Instructor(s): *Matcheva/Sabin*

PHYSICS DEPARTMENT

PHY 2048 Exam 3 April 14, 2010

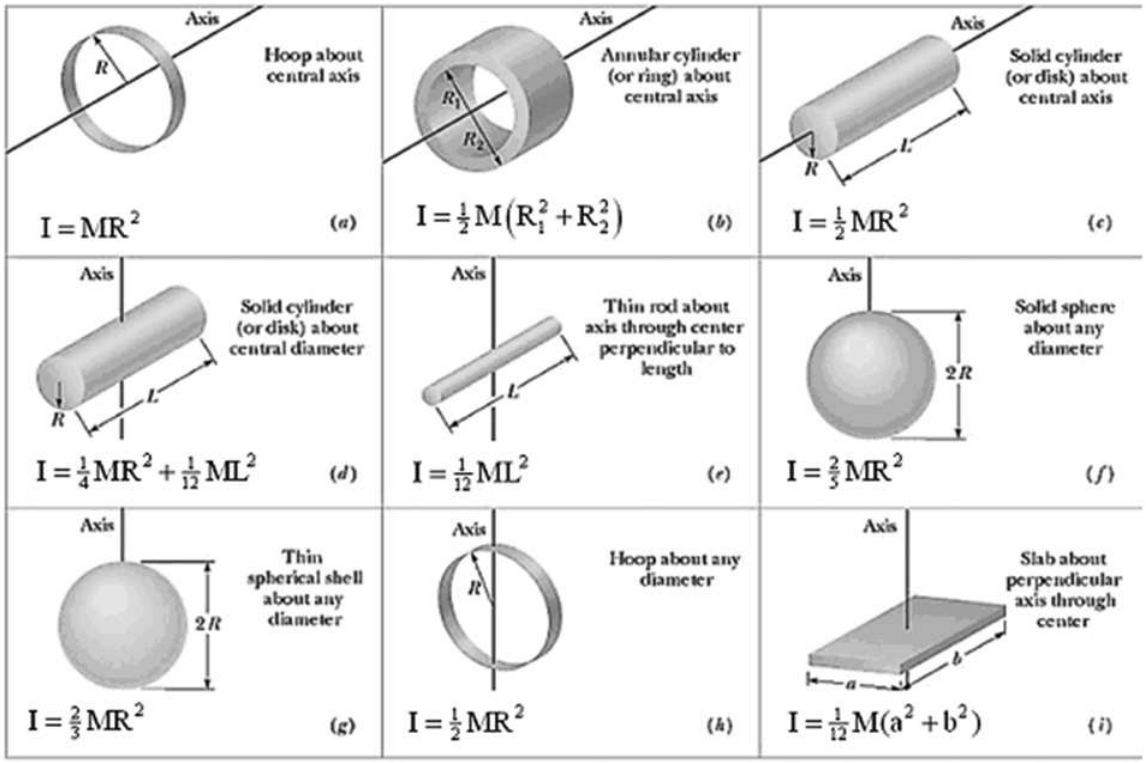
Name (print, last first): _____ Signature: _____

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.
(6) **Hand in the answer sheet separately.**

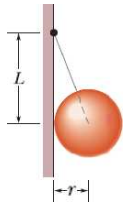
Where needed use $g = 9.80$ m/s^2



1. A uniform plank is 6 m long and weighs 80 N. It is balanced on a sawhorse at its center. An additional 160 N weight is now placed on the left end of the plank. To keep the plank balanced, the sawhorse must be moved what distance to the left?

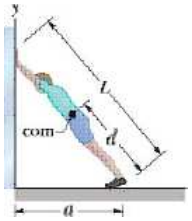
   (1) 2 m (2) 6 m (3) 1.5 m (4) 1 m (5) 0.5 m

2. In the figure, a uniform sphere with a weight of 5 N and radius r is held in place by a massless rope attached to a frictionless wall a vertical distance L above the center of the sphere. If $r = 3L/5$, what is the magnitude of the force on the sphere from the wall?



