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Instructor(s): *Matcheva/Sabin*

PHYSICS DEPARTMENT

PHY 2048 | Final Exam | April 24, 2010

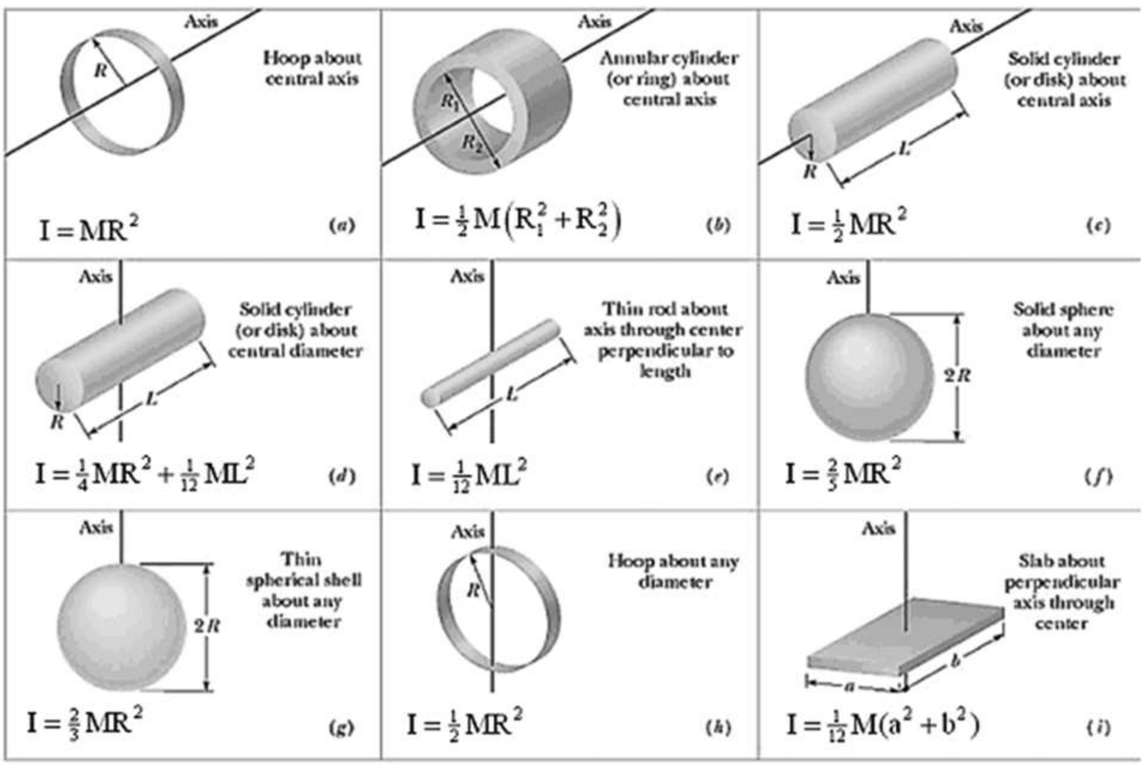
Name (print, last first): ______________________ Signature: ______________________

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



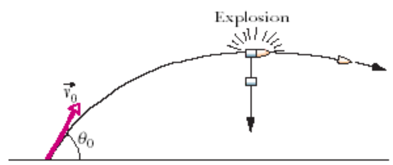
1. A motorist is driving along a straight road at a constant speed of 60 m/s. At time $t = 0$ she passes a parked motorcycle police officer and begins to accelerate at a constant acceleration a. The officer takes off after her at $t = 0$ and accelerates at a constant acceleration of $2a$. What is the speed of the police officer when he reaches the motorist?

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

2. If $\vec{A} \cdot \vec{B} = -|\vec{A} \times \vec{B}|$ and neither $\vec{A}$ or $\vec{B}$ is zero, then the angle between them is:

(1) 135° (2) 45° (3) 0° (4) 180° (5) 150°

3. Near the surface of the Earth, a shell with mass M is shot with an initial velocity $\vec{v}_0$, at an angle of θ_0 with the horizontal as shown in the figure. At the top of the trajectory, the shell explodes into two fragments with mass m_1 and m_2 ($M = m_1 + m_2$). One fragment (mass m_1), whose speed immediately after the explosion is zero, falls vertically and lands a horizontal distance d from the gun. Assuming that the terrain is level and that air drag is negligible, if the mass m_2 lands a horizontal distance of $5d$ from the gun, what is the mass m_2?

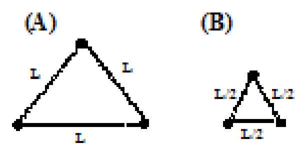


(1) $M/4$ (2) $M/2$ (3) $2M/3$ (4) $3M/4$ (5) $M/3$

4. A solid uniform cylinder with mass M and radius R rolls without sliding along the floor. What is the ratio of its rotational kinetic energy about the rotation axis through its center-of-mass to its translational kinetic energy (*i.e.,* rotational/ translational)?

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

5. Three point particles with equal mass, m, form an equilateral triangle with sides of length L as shown by (A) in the figure. If the particles are moved closer together to form an equilateral triangle with sides of length $L/2$ as shown in (B), what is the change in the gravitational potential energy of the three-particle system, $U_B - U_A$?



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

6. Suppose that you release a small metal ball from rest at the surface of a deep pool of water (with density ρ_{water}) near the surface of the Earth. If the density of the ball is four times the density of water (*i.e.,* $\rho_{\text{ball}} = 4\rho_{\text{water}}$) and if it takes the ball 2 seconds to reach the bottom of the pool, how deep is the pool of water?

