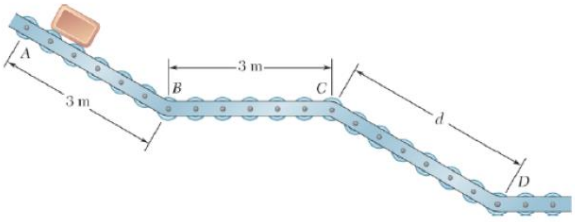
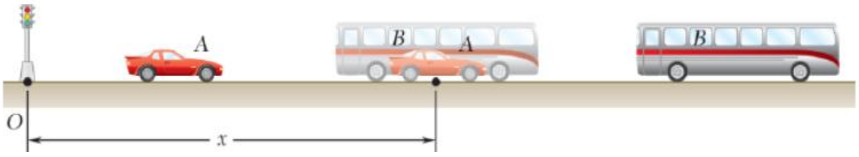
MIE100-Winter 2017
Assignment week 1

1. Based on experimental observations, the acceleration of a particle is defined by the relation $a = -(0.1 + \sin(x/b))$, where a and x are expressed in m/s^2 and meters, respectively. Know that b = 0.8 m and that v = 1 m/s when x = 0. Determine the velocity of the particle when $x = -1$ m. (Round the final answer to three decimal places.)

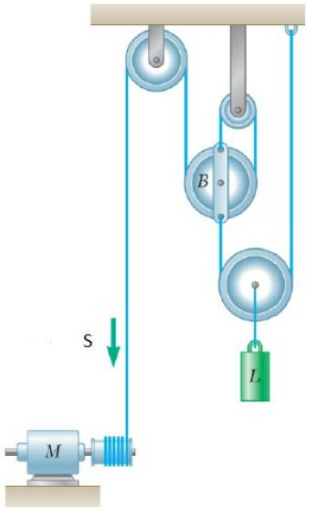
2. A small package is released from rest at A and moves along the skate wheel conveyor ABCD. The package has a uniform acceleration of 6 m/s2 as it moves down sections AB and CD, and its velocity is constant between B and C. The velocity of the package at D is 7.2 m/s. Determine the time required for the package to reach D. (Round the final answer to two decimal places.)



3. Automobile A starts from O and accelerates at the constant rate of 0.75 m/s^2. A short time later it is passed by bus B which is traveling in the opposite direction at a constant speed of 6 m/s. Knowing that bus B passes point O 20 s after automobile A started from there, determine when and where the vehicles passed each other. (Round the time to two decimal places and the position to one decimal place.)

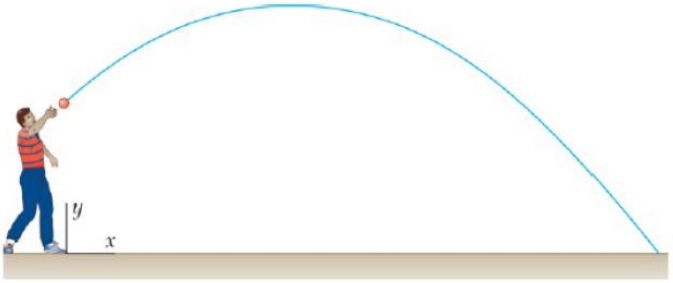


4. The motor M reels in the cable at a constant rate of 100 mm/s. Determine the velocity of load L. (Round the final answer to two decimal places.)

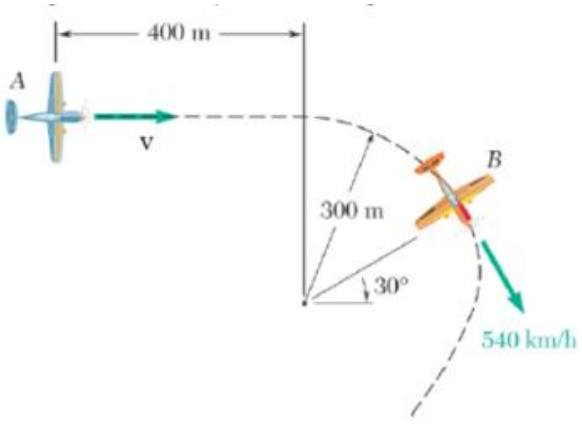


MIE100-Winter 2017
Assignment week 2

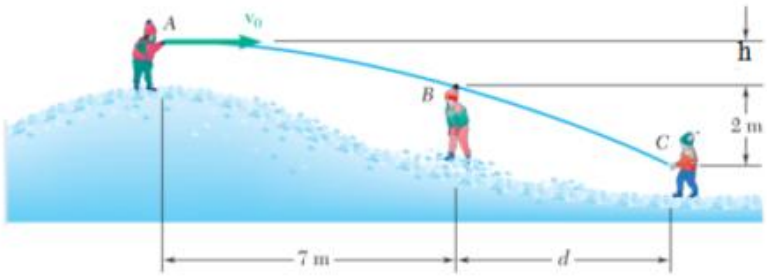
1. A ball is thrown so that the motion is defined by the equations, $x = 4.4t$ and $y=2 + 6t - 4.9\ t^2$, where x and y are expressed in meters and t is expressed in seconds. Determine the velocity at t = 1 s and the horizontal distance the ball travels before hitting the ground. (Round the final answer to two decimal places.)



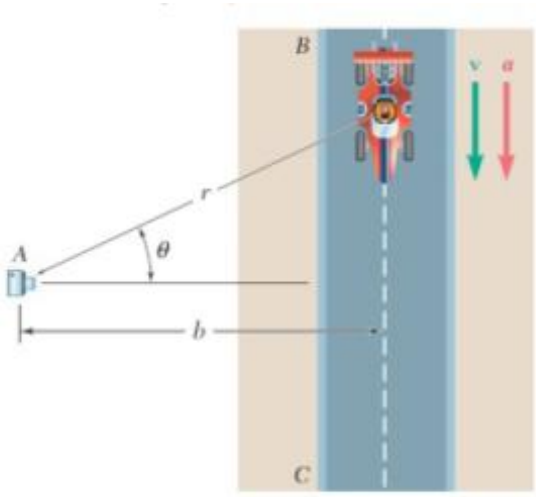
2. At a given instant in an airplane race, airplane A is flying horizontally in a straight line at a speed of 480 km/h, and its speed is being increased at the rate of 8 m/s^2. Airplane B is flying at the same altitude as airplane A and, as it rounds a pylon, is following a circular path of 300-m radius. At the given instant, the speed of B is being decreased at the rate of 3 m/s^2. Determine the acceleration of B relative to A. (Round the final answer to one decimal place.)



3. Three children are throwing snowballs at each other. Child A throws a snowball with a horizontal velocity v_0 which just passes over the head of child B and hits child C. Consider h = 1.5 m. Determine the radius of curvature of the trajectory described by the snowball at Point B. (Round the final answer to one decimal place.)

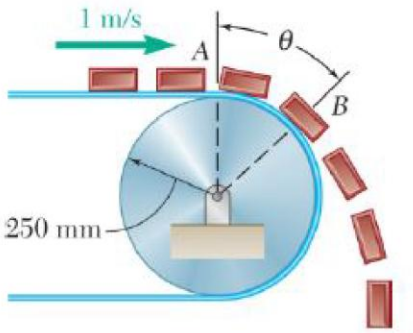


4. To study the performance of a race car, a high-speed camera is positioned at point A. The camera is mounted on a mechanism which permits it to record the motion of the car as the car travels on straightaway BC. It took 0.5 s for the car to travel from the position θ = 60° to the position θ = 35°. Knowing that b = 28 m, determine the average speed of the car during the 0.5s interval. (Round the final answer to one decimal place.)

