University Physics I

Homework Set 13

1. Find the angular speed of the Earth's rotation about its axis in a day.
2. The angular position of a swinging door is described by $\theta = 5.00 + 10.0t + 2.00t^2$, where θ is in radians and t is in seconds, during a certain time interval. Determine:
    a. The angular position, angular speed, and angular acceleration at $t = 0$
    b. The angular position, angular speed, and angular acceleration at $t = 3.00$ s
3. An airplane propeller is rotating at 1900 *rpm* (*rev*/*min*).
    a. Compute the propeller's angular velocity in *rad*/*s*
    b. How many seconds does it take for the propeller to turn through 37°?
4. A fan blade rotates with angular velocity given by $\omega_z(t) = (5.00\ rad/s) - (0.800\ rad/s^3)\ t^2$. Calculate:
    a. The angular acceleration as a function of time, $\alpha_z(t)$.
    b. The instantaneous angular acceleration α_z at $t = 3.00$ s
    c. The average angular acceleration $\bar{\alpha}_z$ for the time interval $t = 0$ to 3.00 s
5. A vinyl record plays at 33.3 *rpm*. Assume it takes 5.00 *s* to reach this full speed, starting from rest.
    a. What is its angular acceleration during the 5.00 *s*?
    b. How many revolutions does the record make before reaching its final angular speed?
6. Mars orbits the Sun at a mean distance of 228 million *km*, in a period of 687 *days*. The Earth orbits the Sun at a mean distance of 149.6 million *km*, in a period of 365.25 *days*. Suppose Earth and Mars were positioned such that the Earth lay on a straight line between the Sun and Mars. Designate this initial Sun-Mars line as the *x*-axis and starting point for the rotational motion of both planets. Exactly 365.25 *days* later, when the Earth has completed one full orbit, what is the difference in the angle (*in radians*) between the Sun-Earth line (*x*-axis) and the current Sun-Mars line?
7. A high-speed flywheel in a motor is spinning at 500 *rpm* when a power failure suddenly occurs. The flywheel has a mass of 40.0 *kg* and diameter 75.0 *cm*. The power is off for 30.0 s, and during that time the flywheel slows due to friction in its axle bearings. During the time the power is off, the flywheel makes 200 complete revolutions.

    a. At what rate (in *rpm*) is the flywheel spinning when the power comes back on?
    b. If the power didn't come back on, how long would it take the flywheel to stop?
    c. How many revolutions would it make during this time?
8. A wheel starts from rest and rotates with constant angular acceleration to reach an angular speed of 12.0 *rad*/*s* in 3.00 s. Find:
    a. The magnitude of the angular acceleration of the wheel
    b. The angle (*in radians*) through which it rotates during this time interval.
9. A rotating wheel requires 3.00 *s* to rotate through 37.0 revolutions. Its angular speed at the end of the 3.00 *s* interval is 98.0 *rad*/*s*. What is the constant angular acceleration of the wheel?

10. A car accelerates uniformly from rest and reaches a speed of 22.0 *m*/*s* in 9.00 *s*. Assuming the diameter of the tires are 58.0 *cm*,
    a. Find the number of revolutions the tire makes during this motion, assuming no slipping.
    b. What is the final angular speed of the tire in *rev*/*s*?

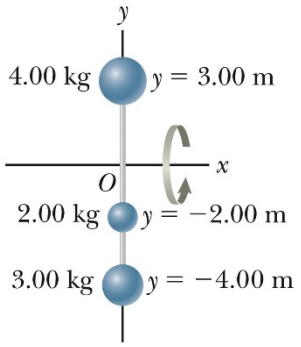
11. The rear wheels of a sports cars have a radius of 46.65 *cm*. The sports car goes from rest to a speed of 29.13 *m*/*s* in 3.945 *s* with a constant acceleration. What is the angular acceleration of the rear wheels, assuming no slipping?