(1) 14.7 m (2) 32.9 m (3) 29.4 m (4) 9.8 m (5) 4.9 m

7. A simple pendulum has a length L. If its period is T when it is on the surface of the Earth (gravitational acceleration $= g$), what is its period when it is on the surface of a planet with gravitational acceleration equal to $g/4$?

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

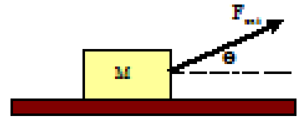
8. A transverse wave on a string moves according to $y(x,t) = A\sin(kx + \omega t)$, where $A = 0.5$ m, $k = \pi/(4m)$, and $\omega = 4\pi/s$. What is the transverse velocity of a point on the string at $x = 4$ m at $t = 1$ s?

(1) -6.28 m/s (2) 6.28 m/s (3) 0 m/s (4) -3.14 m/s (5) 3.14 m/s

9. A block of wood has a mass of 4 kg and density of 600 kg/m^3. It is loaded on top with lead (density = 11400 kg/m^3) so that the block of wood will float in water with 90% of its volume submerged. What is the mass of the lead if the water density is 1000 kg/m^3?

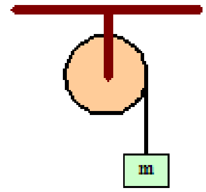
(1) 2 kg (2) 4 kg (3) 1 kg (4) 0.5 kg (5) 6 kg

10. A block of mass M slides along the floor while an external force F_{ext} is applied at an upward angle θ. If the coefficient of kinetic friction between the block and the floor is 0.1763, what angle θ gives the maximum value of the blocks acceleration (while still keeping the block on the table)?



(1) 10° (2) 45° (3) 30° (4) 20° (5) 0°

11. A block of mass m is attached to a cord that is wrapped around the rim of a flywheel of radius R and hangs vertically, as shown. The rotational inertia of the flywheel is $I = MR^2/2$. If, when the block is released and the cord unwinds, the magnitude of the acceleration of the block is equal to $g/2$, what is the mass m of the block?



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

12. The sound intensity 5.0 m from an isotropically radiating point source is 0.50 W/m^2. What is the sound intensity 2.5 m from the same point source?

(1) 2 W/m^2 (2) 1 W/m^2 (3) 4 W/m^2 (4) 3 W/m^2 (5) 8 W/m^2

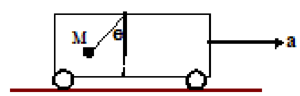
13. The coefficient of static friction between a solid spherical ball with radius R and a horizontal floor is 0.40. What is the magnitude of the maximum acceleration the ball can have without sliding?

(1) g (2) 0.1g (3) 0.2g (4) 0.4g (5) 0.8g

14. A satellite of mass M moves in a circular orbit of radius R around the Earth. If the magnitude of its angular momentum is L, what is its kinetic energy?

(1) $\dfrac{L^2}{2MR^2}$ (2) $\dfrac{2L^2}{MR^2}$ (3) $\dfrac{L^2}{MR^2}$ (4) $\dfrac{L}{R}$ (5) $\dfrac{L^2}{R^2}$

15. Consider a mass M suspended by a very light string from the ceiling of a railway car near the surface of the Earth. The car has a constant acceleration of $a = \sqrt{3}g$ as shown in the figure, causing the mass to hang at an angle θ with the vertical. What is the angle θ?

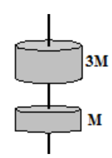


(1) 60° (2) 30° (3) 45° (4) 10° (5) 20°

16. A particle with a mass of 0.5 kg is travelling at a constant velocity in the x-y plane (*i.e.*, $v_z = 0$). If the magnitude of its angular momentum about the origin is 6 J·s when the particle is at the point P = (x,y) = (4 m, 0), and it is equal to 8 J·s when the particle is at the point P = (x,y) = (0, 4 m), what is its speed?

(1) 5 m/s (2) 10 m/s (3) 4 m/s (4) 12 m/s (5) 2.5 m/s

17. Two uniform disks have masses M and $3M$ and the same radius R. They are mounted on the same vertical axis with frictionless bearings as shown in the figure. The upper disk is given an initial angular velocity ω_0 and released to fall on the lower disk, which is initially at rest. Friction between the disk surfaces cause them to rotate together with a common rotational speed ω. What is ω?



(1) $3\omega_0/4$ (2) $\omega_0/4$ (3) $\omega_0/2$ (4) ω_0 (5) $2\omega_0/3$

18. A low flying aircraft skims the ground at a speed of 200 m/s as it approaches a stationary observer. A loud horn whose wavelength at rest is 85 cm is carried on the plane. What frequency does the ground observer hear if the speed of sound is 340 m/s?

(1) 971 Hz (2) 635 Hz (3) 680 Hz (4) 252 Hz (5) 400 Hz

19. An ambulance with its siren on overtakes a moving car. When the ambulance approaches the car, the driver of the car hears the siren with frequency 1200 Hz. What frequency will the driver of the car hear after the ambulance passes him, if the ambulance moves at a constant speed of 20 m/s and the car moves at 10 m/s in the same direction. Take the speed of sound to be 320 m/s.

(1) 1127 Hz (2) 995 Hz (3) 1059 Hz (4) 1091 Hz (5) 1161 Hz

20. (bonus problem) The figure shows three 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 $d = \lambda/3$?

(1) 0 (2) s_m (3) $2s_m$ (4) $3s_m$ (5) $0.5s_m$