Instructor(s): *Mueller/Qiu*

PHYSICS DEPARTMENT

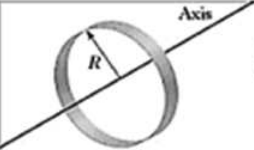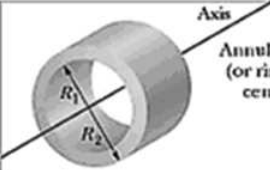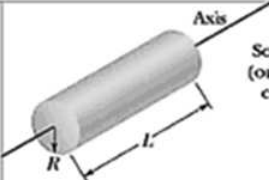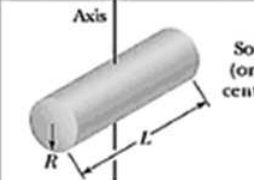PHY2053   Exam 2   November 16, 2010
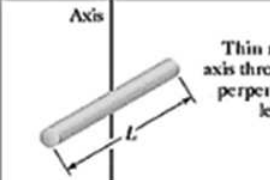
Name (print, last first): _____   Signature: _____

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.
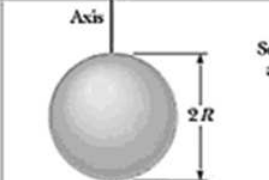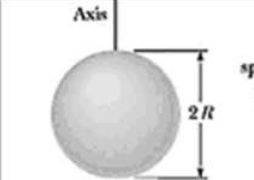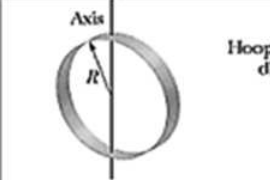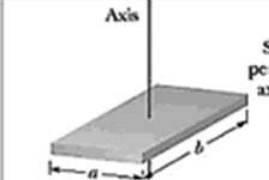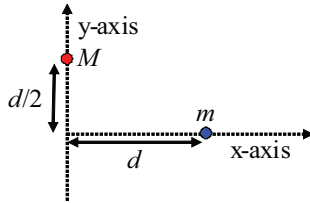
(2) Print your name on this sheet and sign it also.

(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 <u>blue</u> or <u>black</u> 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. If you believe that no listed answer is correct, leave the form blank.**

(6) Hand in the answer sheet separately.

Use $g = 9.80$ m/s^2

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1. An angular speed of 1 rad/s corresponds to about:

(1) 9.55 rev/min   (2) 60 rev/min   (3) 30 rev/min   (4) 19.1 rev/min   (5) 0.159 rev/min

2. A disk rotates about its central axis starting from rest at $t = 0$ and accelerates with constant angular acceleration. At one time it is rotating at 4 rev/s; 60 revolutions later, its angular speed is 16 rev/s. Starting at $t = 0$, what is the time required to complete 64 revolutions?

(1) 8 s   (2) 16 s   (3) 4 s   (4) 32 s   (5) 24 s

3. An astronaut is being tested in a centrifuge. The centrifuge has a radius R and, in starting from rest at $t = 0$, rotates according to $\theta(t) = (0.5 \text{ rad/s}^2) \, t^2$. At what time $t > 0$ is the magnitude of the tangential acceleration equal to the magnitude of the radial acceleration (*i.e.,* centripetal acceleration)?

(1) $t = 1$ s   (2) $t = 2$ s   (3) $t = 0.5$ s   (4) never   (5) need to know the radius R

4. When water freezes, it expands about nine percent. If you store water in a closed compartment like an engine block in your car and let it freeze, how much pressure would the water create? The bulk modulus of ice is 2×10^9 Pa and 1 atm $= 10^5$ Pa.