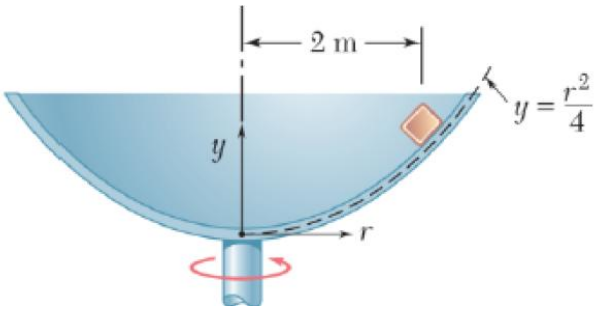


MIE100-Winter 2017
Assignment week 3

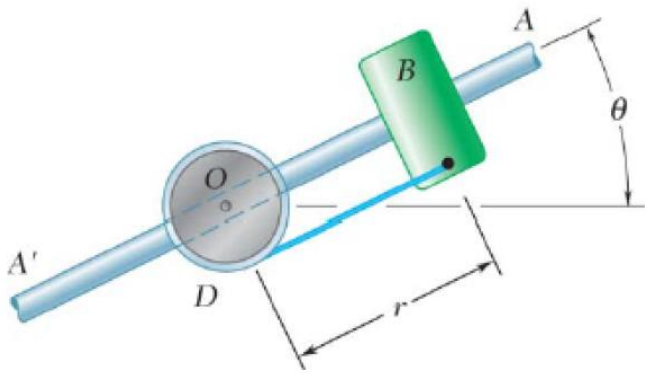
1. A series of small packages, each with a mass of 4.5 kg, are discharged from a conveyor belt as shown. Assume that the coefficient of static friction between each package and the conveyor belt is 0.4. Determine the force exerted by the belt on a package just after it has passed Point *A*.



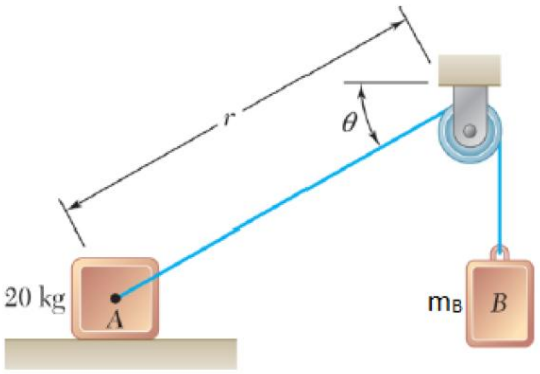
2. A 3kg block is at rest relative to a parabolic dish which rotates at a constant rate about a vertical axis. Knowing that the coefficient of static friction is 0.52 and that r = 2 m, determine the maximum allowable velocity v of the block.



3. The 5.5kg collar B slides on the frictionless arm AA'. The arm is attached to drum D and rotates about O in a horizontal plane at the rate $\dot{\theta}$ = 0.75t, where $\dot{\theta}$ and t are expressed in rad/s and seconds, respectively. As the armdrum assembly rotates, a mechanism within the drum releases cord so that the collar moves outward from O with a constant speed of 0.5 m/s. Knowing that at t = 0, r = 0, determine the time at which the tension in the cord is equal to the magnitude of the horizontal force exerted on B by arm AA'.



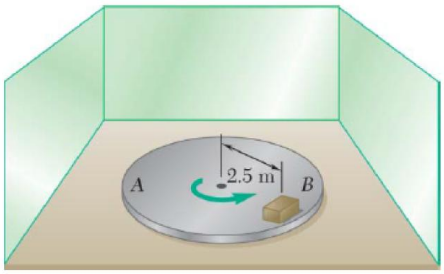
4. The two blocks are released from rest when r = 0.8 m and θ = 30°. The mass of block B is 33 kg. Neglect the mass of the pulley and the effect of friction in the pulley and between block A and the horizontal surface. Determine the initial acceleration of block A.



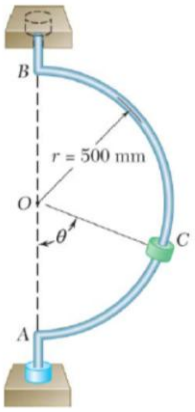
MIE100-Winter 2017
Assignment week 4

1. A 12-kg projectile fired vertically with an initial velocity of 90 m/s, reaches a maximum height and falls to the ground. The aerodynamic drag D has a magnitude $D = 0.0024v^2$ where D and v are expressed in Newtons and m/s, respectively. The direction of the drag is always opposite to the direction of the velocity. Determine the maximum height of the trajectory.

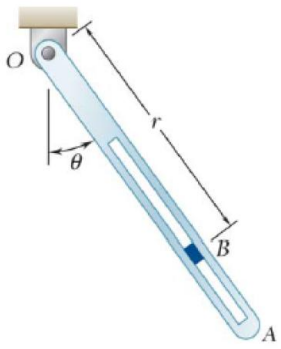
2. A turntable A is built into a stage for use in a theatrical production. It is observed during a rehearsal that a trunk B starts to slide on the turntable 10 s after the turntable begins to rotate. Knowing that the trunk undergoes a constant tangential acceleration of 0.28 m/s^2, determine the coefficient of static friction between the trunk and the turntable.



3. A small 400-g collar C can slide on a semicircular rod which is made to rotate about the vertical AB at a constant rate of 7.5 rad/s. The coefficients of friction are μs = 0.25 and μk = 0.20. Determine the magnitude of the friction force exerted on the collar immediately after release in the position corresponding to θ = 75°.

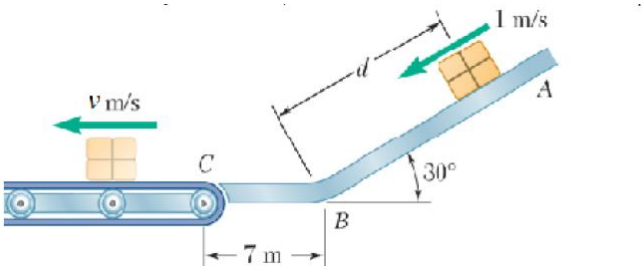


4. A 0.5-kg block B slides without friction inside a slot cut in arm OA which rotates in a vertical plane. The rod has a constant angular acceleration $\ddot{\theta}$ = 10 rad/s^2. Know that when = 54° and r = 0.8 m the velocity of the block is zero. Determine at this instant, the relative acceleration of the block with respect to the arm.

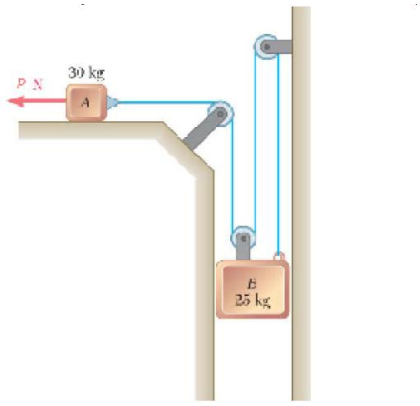


MIE100-Winter 2017
Assignment week 5

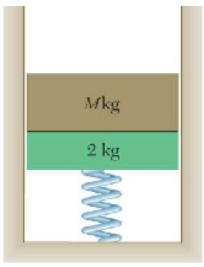
1. Packages are thrown down an incline at *A* with a velocity of 1 m/s. The packages slide along the surface *ABC* to a conveyor belt which moves with a velocity of v = 5.5 m/s. Knowing that μ_k = 0.25 between the packages and the surface *ABC*, determine the distance *d* if the packages are to arrive at *C* with a velocity of 5.5 m/s.



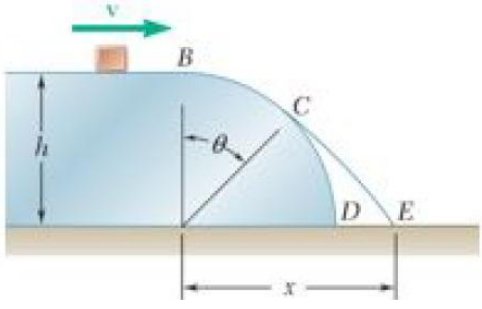
2. The system shown is at rest when a constant 350-N force is applied to block A. Neglect the masses of the pulleys and the effect of friction in the pulleys and between block A and the horizontal surface. Determine the tension in the cable.



