HOMEWORK PROBLEMS (by CT)

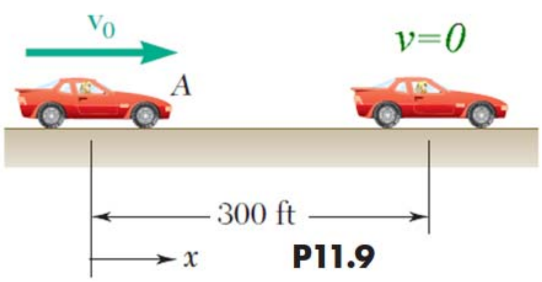
ENGR 240 – DYNAMICS

Problems denoted with an asterisk (*) must include a solution in variable form. The problems descriptions have been altered to add variable names to be used for the given values in the problem. After solving the variable solution, plug in numbers to obtain a numerical solution. Gravity is g.

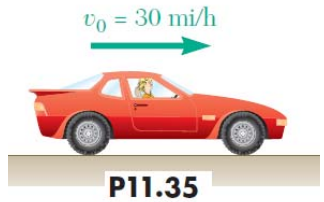
HW 1 – online syllabus Qs ---------------------------

HW 2 – (CH 11 – Particle Kinematics) -----------------

11.5, 9*, 35*, 42, 49*, 51



P11.9



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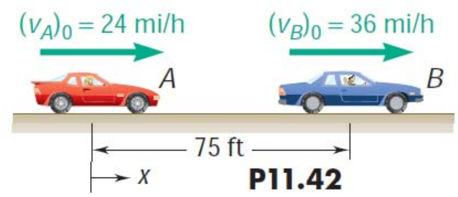
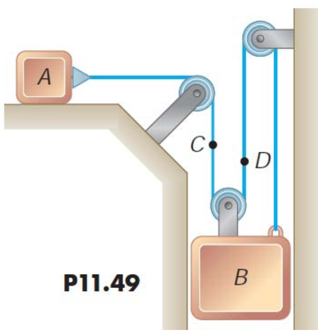
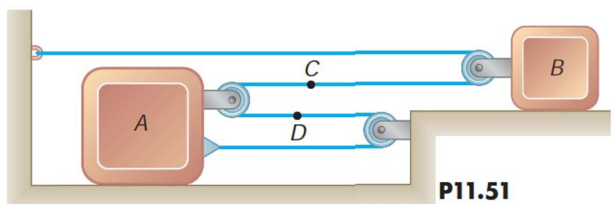


P11.42



P11.49



P11.51

s

1.) 11.5 – A particle moves per $x = 6t^4 - 2t^3 - 12t^2 + 3t + 3$ (x in meters, t in s). Find the time, position x, and velocity v when a = 0.

2.) 11.9* – The brakes of a car are applied, causing it to slow down at a rate of a = –10 ft/s^2. Knowing the car stops in x = 300ft, determine (a) vo, the speed of the car immediately before the brakes were applied, (b) the time, t, required for the car to stop (final velocity is v).

3.) 11.35* – A motorist enters a freeway at vo = 30 mi/hr & accelerates uniformly to $v = 60\,\text{mi/hr}$, traveling distance x = 550 ft before reaching speed v. Determine (a) the acceleration, a, of the car, (b) the time, t, required to reach v.

4.) 11.42 –Automobiles A and B are traveling in adjacent highway lanes and at t = 0 have the positions ($(x_A)_O$ and $(x_B)_O$) and speeds shown. Automobile A has constant acceleration a_A = 1.8 ft/s^2 and B has a constant deceleration (a_B = 1.2 ft/s^2). Determine (a) when and where A will overtake B, (b) the speed of each automobile at that time.

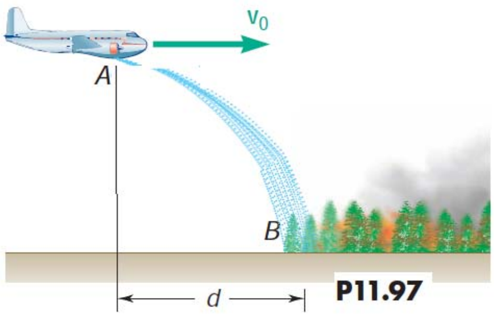
5.) 11.49 – Slider block A moves to the left with constant velocity (v_A = –6 m/s). Determine (a) velocity of block B (v_B), (b) velocity of portion D of cable (v_D), (c) the relative velocity of portion C of the cable with respect to portion D ($v_{C/D}$).

