = 30^\circ$. If the wire has tension $T = 400$ N, what is the value of x ?



- (1) $L/3$
 (2) $L/2$
 (3) $L/4$
 (4) $3L/4$
 (5) $L/5$

5. Let F_1 be the magnitude of the gravitational force exerted on the Sun by Earth and F_2 be the magnitude of the force exerted on Earth by the Sun. Then:

- (1) F_1 is equal to F_2
 (2) F_1 is much greater than F_2
 (3) F_1 is slightly greater than F_2
 (4) F_1 is slightly less than F_2
 (5) F_1 is much less than F_2

6. Assume the Earth has a uniform mass density. An object at the surface of Earth (at a distance R from the center of Earth) weighs 90 N. If the object is in a cave a distance of $2R/3$ from the center of Earth its weight is:

- (1) 60 N (2) 10 N (3) 40 N (4) 135 N (5) 90 N

7. Two point masses are located on the x-axis. Mass m_1 is at the origin (*i.e.*, $x = 0$) and mass m_2 is at $x = d$. If $m_2 = 4m_1$, at what point on the x-axis is the *net* gravitational force on a test mass m from the two masses equal to zero?
- (1) $x = d/3$ (2) $x = -d$ (3) $x = 2d/3$ (4) $x = d/4$ (5) $x = d/2$
8. Two point particles with equal mass M are released from rest a distance d apart and are attracted toward each other due to the gravitational force. What is the speed of the two particles when they are a distance $d/5$ apart?
- (1) $2\sqrt{GM/d}$ (2) $\sqrt{GM/d}$ (3) $\sqrt{2GM/d}$ (4) $2\sqrt{2GM/d}$ (5) $4\sqrt{GM/d}$
9. A spherical shell has inner radius R_1 , outer radius R_2 , and mass M , distributed uniformly throughout the shell. The magnitude of the *net* gravitational force exerted on the shell by a point particle of mass m , located a distance d from the center, inside the inner radius (*i.e.*, $d < R_1$), is:
- (1) zero (2) GMm/R_1^2 (3) GMm/d^2 (4) GMm/R_2^2 (5) $GMm/(R_1 - d)^2$
10. Suppose that you release a small ball from rest at a depth d below the surface in a pool of water and the ball rises and as the ball emerges from the water it shoots up a distance $3d$ above the water. If the drag force on the ball from the water is negligible, what is the ratio of the density of the ball to the density of water, $\rho_{\text{ball}}/\rho_{\text{water}}$? (Neglect any transfer of energy to the splashing and waves produced by the emerging ball and assume that you are near the surface of the Earth.)
- (1) 0.25 (2) 0.33 (3) 0.5 (4) 0.10 (5) 0.75
11. 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 20 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) 2/3 (2) 1/2 (3) 3/2 (4) 1/4 (5) 2
12. Water flows through a horizontal cylindrical pipe of varying cross section. The velocity of the water is 1 m/s at a point where the pipe radius is R . What is the radius of the pipe at a point where the velocity of the water is 4 m/s?
- (1) $R/2$ (2) $2R$ (3) $R/\sqrt{2}$ (4) $\sqrt{2}R$ (5) $R/4$
13. A large water tank near the surface of the Earth is open at the top and has a small hole in the bottom. Assume that the area of the hole is much smaller than the area of the top of the tank. If the speed of the water leaking from the hole is 29.4 m/s, how high is the water level above the bottom of the tank?
- (1) 44.1 m (2) 88.2 m (3) 22.1 m (4) 9.8 m (5) 29.4 m
14. A mass m suspended from an ideal spring with spring constant k oscillates up and down with very small amplitude and period T . If the amplitude of the oscillation is doubled, the period will be:
- (1) T (2) $T/2$ (3) $T/\sqrt{2}$ (4) $\sqrt{2}T$ (5) $T/4$
15. In simple harmonic motion, the displacement is maximum when the:
- (1) velocity is zero
 (2) acceleration is zero
 (3) velocity is maximum
 (4) kinetic energy is maximum
 (5) momentum is maximum

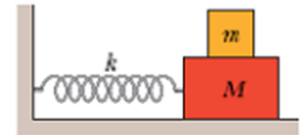
16. The displacement of an object oscillating on a spring is given by $x(t) = A \cos(\omega t + \phi)$. If at $t = 0$ the object is at $A/2$ with velocity in the positive x direction, what is the phase constant ϕ ? (Assume A and ω are positive.)

(1) $5\pi/3$ rad (2) $2\pi/3$ rad (3) $\pi/3$ rad (4) $3\pi/2$ rad (5) $3\pi/5$ rad

17. A particle is in simple harmonic motion with period T and with position as a function of time given by $x(t) = A \cos(\omega t + \phi)$. At time $t = 0$ the particle is at $A/\sqrt{2}$ with positive velocity. If A and ω are positive, the very next time it is at the same position (regardless of its velocity) is:

(1) $t = T/4$ (2) $t = T$ (3) $t = T/2$ (4) $t = T/3$ (5) $t = T/8$

18. In the figure, two blocks ($m = 4$ kg and $M = 16$ kg) and a spring ($k = 122.5$ N/m) are arranged on a horizontal frictionless surface. If the smaller block begins to slip when the amplitude of the simple harmonic motion is greater than 0.5 m, what is the coefficient of static friction between the two blocks? (Assume that the system is near the surface of the Earth.)

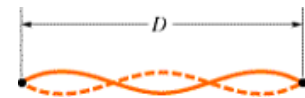


(1) 0.313 (2) 0.391 (3) 0.625 (4) 0.782 (5) 0.156

19. The function $y(x, t) = A \cos(kx - \omega t)$ describes a traveling wave on a taut string with the x -axis parallel to the string. If the wavelength of the wave $\lambda = 0.1$ m and $\omega = 10\pi/s$, what is the magnitude of the phase velocity of the traveling wave?

(1) 0.5 m/s (2) 0.1 m/s (3) 1.0 m/s (4) π m/s (5) 2π m/s

20. A nylon guitar string has a linear density of 5 g/m and is under a tension of 200 N. The fixed supports are $D = 60$ cm apart. The string is oscillating in the standing wave pattern shown in the figure. What is the frequency of the traveling waves whose superposition gives this standing wave?



(1) 500 Hz (2) 50 Hz (3) 250 Hz (4) 25 Hz (5) 100 Hz