Chapter 1.1 - Vector Combination

The velocity of an airplane is 220 m/s in a direction 14° West of South. What are the components of the airplane's velocity?

An unknown force is directed 55 degrees above the +x direction. The y-component of this force is 32 Newtons. What is the magnitude of the unknown force?

Chapter 1.2 - Vector Combination

A hiker starts at his camp and moves the following distances while exploring his surroundings: 75.0 m north, 250 m east, 125 m at an angle 30.0 degrees north of east, and 150 m south. Find his resultant displacement from camp (take east as the positive x-direction and north as the positive-y direction). Answer with 3 SF.

Chapter 1.3 - Vector Combination

A commuter airplane starts from an airport and takes the following route: The plane first flies to city A, located 175 km away in a direction 30.0 degrees north of east. Next, it flies for 150 km in a direciton 20.0 degrees west of north to city B. Finally, the plane flies 190 km due west to city C. Find the magnitude and direction of the plane's displacement from the starting point to city C.

Chapter 2.1 - Speed and Velocity

Two boats start together and race across a 60-km wide lake and back. Boat A goes across at 60 km/hr and returns at 60 km/hr. Boat B goes across at 30 km/hr, and its crew, realizing how far behind it is getting, returns at 90 km/hr. Turnaround times are negligible, and the boat that completes the round trip first wins.

(a) Which boat wins and by how much? Or is it a tie?

(b) What is the average velocity of the winning boat?

Chapter 2.2 - Speed and Velocity

A person travels by car from one city to another with different constant speeds between pairs of cities. She drives for 30.0 min at 80.0 km/hr, 12.0 min at 100 km/hr, 45.0 min at 40.0 km/hr, and then she spends 15.0 min eating lunch and buying gas.

(a) Determine the average speed for the trip.

(b) Determine the distance between the initial and final cities along the route.

Chapter 2.3 - Speed and Velocity

A person takes a trip, driving with a constant speed of 89.5 km/hr, except for a 22.0 min rest stop. If the person's average speed is 77.8 km/hr,
(a) how much time is spent on the trip and
(b) how far does the person travel?

Runner A is initially 4.0 miles west of a flagpole and is running with a constant velocity of 6.0 mi/hr due east. Runner B is initially 3.0 miles east of the flagpole and is running with a constant velocity of 5.0 mi/hr due west. How far are the runners from the flagpole when they meet?

Chapter 2.4 - 1-d Motion with Constant Acceleration

A jet plane lands with a speed of 100 m/s and can decelerate at a maximum rate of -5.00 m/s^2 as it comes to rest.

(a) From the instant the plane touches the runway, what is the minimum time needed before it can come to rest?

(b) Can this plane land on a small tropical island where the runway is 0.800 km long?

A train is traveling down a straight track at 20 m/s when the engineer applies the brakes, resulting in an acceleration of -1.0 m/s^2 as long as the train is in motion. How far does the train move during a 40 second time interval starting at the instant the brakes are applied?

Chapter 2.5 - 1-d Motion with Constant Acceleration

To pass a physical education class at a university, a student must run 1.0 miles in 12 minutes. After running for 10 minutes, she still has 500 yards to go. If her maximum acceleration is 0.15 m/s^2, can she make it? Assuming she maintains a constant acceleration over the last part of her run.

Chapter 2.6 - Freely Falling Bodies

A ball is thrown directly downward with an initial speed of 8.00 m/s from a height of 30.0 meters.

(a) What is the velocity of the ball just before it hits the ground?

(b) After what time interval does it strike the ground?

(c) If the ball is initially thrown upward with a speed of 8.00 m/s, what is the velocity of the ball just before it hits the ground?

Chapter 2.7 - Freely Falling Bodies

A freely falling object, released from rest, requires 1.50 seconds to travel the last 30.0 meters before it hits the ground.

(a) Find the velocity of the object when it is 30.0 meters above the ground.

(b) Find the total distance the object travels during the fall.

Chapter 2.8 - Freely Falling Bodies

A model rocket is launched straight upward with an initial speed of 50.0 m/s. It accelerates with a constant upward acceleration of 2.00 m/s^2 until its engines stop at an altitude of 150 meters.

(a) Describe the motion of the rocket after its engines stop.
(b) What is the maximum height reached by the rocket?
(c) How long after liftoff does the rocket reach its maximum height?
(d) How long is the rocket in the air?

Chapter 3.1 - Motion with Constant Acceleration (2-d)

A student stands on the edge of a cliff and throws a stone horizontally over the edge with a speed of 18.0 m/s. The cliff is 50.0 meters above a flat, horizontal beach. If the base of the cliff is the origin,

(a) What are the coordinates of the initial position of the stone?
(b) What are the components of the initial velocity?
(c) How long after being released does the stone strike the beach below the cliff?
(d) How far from the base of the cliff does the stone strike the beach?
(e) What is the magnitude and direction of the final velocity of the stone in the instant before it hits the beach?

Chapter 3.2 - Motion with Constant Acceleration (2-d)

A place-kicker must kick a football from a point 36.0 meters (about 40 yards) from the field goal uprights. Half the crowd hopes the ball will clear the crossbar, which is 3.05 meters high. When kicked, the ball leaves the ground with a speed of 20.0 m/s at an angle of 53.0 degrees above the horizontal.

(a) By how much does the ball clear or fall short of clearing the crossbar?

(b) Does the ball approach the crossbar while still rising or still falling?

Chapter 3.3 - Motion with Constant Acceleration (2-d)

One of the fastest recorded pitched in major-league baseball was clocked at 101.0 miles/hour. If a pitch were thrown horizontally with this initial velocity, how far would the ball fall vertically by the time it reached home plate, 60.5 feet away?

The best leaper in the animal kingdom is the puma, which can jump to a maximum height of 3.7 meters above the ground when leaving the ground at an angle of 45 degrees above the horizontal. With what speed must the puma leave the ground in order to reach that maximum height?

Chapter 3.4 - Motion with Constant Acceleration (2-d)

A ball is thrown straight upward and returns to the thrower's hand after spending 3.00 seconds in the air. A second ball is thrown at an angle of 30.0 degrees above the horizontal and reaches the same maximum height as the first ball.

(a) At what speed was the first ball thrown?

(b) At what speed was the second ball thrown?

Chapter 3.5 - Motion with Constant Acceleration, multi-part (2-d)

A rocket is launched at an angle of 53.0 degrees above the horizontal with an initial speed of 100 meters/sec. The rocket moves for 3.00 seconds along its initial line of motion with an acceleration of 30.0 m/s^2. At this time, its engines fail and the rocket proceeds to move as a projectile in free fall. Find

(a) the maximum altitude reached by the rocket,

(b) its total time of flight, and

(c) the horizontal distance travelled by the rocket during its flight.

Chapter 3.6 - Motion with Constant Acceleration, multi-part (2-d)

A car is parked on a cliff overlooking the ocean on an incline that makes an angle of 24.0 degrees below the horizontal. The negligent driver leaves the car in neutral, and the emergency brake is defective. The car rolls from rest down the incline with a constant acceleration of 4.00 m/s^2 for a distance of 50.0 meters to the edge of a cliff, which is 30.0 meters above the ocean. Find

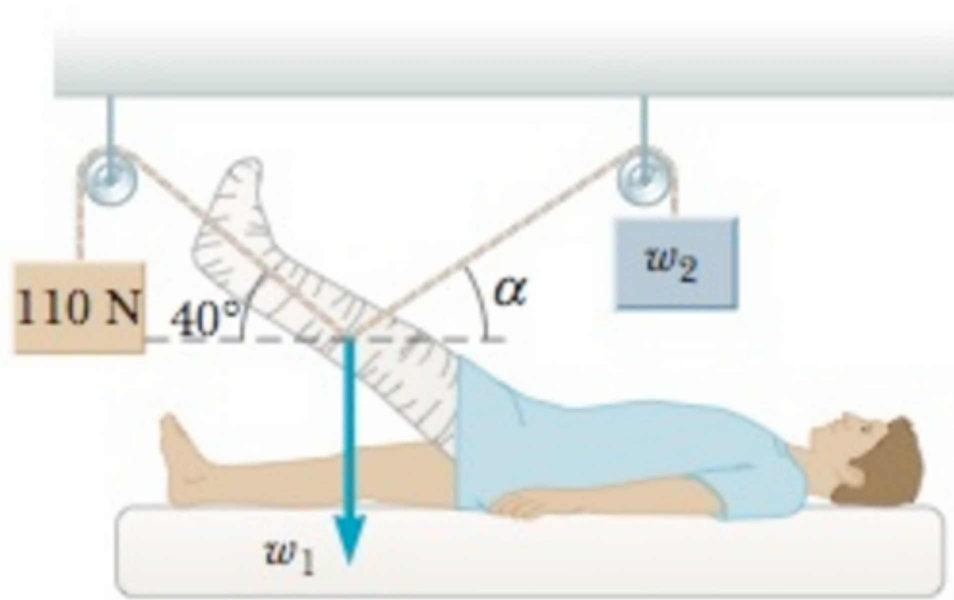
(a) the car's position relative to the base of the cliff when the car lands in the ocean and
(b) the length of time that the car is in the air.

Chapter 4.1 - Forces without friction

A 150 Newton bird feeder is supported by three cables as shown. Find the tension in each cable.

Chapter 4.2 - Forces without friction

The leg and cast shown in the figure below weight 220 Newtons (w_1). Determine the weight (w_2) and the angle (α) needed so that no net force is exerted on the patient's leg.

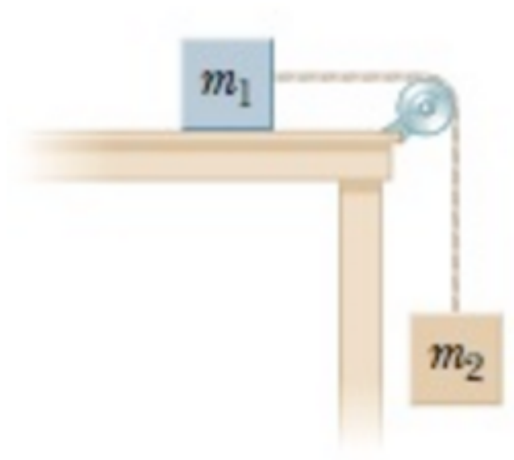


Chapter 4.3 - Forces without friction

An object with mass m1 = 5.00 kg rests on a frictionless horizontal table and is connected to a cable that passes over a pulley and is then fastened to a hanging object with mass m2 = 10.0 kg, as shown below. Find

(a) the acceleration of the two masses (assume they move together) and

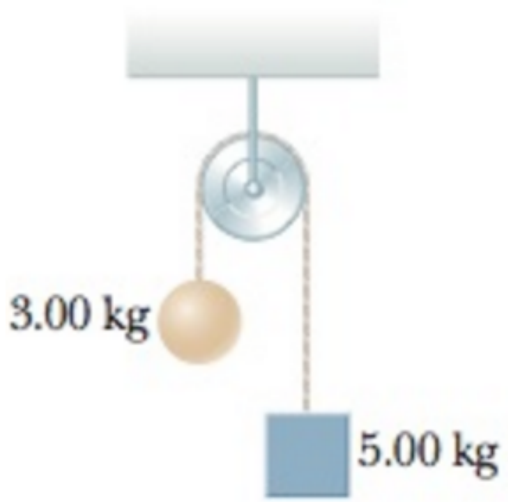
(b) the tension in the cable.