6.) 11.51 – Slider block B moves to the right with constant velocity v_B = 300 mm/s. Find (a) the velocity of slider block A (v_A), (b) the velocity of portion C of the cable (v_C), (c) the velocity of portion D of the cable (v_D), (d) the relative velocity of portion C of the cable with respect to slider block A ($v_{C/A}$).

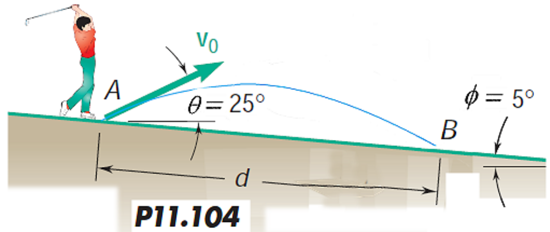
7.) Review – Draw a figure showing a particle in circular motion. Label the radius (r), angle (θ). Then write the equations (as a function of r and θ and their derivatives) for tangential velocity, centripetal acceleration, and tangential acceleration.

HW 3 (CH 11 – Particle Kinematics, cont'd) ------------------------------------

11.97*, 104*, 118, 134*, 145*, 170* (note $\omega = d\beta/dt$), extra prob



P11.97



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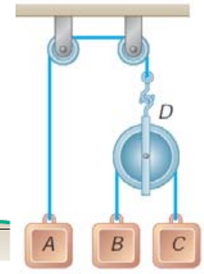
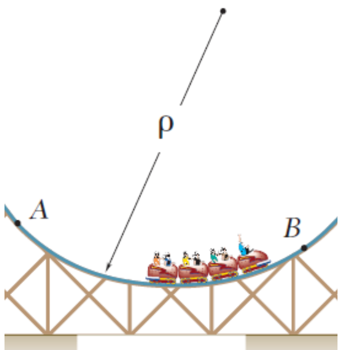
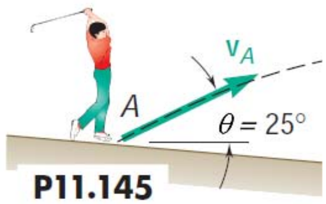


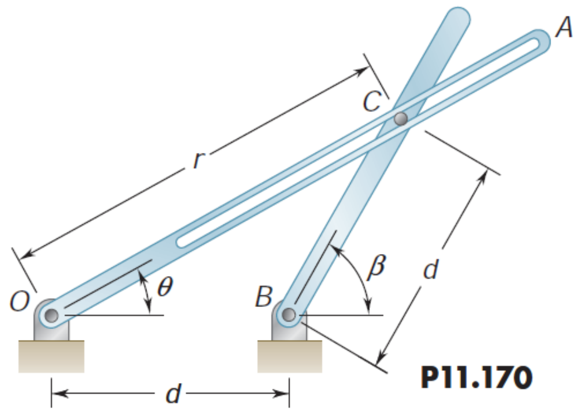
P11.118



P11.134



P11.145



P11.170

1.) 11.97* – An airplane used to drop water on brushfires is flying horizontally in a straight line at vo = 180 mi/h at an altitude of h = 300 ft. Determine the distance d (in ft) at which the pilot should release the water so that it will hit the fire at B.

2.) 11.104* – A golfer hits a golf ball with an initial velocity of vo = 160 ft/s at an angle θ = 25° with the horizontal. Knowing that the fairway slopes downward at an average angle of ϕ = 5°, determine the distance d between the golfer and point B where the ball first lands.

3.) 11.118 – The three blocks shown move with constant velocities. Find the velocity of each block (V_A, V_B, V_C), knowing that the relative velocity of A with respect to C is $v_{A/C}$ = 300 mm/s upward and that the relative velocity of B with respect to A is $v_{B/A}$ = 200 mm/s downward.

4.) 11.134* – Determine the maximum speed (v_{max}) that the cars of the roller-coaster can reach along the circular portion AB of the track (having radius of curvature ρ = 25 m) so that the normal component of their acceleration does not exceed 3g. Express numerical answer in km/hr.

