Practice Problems for Physics 111 Common Exam 3, Spring 2023
Chapter 8, 9, 10

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?

A) +24**i** N s
B) –24**i** N s
C) +18**j** N s
D) –18**j** N s
E) +8.0**i** N s

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?

A) 36 m/s
B) 50 m/s
C) 75 m/s
D) 86 m/s
E) 11 m/s

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?

A) 2 s
B) 4 s
C) 6 s
D) 8 s
E) 10 s

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?

A) 12 m
B) 18 m
C) 24 m
D) 31 m
E) 47 m

5. An electric motor can accelerate a 4-kg grinding wheel in a form of a solid disk of radius 0.2 m from rest to 75 rad/s in 15 s. Find the torque generated by the motor.

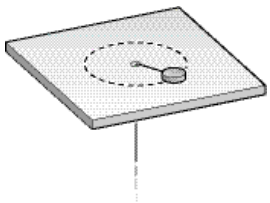
A) 0.05 N·m
B) 0.10 N·m
C) 0.20 N·m
D) 0.30 N·m
E) 0.40 N·m

6. A uniform cylinder of radius *R*, mass *M* , and length *L* rotates freely about a horizontal axis parallel and tangent to the cylinder, as shown below. The moment of inertia of the cylinder about this axis is

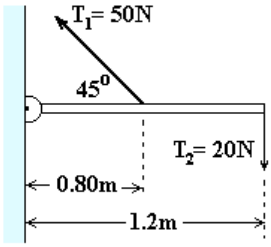
A) $\frac{1}{2}MR^2$.
B) $\frac{2}{3}MR^2$.
C) MR^2
D) $\frac{3}{2}MR^2$**.**
E) $\frac{7}{5}MR^2$.

7. A puck on a frictionless air hockey table has a mass of 0.5 kg and is attached to a cord passing through a hole in the surface as in the figure. The puck is revolving at a distance 2.0 m from the hole with an angular velocity of 0.40 rev/s. What is the kinetic energy of the puck?

A) 2.4 J
B) 4.8 J
C) 6.3 J
D) 12.6 J
E) 18.4 J



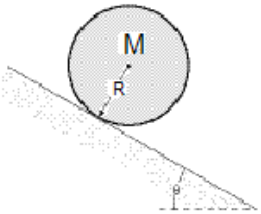
8. What is the magnitude of the net torque produced by two tension forces T_1 and T_2 about the hinge?



A) 4.3 Nm
B) 18.5 Nm
C) 28.7 Nm
D) 43.5 Nm
E) 52.3 Nm

9. 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 ?

A) 1 J
B) 2 J
C) 4 J
D) 6 J
E) 8 J

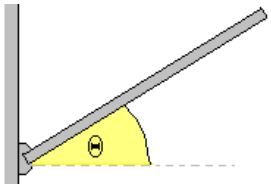


10. A basketball is rolling without slipping along a horizontal surface with total kinetic energy 20 J. How much energy (in Joules) is due to the rotational kinetic energy of the ball about its center of mass? Basketballs are hollow shells. ($I = 2/3\ mr^2$.)

A) 10
B) 8
C) 13.3
D) 4
E) 12

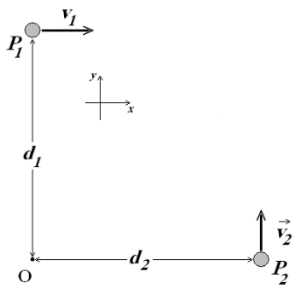
11. A thin uniform rod (length = 1.2 m, mass = 2.0 kg) is pivoted about a horizontal, frictionless pin through one end of the rod. The rod is released when it makes an angle of 25° with the horizontal. What is the angular acceleration of the rod at the instant it is released?