   (1) 3 N (2) 5 N (3) 1.5 N (4) 3.75 N (5) 2 N

3. In the figure, a climber leans out against a vertical ice wall that has negligible friction. The distance $a = 3L/5$. His center of mass is a distance $d = 0.4L$ from the feet-ground contact point. If he is on the verge of slipping, what is the coefficient of static friction between feet and ground?

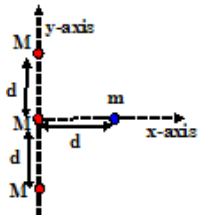


   (1) 0.3 (2) 0.4 (3) 0.375 (4) 0.5 (5) 0.25

4. Let M denote the mass of Earth and let R denote its radius. What is the ratio g/G at Earth's surface, where G is Newton's constant and g is the acceleration due to gravity at the surface of the earth?

   (1) M/R^2 (2) R^2/M (3) MR^2 (4) M/R (5) 1.0

5. Three point masses M are located on the y-axis, one at the origin ($y = 0$) and the other two at $y = \pm d$ as shown in the figure. A fourth point mass m 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 the other three masses?



   (1) $1.71GMm/d^2$ (2) $2.00GMm/d^2$ (3) $2.41GMm/d^2$ (4) $1.41GMm/d^2$ (5) $3.00GMm/d^2$

6. Assume the Earth is s sphere with a uniform mass density and radius R. If a man weighs 200 N on the surface of the Earth, how much does he weigh when he is in a deep mine shaft inside the Earth a distance of $R/4$ from the surface of the Earth?

   (1) 150 N (2) 50 N (3) 200 N (4) 100N (5) 75 N

7. Near the surface of the Earth (acceleration due to gravity = g) it takes time t for an object of mass m to reach the surface of the Earth when dropped from rest a height h above the surface. If an object with mass $4m$ is dropped from rest a height h from the surface of a planet with an acceleration due to gravity equal to $g/4$, how long will it take to hit the surface of the planet?

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

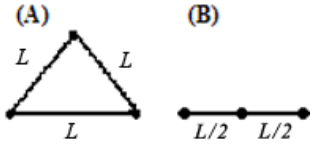
8. Two satellites are in circular orbit around the Earth. The first satellite has mass M_1 and is travelling in a circular orbit of radius R_1. The second satellite has mass $M_2 = 2M_1$ is travelling in a circular orbit of radius $R_2 = 4R_1$. If the first satellite completes one revolution of the Earth in time T, how long does it take the second satellite to make one revolution of the Earth?

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

9. A man enters a tall tower near the surface of the Earth. He notes that a long pendulum extends from the ceiling and nearly touches the floor and that the period of the pendulum is 18.85 s. Assuming that the pendulum is a simple pendulum, how tall is the tower?

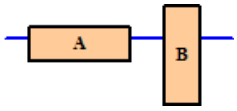
(1) 88.2 m (2) 78.4 m (3) 117.6 m (4) 39.2 m (5) 176.4 m

10. Three point particles with equal mass, m, form an equilateral triangle with sides of length L as shown by (A) in the figure. If one of the masses is moved to a position midway between the other two masses as shown in (B), what is the change in the gravitational potential energy of the three-particle system, $U_B - U_A$?



(1) $-2Gm^2/L$ (2) $+3Gm^2/L$ (3) $-5Gm^2/L$ (4) $-Gm^2/L$ (5) $+2Gm^2/L$

11. Two identical blocks of ice float in water as shown in the figure. Which of the following statements is true?



(1) The two blocks displace equal volumes of water since they have the same weight.
(2) Block B displaces a greater volume of water since the pressure acts on a smaller bottom area.
(3) Block A displaces a greater volume of water since the pressure is less on its bottom.
(4) Block B displaces a greater volume of water since its submerged end is lower in the water.
(5) Block A displaces a greater volume of water since its submerged end has a greater area.