(1) 1800 atm   (2) 900 atm   (3) 9 atm   (4) 270 atm   (5) 2700 atm

5. 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 from 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

6. If the mass of the Sun is M_S and the mass of the Earth is M_E, and if F_1 is the magnitude of the gravitational force exerted on the Sun by Earth and F_2 is the magnitude of the force exerted on Earth by the Sun, then the ratio F_1/F_2 is:

(1) 1   (2) M_E/M_S (3) $\sqrt{M_E/M_S}$ (4) M_S/M_E (5) $\sqrt{M_S/M_E}$

7. 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) $2GM^2/d^2$

8. 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) $x = d/2$

9. 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 of the Earth, is:

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

10. A solid cylinder having a mass of 2 kg can rotate about its central axis as shown in the figure. Forces are applied as shown with $F_1 = 3.0$ N, $F_2 = 1.0$ N, $F_3 = 8.0$ N, and $F_4 = 10.0$ N. Also, $r = 5.0$ cm and $R = 20.0$ cm. Taking the clockwise direction to be negative, find the angular acceleration of the cylinder.
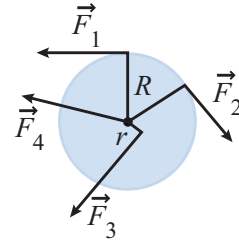
(1) 0 rad/s^2
(2) 20.0 rad/s^2
(3) -20.0 rad/s^2
(4) 40.0 rad/s^2
(5) -40.0 rad/s^2

11. A cylinder with mass M and radius R rolls without sliding along the floor. If its translational kinetic energy is three times greater than its rotational kinetic energy about the rotation axis through its center of mass (*i.e.*, the central axis of the cylinder), what is its moment of inertia about the central axis?

(1) $MR^2/3$ (2) $MR^2/2$ (3) $2MR^2/5$ (4) MR^2 (5) $2MR^2/3$

12. Three identical, uniform rods have forces acting in directions and at locations indicated in the figure. The forces all have the same magnitude. Which of the rods could be in static equilibrium if an additional force of the same magnitude were applied somewhere to the uniform rod?
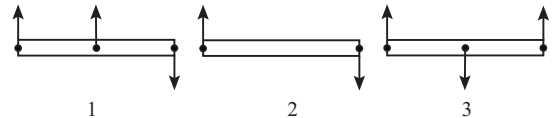
(1) Only 3   (2) Only 1   (3) Only 2   (4) Only 1 and 2   (5) All three

13. 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

14. 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) 200 N·m
(5) 75 N·m
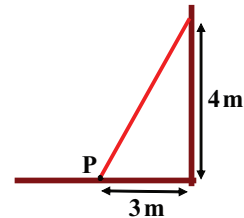
15. A turntable has a moment of inertia of 3.0×10^{-2} kg·m^2 and spins freely on a frictionless bearing at 25 rev/min. A 0.30-kg ball of putty is dropped vertically on the turntable and sticks at a point 0.10 m from the center. By what factor does the kinetic energy of the system change after the putty is dropped onto the turntable?

(1) 0.91   (2) 1.0   (3) 0.82   (4) 1.1   (5) 1.5

16. A mouse of mass $M/6$ lies on the rim of a solid uniform disk of mass M that can rotate freely about its center like a merry-go-round. Initially the mouse and disk rotate together with an angular velocity of ω. If the mouse walks to a new position that is at the center of the disk, what is the new angular velocity of the mouse-disk system?

(1) $4\omega/3$ (2) ω (3) $\omega/2$ (4) 2ω (5) $3\omega/2$

17. 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

18. Two identical blocks of ice float in water as shown in the figure. Which of the following statements is true?
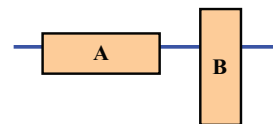
    (1) The two blocks displace equal volumes of water since they have the same weight.
    (2) Block B displaces a greater volume of water since the pressure acts on a smaller bottom area.
    (3) Block A displaces a greater volume of water since the pressure is less on its bottom.
    (4) Block B displaces 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.

19. 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) $\frac{2}{3}\rho_{\text{water}}$

20. 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 $\frac{1}{3}$ the density of water (*i.e.*, $\rho_{\text{ball}} = \frac{1}{3}\rho_{\text{water}}$), 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