Chapter 4.4 - Forces without friction

Two objects with masses of 3.00 kg and 5.00 kg are connected by a light string that passes over a frictionless pulley, as shown below. Determine

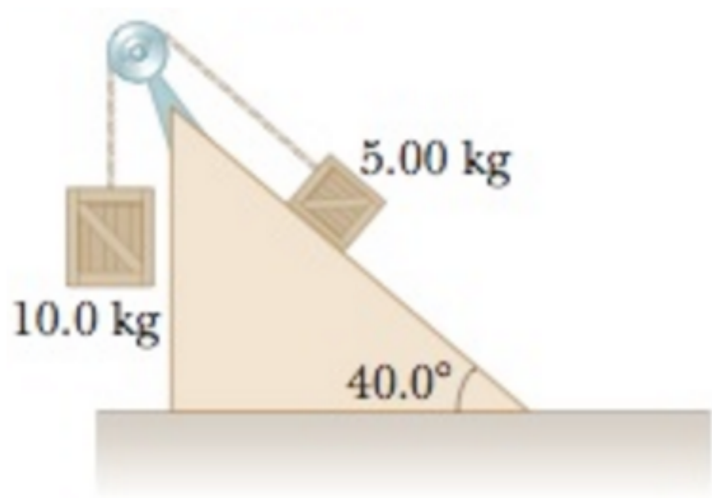
(a) the tension in the string,
(b) the acceleration of each object (assume they move together) and
(c) the distance each object will move in the first second of motion if both objects start from rest.



Chapter 4.5 - Forces without friction

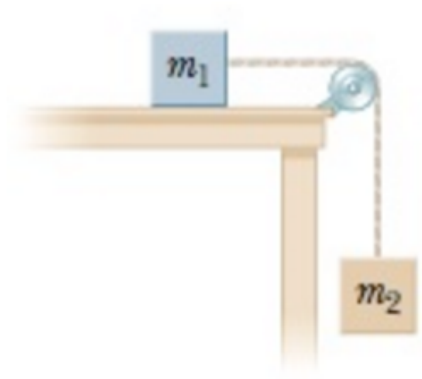
Two packing crates of masses 10.0 kg and 5.00 kg are connected by a light string that passes over a frictionless pulley as shown below. The 5.00-kg crate lies on a smooth 40.0 degree incline. Find

(a) the acceleration of the 5.00-kg crate and
(b) the tension in the string.



Chapter 4.6 - Force problems with kinetic friction

An object with mass m_1 = 5.00 kg rests on a frictionless horizontal table and is connected to a cable that passes over a pulley and is then fastened to a hanging object with mass m_2 = 10.0 kg, as shown below. Starting from rest, m_2 falls 1.00 meters in 1.20 seconds. Determine the coefficient of kinetic friction between m_1 and the table.



Chapter 4.7 - Force problems with kinetic friction

A 3.00 kg block starts from rest at the top of a 30.0 degree incline and slides 2.00 meters down the incline in 1.50 seconds. Find
(a) the acceleration of the block,
(b) the coefficient of kinetic friction between the block and the incline,
(c) the frictional force acting on the block, and
(d) the speed of the block after it has slid 2.00 meters.

Chapter 4.8 - Force problems with kinetic friction

A block of mass 5.8 kg is pulled up a 25 degree incline by an applied force of magnitude 32 N parallel to the incline.

(a) Find the acceleration of the block if the incline is frictionless.

(b) Find the acceleration of the block if the coefficient of kinetic friction between the block and incline is 0.10.

Chapter 4.9 - Force problems with kinetic friction

A student decides to move a box of books into her dormitory room by pulling on a rope attached to the box. She pulls with a force of 80.0 N at an angle of 25.0 degrees above the horizontal. The box has a mass of 25.0 kg, and the coefficient of kinetic friction between box and floor is 0.300.

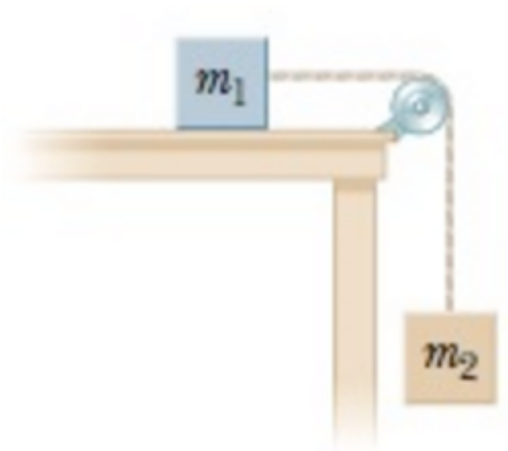
(a) Find the acceleration of the box.

(b) The student now starts moving the box up a 10.0 degree incline, keeping her 80.0 N force directed at a 25 degree angle above the incline (35 degrees above the horizontal). If the coefficient of kinetic friction is the same, what is the new acceleration of the box?

Chapter 4.10 - Force problems with static friction

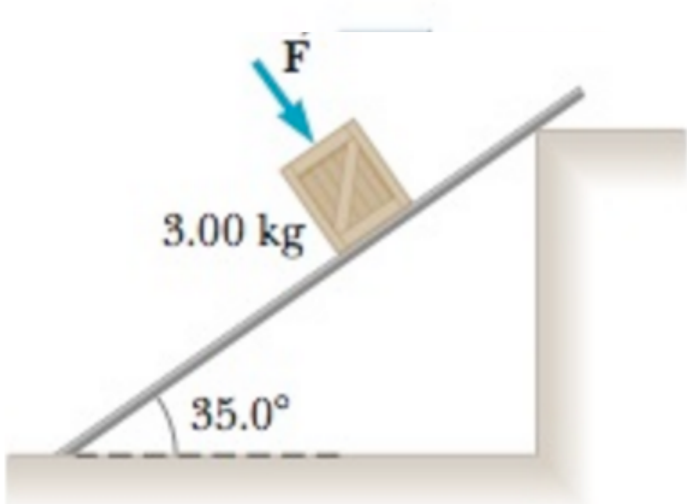
An object with mass m_1 = 10.0 kg rests on a frictionless horizontal table and is connected to a cable that passes over a pulley and is then fastened to a hanging object with mass m_2 = 4.00 kg, as shown below. The coefficient of static friction between m_1 and the horizontal surface is 0.50, and the coefficient of kinetic friction is 0.30.

(a) If the system is released from rest, what will its acceleration be?
(b) If a = 0, what is the force of static friction acting on m_1 (magnitude and direction)?
(c) If a is non-zero, what is the force of kinetic friction acting on m_1?
(d) If the system is set in motion with m_2 moving downward, what will be the acceleration of the system?



Chapter 4.11 - Force problems with static friction

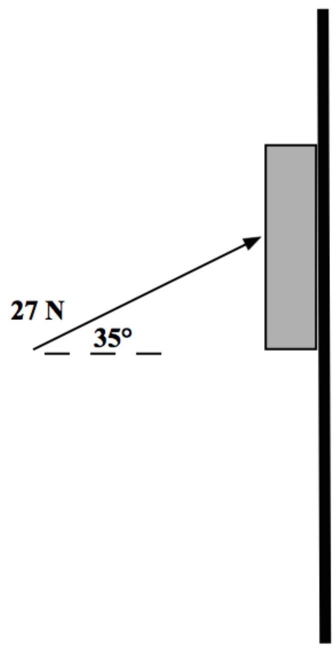
The coefficient of static friction between the 3.00 kg crate and the 35.0 degree incline is 0.300. What minimum force F must be applied to the crate perpendicular to the incline to prevent the crate from sliding down the incline?



Chapter 4 .12 - Force problems with static friction

A 3.1-kg book is initially at rest against a vertical wall. An applied force of 27 N acts on the book at an angle of 35° above the horizontal as shown. The coefficient of static friction is 0.44. The coefficient of kinetic friction is 0.29.

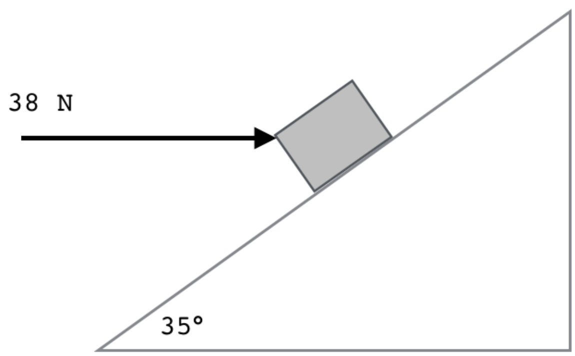
Does the book move? If no, find the magnitude and direction of the force of static friction acting on the book. If yes, find the magnitude and direction of the book's acceleration.



Chapter 4.13 - Force problems with static friction

A 15 kg mass is at rest on a ramp inclined 35° above the horizontal as shown below. A horizontal applied force of 38 N acts on the mass. The coefficient of static friction is 0.41. The coefficient of kinetic friction is 0.27. Does the mass move?

If yes, what is its acceleration (magnitude and direction)?
If no, what is the force of static friction acting on the mass (magnitude and direction)?



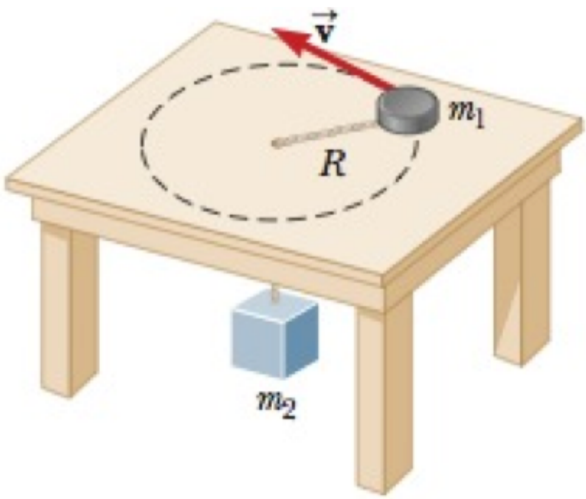
Chapter 5.1 - Circular motion, acceleration and force

A car can go around a flat curve having a radius of 150 m with a maximum speed of 58 miles/hour. Given the same road surface, what is the maximum speed (in miles/hour) the same car can go around a curve having a radius of 75.0 m?