3. A 5-kg block rests on top of a 2-kg block supported by, but not attached to, a spring of constant 40 N/m. The upper block is suddenly removed. Determine the maximum speed reached by the 2kg block.

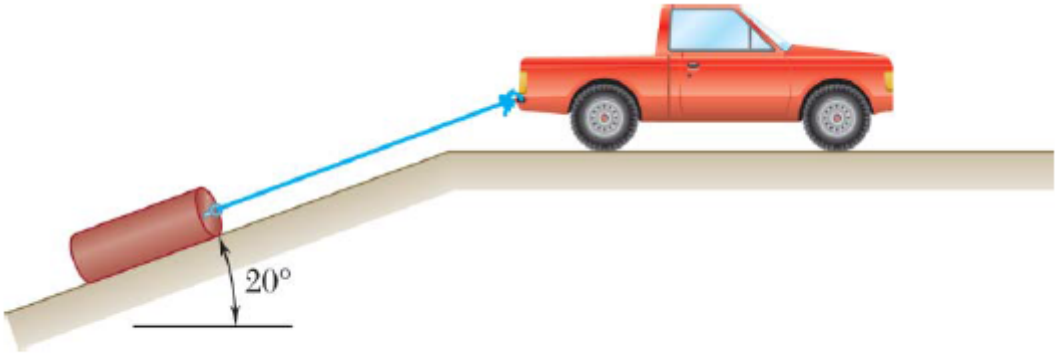


4. A small block slides at a speed v on a horizontal surface. Knowing that h = 1.3 m, determine the required speed of the block if it is to leave the cylindrical surface BCD when θ = 35°.



1. Award: **10.00 points**

A truck is hauling a 300-kg log out of a ditch using a winch attached to the back of the truck. Knowing the winch applies a constant force of 2800 N and the coefficient of kinetic friction between the ground and the log is 0.45, determine the time for the log to reach a speed of 0.5 m/s. (Round the final answer to three decimal places.)



The time is _____ s.

In anticipation of a long 6° upgrade, a bus driver accelerates at a constant rate from 83 km/h to 101.5 km/h in 8 s while still on a level section of the highway. The speed of the bus is 101.5 km/h as it begins to climb the grade at time $t = 0$ and the driver does not change the setting of the throttle or shift gears.

2. Award: **10.00 points**

Determine the speed of the bus when t = 10 s. (Round the final answer to two decimal places.)
(You must provide an answer before moving to the next part.)

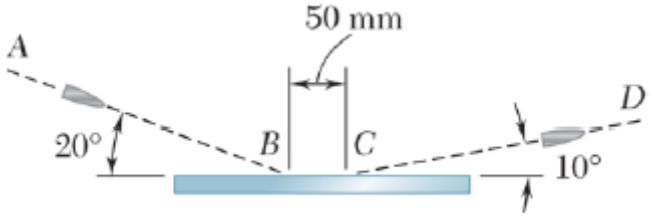
The speed of the bus is _____ km/h.

3. Award: **10.00 points**

Determine the time when the speed is 60 km/h. (Round the final answer to two decimal places.)
The time is _____ s.

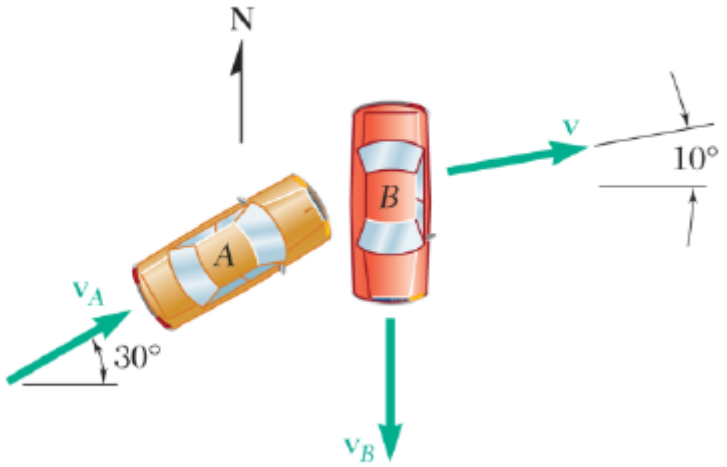
4. Award: **10.00 points**

A 24-g steel-jacketed bullet is fired with a velocity of 610 m/s toward a steel plate and ricochets along path *CD* with a velocity 500 m/s. Knowing that the bullet leaves a 50-mm scratch on the surface of the plate and assuming that it has an average speed of 600 m/s while in contact with the plate, determine the magnitude and direction of the impulsive force exerted by the plate on the bullet. (Round the final answers to one decimal place.)



The magnitude of the impulsive force is ____ kN and its direction is ____ ° to the plate.

At an intersection car *B* was traveling south and car *A* was traveling 30° north of east when they slammed into each other. Upon investigation, it was found that after the crash, the two cars got stuck and skidded off at an angle of 10° north of east. Each driver claimed that he was going at the speed limit of 50 km/h and that he tried to slow down, but couldn't avoid the crash because the other driver was going a lot faster. The masses of cars *A* and *B* were 1600 kg and 1300 kg, respectively.

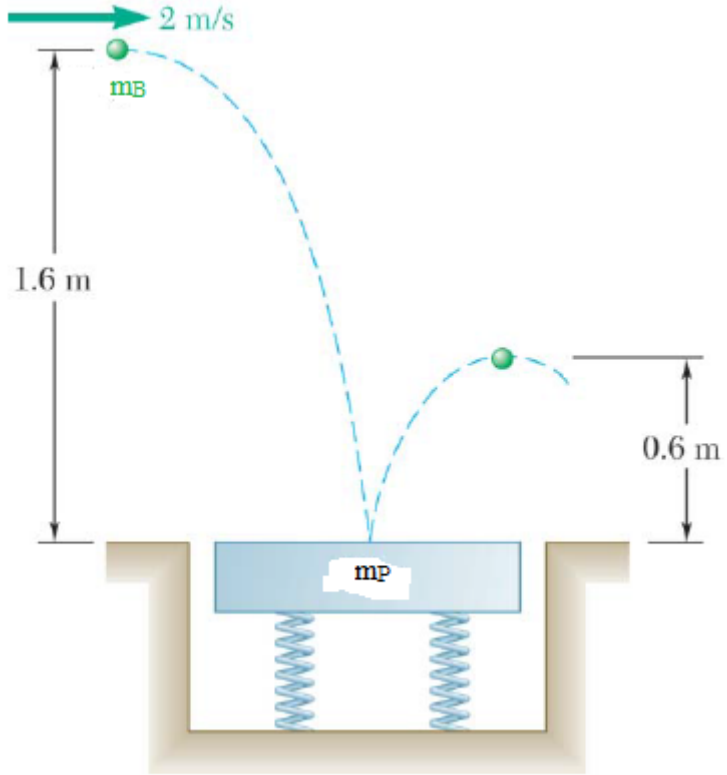


5. Award: **10.00 points**

Determine the relationship between the speed of car *A* (v_A) and the speed of car *B* (v_B). (Round the final answer to two decimal places.)
(You must provide an answer before moving to the next part.)

v_A = _____ v_B.
Which car was going faster?
(Click to select) ▼

A 55-g ball is projected from a height of 1.6 m with a horizontal velocity of 2 m/s and bounces from a 360-g smooth plate supported by springs. The height of the rebound is 0.6 m.