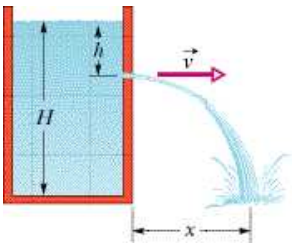
12. An object hangs from a spring balance. When submerged in water the object weighs one-half what it weighs in air. If, when submerged in an unknown liquid with density ρ_X, the object weighs three-fourths what it weighs in air, what is the density of the unknown liquid?

(1) $\frac{1}{2}\rho_{\text{water}}$ (2) $2\rho_{\text{water}}$ (3) $\frac{3}{4}\rho_{\text{water}}$ (4) $\frac{1}{3}\rho_{\text{water}}$ (5) $\frac{2}{3}\rho_{\text{water}}$

13. Suppose that you release a small ball from rest at a depth of 39.2 m below the surface in a pool of water (with density ρ_{water}) near the surface of the Earth. If the density of the ball is 1/3 the density of water (i.e., $\rho_{\text{ball}} = 1/3\rho_{\text{water}}$), how long does it take the ball to reach the surface?

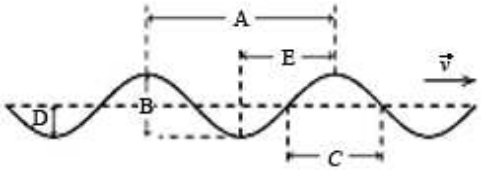
(1) 2 s (2) 1 s (3) 4 s (4) 3 s (5) 1.41 s

14. The figure shows a stream of water flowing through a small hole at depth h in a large tank holding water to height H. Assume that the area of the hole is much smaller than the area of the top of the tank. If the stream of water strikes the floor a horizontal distance $x = H$ from the bottom of the tank, what is h?



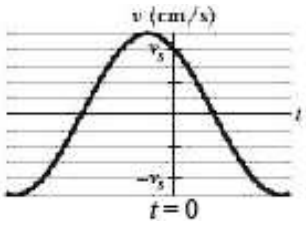
(1) $H/2$
(2) zero
(3) $H/4$
(4) $3H/4$
(5) $H/3$

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



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

16. What is the phase constant, ϕ, in degrees (from 0° to 360°) for the harmonic oscillator with the velocity function $v(t)$ given in the figure, if the position function $x(t)$ has the form $x(t) = A\cos(\omega t + \phi)$ with $A > 0$? The vertical axis crosses the time axis at the point $t = 0$.



(1) 306.9° (2) 53.1° (3) 126.9° (4) 233.1° (5) 315.0°

17. A simple harmonic oscillator consists of a block of mass 2 kg attached to a spring of spring constant 200 N/m. If the speed of the block is 40 m/s when the displacement from equilibrium is 3 m, what is the amplitude of the oscillations?

(1) 5 m (2) 4 m (3) 3 m (4) 6 m (5) 10 m

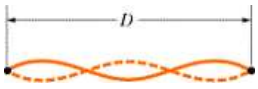
18. The function $y(x,t) = A\cos(kx - \omega t)$ describes a wave on a taut string with the x-axis parallel to the string. The wavelength is $\lambda = 3.14$ cm and the amplitude is $A = 0.1$ cm. If the maximum transverse speed of any point on the string is 10 m/s, what is the speed of propagation of the travelling wave in the x-direction?

(1) 50 m/s (2) 100 m/s (3) 31.4 m/s (4) 60 m/s (5) 2 m/s

19. In simple harmonic motion, the kinetic energy is greatest when:
A. the potential energy is zero
B. the displacement is zero
C. the speed is maximum
D. the force is zero

(1) all of these answers (2) only A and C (3) only A, B, and C (4) only C (5) only A, B, and D

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 a distance D apart. The string is oscillating in the standing wave pattern shown in the figure. If the frequency of the traveling waves whose superposition gives this standing wave is 500 Hz, what is the distance D?



(1) 60 cm (2) 40 cm (3) 90 cm (4) 50 cm (5) 30 cm