Chapter 5.2 - Circular motion, acceleration and force

An air puck of mass $m_1 = 0.25$ kg is tied to a string and allowed to revolve in a circle of radius $R = 1.0$ m on a frictionless horizontal table. The other end of the string passes through a hole in the center of the table, and a mass of $m_2 = 1.0$ kg is tied to it, as shown below. The suspended mass remains in equilibrium while the puck on the tabletop revolves.

(a) What is the tension in the string?
(b) What is the speed of the puck?
(c) How much time does it take for the puck to move in a complete circle?



Chapter 5.3 - Circular motion, acceleration and force

Two banked curves have the same radius. Curve A is banked at an angle of 13°, and curve B is banked at an angle of 19°. A car can travel around curve A without relying on friction with a speed of 18 m/s. At what speed can the car travel around curve B without relying on friction?

Chapter 5.4 - Vertical circular motion

A 40-kg child takes a ride on a Ferris wheel that rotates four times each minute and has a diameter of 18.0 m.

(a) What is the centripetal acceleration of the child?
(b) What force (magnitude and direction) does the seat exert on the child at the lowest point of the ride?
(c) What force does the seat exert on the child at the highest point of the ride?
(d) What is the magnitude and direction of the total force the seat exerts on the child when the child is halfway between the top and bottom (assume both normal force and static friction keep the child in place on the seat)?

Chapter 5.5 - Vertical circular motion

A 55-kg acrobat swings on a 2.5 meter long rope in a circular arc. At the bottom of the arc, the acrobat is moving with a speed of 6.0 m/s. If the rope can sustain a maximum tension of 1500 Newtons, does the rope break? Justify your answer mathematically.

Chapter 5.6 - Vertical circular motion

Assume the Earth is a perfect sphere with a radius of 6380 km. A 75.0-kg person standing on a scale at the North Pole would see a reading of 735 N. What would the scale read for a person standing on the equator?

Chapter 5.7 - Gravity and circular orbits

The mass of the Sun is 1.99×10^{30} kg.
The mass of Earth is 5.98×10^{24} kg.
The distance between their centers is 1.50×10^{11} meters.
The radius of Earth is 6380 km.

At what distance from Earth can an object be placed so that the net gravitational force exerted by Earth and the Sun on that object is zero? Answer as a multiple of Earth's radius.

Chapter 5.8 - Gravity and circular orbits

An artificial satellite circling the Earth completes each orbit in 110 minutes.

(a) Assuming Earth's radius is 6380 km, find the altitude of the satellite above Earth's surface, in miles.

(b) What is the value of "g" at the altitude of the satellite?

Chapter 6.1 - Work and Energy

A 70-kg base runner begins his slide into second base when he is moving at a speed of 4.0 m/s. The coefficient of friction between his clothes and the Earth is 0.70. He slides so that his speed is zero just as he reaches the base.

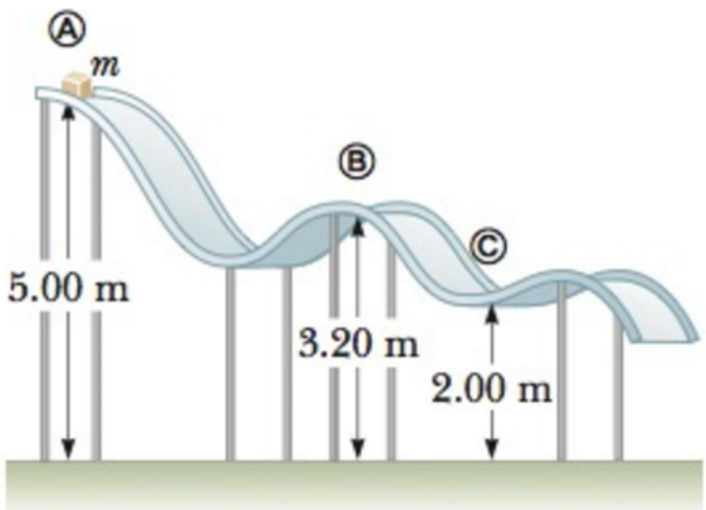
(a) How much work is done by friction during the slide?

(b) How far does the runner slide?

Chapter 6.2 - Work and Energy

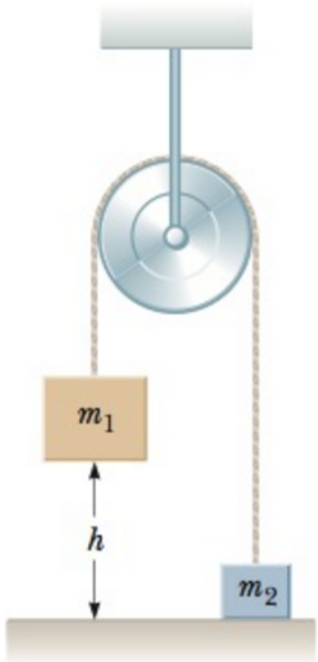
A block of mass m = 5.00 kg is released from rest from point A and slides on the frictionless track shown. Determine

(a) the block's speed at points B and C and
(b) the work done by the gravitational force on the block as it moves from point A to point C.



Chapter 6.3 - Work and Energy

Two blocks are connected by a light string that passes over a frictionless pulley. The system is released from rest while m_2 (4.2 kg) is on the floor and m_1 (6.5 kg) is h = 3.2 meters above the floor. What is the speed of m1 just before it hits the floor?



Chapter 6.4 - Work and Energy

Tarzan swings on a 30.0-m-long vine initially inclined at an angle of 37.0° with respect to the vertical.

(a) If he starts from rest, what is his speed at the bottom of the swing?

(b) If his speed at the bottom of the swing is 9.00 m/s, how much work was done by frictional forces during the swing?

Chapter 6.5 - Work and Energy

An airplane of mass 15,000 kg is moving at 60.0 m/s. The pilot increases the engine's thrust to 75,000 N. The resistive force exerted by air on the airplane has a magnitude of 40,000 N.

(a) Is the work done by the engine on the airplane equal to the change in the airplane's kinetic energy after it travels some distance? Explain.
(b) Is mechanical energy conserved? Explain.
(c) Find the speed of the airplane after it has traveled 500 meters, assuming the plane is in level flight throughout its motion.

Chapter 6.6 - Work and Energy

A skier starts from rest at the top of a hill that is inclined 10.5° with respect to the horizontal. The hillside is 200 meters long, and the coefficient of friction between snow and skis is 0.0750. At the bottom of the hill, the snow is level and the coefficient of friction is unchanged. How far does the skier glide along the horizontal portion of the snow before coming to rest?

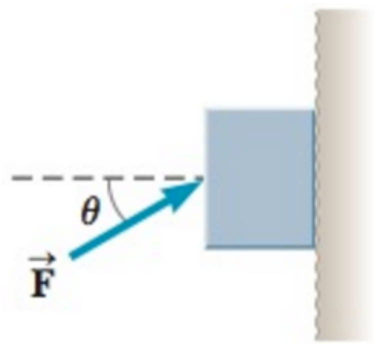
Chapter 6.7 - Work and Energy

A wooden block of unknown mass is given an initial speed of 6.0 m/s up a 21° inclined track. The coefficient of kinetic friction between block and ramp is 0.18. How far up the incline does the block move before stopping?

Chapter 6.8 - Work and Energy

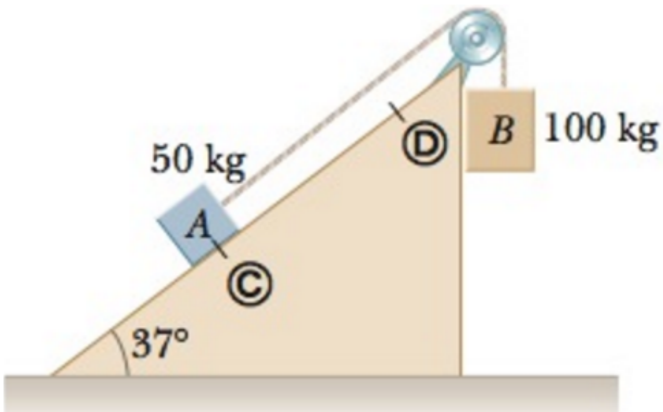
A 5.0-kg block is pushed 3.0 m up a vertical wall with a constant speed of 1.5 m/s by a constant force of magnitude F applied at an angle of 30° above the horizontal. If the coefficient of friction between block and wall is 0.30, determine

(a) the work done by the applied force F,
(b) the work done by gravity, and
(c) the work done by the normal force between block and wall.



Chapter 6.9 - Work and Energy

Two blocks, A and B (with masses 50.0 kg and 100.0 kg respectively), are connected by a string. The pulley is frictionless and of negligible mass. The coefficient of kinetic friction between block A and the incline is 0.25. Determine the velocity of block A as it moves from point C to point D, a distance of 20.0 meters up the incline (block B moves downward 20 meters at the same time) if the system starts from rest.



Chapter 6.10 - Work and Energy

(Problem #39) A slingshot fires a pebble from the top of a building with a speed of 14.0 m/s. The building is 31.0 meters tall. Ignoring air resistance, find the speed with which the pebble strikes the ground when the pebble is fired

(a) horizontally,
(b) vertically straight up and
(c) vertically straight down.

Chapter 6.11 - Work and Energy (Univeral Gravity)

A rocket is launched from the surface of the Earth directly upward with an initial speed of 12,500 miles/hour. To what maximum altitude (in miles) above the Earth's surface does the rocket rise? You may *NOT* assume that the acceleration due to gravity is constant for this problem.

Chapter 6.12 - Work and Energy (Univeral Gravity)

A 4500-kg rocket is launched from the surface of the Earth, initially at rest. How much work must the rocket's engines do in order to achieve a circular orbit at an altitude of 1200 miles above Earth's surface? Assume the rocket's mass remains constant during the flight.

How much work would the rocket's engines need to do in order for the rocket to just barely escape Earth's gravitational influence?

Chapter 6.13 - Power

A skier of mass 70 kg is pulled up a slope by a motor-driven cable.

