

Instructor(s): *Mueller/Saab*PHYSICS DEPARTMENT
Exam 3

December 8, 2009

PHY 2048

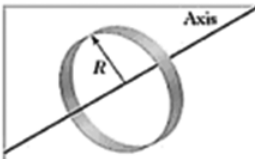
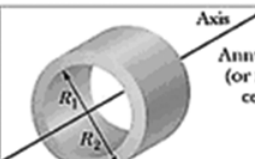
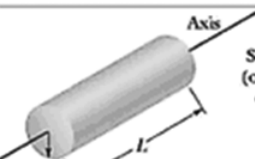
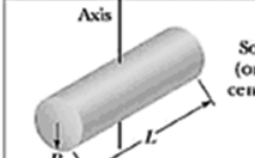
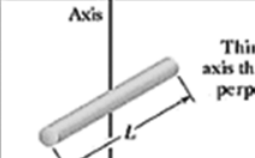
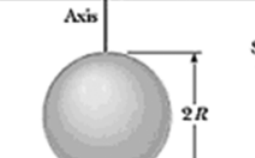
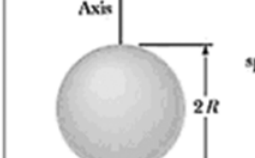
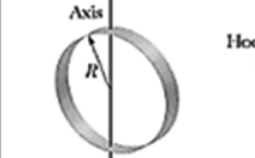
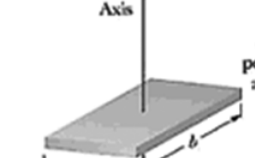
Name (print, last first): _____

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) **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>$I = \frac{2}{5}MR^2$ (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>

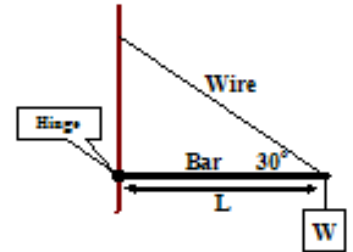
1. The ideal mechanical advantage is defined to be the ratio of the weight W to the force of the pull F_P for equilibrium (*i.e.*, W/F_P in equilibrium). Assuming that the pulleys rotate without friction and without the rope slipping, what is the ideal mechanical advantage of the combination of pulleys shown in the figure?

- (1) 7
(2) 1
(3) 2
(4) 3
(5) 4



2. A uniform horizontal bar has length L and a weight of 100 N as shown in the figure. If the block has weight $W = 200$ N, what is the tension in the wire?

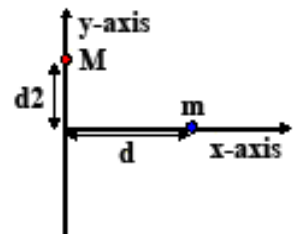
- (1) 500 N
(2) 400 N
(3) 200 N
(4) 300 N
(5) need to know L



3. The center of gravity coincides with the center of mass:

- (1) if the acceleration due to gravity is uniform over the body
(2) always
(3) never
(4) if the center of mass is at the geometrical center of the body
(5) if the body has a uniform distribution of mass

4. One point mass M is located on the y -axis a distance $d/2$ from the origin (at $y = d/2$) as shown in the figure. A second point mass with mass $m = 5M$ is on the x -axis a distance $x = d$ from the origin. What is the magnitude of the *net* gravitational force on the mass m due to mass M ?

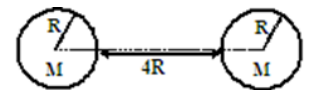


- (1) $4GM^2/d^2$ (2) GM^2/d^2 (3) $8GM^2/d^2$ (4) $5GM^2/d^2$ (5) $2GM^2/d^2$

5. Assume the Earth has a uniform mass density. If an object is in a cave a distance of $R/2$ from the center of Earth experiences a gravitational force with magnitude F on it due to the Earth, what is the magnitude of the gravitational force on it due to the Earth when it is a distance of $2R$ from the center of the Earth?

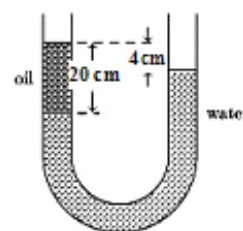
- (1) $F/2$ (2) F (3) $2F$ (4) $F/4$ (5) $4F$

6. Two solid spheres with radius R and uniform mass density have equal mass M . As shown in the figure, they are released from rest a distance $4R$ apart and are attracted toward each other due to the gravitational force. What is the sum of the kinetic energies of the two spheres when they collide?