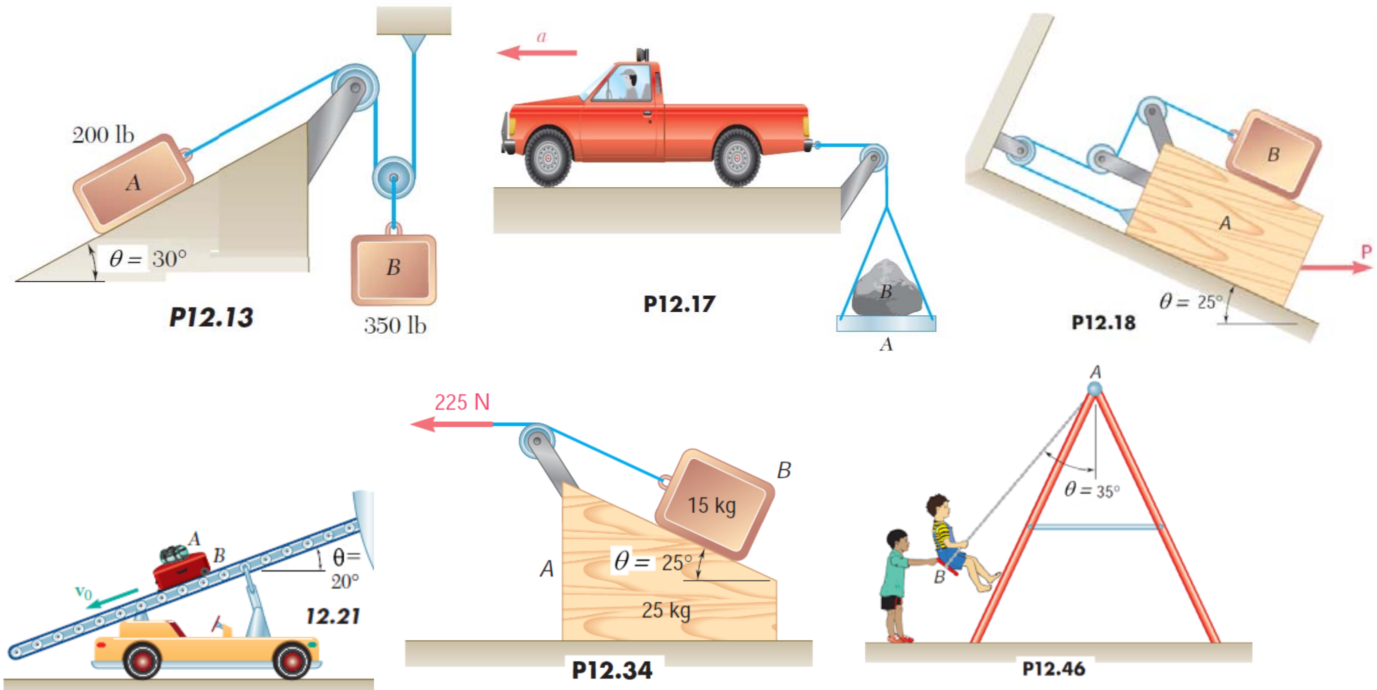
5.) 11.145* – A golfer hits a golf ball from point A with an initial velocity of vo = 50 m/s at an angle of θ = 25° with the horizontal. Determine the radius of curvature of the trajectory described by the ball at (a) point A and (b) the highest point in the trajectory.

6.) 11.170* – Pin C is attached to rod BC and slides freely in the slot of rod OA. Rod BC rotates at a constant rate $\dot{\beta}$. At the instant when β = 60°, find (a) $\dot{r}$ & $\dot{\theta}$ and (b) $\ddot{r}$ & $\ddot{\theta}$ (answers should be in terms of d & $\dot{\beta}$).

7.) Extra problem – derive the radial/transverse kinematics equations for velocity and acceleration (in r & θ).

HW 4 – (CH 12 – Particle Kinetics) --

12.13*, 12.17*, 12.18*; 12.21*, 12.34*, 12.46*



1.) 12.13* – Two blocks (masses, m_A & m_B) shown are originally at rest. Neglect the mass of pulleys and friction. The incline is at θ = 30°. Find (a) the acceleration of each block (a_A & a_B), and (b) tension T in the cable.