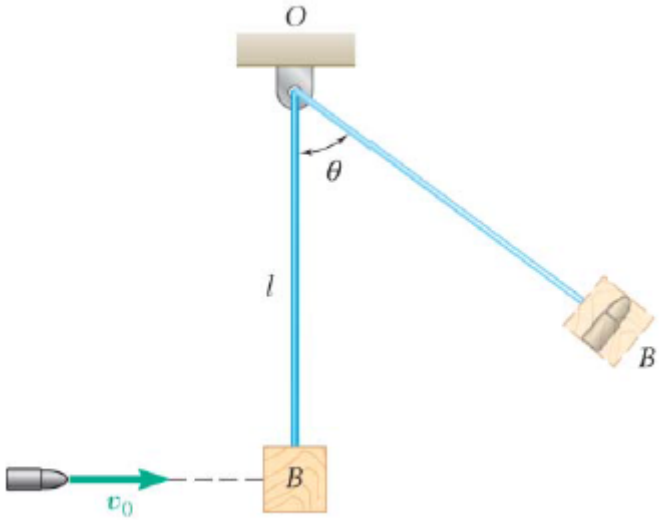
6.

Award: **10.00 points**

Determine the velocity of the plate immediately after the impact. (Round the final answer to three decimal places.)
(You must provide an answer before moving to the next part.)

The velocity of the plate immediately after the impact is _____ m/s ↓.

A ballistic pendulum is used to measure the speed of high-speed projectiles. A bullet *A* weighing 18 g is fired into a 2.2-kg wood block *B* suspended by a cord of length $l = 2.2$ m. The block then swings through a maximum angle of $\theta = 60°$.

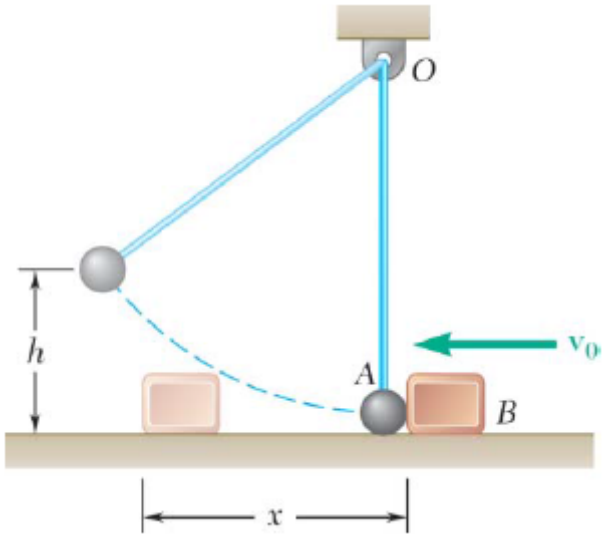


7.

Award: **10.00 points**

Determine the initial speed of the bullet v_0. (Round the final answer to two decimal places.)
The initial speed of the bullet is _____ m/s.

A 1-kg block *B* is moving with a velocity $\mathbf{v}_0$ of magnitude $v_0 = 2.5$ m/s as it hits the 0.5-kg sphere *A*, which is at rest and hanging from a cord attached at *O*. Take $\mu_k = 0.6$ between the block and the horizontal surface and $e = 0.8$ between the block and the sphere.

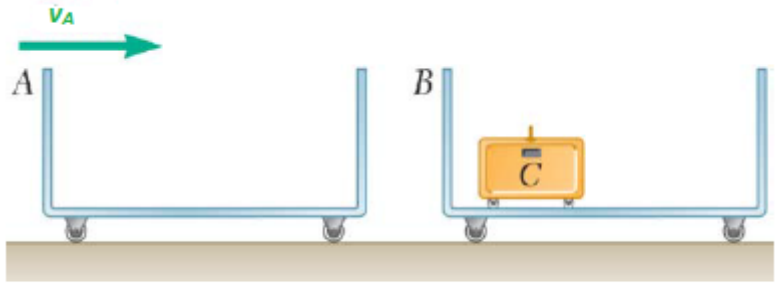


8. Award: **10.00 points**

Determine the maximum height *h* reached by the sphere after impact. (Round the final answer to three decimal places.)

The maximum height *h* is _____ m.

After having been pushed by an airline employee, an empty 40-kg luggage carrier *A* hits with a velocity of v_A = 9.5 m/s an identical carrier *B* containing a 15-kg suitcase at rest equipped with rollers. The impact causes the suitcase to initially roll into the left wall of carrier *B*, then upon impact with the left wall of carrier *B*, roll to the right. The coefficient of restitution between the two carriers is 0.80 and that the coefficient of restitution between the suitcase and the wall of carrier *B* is 0.30.



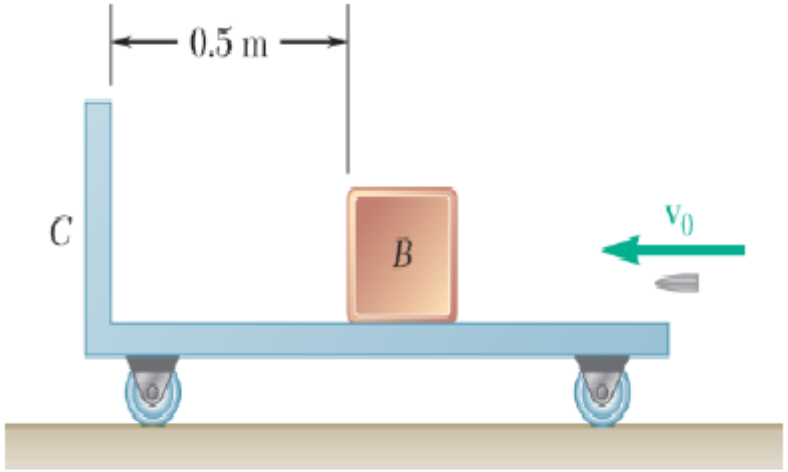
9. Award: **10.00 points**

Determine the velocity of carrier *B* after the suitcase hits its wall for the first time. (Round the final answer to two decimal places.) (You must provide an answer before moving to the next part.)

The velocity of carrier *B* is _____ m/s.

10. Award: **10.00 points**

A 0.03-kg bullet is fired with a horizontal velocity of 480 m/s and becomes embedded in block *B* which has a mass of 3 kg. After the impact, block *B* slides on a 30-kg carrier *C* until it impacts the end of the carrier. Knowing the impact between *B* and *C* is perfectly plastic and the coefficient of kinetic friction between *B* and *C* is 0.2, determine the velocity of the bullet and block *B* after the first impact and the final velocity of the carrier. (Round the final answer answers to two decimal places.)

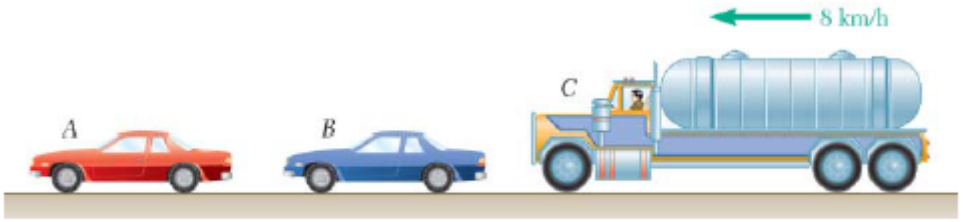


The velocity of the bullet and block *B* after the first impact is _____ m/s ←.
The final velocity of the carrier is _____ m/s ←.

11. Award: **10.00 points**

Two identical 1350-kg automobiles *A* and *B* are at rest with their brakes released when *B* is struck by a 5700-kg truck *C* which is moving to the left at 8 km/h. A second collision then occurs when *B* strikes *A*. Assuming the first collision is perfectly plastic and the second

collision is perfectly elastic, determine the velocities of the three vehicles just after the second collision. (Round the final answers to two decimal places.)



The velocity of car *A* is $\mathbf{v}_A$ = ____ km/hr ←.
The velocity of car *B* is $\mathbf{v}_B$ = ____ km/hr ←.
The velocity of truck *C* is $\mathbf{v}_C$ = ____ km/hr ←.