A) 11.1 rad/s^2
B) 7.4 rad/s^2
C) 8.4 rad/s^2
D) 5.9 rad/s^2
E) 6.5 rad/s



12. In the instant of the figure, two particles move in an *xy* plane. Particle P_1 has mass 2.5 kg and speed 4.2 m/s, and it is at distance d_1 =2.0 m from point *O*. Particle P_2 has mass 6.0 kg and speed 3.5 m/s, and it is at distance d_2 =1.5 m from point *O*. What are the magnitude (in kgm^2/s) and the direction of the net angular momentum of the two particles about O?

A) $\underline{\mathbf{L}} = -8\,\underline{\mathbf{i}} + 2\,\underline{\mathbf{j}}$
B) $\underline{\mathbf{L}} = -10.5\,\underline{\mathbf{k}}$
C) $\underline{\mathbf{L}} = 0$
D) $\underline{\mathbf{L}} = 52.5\,\underline{\mathbf{k}}$
E) $\underline{\mathbf{L}} = 10.5\underline{\mathbf{k}}$



13. 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).

Ans. $\vec{\boldsymbol{\tau}} = (-\mathbf{1.05})\hat{\boldsymbol{k}}$

14. A projectile is launched from the ground level with initial speed of 140 m/s at some angle to horizontal. What will be the speed of the projectile when it reaches elevation of 500 m (assume the launch angle is sufficient for the projectile to reach this elevation or higher; neglect air resistance). Hint: use energy conservation.

Ans. 100

15. 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?

Ans. 1440k

16. 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?

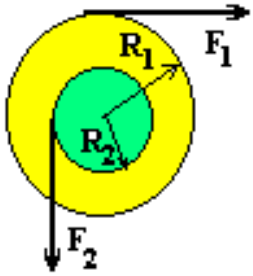
Ans. 225 rev/min

17. Two bodies, x and y, have equal kinetic energies. The mass of x is nine times that of y. The ratio of the momentum of y to that of x is:
Ans. **1:3**

18. 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?

Ans. 49.35 J.

Problems 21, 22, 23
A solid cylinder of mass M = 10kg is pivoted about a frictionless axis through the center. A rope wrapped around the outer radius R_1 = 1 m, exerts a force F_1 = 5 N to the right. A second rope wrapped around another section of radius R_2 = 0.5 m exerts a force F_2 = 6 N downward.



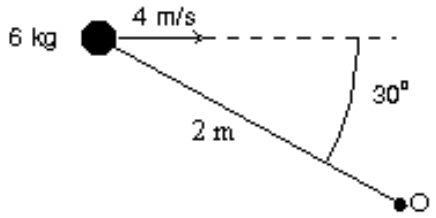
19. The angular acceleration of the cylinder is closest to:
Ans. -0.4rad/s^2

20. The angular velocity after first 5 seconds, if it starts from rest is closest to:
Ans. -2 rad/s

21. The number of rotations the disk rotates through in the first 5 seconds, if it starts from rest is closest to:
Ans. 0.8

22. A 6-kg particle moves to the right at 4 m/s as shown. Its angular momentum in kg $\times m^2/s^2$ about the point O is:

Ans.24



23. A figure skater goes into a spin, starting with her arms up and close to her body as shown. When she extends her arms horizontally sometime later:

Ans. her angular velocity decreases.

24. 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.

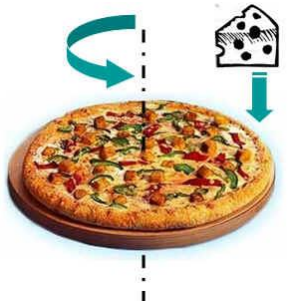
Ans. 20 N·s

25. 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.

Ans. 2000 N

26. A pizza together with its pan is rotating about a vertical axis through its center. Its rotational inertia **I = 2.0 kg.m^2** and radius **r** = **50 cm.** The initial angular speed is **4.0 rad/s**. A **1.0 kg** chunk of Mozzarella cheese is initially at rest over the disk. It drops vertically onto the pizza from above and sticks to the edge. What is the angular speed of the pizza after the cheese becomes stuck to it?

Ans. **3.56 rad/s**



27. 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:

Ans. 0.61 rad/s

28. 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.

Ans. x_{cm}=0.75 m, y_{cm}= 1.0 m