2.) 12.17* – A truck ($W_T = 5000\,\text{lb}$) is used to lift a boulder B ($W_B = 1000\,\text{lb}$) that is on a pallet A ($W_A = 200\text{ lb}$). Knowing the acceleration of the truck (a_T) is 1 ft/s^2, determine (a) the horizontal force between the tires and the ground, and (b) the force between the boulder and the pallet.

3.) 12.18* – Block A (m_A = 40 kg) and block B (m_B = 8 kg) are as shown. The coefficient of friction between all surfaces of contact are $\mu_S = 0.2$ and $\mu_K = 0.15$. If P = 0, determine (a) the acceleration of block B (a_B), and (b) the tension T in the cord. The incline is at θ = 25°.

4.) 12.21* – A baggage conveyor is used to unload luggage from an airplane. The duffel bag A (m_A = 10 kg) is sitting on top of suitcase B (m_B = 20 kg). The conveyor is moving the bags down at a constant speed (v = 0.5 m/s) when the belt suddenly stops. The coefficient of friction between the belt and B is μ = 0.3 & that bag A does not slip on suitcase B, determine the smallest allowable coefficient of static friction between the bags (μ_{AB}).

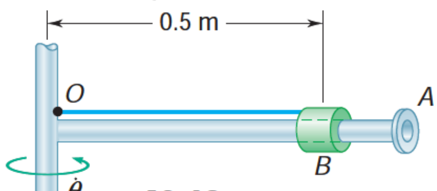
5.) 12.34* – Block B (m_B = 15 kg) is supported by block A (mass m_A = 25 kg) and is attached o a cord to which a P = 225 N horizontal force is applied as shown. Neglect friction. Find (a) the acceleration of block A (a_A), and (b) the acceleration of block B relative to A ($a_{B/A}$).

6.) 12.46* – A child (m = 22 kg) sits on a swing and is held in the position shown by a second child. Neglecting the mass of the swing, determine the tension T in rope AB (a) while the second child holds the swing with his arms outstretched horizontally (θ = 35°), (b) immediately after the swing is released.

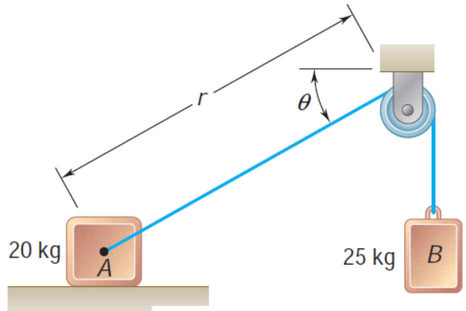
7.) Practice FBD's

HW 5 (CH 12 – Particle Kinetics, cont'd) ---

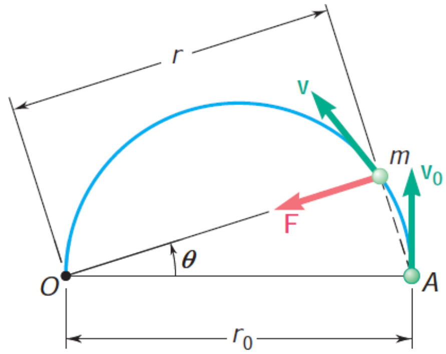
12.69*, 12.71*, 12.76*, 12.123*, 12.124*