(a) How much work is required the pull her 60 meters up a 30° frictionless slope at a constant speed of 2.0 m/s?

(b) What power (in hp) must a motor have in order to perform this task?

Chapter 6.14 - Power

A helicopter, starting from rest, accelerates straight up from the roof of a hospital. The lifting force does work in raising the helicopter. An 810-kg helicopter rises from rest to a speed of 7.0 m/s in a time of 3.5 s. During this time it climbs to a height of 8.2 m. What is the average power generated by the lifting force?

Chapter 7.1 - Force and impulse

A 0.280-kg volleyball approaches a player horizontally with a speed of 15.0 m/s in the -x direction. The player strikes the ball with her fist and causes the ball to move in the opposite direction with a speed of 22.0 m/s.

(a) What impulse is delivered to the ball by the player?

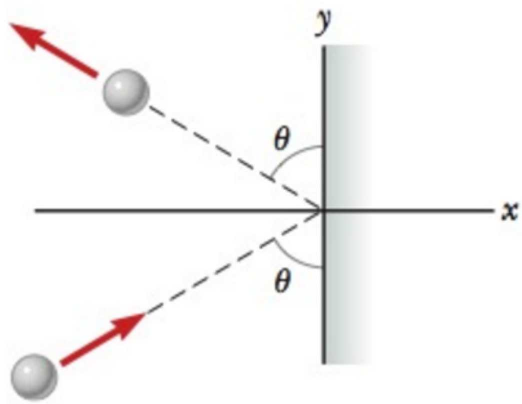
(b) If the player's fist is in contact with the ball for 0.060 sec, find the magnitude and direction of the average force exerted on the player's fist.

Chapter 7.2 - Force and impulse

A ball of mass 0.150 kg is dropped from rest from a height of 1.25 m. It rebounds from the floor to reach a height of 0.960 m. If the ball was in contact with the floor for 0.085 sec, what is the magnitude and direction of the average force exerted on the ball by the floor?

Chapter 7.3 - Force and impulse

A 3.00-kg steel ball strikes a massive wall at 10.0 m/s at an angle of θ = 60.0° with the plane of the wall. It bounces off the wall with the same speed and angle. If the ball is in contact with the wall for 0.200 sec, what is the magnitude and direction of the average force exerted by the wall on the ball?



Chapter 7.4 - One-dimensional collisions

A rifle with a weight of 30 N fires a 5.0-gram bullet with a speed of 300 m/s.

(a) Find the recoil speed of the rifle.

(b) If a 700-N woman holds the rifle firmly against her shoulder, find the recoil speed of the woman and the rifle.

Chapter 7.5 - One-dimensional collisions

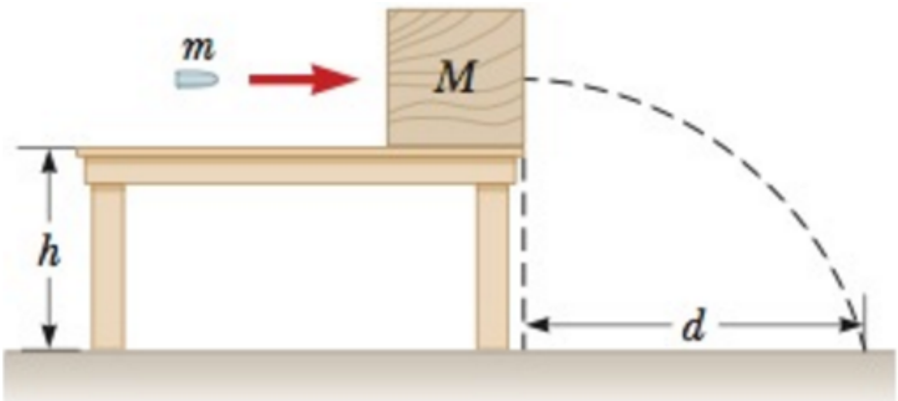
A 0.030-kg bullet is fired vertically at 200 m/s into a 0.15-kg baseball that is initially at rest.

(a) How high does the combined bullet and baseball rise after the collision, assuming the bullet embeds itself in the ball?

(b) How much kinetic energy is lost in the collision?

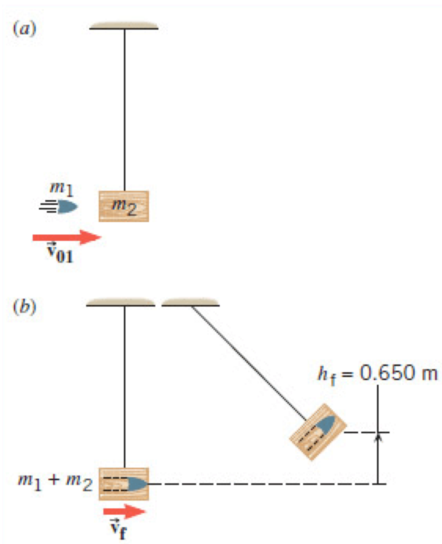
Chapter 7.6 - One-dimensional collisions

A bullet of mass m = 8.00 grams is fired into a block of mass M = 250 grams that is initially at rest at the edge of a table of height h = 1.00 m. The bullet remains in the block, and after the impact, the block lands d = 2.00 m from the bottom of the table. Determine the initial speed of the bullet.



Chapter 7.7 - One-dimensional collisions

The ballistic pendulum is a device used to measure the speed of a fast-moving projectile such as a bullet. The bullet is fired into a large block of wood suspended from some light wires. The bullet is stopped by the block, and the entire system swings up to a height h. It is possible to obtain the initial speed of the bullet by measuring h and the two masses. Assume the mass of the bullet m_1 = 5.00 g, the mass of the pendulum, m_2 = 1.00 kg, and h = 65.0 cm. Calculate the initial speed of the bullet and the amount of kinetic energy lost in the collision.

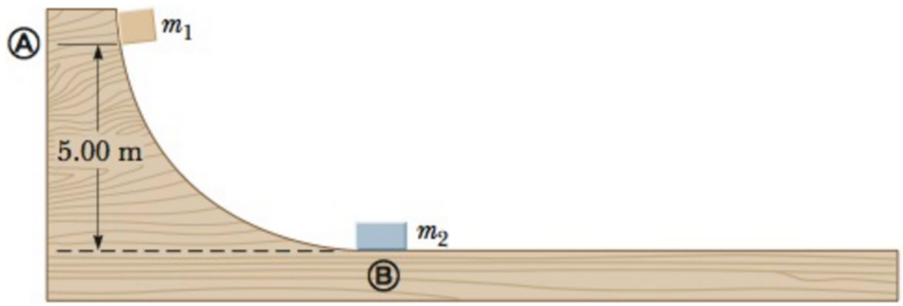


Chapter 7.8 - One-dimensional collisions

Consider a frictionless curved track as shown below. A block of mass m_1 = 5.00 kg is released from point A. It makes a head-on elastic collision at point B with a block of mass m_2 = 10.0 kg that is initially at rest.

(a) Calculate the maximum height to which m_1 rises after the collision.

(b) If the track to the right of m_2 is rough with a coefficient of kinetic friction of 0.13, how far does m_2 slide after the collision before coming to rest?



Chapter 7.9 - One-dimensional collisions

Ball A moves to the right at a velocity of 2.00 m/s on a frictionless table, collides head-on with a stationary ball B that is twice as massive. Find the final velocities of each ball if the collision is (a) elastic and (b) completely inelastic.

Chapter 7.10 - Two-dimensional collisions

A 90.0-kg fullback running east with a speed of 5.00 m/s is tackled by a 95.0-kg opponent running north with a speed of 3.00 m/s. The two players stick together after their collision, so it is perfectly inelastic.

(a) Calculate the magnitude and direction of the velocity of the combined mass after the collision.

(b) Determine how much kinetic energy was lost during the collision.

Chapter 7.11 - Two-dimensional collisions

A 2000-kg car moving east at 10.0 m/s collides with a 3000-kg car moving north. The cars stick together and move as a unit after the collision, at an angle 40.0° north of east. Find the speed of the 3000-kg car before the collision.

Chapter 8.1 - Equations of Angular Motion (with constant angular acceleration)

(Ch 8, #3) The Earth spins on its axis once a day and orbits the sun once a year (365.25 days). Determine the average angular velocity (in rad/s) of the Earth as it

(a) spins on its axis and
(b) orbits the sun. In each case, take the direction of Earth's motion to be positive.

Chapter 8.2 - Equations of Angular Motion (with constant angular acceleration)

A potter's wheel moves uniformly from rest to an angular speed of 1.0 rev/s in 30.0 s.

(a) Find its angular acceleration, in rad/s^2.

(b) Through how many revolutions does the wheel turn as it accelerates to its final speed?

Chapter 8.3 - Angular vs tangential quantities

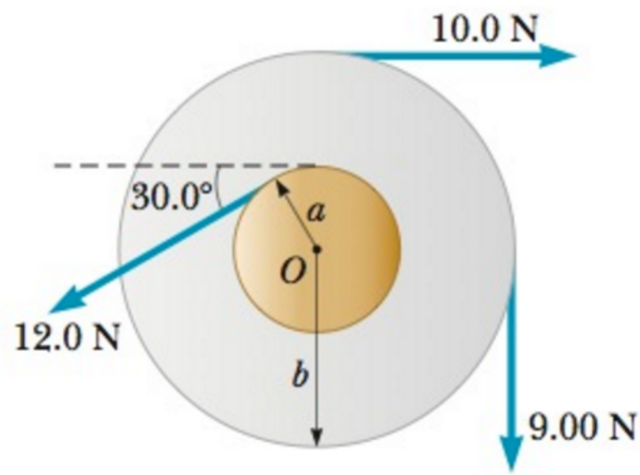
A car initially traveling at 29.0 m/s undergoes a constant negative acceleration of magnitude 1.75 m/s^2 after its brakes are applied.

(a) How many revolutions does each tire make before the car comes to a stop, assuming the car does not skid and the tires have radii of 0.330 m?

(b) A pebble stuck to the rim of the tire travels how many meters as the car stops?

