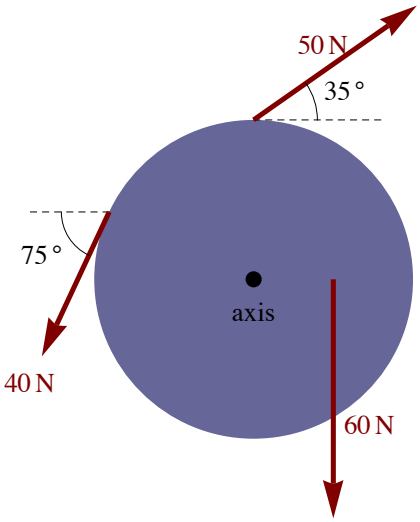
Chapter I - Problems

Blinn College - Physics 2425 - Terry Honan

Problem I.1

A uniform disk with a 12 kg mass and a 20 cm radius rotates about a perpendicular axis through the center. Three forces act on it as shown. The 50 N and 40 N forces act at the rim with the 40 N tangent to it, and the 60 N acts a distance of 10 cm from the axis as shown.

(a) What is the net torque on the disk?
(b) What is the angular acceleration of the disk?

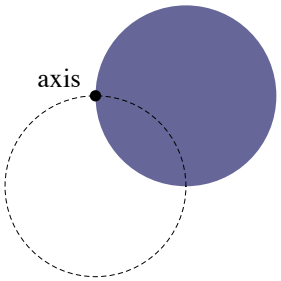


Problem I.2

Consider Atwood's Machine with a massive pulley. m_1 begins on the floor, m_2 is initially at a height d, and they are connected over a pulley with a moment of inertia I and radius r. As usual, take $m_2 > m_1$. What is the speed of m_2 when it hits the floor?

Problem I.3

A disk swings without friction about a perpendicular axis at its rim. It is released from a postion shown as a solid disk.
(a) What is the angular velocity of the disk when it swings through the bottom position, shown as dashed.
(b) What is the speed of the bottom point on the disk at the bottom position of the disk?
(c) Repeat parts (a) and (b) replacing the disk with a hoop.



Problem I.4

A pulley is a uniiform disk of mass M and radius R. It is in a vertical orientation with a horizontal axis. A string is attached to the rim of the pulley and wrapped many times around it. The free end of the string is connected to a hanging mass m. The hanging mass is released from rest from a height d above a floor.
(a) What is the tension in the string and what is the acceleration of the haning mass?
(b) Using kinematics find the speed of the mass when it hits the floor.
(c) Use conservation of energy to find the speed of the mass when it hits the floor.

Problem I.5

A 8 kg uniform solid cylinder rolls without slipping on a horizontal surface. When its speed is 10 m/s (the speed of the center of mass) what are
(a) the translational kinetic energy,
(b) the rotational kinetic energy and
(c) the total kinetic energy.

Problem I.6

Consider a bowling ball of mass M. If it is a uniform sphere, then what is its total kinetic energy when it rolls down a lane with a linear speed of v. Give a value when $M = 4\,\text{kg}$ and $v = 10\,m/s$.

Problem I.7

$$\vec{A} = \left(-3\,\hat{x} + 4\,\hat{y}\right) \text{ and } \vec{B} = \left(2\,\hat{x} + 3\,\hat{y}\right)$$

Using the vectors $\vec{A}$ and $\vec{B}$ evaluate
(a) $\vec{A} \times \vec{B}$ and
(b) The angle between $\vec{A}$ and $\vec{B}$.

Problem I.8

If two vectors satisfy $\left\|\vec{A} \times \vec{B}\right\| = \vec{A} \cdot \vec{B}$ then what is the angle beween $\vec{A}$ and $\vec{B}$?

Problem I.9

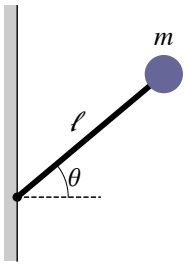
The position vector as a function of time for a 2 kg particle is given by $\vec{r}(t) = 6\,\hat{x} + 5\,t\,\hat{y}$ in SI units. What is the angular momentum as a function of time?

Problem I.10

A projectile is shot from the origin with an initial speed v_0 at an angle θ above horizontal.
(a) What is the angular momentum of the projectile at the origin?
(b) What is the angular momentum when at the highest position?
(c) What is the angular momentum just before it hits the level ground?
(d) What torque is responsible for this change in angular momentum?

Problem I.11

At $t = 0$ a ball of mass m is dropped from the top end of a rod of lenght ℓ at an angle of θ above horizontal, as shown. What is the angular momentum as a function of time about the base of the rod.



Problem I.12

A horizontal platter with moment of inertia I rotates without friction with an angular velocity ω_0. A mass m is dropped onto the platter. It lands and sticks to the platter a distance d from the axis.
(a) What is the angular velocity after the mass sticks to the platter?
(b) What is K_f / K_i, the ratio of the final kinetic energy to the initial kinetic energy?

Problem I.13

Junior stands at the rim of a stationary horizontal turntable. Junior starts to walk clockwise at a speed of $2\,m/s$ relative to the ground. The turntable has a radius of 3 m and a moment of inertia of $300\,\text{kg}\cdot m^2$. If Junior has a mass of 45 kg then what is the angular velocity and sense of rotation of the turntable while Junior is walking?

Problem I.14

A thin rod of mass M and length ℓ is free to rotate in a horizontal plane about an axis at one end without friction. A bullet of mass m is shot perpendicuarly into the rod, initially at rest. It hits and embeds in the rod a distance d from the axis. What is the final angular velocity of the rod after the bullet embeds?

Problem I.15

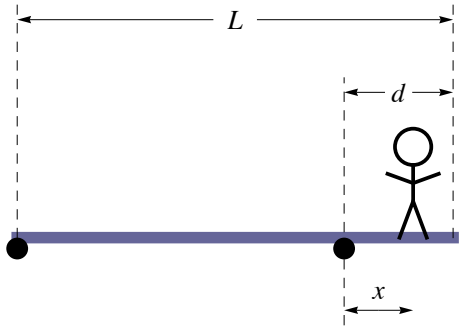
A person holds a baseball bat in a horizontal position with one hand with the hand at the base of the bat. The bat has a weight of 9 N and the center of mass is 55 cm from the hand. That is the force of the hand on the bat and what is the torque of the hand on the bat?

Problem I.16

A uniform ladder leans against a frictionless wall. The ladder makes an angle of 60° with the floor and the coefficient of static friction between the ladder and floor is 0.40. Suppose a painter whose mass is twice that of the ladder climbs the ladder. How far along the ladder can the painter climb without the base of the ladder slipping? Give your answer as a fraction of the length of the ladder.

Problem I.17

A scaffold with a length L and mass m_1 is supported at two positons, at the left end and a distance d from the right end as shown in red. A painter of mass m_2 stands a distance of x from the support on the right. If the painter stands too far to the right the scaffold will tilt and fall. What is the largest value of x where the painter can stand?



Problem I.18

The wheel base (the distance between axles) of a 1500 kg car is 3 m. If the center of mass of the car is 1.20 m behind the front axle, then what is the force on the ground of each wheel of the car?

Problem I.19

A sign consists of a uniform half circular disk. It is supported by two vertical ropes as shown. One is on the left side of the sign. The distance between the ropes is 2/3 the width of the sign. What fraction of the sign's weight is supported by each rope?