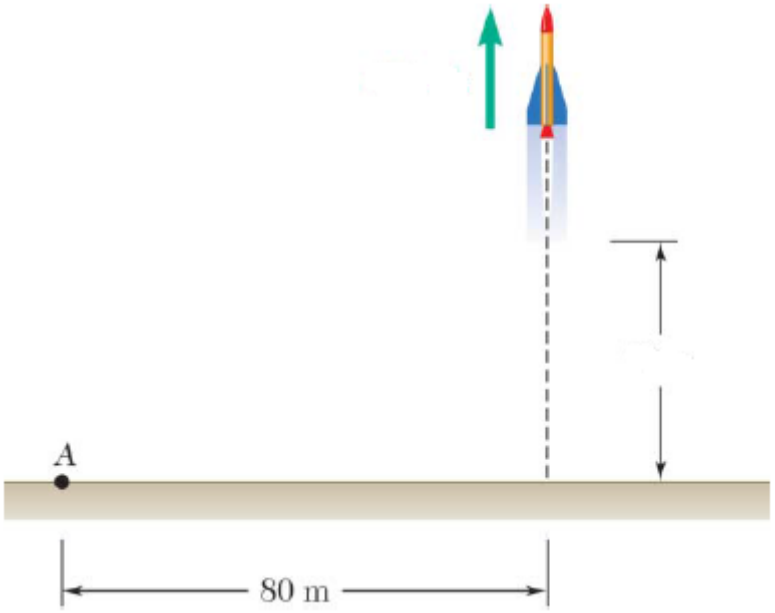
12. Award: **10.00 points**

Two identical cars *A* and *B* are at rest on a loading dock with brakes released. Car *C*, of a slightly different style but of the same weight, has been pushed by dock workers and hits car *B* with a velocity of 2.25 m/s. Knowing that the coefficient of restitution is 0.8 between *B* and *C* and 0.5 between *A* and *B*, determine the velocity of each car after all collisions have taken place. (Round your answer to three decimal places.)

The velocity of car *A* is ____ m/s ←.
The velocity of car *B* is ____ m/s ←.
The velocity of car *C* is ____ m/s ←.

13. Award: 10.00 points

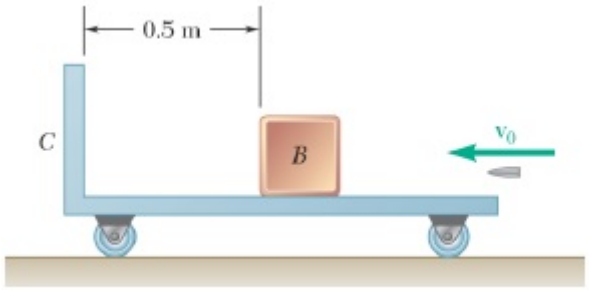
A 3-kg model rocket is launched vertically and reaches an altitude of 70 m with a speed of 30 m/s at the end of powered flight, time $t = 0$. As the rocket approaches its maximum altitude it explodes into two parts of masses m_A = 1.05 kg and m_B = 1.95 kg. Part A is observed to strike the ground 80 m west of the launch point at t = 6 s. Determine the position of part B at that time. (Round the final answers to one decimal place.)



The position of part B is _____ m (east) and _____ m (up).

14. Award: 10.00 points

A 30-g bullet is fired with a horizontal velocity of 500 m/s and becomes embedded in block *B* which has a mass of 3 kg. After the impact, block *B* slides on 30-kg carrier *C* until it impacts the end of the carrier. Knowing the impact between *B* and *C* is perfectly plastic and the coefficient of kinetic friction between *B* and *C* is 0.2, determine the energy loss due to friction and the impacts. (Round the final answers to two decimal places.)



The energy lost due to friction is _____ J.
The impact loss due to *AB* impacting the carrier is _____ J.
The impact loss at first impact is _____ J.

Two automobiles *A* and *B* of mass m_A and m_B, respectively, are traveling in opposite directions when they collide head on. The impact is assumed to be perfectly plastic, and it is further assumed that the energy absorbed by each automobile is equal to its loss of kinetic energy with respect to a moving frame of reference attached to the mass center of the two-vehicle system. The energy absorbed by automobile *A* and by automobile *B* is denoted by E_A and E_B.

15.

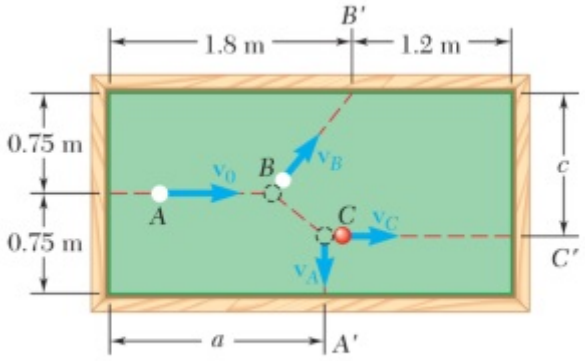
Award: **10.00 points**

Compute E_A and E_B knowing that m_A =1600 kg and m_B = 900 kg and that the speeds of A and B are 105 km/h and 75 km/h, respectively.
The value of E_A is determined to be _____ kJ.
The value of E_B is determined to be _____ kJ.

16.

Award: **10.00 points**

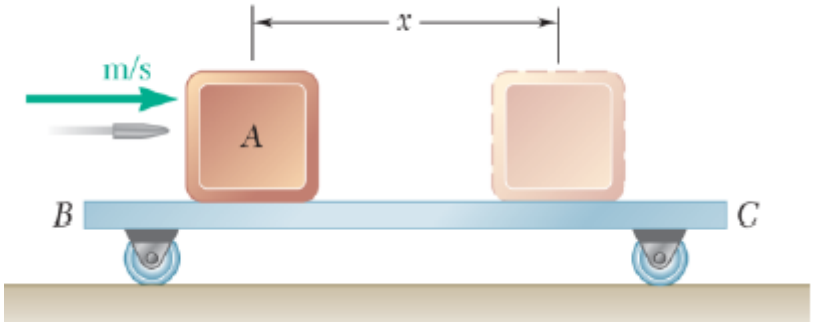
In a game of billiards, ball A is given an initial velocity $\mathbf{v}_0$ along the longitudinal axis of the table. It hits ball B and then ball C, which are both at rest. Balls A and C are observed to hit the sides of the table
squarely at A' and C', respectively, and ball B is observed to hit the side obliquely at B'. Knowing that v_0 = 5 m/s, v_A = 1.92 m/s and a = 1.65 m, determine the velocities $\mathbf{v}_B$ and $\mathbf{v}_C$ of balls B and C
and the Point C' where ball C hits the side of the table. Assume frictionless surfaces and perfectly elastic impacts (that is, conservation of energy).



The velocity of ball B is _____ m/s ∡ _____°. (Round the final answers to two decimal places.)
The velocity of ball C is _____ m/s →. (Round the final answer to two decimal places.)
The Point C' where ball C hits the side of the table is _____ m. (Round the final answer to three decimal places.)

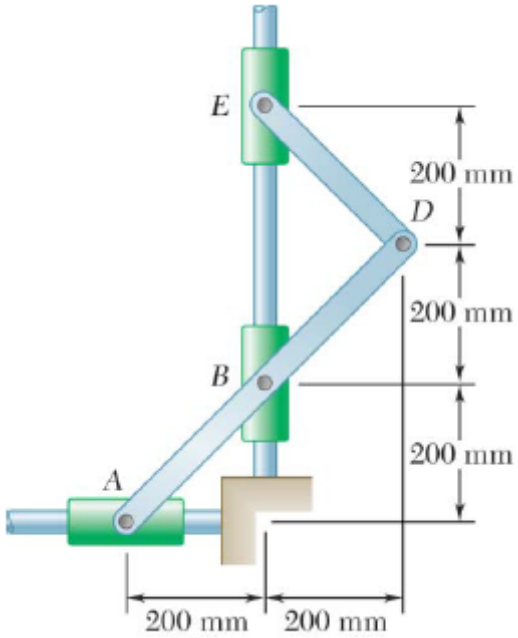
17. Award: **10.00 points**

A 30-g bullet is fired with a velocity of 500 m/s into block *A*, which has a mass of 5 kg. The coefficient of kinetic friction between block *A* and cart *BC* is 0.50. Knowing that the cart has a mass of 4 kg and can roll freely, determine the final velocity of the cart and block and the final position of the block on the cart. (Round the final answers to three decimal places.)