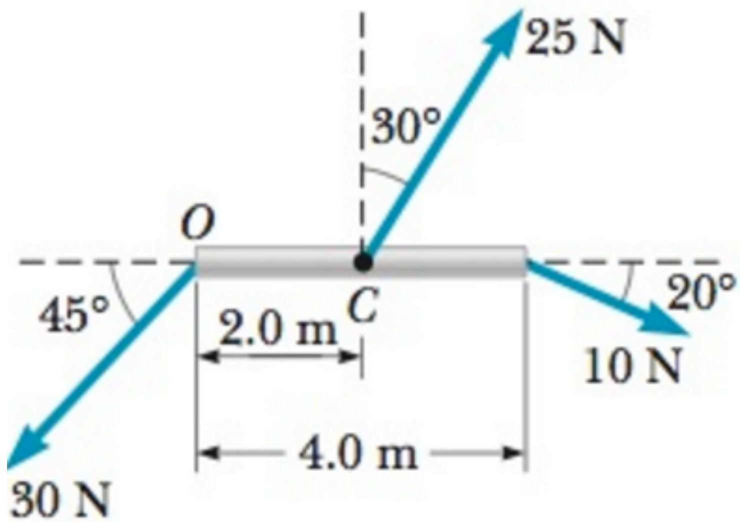
Chapter 9.1 - Calculating Torque

Find the net torque on the wheel shown below about the axle through O perpendicular to the page. Assume a = 10.0 cm and b = 25.0 cm.



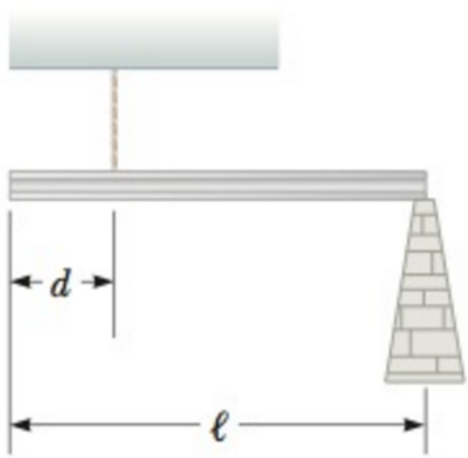
Chapter 9.2 - Calculating Torque

Calculate the net torque (magnitude and direction) on the beam about
(a) an axis through O perpendicular to the page and
(b) an axis through C perpendicular to the page.



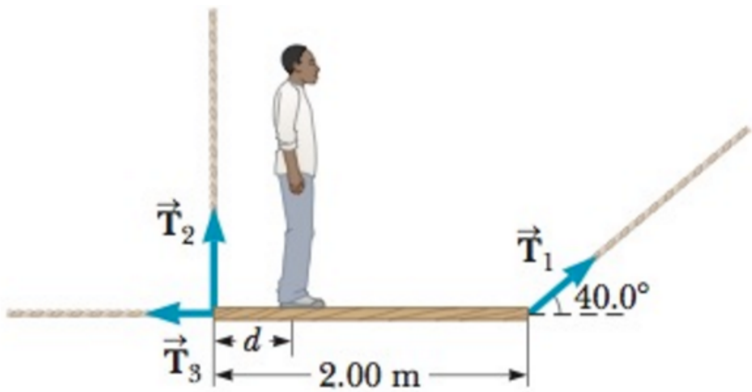
Chapter 9.3 - Static Equilibrium

A uniform 35.0-kg beam of length ℓ = 5.00 m is supported by a vertical rope located d = 1.20 m from its left end. The right end of the beam is supported by a vertical column. Find
(a) the tension in the rope and
(b) the force that the column exerts on the right end of the beam.



Chapter 9.4 - Static Equilibrium

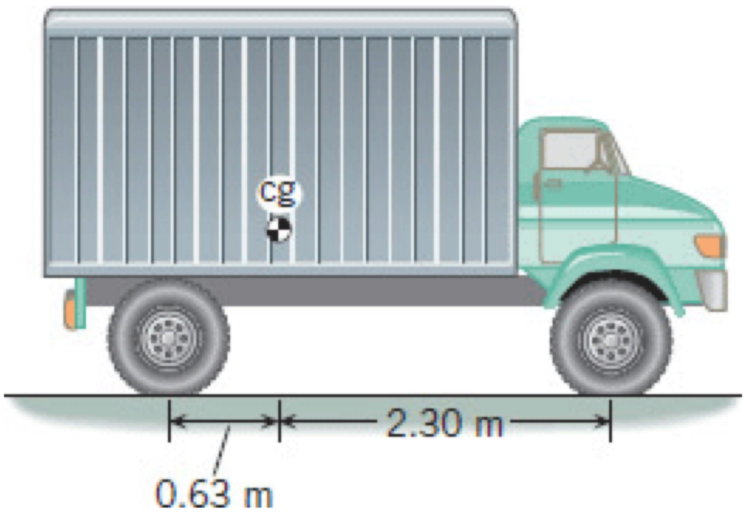
A uniform plank of length 2.00 m and mass 30.0 kg is supported by three ropes, as indicated by the vectors below. Find the tension in each rope when a 700-N person is d = 0.500 m from the left end.



Chapter 9.5 - Static Equilibrium

(Ch 9, #14) Workers have loaded a delivery truck in such a way that its center of gravity is only slightly forward of the rear axle, as shown below. The mass of the truck and its contents is 7460 kg. Find the magnitudes of the forces exerted by the ground on

(a) the front wheels (combined) and
(b) the rear wheels (combined) of the truck.



Chapter 9.6 - Static Equilibrium

(Ch 9, Example 4, Animated Figure 9.6) An 8.00-m uniform ladder of weight 355 N leans against a smooth vertical wall. The term "smooth" means that the wall can only exert a normal force directed perpendicular to the wall and cannot exert a frictional force parallel to the wall. A firefighter with weight 875 N stands 6.30 m up from the bottom of the ladder. If the ladder is on the verge of slipping, what is the coefficient of static friction between the ladder and the ground?

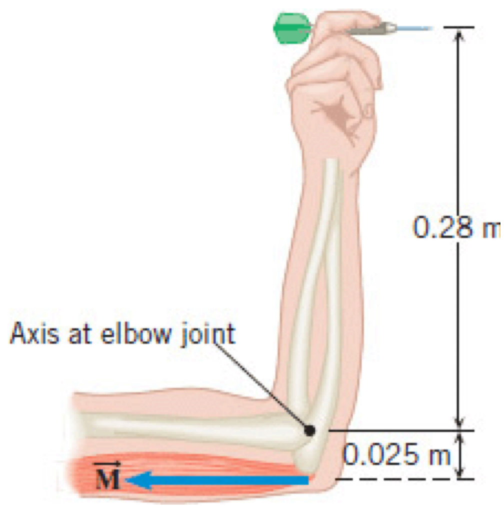
Chapter 9.7 - Newton's 2nd Law of Rotation

A large grinding wheel in the shape of a solid cylinder of radius 0.330 m is free to rotate on a vertical axle with a constant frictional torque of 15 N-m. A constant tangential force of 250 N applied to its edge, causing the wheel to have an angular acceleration of 0.940 rad/s^2.

(a) What is the moment of inertia of the wheel?
(b) What is the mass of the wheel?
(c) If the wheel starts from rest, what is its angular velocity after 5.00 s have elapsed?

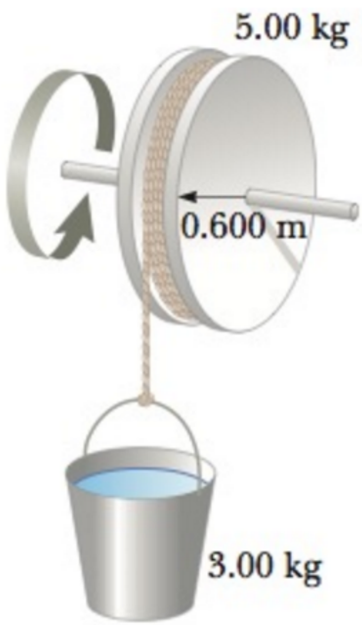
Chapter 9.8 - Newton's 2nd Law of Rotation

(Ch 9, #40, Chalkboard Video) The drawing shows a model for the motion of the human forearm in throwing a dart. Because of the force M applied by the triceps muscle, the forearm can rotate about an axis at the elbow joint. Assume that the forearm has the dimensions shown in the drawing and a moment of inertia of 0.065 kg-m^2 (including the effect of the dart) relative to the axis at the elbow. Assume also that the force M acts perpendicular to the forearm. Ignoring the effect of gravity and any frictional forces, determine the magnitude of the force M needed to give the dart a tangential speed of 5.0 m/s in 0.10 s, starting from rest.



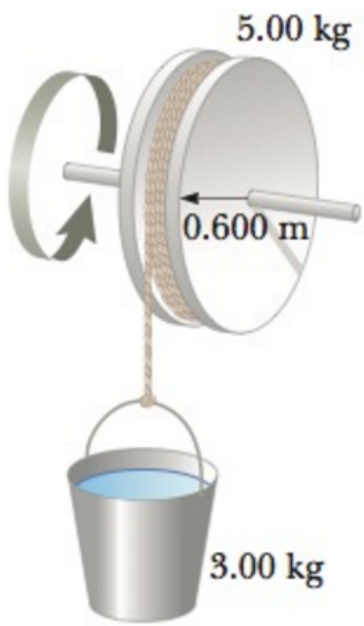
Chapter 9.9 - Newton's 2nd Law of Rotation

The light string attached to the bucket in the diagram below is wrapped around the spool and does not slip as it unwinds. Determine the angular speed of the spool after the 3.00 kg bucket has fallen 4.00 m, starting from rest. Assume the spool is a solid cylinder.



Chapter 9.10 - Rotational Work and Energy

The light string attached to the bucket in the diagram below is wrapped around the spool (a solid cylinder) and does not slip as it unwinds. Determine the angular speed of the spool after the 3.00 kg bucket has fallen 4.00 m, starting from rest. Use work and energy concepts to solve this problem.



Chapter 9.11 - Rotational Work and Energy

A sphere of unknown mass and radius 0.20 m rolls without slipping a distance of 6.0 meters down a ramp that is inclined at 37° with the horizontal.

(a) What is the angular speed of the sphere at the bottom of the slope if it starts from rest?
(b) If the sphere is doubled in size, what is the angular speed at the bottom of the slope?
(c) A ring rolls without slipping down the same slope for the same distance. What is its angular speed at the bottom of the slope?
(d) If both start at the same time, which would win a race? Explain.