12. A disk with a radius of 8.00 *cm* rotates at a constant rate of 1200 *rpm* about a central axis. Determine:
    a. Its angular speed in *rad*/*s*
    b. The tangential speed at a point 3.00 *cm* from its center
    c. The centripetal acceleration of a point on the rim
    d. The total distance a point on the rim moves in 2.00 *s*

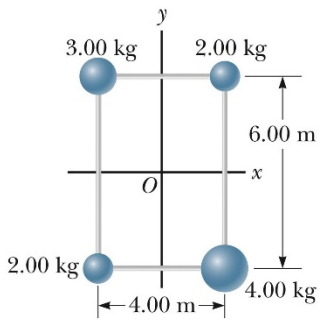
13. A compact disc (CD) stores music in a coded pattern of tiny pits 10^{-7} *m* deep. The pits are arranged in a track that spirals outward toward the rim of the disc; the inner and outer radii of the spiral are 25.0 *mm* and 58.0 *mm*, respectively. As the disc spins inside a CD player, the track is scanned by a laser at a constant linear speed of 1.25 *m*/*s*.
    a. What is the angular speed of the CD when the innermost part of the track is scanned?
    b. What is the angular speed of the CD when the outermost part of the track is scanned?
    c. If the maximum playing time of a CD is 74.0 *min*, what would be the length of the track be (*in km*) if stretched into a straight line?
    d. What is the average angular acceleration during the entire 74 *min* of playing time?

14. Determine the moment of inertia for three children weighing 60.0 *lbs*, 45 *lbs*, and 80 *lbs* sitting at different points on the edge of a rotating merry-go-round, which has a radius of 12.0 *ft*. Ignore the merry-go-round and treat their masses as point-masses.

15. Rigid rods of negligible mass lying along the *y*-axis connect three particles as shown in the figure at right. The system rotates about the *x*-axis with an angular speed of 2.00 *rad*/*s*. Find:
    a. The moment of inertia about the *x*-axis
    b. The total rotational kinetic energy
    c. The tangential speed of each particle

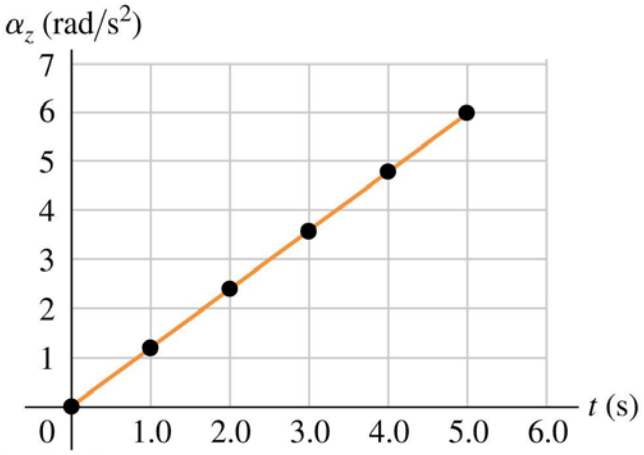


16. Four particle connected by rigid rods of negligible mass are centered about the origin in a rectangular fashion as shown at right. The origin is the center of the rectangle. The system rotates in the *xy* plane about the *z*-axis with an angular speed of 6.00 *rad*/*s*. Calculate:
    a. The moment of inertia of the system about the *z*-axis
    b. The rotational kinetic energy of the system.



17. A uniform solid cylinder of mass $M = 5.00\ kg$ is rolling without slipping along a horizontal surface. The velocity of its center of mass is 30.0 *m*/*s*. Calculate its total kinetic energy.

18. A technician is testing a computer-controlled, variable-speed motor. She attaches a thin disk to the motor shaft, with the shaft at the center for the disk. The disk starts from rest, and sensors attached to the motor shaft measure the angular acceleration α_z of the shaft as a function of time. The results from one test run are listed below.



a. Through how many revolutions has the disk turned in the first 5.0 *s*?

Hint: Find the slope of the graph to get $\alpha_z(t)$, then integrate to get $\omega(t)$. Integrate again to get $\theta(t)$.

b. What is the angular velocity, in *rad*/*s*, of the disk at 5.0 *s*?

c. What is the angular velocity when it has turned through 2 *rev*?