- (1) $GM^2/(3R)$ (2) $GM^2/(2R)$ (3) $2GM^2/R$ (4) GM^2/R (5) $2GM^2/(3R)$

7. Assume that Earth is in circular orbit around the Sun with kinetic energy K and potential energy U . If U is taken to be zero for infinite separation, what is the relationship between K and U ?
- (1) $K = -U/2$ (2) $K = U$ (3) $K = U/2$ (4) $K = -U$ (5) depends on the radius of the orbit
8. The Sun has a mass that is much greater than the mass of the Earth. If we assume that the Earth travels in a circular path around the Sun, then the period of the circular motion T is about one year. Suppose instead that the Earth and the Sun remained the same distance apart but the Earth had the same mass as the Sun. Assuming that the Earth now travels in a circular orbit about the center-of-mass of the Earth-Sun system, how long would it take the Earth to make one complete revolution?
- (1) $T/\sqrt{2}$ (2) $\sqrt{2}T$ (3) $T/2$ (4) $2T$ (5) T
9. Suppose that you release a small ball from rest at a depth d below the surface in a pool of water (with density ρ_{water}). If the speed of the ball when it reaches the surface is \sqrt{gd} , what is the ratio of the density of the ball to the density of water, $\rho_{\text{ball}}/\rho_{\text{water}}$? (Note that g is the acceleration due to gravity.)
- (1) $2/3$ (2) $1/2$ (3) $3/4$ (4) $1/3$ (5) $1/4$
10. A large water tank, open at the top, 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. When the water level is 19.6 m above the bottom of the tank, what is the speed of the water leaking from the hole?
- (1) 19.6 m/s (2) 28.0 m/s (3) 39.6 m/s (4) 12.7 m/s (5) 784 m/s
11. Water flows through a horizontal cylindrical pipe of varying cross section. The velocity is 9 m/s at a point where the pipe diameter is 1 cm. At a point where the pipe diameter is 3 cm, the velocity is:
- (1) 1 m/s (2) 9 m/s (3) 3 m/s (4) 4 m/s (5) 2 m/s
12. The density of ice is about 0.92 times the density of water. What fraction of the total volume of an ice cube floating in water is above the surface of the water?
- (1) 0.08 (2) 0.92 (3) 0.43 (4) 0.16 (5) zero
13. 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
14. The displacement of an object oscillating on a spring is given by $x(t) = A \cos(\omega t + \phi)$. If at $t = 0$, the velocity of the object is zero and the acceleration is positive, what is the phase constant ϕ ? (Assume A and ω are positive.)
- (1) $\pi \text{ rad}$ (2) $2\pi/3 \text{ rad}$ (3) $\pi/2 \text{ rad}$ (4) $3\pi/2 \text{ rad}$ (5) zero

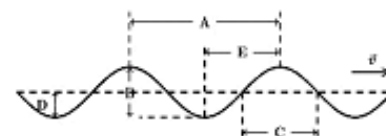
15. The function $y(x, t) = A \cos(kx - \omega t)$, describes a wave traveling to the right on a tight string with the x-axis parallel to the string. The transverse velocity of the string is $u(x, t) = dy/dt$. If the wave is traveling to the right at speed v , what is the maximum transverse speed of a particle in the string?

(1) kvA (2) kA (3) v (4) ω/k (5) $\sqrt{v\omega/k}$

16. In simple harmonic motion, the magnitude of the acceleration is greatest when:

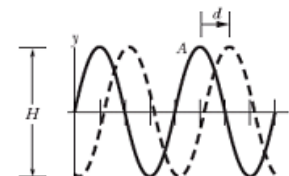
(1) the displacement is maximum
 (2) the displacement is zero
 (3) the speed is maximum
 (4) the force is zero
 (5) the speed is between zero and its maximum

17. A sinusoidal wave is traveling toward the right as shown in the figure. Which letter correctly labels the wavelength of the wave?



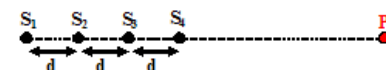
(1) A (2) E (3) C (4) B (5) D

18. A sinusoidal wave moving along a string is shown twice in the figure. Crest A travels in the positive direction along the x-axis and moves a distance $d = 12$ cm in 3 ms. If the tick marks along the x-axis are 10 cm apart, what is the frequency of the traveling wave?



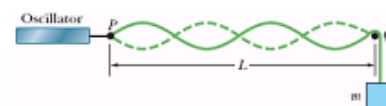
(1) 100 Hz (2) 200 Hz (3) 50 Hz (4) 150 Hz (5) 300 Hz

19. 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 $d = \lambda/4$?



(1) zero (2) s_m (3) $2s_m$ (4) $3s_m$ (5) $4s_m$

20. A string, which is tied to a sinusoidal oscillator at P and which runs over a support Q , is stretched by a block of mass m . The distance $L = 2.0$ m, the linear mass density of the string $\mu = 4.9$ g/m, and the oscillator frequency $f = 100$ Hz. The motion at P is in the vertical direction, and its amplitude is small enough for that point to be considered a node. A node also exists at Q . What mass allows the oscillator to set up the second harmonic on the string? (Remember that the speed of a wave on a string with tension τ and linear mass density μ is $v = \sqrt{\tau/\mu}$.)



(1) 20 kg (2) 5 kg (3) 10 kg (4) 40 kg (5) 80 kg