 77777

Instructor(s): *Mueller/Saab*

PHYSICS DEPARTMENT

PHY 2048 Final Exam December 12, 2009

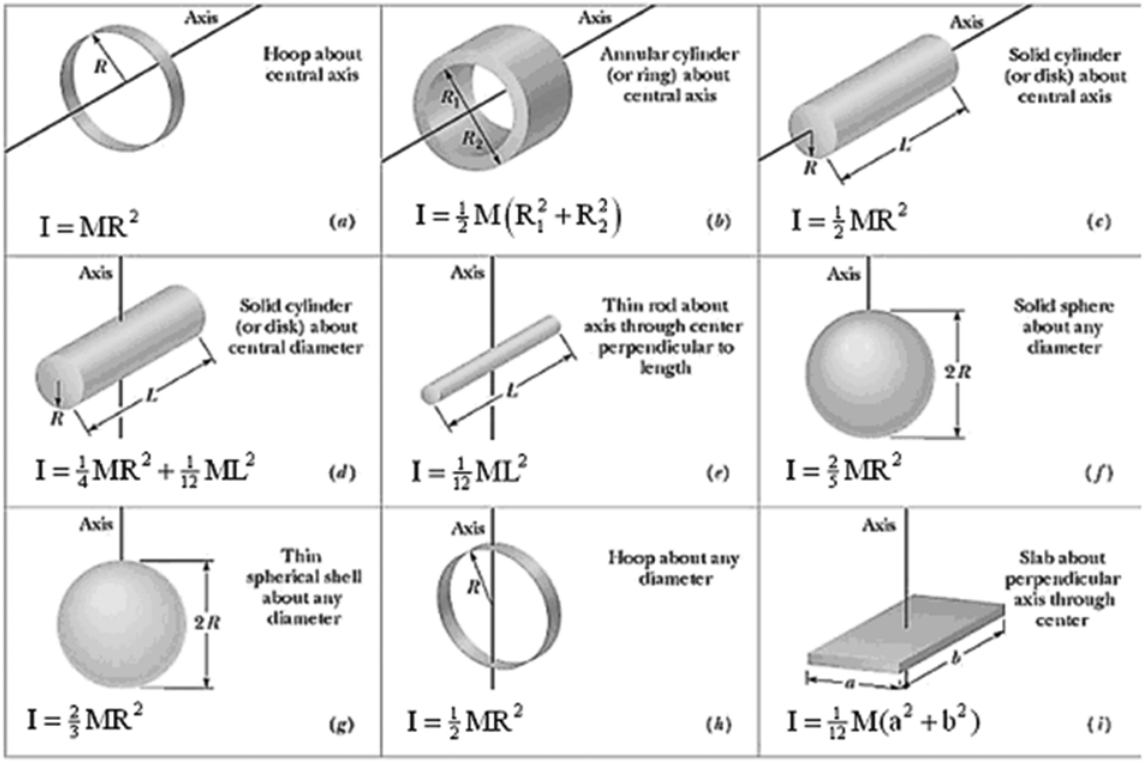
Name (print, last first): _____ Signature: _____

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 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 $g = 9.80$ m/s^2

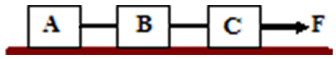


 77777

1. A motorist drives along a straight road at a constant speed of 60 m/s. At time $t = 0$ she passes a parked motorcycle police officer. The officer takes off after her at $t = 0$ and accelerates according to the formula $a(t) = bt$, where t is the time and b is a positive constant. What is the speed of the police officer when he reaches the motorist?

   (1) 180 m/s (2) 240 m/s (3) 160 m/s (4) 120 m/s (5) need to know b

2. Three blocks (A,B,C), each having mass $M_A = M$, $M_B = 2M$, $M_C = 3M$ 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?

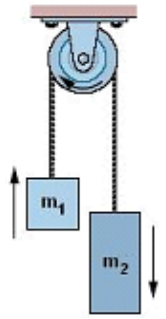


   (1) $F/3$ (2) $F/2$ (3) $2F/3$ (4) zero (5) F

3. A particle moves along the x axis under the influence of a conservative force. The potential energy is given by $U(x) = A(x-b)^2$, where x is position of the particle and A and b are positive constants. If the particle has a kinetic energy of Ab^2 when it is at $x = b$, what is the kinetic energy of the particle at $x = 0$?

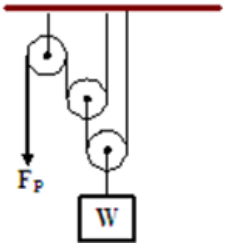
   (1) 0 (2) Ab^2 (3) $2Ab^2$ (4) $A(1-b)^2$ (5) need to know the mass of the particle

4. The figure shows two blocks attached by a massless rope around a pulley. The pulley has radius R and rotates on a frictionless horizontal axis through its center with moment of inertia $I = MR^2$. If $m_2 = 3M$ and $m_1 = 2M$, what is the magnitude of the acceleration of the mass m_2 when it is released from rest?