The final velocity of the cart and block is _____ m/s.
The final position of the cart and block is _____ m.

Two rods *ABD* and *DE* are connected to three collars as shown. The angular velocity of *ABD* is 4.6 rad/s clockwise at the instant shown.



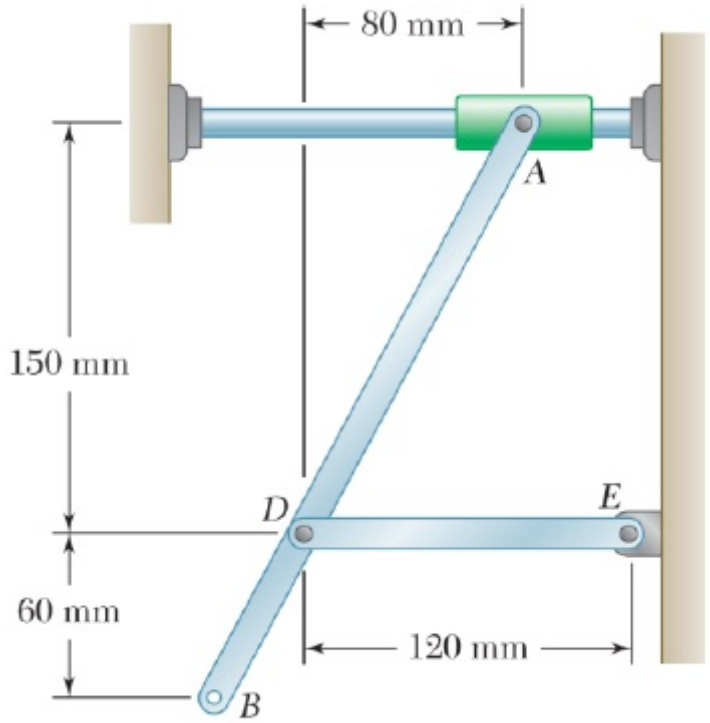
1. Award: **10.00 points**

Determine the angular velocity of *DE.* (Round the final answer to one decimal place.) (You must provide an answer before moving to the next part.)

The angular velocity of *DE* is [ ] rad/s ↺.

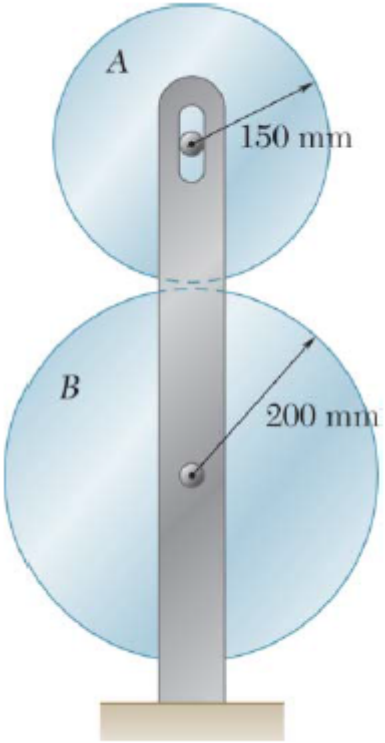
2. Award: **10.00 points**

Knowing that at the instant shown the velocity of collar *A* is 920 mm/s to the left, determine the angular velocity of rod *ADB* and the velocity of point *B*.



The angular velocity of rod *ADB* is [ ] rad/s ↺. (Round the final answer to two decimal places.)
The velocity of point *B* is [ ] mm/s ∢ 61.8°. (Round the final answer to the nearest whole number.)

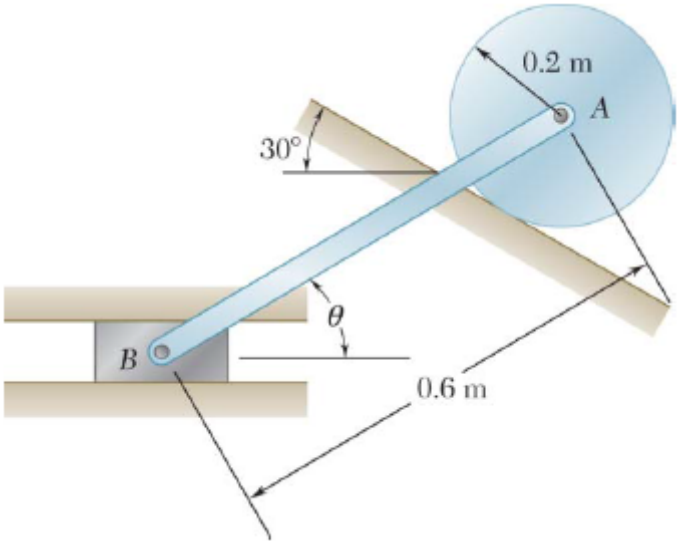
Two friction disks *A* and *B* are brought into contact when the angular velocity of disk *A* is 240 rpm counterclockwise and disk *B* is at rest. A period of slipping follows and disk *B* makes 2 revolutions before reaching its final angular velocity. Assume that the angular acceleration of each disk is constant and inversely proportional to the cube of its radius.



1. Award: **10.00 points**

This question and its points have been dropped for all students

The disk is released from rest and rolls down the incline. The speed of A is 1.2 m/s when $\theta = 0°$.



2.

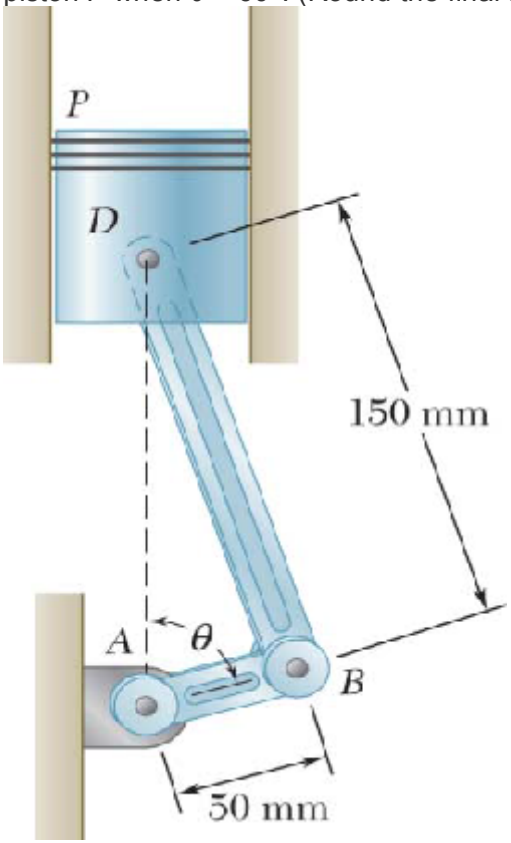
Award: **10.00 points**

Determine the angular velocity of the rod. (Round the final answer to three decimal places.)

The angular velocity of the rod is _____ rad/s ↻.