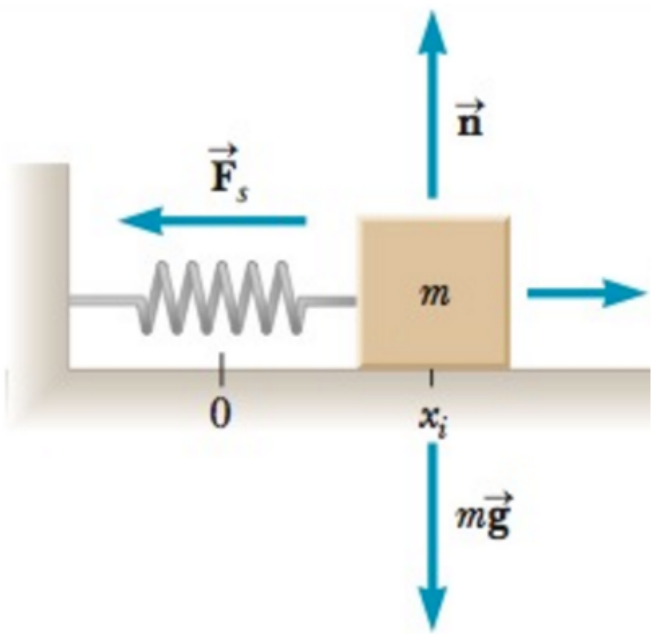
Chapter 9.12 - Angular Momentum

A 60.0-kg woman stands at the rim of a horizontal turntable having a moment of inertia of 500 kg-m2 and a radius of 2.00 m. The turntable is initially at rest and is free to rotate about a frictionless, vertical axle through its center. The woman than starts walking around the rim clockwise (as viewed from above the system) at a constant speed of 1.50 m/s relative to Earth.

(a) In what direction and with what angular speed does the turntable rotate?
(b) How much work does the woman do to set herself and the turntable in motion?
(c) If the initial speed of both is 1.1 rad/s and the woman walks inward 1.5 meters, what is the new speed of the system?
(d) How much work does the woman do as she walks inward?

Chapter 10.1 - Spring Force

(Ch 10, #4) A spring lies on a horizontal table, and the left end of the spring is attached to a wall. The other end is connected to a box. The box is pulled to the right, stretching the spring. Static friction exists between the box and the table (pointing to the right), so when the spring is stretched only by a small amount and the box is released, the box does not move. The mass of the box is 0.80 kg, and the spring has a spring constant of 59 N/m. The coefficient of static friction between the box and the table on which it rests is $\mu_s = 0.74$. How far can the spring be stretched from its unstrained position without the box moving when it is released?



Chapter 10.2 - Reference Circle

(Ch 10, #17) A block of mass $m = 0.750$ kg is fastened to an unstrained horizontal spring whose spring constant is $k = 82.0$ N/m. The block is given a displacement of $+0.120$ m, where the plus sign indicates that the displacement is along the $+x$ axis, and then released from rest.

(a) What is the force (magnitude and direction) that the spring exerts on the block just before the block is released?

(b) Find the angular frequency ω of the resulting oscillatory motion.

(c) What is the maximum speed of the block?

(d) Determine the magnitude of the maximum acceleration of the block.

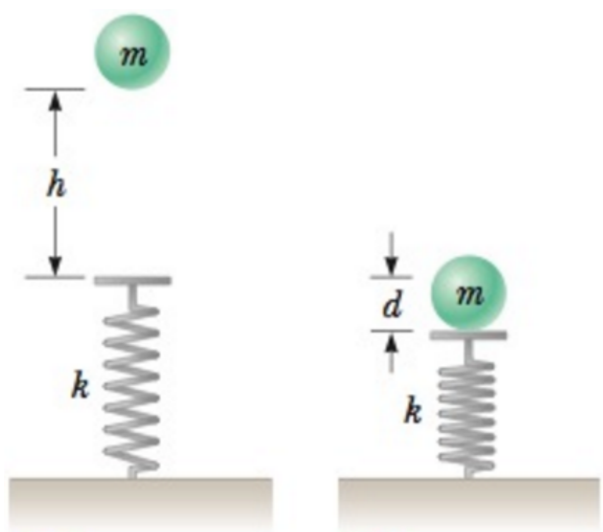
Chapter 10.3 - Energy and Harmonic Motion

A ball of mass m = 1.80 kg is released from rest at a height h = 65.0 cm above a light vertical spring of force constant k. The ball strikes the top of the spring and compresses it a distance d = 9.00 cm. Neglecting any energy losses during the collision, find

(a) the speed of the ball as it touches the spring,

(b) the force constant of the spring,

(c) the mechanical energy of the system.



Chapter 10.4 - Energy and Harmonic Motion

(Ch 10, #33 and Example 7) A 10.0 gram block is resting on a horizontal, frictionless surface and is attached to a horizontal spring of k = 124 N/m. The block is shoved parallel to the spring axis and given an initial speed of 8.00 m/s, while the spring is initially unrestrained.

(a) What is the amplitude of the resulting harmonic oscillation?
(b) What is the speed of the block when the spring is compressed by an amount equal to half of its maximum compression?
(c) How far is the spring from its equilibrium position when the block is moving at half of its maximum speed?

Chapter 10.5 - The Pendulum

(Ch 10, #45) The length of a simple pendulum is 0.79 m and the mass of the particle (the "bob") at the end of the cable is 0.24 kg. The pendulum is pulled away from its equilibrium position by an angle of 8.50° and released from rest. Assume that friction can be neglected and that the resulting oscillatory motion is simple harmonic motion.

(a) What is the angular frequency of the motion?
(b) Using the position of the bob at its lowest point as the reference level, determine the total mechanical energy of the pendulum as it swings back and forth.
(c) What is the bob's speed as it passes through the lowest point of the swing?

Chapter 10.6 - Stress and Strain

(Ch 10, #55) A 59-kg water skier is being pulled by a nylon rope that is attached to a boat. The unstretched length of the rope is 12 m, and its cross-sectional area is 2.0×10^{-5} m^2. As the skier moves, a resistive force (due to the water) of magnitude 130 N acts on her; this force is directed opposite to her motion. What is the change in length of the rope when the skier has an acceleration of magnitude 0.85 m/s^2? The Young's Modulus for nylon is 3.7×10^9 N/m^2.

Chapter 10.7 - Stress and Strain

(Ch 10, #72) A 6.8-kg bowling ball is attached to the end of a nylon cord (Young's Modulus is 3.7×10^9 N/m^2) with a cross sectional area of 3.4×10^{-5} m^2. The other end of the cord is fixed to the ceiling. When the bowling ball is pulled to one side and released from rest, it swings downward in a circular arc. At the instant it reaches its lowest point, the bowling ball is 1.4 m lower than the point from which it was released, and the cord is stretched by 2.7 mm from its unstrained length. What is the unstrained length of the cord?

Chapter 10.8 - Stress and Strain

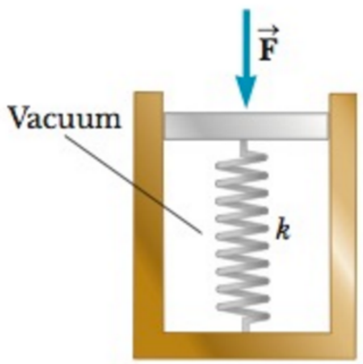
(Ch 10, #80) Between each pair of vertebrae in the spinal column is a cylindrical disc of cartilage. Typically, this disc has a radius of 30 mm and a thickness of 7.0 mm. The shear modulus of cartilage is 1.2×10^7 N/m^2. Suppose that a shearing force of magnitude 11 N is applied parallel to the top surface of the disc while the bottom surface remains fixed in place. How far does the top surface move (in mm) relative to the bottom surface?

Chapter 11.1 - Density, Pressure and Pascal's Principle

The spring of the pressure gauge shown below has a force constant of 1500 N/m, and the circular piston has a radius of 1.10 cm.

(a) What the gauge is surrounded by air at one atmosphere of pressure, by how much is the piston compressed compared to vacuum?

(b) As the gauge is lowered into the water, the spring is compressed an additional 0.85 cm compared to its compression in the air. What is the depth below the surface?

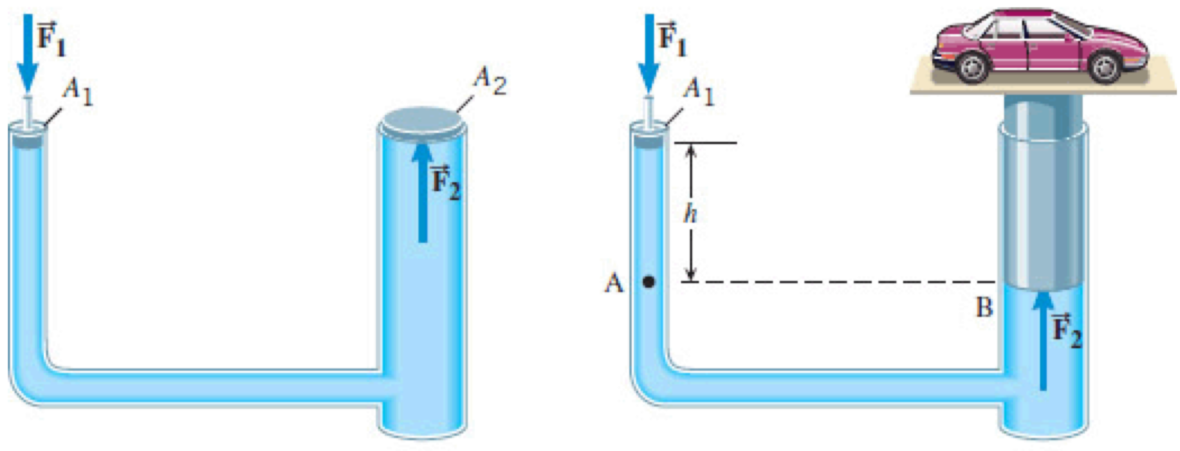


Chapter 11.2 - Density, Pressure and Pascal's Principle

(Ch 11, Examples 7 and 8) In the hydraulic lift shown below, the input piston on the left has a radius of 12 mm and a negligible weight. The output plunger on the right as a radius of 150 mm. The combined weight of the car and the plunger is 20,500 N. Since the output force has a magnitude of 20,500 N, it supports the car.

(a) Suppose the bottom surfaces of the piston and plunger are at the same level, so that h = 0. What is the magnitude of the input force F_1 needed so that F_2 = 20,500 N?

(b) What input force is needed if the height h = 110 cm?