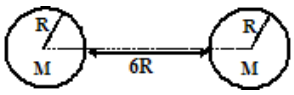
   (1) $g/6$
   (2) $g/4$
   (3) $g/3$
   (4) $2g/3$
   (5) $g/2$

5. 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

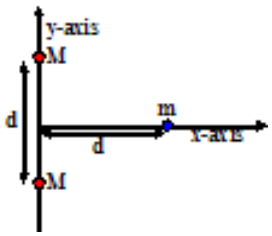
6. Two solid spheres with radius R and uniform mass density have equal mass M. As shown in the figure, they are released from rest a distance $6R$ apart and are attracted toward each other due to the gravitational force. What is the sum of the kinetic energies of the two spheres when they collide?



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

 77777

7. Two point masses with mass M are located on the y-axis a distance d apart (at $y = \pm d/2$) as shown in the figure. A third point mass with mass $m = 5\sqrt{5}M$ 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 two masses?

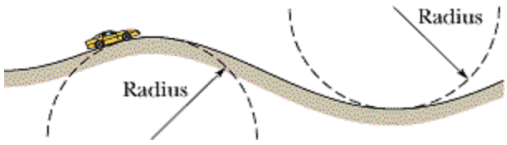


(1) $16GM^2/d^2$ (2) GM^2/d^2 (3) $8GM^2/d^2$ (4) $4GM^2/d^2$ (5) $2GM^2/d^2$

8. A boy whirls a 0.25-kg stone in a horizontal circle of radius 1.0 m and at height 2.0 m above level ground. The string breaks, and the stone flies off horizontally and strikes the ground after traveling a horizontal distance D. If the tension in the string was 9.8 N when it broke, what is the distance D?

(1) 4 m (2) 2 m (3) 16 m (4) 3 m (5) 9 m

9. In the figure, a car is driven at speed v_1 over a circular hill and then into a circular valley with the same radius, but with speed v_2. At the top of the hill, the normal force on the driver from the car seat is zero and the driver's mass is M. If $v_2 = 2v_1$, what is the magnitude of the normal force on the driver from the seat when the car passes through the bottom of the valley?

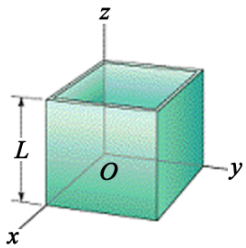


(1) 5 Mg (2) 2 Mg (3) Mg (4) 0.5 Mg (5) zero

10. A particle starts from rest at time $t = 0$ and moves along the x axis. If the net force on it is proportional to the time t, its kinetic energy is proportional to:

(1) t^4 (2) t (3) t^2 (4) $1/t^2$ (5) none of these answers

11. The figure shows a cubical box with each side consisting of a uniform metal plate of negligible thickness. Each of the four sides have mass, M, and the bottom has mass $2M$. The box is open at the top (at $z = L$) and has edge length L. What is the z-coordinate of the center-of-mass?

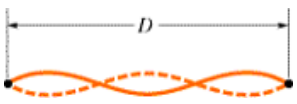


(1) $z = L/3$ (2) $z = L/2$ (3) $z = L/4$ (4) $z = L/6$ (5) $z = 2L/3$

12. 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

13. 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

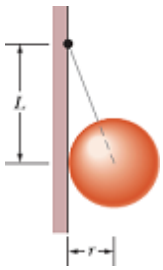
14. The velocity of an object is given as a function of time by $v(t) = 4t - 3t^2$, where v is in m/s and t is in seconds. If the object is at $x = 0$ at $t = 0$, where is it at time $t = 2$ s?

(1) $x = 0$ m (2) $x = -2$ m (3) $x = 2$ m (4) $x = 4$ m (5) $x = 16$ m

15. Near the surface of the Earth, a car is traveling at a constant speed v around a flat circular race track with a radius of 50 m. If the coefficients of kinetic and static friction between the car's tires and the road are $\mu_k = 0.1$, $\mu_s = 0.4$, respectively, what is the maximum speed the car can travel without slipping?

(1) 14 m/s (2) 28 m/s (3) 196 m/s (4) 22 m/s (5) 7 m/s

16. In the figure, a uniform sphere with a weight of 4 N and radius r is held in place by a massless rope attached to a frictionless wall a distance L above the center of the sphere. If $r = 3L/4$ what is the force on the sphere from the wall?



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

17. A projectile is fired straight upward from Earth's surface with a speed that is half the escape speed. If R is the radius of Earth, the highest altitude reached, measured from the surface, is:

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

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 400 Hz toward an approaching truck. The waves sent out by the detector are reflected off the truck and then are received back at the detector. If the frequency of the waves received back at the detector is 500 Hz, what is the speed of the truck? (Take the speed of sound to be 343 m/s.)

(1) 38.1 m/s (2) 19.1 m/s (3) 68.6 m/s (4) 85.8 m/s (5) 3.4 m/s

20. In the figure, a French submarine and a U.S. submarine move toward each other during maneuvers in motionless water in the North Atlantic. The French sub moves at speed $v_F = 100$ km/h, and the U.S. sub at $v_{US} = 200$ km/h. The French sub sends out a sonar signal (sound wave in water) at 1,000 Hz. Sonar waves travel at 5000 km/h. What frequency is detected by the French sub in the signal reflected back to it by the U.S. sub?

(1) 1,127.6 Hz (2) 1,061.2 Hz (3) 1,062.5 Hz (4) 1,128.9 Hz (5) 1,231.4 Hz