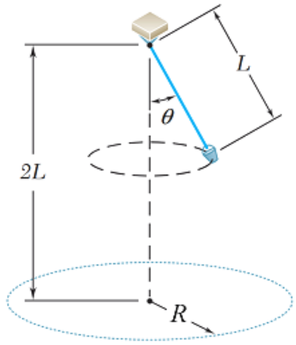
12.69



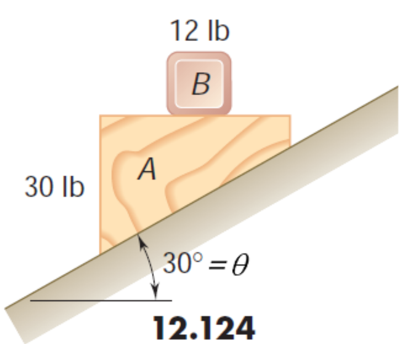
P12.71



12.76



12.123



12.124

1.) 12.69* – A horizontal rod OA rotates about a vertical shaft according to the relation $\dot{\theta} = 10t$ where $\dot{\theta}$ and t are expressed in rad/s and seconds, respectively. Collar B (m = 250 g) is held by a cord ($r_O = 0.5\,\text{m}$) with a breaking strength of F = 18 N. Neglecting friction, determine, immediately after the cord breaks, (a) the relative acceleration of the collar with respect to the road ($a_{B/OA} = \ddot{r}$), (b) the magnitude of the horizontal force (Fh) exerted on the collar by the rod. Neglect gravity. Answer in terms of F, m, & r_O

2.) 12.71* – Two blocks (masses m_A & m_B) are released from rest when r = 0.8 m and θ = 30°. Neglecting the mass of the pulley and friction, determine (a) the initial tension T of the cable, (b) the initial acceleration of block A (a_A), and (c) the initial acceleration of block B (a_B).

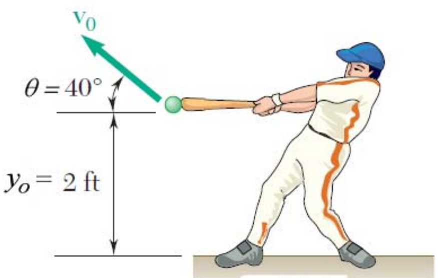
3.) 12.76* – A particle (mass m) is projected from point A with an initial velocity (vo) perpendicular to line OA and moves under a central force **F** along a semicircular path of diameter OA. Observing that $r = r_O \cos\theta$ and using Eq. (12.27), show that the speed of the particle is $v = v_O / \cos^2\theta$.

4.) 12.123* – A bucket is attached to a rope of length L = 1.2 m and is made to revolve in a horizontal circle. Drops of water leaking from the bucket fall and strike the floor along the perimeter of a circle of radius R. Determine radius a when θ = 30 degrees.

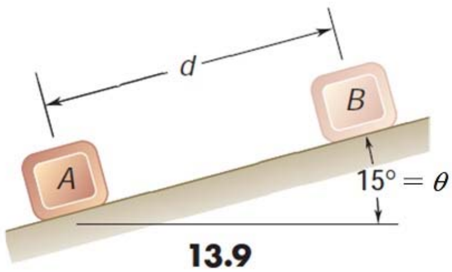
5.) 12.124* – Block B ($W_B = 12\,\text{lb}$) rests as shown on the upper surface of wedge A ($W_A = 30\,\text{lb}$). The angle of the slope is $\theta = 30^\circ$. Neglect friction, and find immediately after the system is released from rest (a) the acceleration of a ($\mathbf{a}_A$) and (b) the acceleration of B relative to A ($\mathbf{a}_{B/A}$).

HW 6 (CH 13 – P Work/Energy) ---

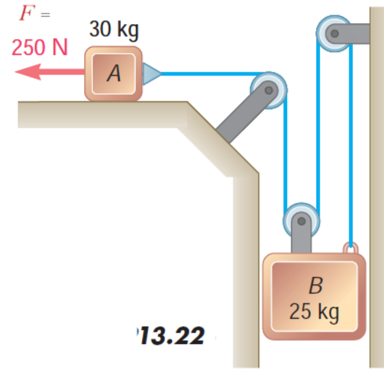
13.3*, 13.9*, 13.22*, other problems, 13.58*, 13.61*, 13.64*