3. Award: **10.00 points**

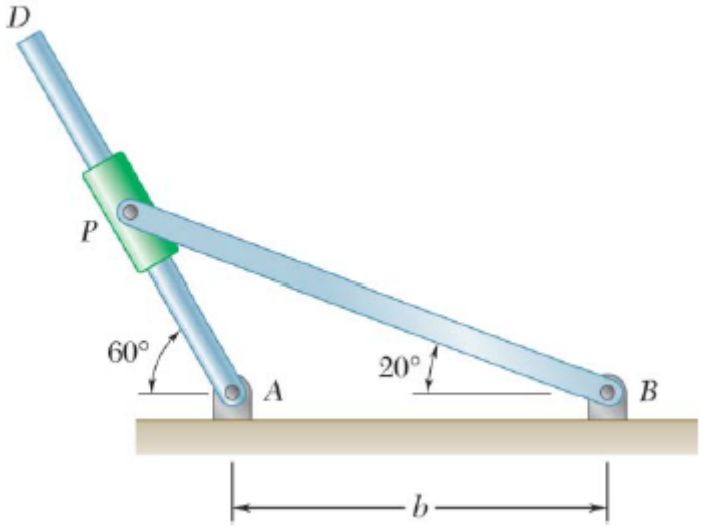
Knowing that crank *AB* rotates about point *A* with a constant angular velocity of 910 rpm clockwise, determine the acceleration of the piston *P* when $\theta = 60°$. (Round the final answer to two decimal places.)



The acceleration of the piston *P* when $\theta = 60°$ is _____ $m/s^2 \downarrow$.

Two rotating rods are connected by slider block *P*. The rod attached at *A* rotates with a constant angular velocity ω_A.

Given: $b = 300$ mm, $\omega_A = 11.4$ rad/s.



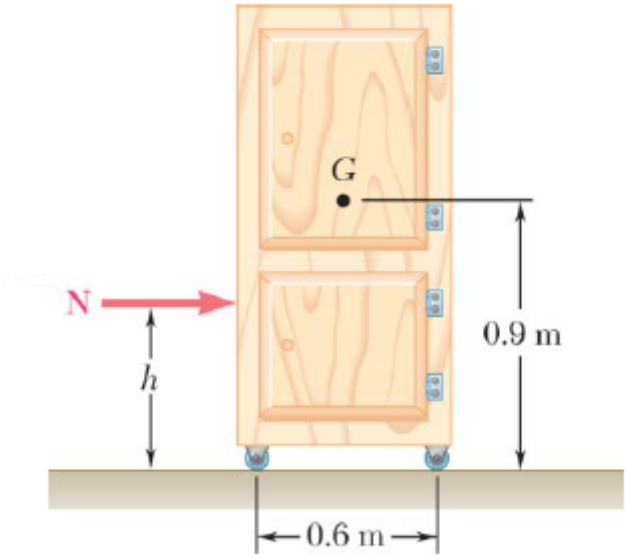
4.

Award: **10.00 points**

For the position shown, determine the angular velocity of the rod attached at *B*. (Round the final answer to two decimal places.)

The angular velocity of the rod attached at *B* is [ ] rad/s.

A 29-kg cabinet is mounted on casters that are locked and slide on the rough floor ($\mu_k = 0.34$). A 145-N force is applied as shown in the figure.

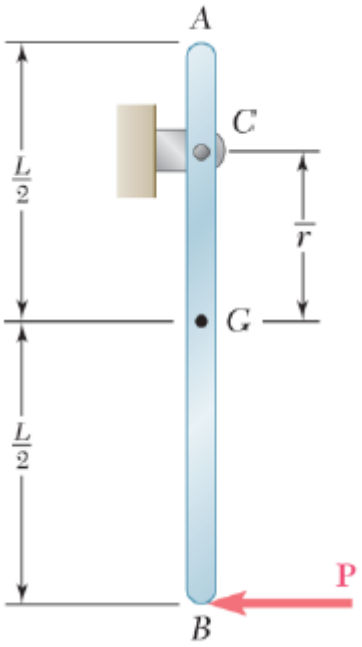


1. Award: **10.00 points**

Determine the range of values of h for which the cabinet will not tip. (Round the final answer to three decimal places.)

Range of values of h: $h \leq$ ____

A uniform slender rod of length L = 980 mm and mass m = 4.4 kg is suspended from a hinge at C. A horizontal force **P** of magnitude 75 N is applied at end B.



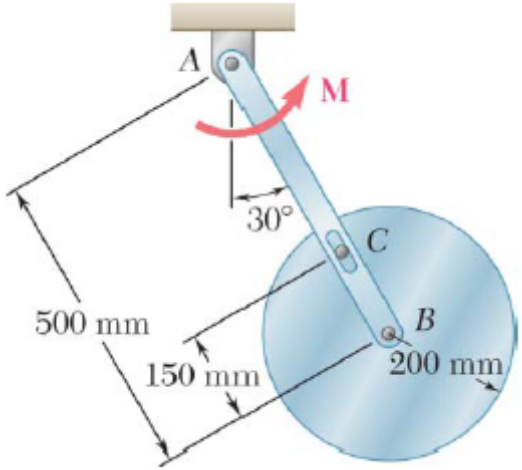
2.

Award: **10.00 points**

Determine the distance $\bar{r}$ for which the horizontal component of the reaction at C is zero. (Round the final answer to the nearest whole number.)

The distance is _____ mm.

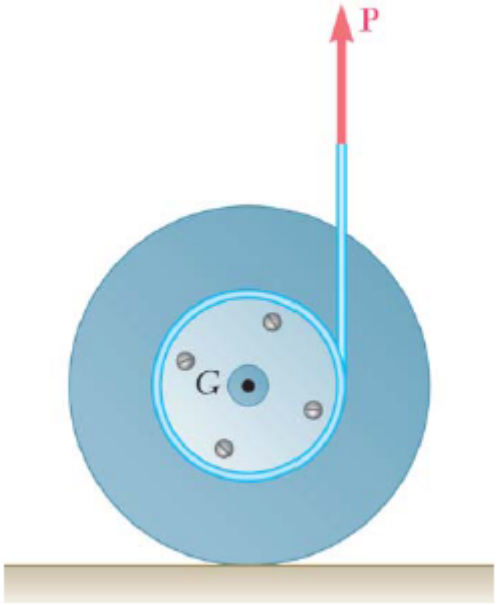
A 9-kg uniform disk is attached to the 5-kg slender rod *AB* by means of frictionless pins at *B* and *C*. The assembly rotates in a vertical plane under the combined effect of gravity and of a couple **M** which is
applied to rod *AB*. At the instant shown, the assembly has an angular velocity of 6 rad/s and an angular acceleration of 28 rad/s^2, both counterclockwise.



3. Award: **10.00 points**

Determine the couple **M**. (Round the final answer to one decimal place.)
The couple **M** is _____ N·m ↺.

A drum of 60-mm radius is attached to a disk of 120-mm radius. The disk and drum have a total mass of 6 kg and a combined radius of gyration of 90 mm. A cord is attached as shown and pulled with a force **P** of magnitude 20 N. The disk rolls without sliding.



4. Award: **10.00 points**

Determine the minimum value of the coefficient of static friction compatible with this motion. (Round the final answer to three decimal places.)

The minimum value of the coefficient of static friction is _____.

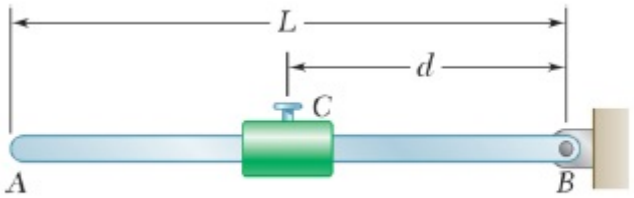
1. Award: **10.00 points**

A 205-kg flywheel is at rest when a constant 300 N•m couple is applied. After executing 560 revolutions, the flywheel reaches its rated speed of 2400 rpm. Knowing that the radius of gyration of the flywheel is 400 mm, determine the average magnitude of the couple due to kinetic friction in the bearing. (Round the final answer to two decimal places.)

The average magnitude of the couple due to kinetic friction in the bearing is _____ N•m.