(a) (b)

Chapter 11.3 - Buoyancy

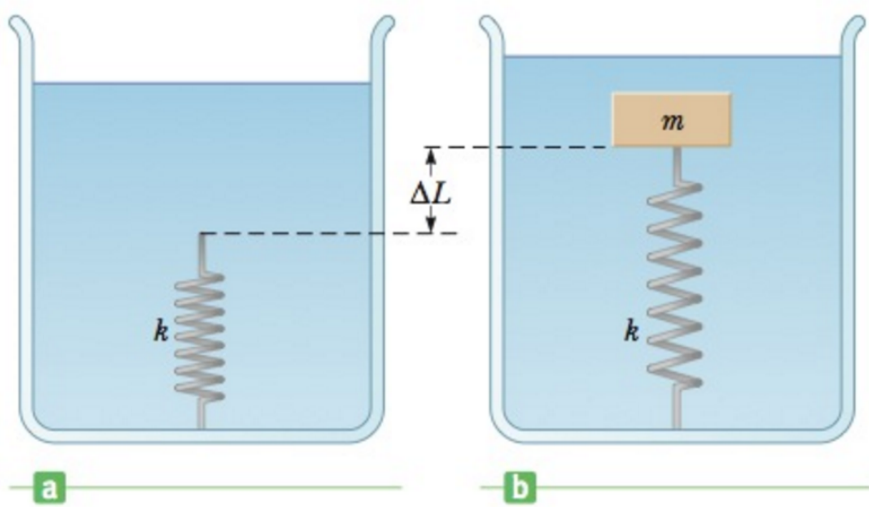
A sample of unknown material weighs 300 N in air and 200 N when immersed in alcohol with a specific gravity of 0.700. What are (a) the volume and (b) the density of the unknown material?

Chapter 11.4 - Buoyancy

A spherical balloon of mass 226 kg is filled with helium gas until its volume is 325 m^3. Assume the density of air is 1.29 kg/m^3 and the density of helium is 0.179 kg/m^3. What maximum additional mass can the balloon support while remaining stationary, floating in the air?

Chapter 11.5 - Buoyancy

A light spring of force constant k = 160 N/m rests vertically on the bottom of a large beaker of water. A 5.00 kg block of wood with a density of 650 kg/m^3 is connected to the spring, and the block-spring system is allowed to come to static equilibrium. What is the elongation ΔL of the spring?

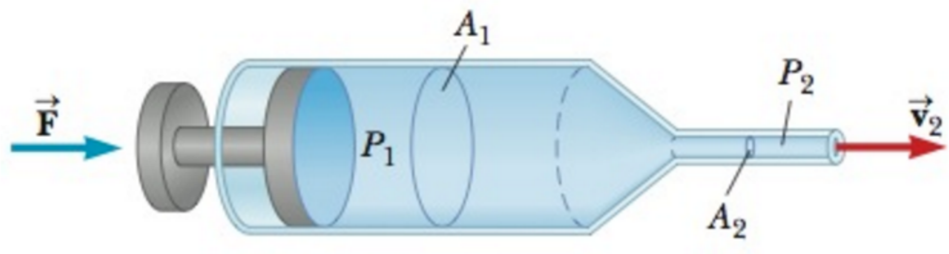


Chapter 11.6 - Fluid Dynamics

Water flows from a pipe with a diameter of 2.5 cm at a speed of 4.2 m/s. How long will it take for this water to fill a 50 gallon barrel?

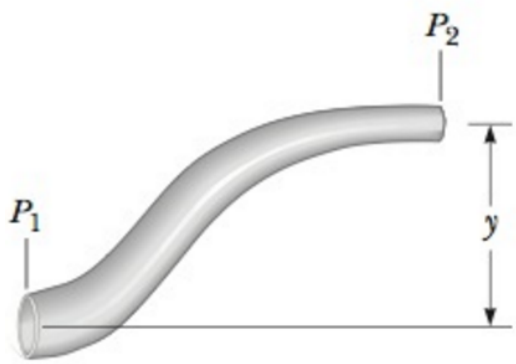
Chapter 11.7 - Fluid Dynamics

A hypodermic syringe contains a medicine with the density of water. The barrel of the syringe has a cross-sectional area of 2.50×10^{-5} m^2. In the absence of force on the plunger, the pressure everywhere is 1.00 atm. A force F of magnitude 2.00 N is exerted on the plunger, making medicine squirt from the needle. Determine the medicine's flow speed through the needle. Assume the pressure in the needle remains equal to 1.00 atm and that the syringe is horizontal.



Chapter 11.8 - Fluid Dynamics

Water moves through a constricted pipe in steady, ideal flow. At the lower point shown, the pressure is 1.75×10^5 Pa and the pipe radius is 3.00 cm. At the higher point located at $y = 2.50$ m, the pressure is 1.20×10^5 Pa and the pipe radius is 1.50 cm. Find the speed of flow
(a) in the lower section and
(b) in the upper section.
(c) Find the volume flow rate through the pipe.



Chapter 11.9 - Fluid Dynamics

A large storage tank, open to the atmosphere at the top and filled with water, develops a small hole in its side at a point 16.0 m below the water level. If the rate of flow from the leak is 2.50×10^{-3} m^3/min, determine

(a) the speed at which the water leaves the hole and

(b) the diameter of the hole.

Chapter 12.1 - Temperature and Thermal Expansion

(Ch 12, #12) The Eiffel Tower is a steel structure whose height increases by 19.4 cm when the temperature changes from -9 to +41° C. What is the approximate height (in meters) at the lower temperature?

The density of gasoline is 730 kg/m^3 at 0°C. Its average coefficient of volume expansion is 9.60×10^{-4}. Note that 1.00 gal = 0.00380 m^3.

(a) Calculate the density of gasoline if it is warmed by 20.0°C.
(b) Calculate the mass of 10.0 gallons of gas at 20.0°C.
(c) How many extra kilograms of gasoline would you get if you bought 10.0 gallons of gasoline at 0°C rather than at 20.0°C from a pump that is not compensated for temperature changes.

Worksheet 12.2 - Thermal Energy and Calorimetry

An unknown substance has a mass of 0.125 kg and an initial temperature of 95.0°C. The substance is then dropped into a calorimeter made of aluminum containing 0.285 kg of water initially at 25.0°C. The mass of the aluminum container is 0.150 kg, and the temperature of the calorimeter increases to a final equilibrium temperature of 32.0°C. Assuming no thermal energy is transferred to the environment, calculate the specific heat of the unknown substance.

Worksheet 12.3 - Phase Changes

How much energy is required to change a 40-g ice cube from ice at -10°C to steam at 110°C?

The specific heat of ice is 2090 J/kg °C.
The specific heat of water is 4186 J/kg °C.
The specific heat of steam is 2010 J/kg °C.
The latent heat of fusion for water is 333,000 J/kg.
The latent heat of vaporization for water is 2,260,000 J/kg.

Worksheet 12.4 - Phase Changes

A 100-g cube of ice at -25°C is dropped into 1.0 kg of water that was originally at 95°C.

(a) What is the final temperature of the system, assuming all of the ice melts?

(b) If there are initially 2.0 kg of ice, then the final temperature of the system is 0°C and not all of the ice melts. How much ice melts in this case before the system reaches equilibrium?

The specific heat of ice is 2090 J/kg °C.
The specific heat of water is 4186 J/kg °C.
The latent heat of fusion for water is 333,000 J/kg.

<u>Worksheet 12.5 - Phase Changes</u>

A 250-gram block of ice is cooled to -78°C and then added to 560 grams of water in an 80-gram copper calorimeter at an initial temperature of 25°C. Determine the final temperature of the system. If not all of the ice melts, determine how much ice melts.

The specific heat of ice is 2090 J/kg °C.
The specific heat of water is 4186 J/kg °C.
The specific heat of copper is 387 J/kg °C.
The latent heat of fusion for water is 333,000 J/kg.

Chapter 13.1 - Conduction

The average thermal conductivity of the walls and roof of a hour is 4.8×10^{-4} kW/m °C, and their average thickness is 21.0 cm. The house is heated with natural gas, with a heat of combustion (energy released per cubic meter of gas burned) of 9300 kcal/m^3. How many cubic meters of gas must be burned each day to maintain an inside temperature of 25.0°C if the outside temperature is 0.0°C? Assume the surface area is 420 m^2.

Chapter 13.2 - Conduction

A styrofoam box has a surface area of 0.80 m^2 and a wall thickness of 2.0 cm. The temperature of the inner surface is 5.0°C, and the outside temperature is 25°C. If it takes 8.0 hours for 5.0 kg of ice to melt in the container, determine the thermal conductivity of the styrofoam.

Chapter 13.3 - Conduction

A single-paned glass window has a cross sectional area of 1.0 m^2 and consists of a single 1.0-cm thick pane of glass. If the inside temperature is 23°C while the outside temperature is 0°C,

(a) determine the rate of energy transfer though the glass.
(b) If energy costs 12 cents per kilowatt-hour, how much does this energy loss cost per day?
(c) If the single-pane window is replaced with a double-pane window (same surface area) with two glass panes, each 0.5-cm thick and a 1.0-cm thick layer of sealed air in between, determine the rate of energy transfer through the glass.
(d) How much does this energy loss cost per day?

Chapter 13.4 - Conduction

(Ch 13, #29) Suppose the skin temperature of a naked person is 34°C when the person is standing inside a room with a temperature of 25°C. The skin area of the individual is 1.5 m^2.

(a) Assuming the emissivity is 0.80, find the net loss of radiant power from the body.

(b) Determine the number of food calories of energy (1 food calorie = 1kcal = 4186 Joules) that are lost in one hour due to the net loss rate obtained in part (a). Metabolic conversion of food into energy replaces this loss.

Chapter 14.1 - Ideal Gas Law

(Ch 14, #5) The active ingredient in the allergy medication Claritin contains carbon (C), hydrogen (H), chlorine (Cl), Nitrogen (N) and oxygen (O). Its molecular formula is $C_{22}H_{23}ClN_2O_2$. The standard adult dosage is 1.572×10^{19} molecules of this species. Determine the mass (in grams) of the active ingredient in the standard dosage.

An ideal gas at 28.0 °C and a pressure of 1.50 atm occupies a volume of 4500 Liters.

(a) How many moles of gas are present?

(b) If the volume is increased to 6500 L and the temperature raised to 52.0 °C, what will be the new pressure of the gas?

Chapter 14.2 - Ideal Gas Law

An unknown amount of gas is confined in a rigid tank at a pressure of 11.0 atm and a temperature of 25.0 °C. If two-thirds of the gas is removed and the temperature raised to 75.0 °C, what is the new pressure of the gas remaining in the tank?

The density of Helium gas at 0°C is 0.179 kg/m^3. The temperature is then raised to 100°C, but the pressure is kept constant. Assuming the helium is an ideal gas, determine the new density.

Chapter 14.3 - Ideal Gas Law

(Ch 14, #17) A clown at a birthday party has brought along a helium cylinder, with which he intends to fill balloons. When full, each balloon contains 0.034 m^3 of Helium at an absolute pressure of 1.2 x 10^5 Pa. The cylinder contains helium at an absolute pressure of 1.6 x 10^7 Pa and has a volume of 0.0031 m^3. The temperature of the helium in the tank and in the balloons is the same and remains constant. What is the maximum number of balloons that can be filled?