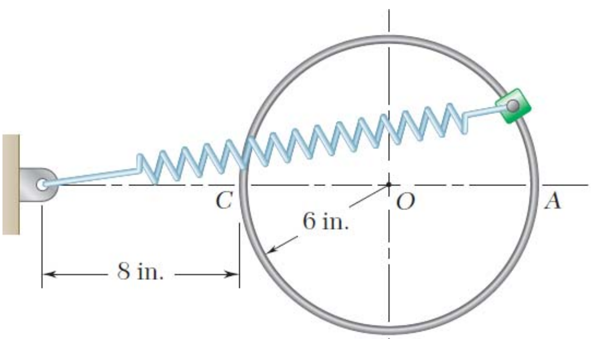
13.3



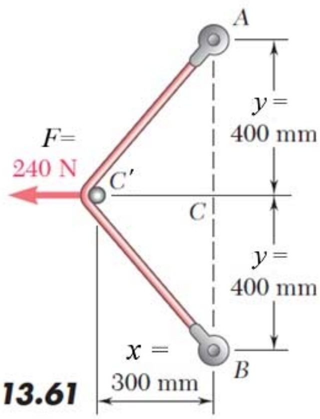
13.9



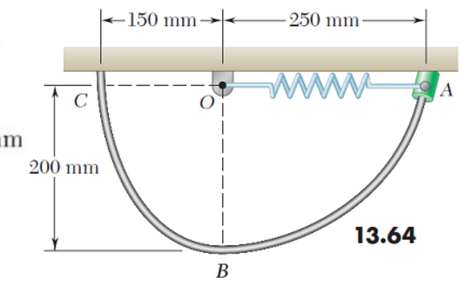
13.22



13.58



13.61



13.64

1.) 13.3* – A baseball player hits a baseball (W = 5.1 oz) with an initial velocity ($v_O = 140$ ft/s) at an angle above the horizontal ($\theta = 40^\circ$) as shown (yo = 2 ft). Find (a) the KE immediately after the hit (To), (b) the KE at max height (T_1), and (c) the max height above the ground reached by the ball (h_1).

2.) 13.9* – A package is projected up an incline (θ = 15°) at A with an initial velocity ($v_O = 8$ m/s). There is friction between the package and incline ($\mu = 0.12$). Find (a) max distance d the package moves up the incline, (b) the velocity of the package as it returns to its original position (v_2).

3.) 13.22* – The system of blocks A and B (masses m_A & m_B) shown is at rest when a constant force ($F = 250$ N) is applied to block A. Neglect friction and the mass of the pulleys. Find (a) the velocity of block B (v_B) after block A has moved ($x = 2$ m), and (b) the tension (F, note T is KE) in the cable.

Write expressions for total mechanical energy at each state (2-3 probs)

For the remaining problems use the equation ($U_{NC} = E_2 - E_1$). Where E is the total mechanical energy (KE + PE) at the given state. U_{NC} = work of any frictional forces or external forces that change KE without changing PE assessed in E_1 and E_2.

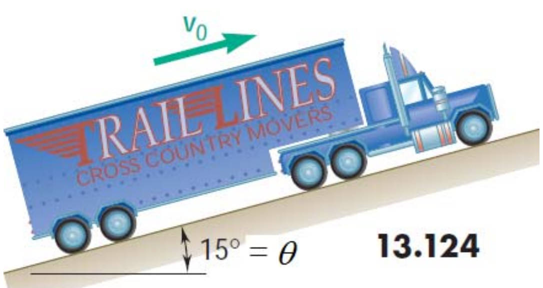
5.) 13.58* – A collar (W = 3 lb) is attached to a spring and slides without friction on a circular rod in the HORIZONTAL plane. The spring ($k = 1.5$ lb/in) has an undeformed length of $l_O = 7$ inches. The collar is in equilibrium at A and is given a slight push to get it moving. Find the velocity of the collar as it passes through (a) point B (v_B), and (b) point C (v_C). Note denote distance variables as: DC, DA, and DB.

6.) 13.61* – An elastic cord is stretched between 2 points A and B located $2y = 0.8\text{ m}$ apart in the horizontal plane. When stretched directly between A and B, the tension is $P_2 = 40\text{ N}$. The cord is then stretched as shown until its midpoint C has moved through $x = 0.3\text{ m}$ to C', and a force of $F = 240\text{ N}$ is required to hold the cord at C'. A pellet ($m = 0.1\text{ kg}$) is placed at C' and the cord is released. Find the speed of the pellet as it passes through C.