2. Award: **10.00 points**

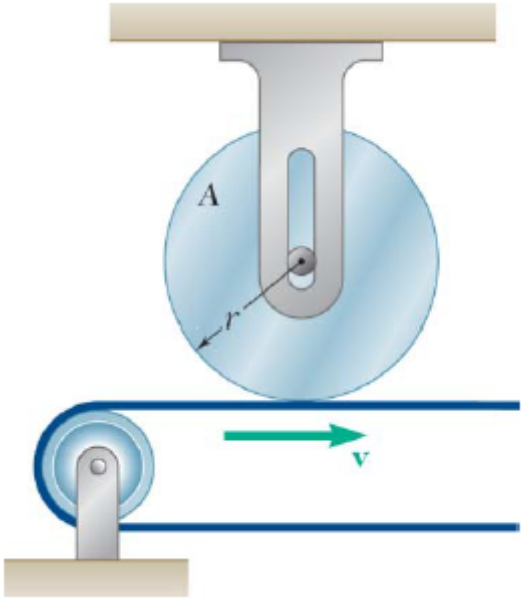
A collar with a mass of 1 kg is rigidly attached at a distance d = 300 mm from the end of a uniform slender rod AB. The rod has a mass of 3 kg and is of length L = 600 mm. Knowing that the rod is released from rest in the position shown, determine the angular velocity of the rod after it has rotated through 90°. (Round the final answer to two decimal places.)



The angular velocity of the rod after it has rotated through 90° is _____ rad/s ↺.

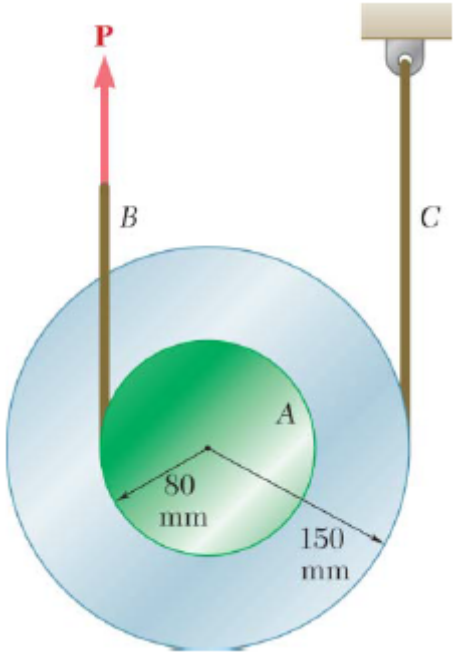
3. Award: **10.00 points**

Disk *A*, of weight 5 lb and radius r = 3 in., is at rest when it is placed in contact with a belt that moves at a constant speed v = 51.5 ft/s. Knowing that μ_k = 0.20 between the disk and the belt, determine the time required for the disk to reach a constant angular velocity. (Round the final answer to two decimal places.)



The time required for the disk to reach a constant angular velocity is _____ s.

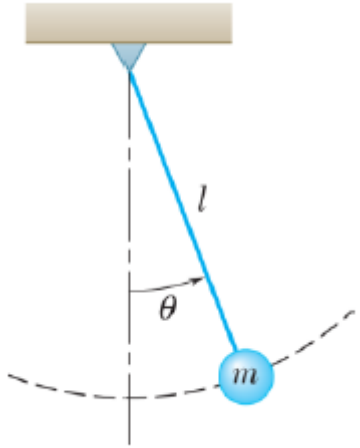
The double pulley shown has a mass of 3.36 kg and a radius of gyration of 100 mm. When the pulley is at rest, a force **P** of magnitude 24 N is applied to cord *B*.



4. Award: **10.00 points**

This question and its points have been dropped for all students

A simple pendulum consisting of a bob attached to a cord of length l = 800 mm oscillates in a vertical plane.

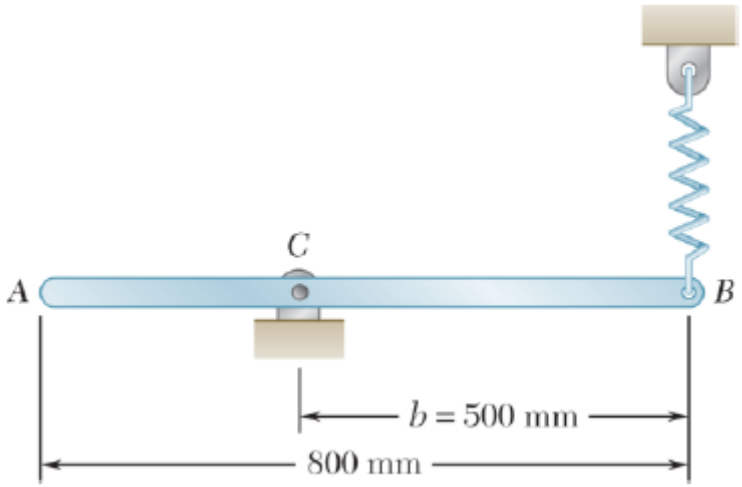


1. Award: **10.00 points**

Assuming simple harmonic motion and knowing that the bob is released from rest when θ = 6°, determine the maximum velocity of the bob. (Round the final answer to the nearest whole number.)

The maximum velocity of the bob is v_m = _____ mm/s.

The uniform rod shown has mass 6 kg and is attached to a spring of constant $k = 780$ N/m. End B of the rod is depressed 10 mm and released.



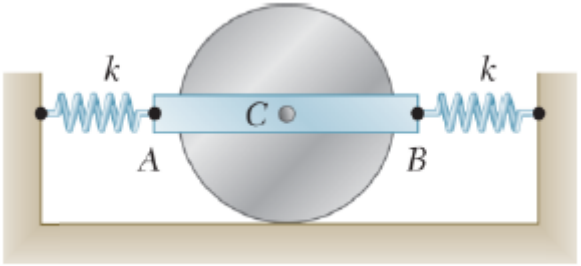
2.

Award: **10.00 points**

Determine the period of vibration. (Round the final answer to three decimal places.)

The period of vibration is _____ s.

A 6-kg uniform cylinder can roll without sliding on a horizontal surface and is attached by a pin at point C to the 4-kg horizontal bar AB. The bar is attached to two springs, each having a constant of $k = 5.8$ kN/m, as shown. The bar is moved 12 mm to the right of the equilibrium position and released.

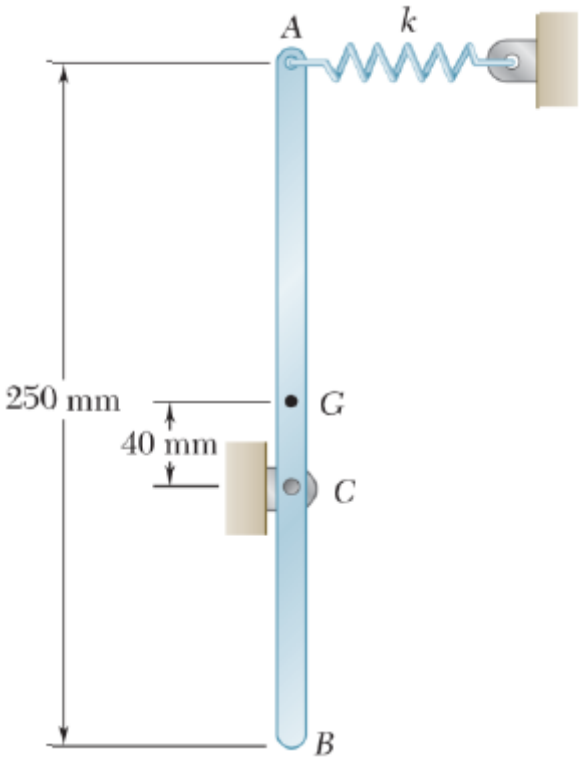


3. Award: **10.00 points**

Determine the period of vibration of the system. (Round the final answer to three decimal places.)

The period of vibration of the system is _____ s.

The 8-kg uniform bar *AB* is hinged at *C* and is attached at *A* to a spring of constant $k = 620$ N/m. End *A* is given a small displacement and released.



4. Award: **10.00 points**

Determine the frequency of small oscillations. (Round the final answer to two decimal places.)
The frequency of small oscillations is _____ Hz.