Practice Problems for Physics 111 Common Exam 3, Spring 2025
Chapters 8, 9

(Exclude problems 5, 7, 15, 17, and 18. You may use them as study material for the final exam.)

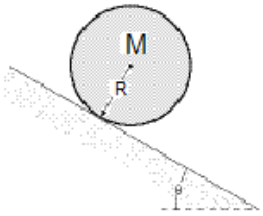
1. A 3.0-kg ball with an initial velocity of (4**i** + 3**j**) m/s collides with a wall and rebounds with a velocity of (–4**i** + 3**j**) m/s. What is the impulse exerted on the ball by the wall?

2. An 80-g particle moving with an initial speed of 50 m/s in the positive *x* direction strikes and sticks to a 60-g particle moving 50 m/s in the positive *y* direction. What is the magnitude of the velocity of the composite system after the collision?

3.A merry-go-round rotates from rest with an angular acceleration of 1.56 rad/s^2. How long does it take to rotate through the first 2 rev?

4. A wheel, with radius R = 0.5 m, initially has an angular velocity of 2.5 rev/s, and is slowing down at a rate of 2 rad/s^2. By the time it stops spinning about its center, what distance will a point on the outer rim have traveled?

5. A solid ball of mass of 0.25 kg rolls without slipping 4 m down an incline that makes an angle of 25^0 a with a horizontal. If it starts from rest, what is its kinetic energy at the bottom of the incline ?



6. A basketball is rolling without slipping along a horizontal surface with total kinetic energy 20 J. How much energy (in Joules) is due to the rotational kinetic energy of the ball about its center of mass? Basketballs are hollow shells. ($I = 2/3\ mr^2$.)

7. A hollow, spherical shell with mass 2.00 kg rolls without slipping down a 38.0° slope. Find the acceleration, the friction force, and the minimum coefficient of static friction needed to prevent slipping.

8. A 10-kilogram bicycle wheel is rotating at 60 rev/min. It is essentially a thin hoop with a radius of 0.5 meters and a rotational inertia $I = mr^2$. How much work must be done to bring it to a stop?

9. You throw a ball with a mass of 0.40 kg against a brick wall. It is moving horizontally to the left at 30 m/s when it hits the wall; it rebounds horizontally to the right at 20 m/s. Find the impulse of the net external force on the ball during its collision with the wall.

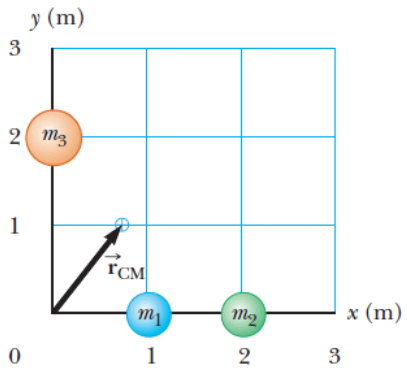
10. In the previous problem, if the ball is in contact with the wall for 0.010 s, find the average horizontal force that the wall exerts on the ball during the impact.

11. Two small spheres, each with mass 0.0200 kg, are connected by a light 1.60 m long rod. The spheres rotate about an axis that is perpendicular to the rod at its center. What is the angular speed in rad/s of the spheres if the total kinetic energy is 1.28 J?

12. The mass of Sun is 2.0×10^{30} kg and the mass of Earth is 6.0×10^{24} kg. If the distance between Sun and Earth is 1.50×10^{8} km, the center of mass of the Sun-Earth system is located at the following distance from the center of the Sun (use the system of coordinates with the origin at the center of the Sun, and the Earth lies on the x-axis):

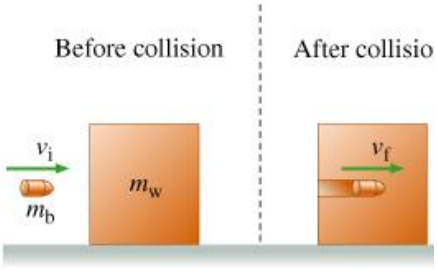
13. A playground merry-go-round has a radius of 3.0 m and a rotational inertia of 600 kg × m^2 . It is initially spinning at 0.80 rad/s when a 20-kg child crawls from the center to the rim. When the child reaches the rim the angular velocity of the merry-go-round is:

14. A system consists of three particles with masses $m_1 = m_2 = 1.0$ kg and $m_3 = 2.0$ kg. located as shown in Figure. Find the coordinates of the center of mass of the system.



15. One force acting on a machine part is $\vec{F} = (-5.00N)\hat{\imath} + (4.00N)\hat{\jmath}$. The vector from the origin to the point where the force is applied is s $\vec{r} = (-0.450m)\hat{\imath} + (0.150m)\hat{\jmath}$. (a) In a sketch, show $\vec{r}$, $\vec{F}$ and the origin. (b) Use the right-hand rule to determine the direction of the torque. (c) Calculate the vector torque for an axis at the origin produced by this force. Verify that the direction of the torque is the same as you obtained in part (b).

16. In order to find the speed of a fast bullet, it is fired into a 4.0 kg wooden block on a horizontal surface. The bullet gets stuck in the block which starts moving with the speed of V_f=2.5 m/s. Find the original speed of the bullet V_i if its mass is 7.54 gram.



17. A 6 kg particle with velocity **v** = -2**i** + 5**j** is at x = 30 m, y = 45 m. What is the angular momentum of the particle about the origin?

18. A wheel is rotating freely at angular speed 900 rev/min on a shaft whose rotational inertia is negligible. A second wheel, initially at rest and with three times the rotational inertia of the first, is suddenly coupled to the same shaft. What is the angular speed of the resultant combination of the shaft and two wheels?

19. At $t = 0$ the current to a dc electric motor is reversed, resulting in an angular displacement of the motor shaft given by $\boldsymbol{\theta(t) = (250\ rad/s)t - (20.0\ rad/s^2)t^2 - (1.50\ rad/s^3)t^3}$. (a) At what time is the angular velocity of the motor shaft zero? (b) Calculate the angular acceleration at the instant that the motor shaft has zero angular velocity. (c) How many revolutions does the motor shaft turn through between the time when the current is reversed and the instant when the angular velocity is zero? (d) How fast was the motor shaft rotating at $t = 0$, when the current was reversed? (e) Calculate the average angular velocity for the time period from $t = 0$ to the time calculated in part (a).

Answer Key

1. **–24i N·s**
2. **36 m/s**
3. **4 s**
4. **31 m**
5. **4 J**
6. **8**
7. **3.62 m/s^2, 4.83 N, 0.313**
8. **49.35 J**
9. **20 N·s**
10. **2000 N**
11. **10**
12. **450 km**
13. **0.61 rad/s**
14. **x_{cm}=0.75 m, y_{cm}= 1.0 m**
15. **$\vec{\tau} = (-1.05)\hat{k}$**
16. **1330**
17. **1440k**
18. **225 rev/min**
19. **(a) 4.23s; (b) -78.1rad/s2; (c) 586rad= 93.3 rev; (d) 250 rad/s; (e) 138 rad/s**