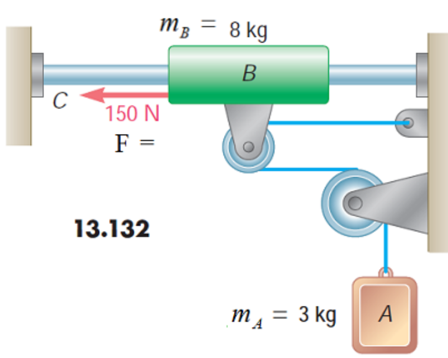
7.) 13.64* – A collar (m = 2 kg) is attached to a spring (k = 600 N/m) and slides without friction in the VERTICAL plane along a curved rod ABC. The spring is undeformed when the collar is at C. If the collar is released at A with no initial velocity, determine its velocity (a) as it passes thru B (v_B) and (b) as it reaches C (v_C). Denote distances as OA, OB, and OC.

HW 7 (CH 13 – Impulse/Momentum) --

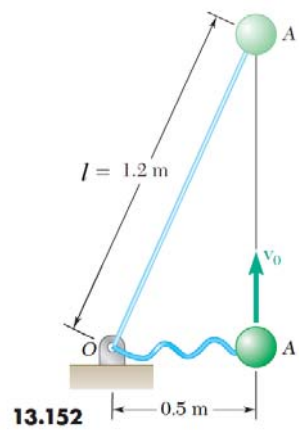
13.124*, 13.132*, 13.152*, 13.165*, 13.172*, 13.182*



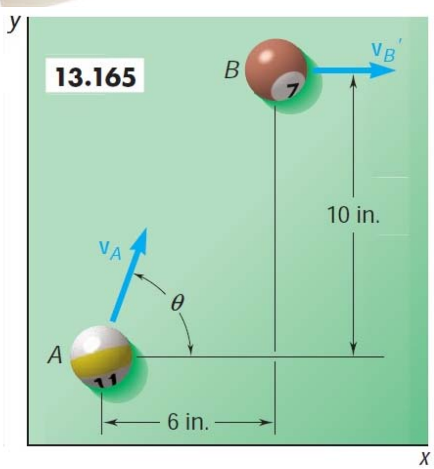
13.124



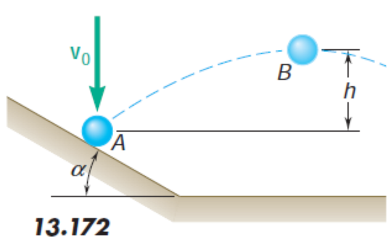
13.132



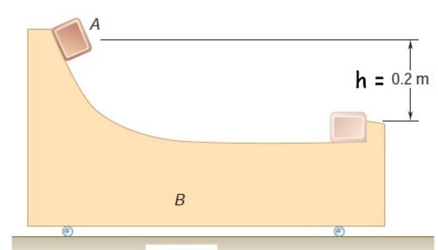
13.152



13.165



13.172



13.182

1.) 13.124* – A truck (W = 10 tons, where 1 ton = 2000 lb) enters an upward ramp (θ = 15°) at a high speed ($v_0 = 108\text{ ft/s}$) and travels for t_1 = 6 s before its speed becomes $v_1 = 36\text{ ft/s}$. Assume constant deceleration. Find (a) F_B (braking force), (b) the additional time (t_2) required for the truck to stop.

2.) 13.132* – The system shown ($m_A = 3\,\text{kg}, m_B = 8\,\text{kg}$) is at rest when a constant force (F = 150 N) is applied to collar B. Neglect friction. Find (a) time (t) for v_B to reach 2.5 m/s (←), (b) the corresponding tension (T) in cable at that time.

3.) 13.152* – A sphere (m = 2 kg) is connected to a fixed point O by an inextensible cord (L = 1.2 m). The sphere rests on a frictionless horizontal surface at a distance of x = 0.5 m from O when it is given a velocity ($\mathbf{v_0}$) in a direction perpendicular to OA. It moves freely until it reach A', when the cord becomes taut. Find the maximum possible velocity v_0 if the impulse of the force exerted on the cord is not to exceed $\hat{F} = 3\,\text{Ns}$.