Chapter 14.4 - Kinetic Theory of Gases

(Ch 14, #35) Suppose a tank contains 680 m^3 of neon (Ne) at an absolute pressure of 1.0 atm. The temperature is changed from 293.2 to 294.3 K. What is the increase in the internal energy of the neon?

Chapter 14.5 - Kinetic Theory of Gases

(Ch 14, #42) Compressed air can be pumped underground into huge caverns as a form of energy storage. The volume of a cavern is 5.6×10^5 m3, and the pressure of the air in it is 7.7×10^6 Pa. Assume that air is a diatomic ideal gas with an internal energy $U = {}^5/_2nRT$. If one home uses 30.0 kW-hr of energy per day, how many homes could this internal energy serve for one day?

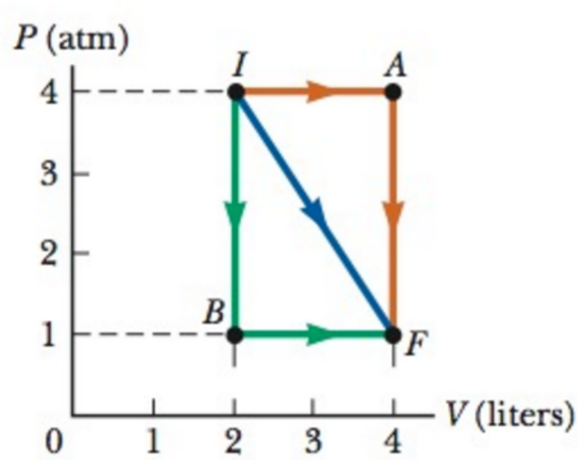
Chapter 15.1 - Thermodynamics of an Ideal Gas

Consider the process described by the figure below that describes a gas (system) expanding three different ways.

a) Calculate the work done by the system for paths IAF, IBF and IF.

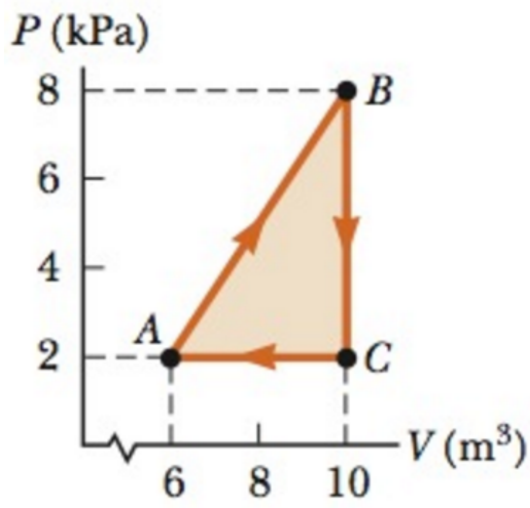
b) If 465 J of heat are added to the system as it moves along the IAF path, determine the change in internal energy, ΔU, along this path.

c) How much heat is added to the system as it moves along the IBF path?



Chapter 15.2 - Thermodynamics of an Ideal Gas

Consider the cyclic process describe below. Determine the amount of heat that must be added to the gas in order for it to do the work in the cycle ABCA.



Chapter 15.3 - Thermodynamics of an Ideal Gas

(Ch 15, #9) When a .22-caliber rifle is fired, the expanding gas from the burning gunpowder creates a pressure behind the bullet. This pressure causes the force that pushes the bullet through the barrel. The barrel has a length of 0.61 m and an opening whose radius is 2.8 mm. A bullet (mass = 2.6 grams) has a speed of 370 m/s after passing through the barrel. Ignore friction and determine the average pressure of the expanding gas.

Chapter 15.4 - Thermodynamics of an Ideal Gas

(Ch 15, #17) The pressure of a gas remains constant while the temperature increases by 53.0 °C, volume increases by 1.4 L and the internal energy increases by 939 J. The mass of gas is 24.0 grams, and its specific heat capacity is 1080 J/kg °C. Determine the pressure.

Chapter 15.5 - Thermodynamics of an Ideal Gas

(Ch 15, #24) One-half mole of a monatomic ideal gas expands adiabatically and does 610 J of work. By how many kelvins does its temperature change? Does the temperature increase or decrease?

Chapter 16.1 - Waves on a String

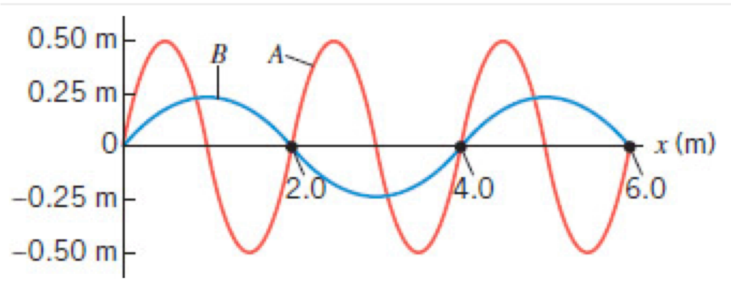
(Ch 16, #3) A woman is standing in the ocean, and she notices that after a wave crest passes, five more crests pass in a time of 50.0 s. The distance between two successive crests is 32 m. Determine, if possible, the wave's

(a) period,
(b) frequency,
(c) wavelength,
(d) speed, and
(e) amplitude. If it is not possible to determine any particular quantity, write "not possible."

A cork on the surface of a pond bobs up and down two times per second on ripples having a wavelength of 8.50 cm. If the cork is 10.0 m from the shore, how long does it take a ripple passing the cork to reach the shore?

Chapter 16.2 - Waves on a String

(Ch 16, #19) The drawing below shows a graph of two waves traveling to the right at the same speed.
(a) Determine the wavelength of each wave.
(b) If the speed of each wave is 12 m/s, calculate the frequency of each wave.
(c) What is the maximum (transverse) speed for a particle attached to each wave?



A string is 50.0 cm long and has a mass of 3.00 grams. A wave travels at 5.00 m/s along this string. A second string has the same length but half the mass of the first string. If the two strings are under the same tension, what is the speed of a wave along the second string?

Chapter 16.3 - Sound Waves

(Ch 16, #89) A recording engineer works in a soundproofed room that is 44.0 dB quieter than the outside. If the sound intensity that leaks into the room is 1.20×10^{-10} W/m^2, what is the intensity outside?

(Ch 16, #67) A listener doubles his distance from a source that emits sound uniformly in all directions. There are no reflections. By how many decibels does the sound intensity level change?

Chapter 16.4 - Sound Waves

(Ch 16, #96) The average sound intensity inside a busy neighborhood restaurant is 3.2×10^{-5} W/m^2. How much energy goes into each ear (area = 2.1×10^{-3} m^2) during a one-hour meal?

Two speakers produce sound levels of 75.0 dB and 80.0 dB, respectively.

(a) What total sound intensity do you experience?

(b) What is the combined decibel level?

Chapter 16.5 - Sound Waves

(Ch 16, #82) A loudspeaker in a parked car is producing sound with a frequency of 20,510 Hz. A healthy young person with normal hearing is standing nearby on the sidewalk but cannot hear the sound because the frequency is too high (from 16.5, the frequency of sound must be between 20-20,000 Hz to be audible for most people). When the car is moving, however, this person can hear the sound.

(a) Is the car moving toward or away from the person? Explain.

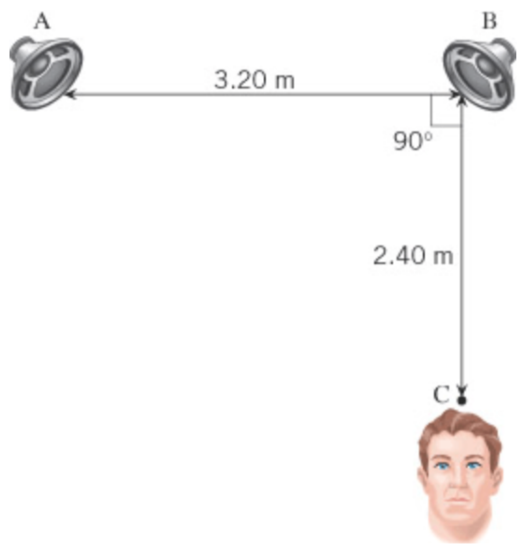
(b) If the speed of sound is 343 m/s, what is the minimum speed of the moving car?

Chapter 17.1 - Constructive and Destructive Interference

(Ch 17, Example 1, Problem #55) Loudspeakers A and B are vibrating in phase and are playing the same tone, which has a frequency of 250 Hz. Assume the speed of sound is 343 m/s.

(a) Does the listener at point C experience destructive interference (quiet sound) or constructive interference (loud sound)? Justify your answer.

(b) If you move speaker A to the left by some distance, what is the distance from speaker B where you will have the same situation (constructive or destructive interference) as experienced in part a for the first time as you move left?



Chapter 17.2 - Constructive and Destructive Interference

(Ch 17, #9) Two loudspeakers on a concert stage are vibrating in phase. A listener is 50.5 m from the left speaker and 26.0 m from the right one. The listener can respond to all frequencies from 20 to 20,000 Hz, and the speed of sound is 343 m/s. What are the two lowest frequencies that can be heard loudly due to constructive interference?

Chapter 17.3 - Diffraction

(Ch 17, #13) Sound exits a diffraction horn loudspeaker through a rectangular opening like a small doorway. Such a loudspeaker is mounted outside on a pole. In winter, when the temperature is 273 K, the diffraction angle has a value of 15.0°. What is the diffraction angle for the same sound on a summer day when the temperature is 311 K?

<u>Chapter 17.4 - Beats</u>

(Ch 17, #24) Two cars have identical horns, each emitting a frequency of 395 Hz. One of the cars is moving with a speed of 12.0 m/s toward an observer waiting at a corner, and the other car is parked. The speed of sound is 343 m/s. What is the beat frequency heard by the observer?

Chapter 17.5 - Standing Waves

(Ch 17, #29) On a cello, the string with the largest linear density (0.0156 kg/m) is the C string. This string produces a fundamental frequency of 65.4 Hz and has a length of 0.800 m between the two fixed ends. Find the tension in the string.

Chapter 17.6 - Standing Waves

(Ch 17, #33) A string has a linear density of 0.0085 kg/m and is under a tension of 280 N. The string is 1.8 m long, fixed at both ends, and is vibrating in the standing wave pattern shown below. Determine

(a) the speed,
(b) the wavelength and
(c) the frequency of the traveling waves that make up the standing wave.