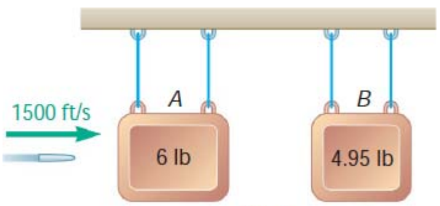
4.) 13.165* – Two billiard balls A & B (same mass m & diameter d = 2.37") are as shown. Ball A has velocity $v_A = 3\,\text{ft/s}$ when it strikes B, which is at rest. B then moves in the x direction after impact. Find (a) angle θ, (b) the velocity of B after impact (v_B'). Positional variables are x = 6" and y = 10", and e = 0.9.

5.) 13.172* – A sphere with vertical velocity ($v_0 = 5\,\text{m/s}$) strikes an inclined plane (α = 30°, e = 0.8) and rebounds as shown. Find the height h reached by the sphere.

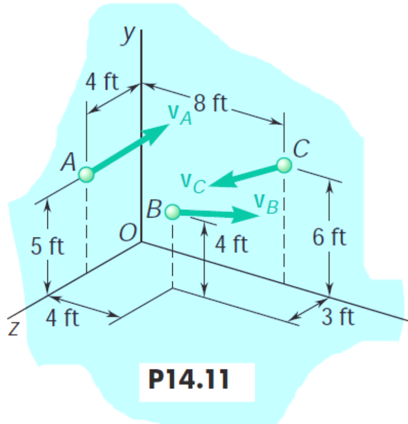
6.) 13.182* – Block A (mass $m_A = 10\,\text{kg}$) is released from rest and slides on B (mass $m_B = 30\,\text{kg}$) until it hits a bumper as shown. Find the velocities of A and B immediately after impact when (a) e = 0, (b) e = 0.7. (Hint: also use work/E)

HW 8 (CH 14 – System of Ps) ---

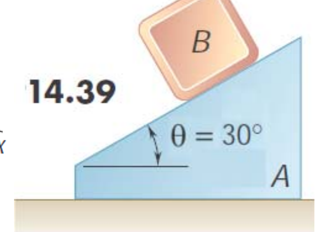
14.4*, 14.11, 14.39, 14.43, 14.49



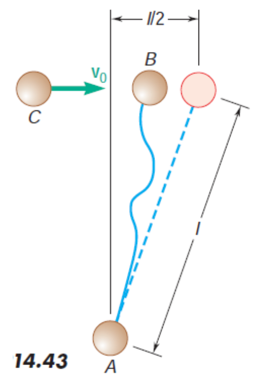
14.4



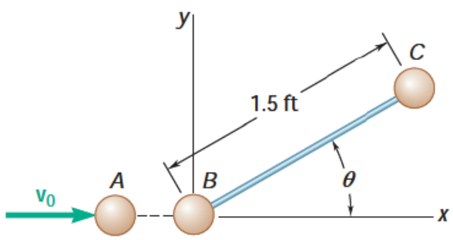
P14.11



14.39



14.43



14.49

1.) 14.4* – A bullet is fired with a horizontal velocity of $v_O = 1500\,\text{ft/s}$ through block A (W_A = 6 lb) and becomes embedded in block B (W_B = 4.95-lb). Knowing that blocks A and B start moving with velocities of $v_A' = 5\,\text{ft/s}$ and $v_B' = 9\,\text{ft/s}$, respectively, determine (a) the weight of the bullet (w), (b) its velocity as it travels from block A to block B (v_1).

2.) 14.11 – A system consists of three particles A, B, and C (weights W_A = 5 lb, W_B = 4 lb, W_C = 3 lb). Their velocities (in xyz & in ft/s) are $\mathbf{v}_A = (2,3,-2)$, $\mathbf{v}_B = (v_x, 2, v_z)$, $\mathbf{v}_C = (-3,-2,1)$. Find v_x & v_z for particle B for which the angular momentum $\mathbf{H}_O$ of the system is parallel to the x-axis, & (b) the value of $\mathbf{H}_O$.

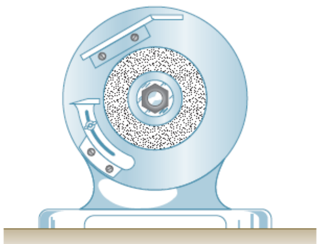
3.) 14.39* – Block B (W_B = 15 lb) starts from rest & slides on wedge A (W_A = 25 lb, angle θ = 30°) which is supported by a horizontal surface. Neglecting friction, determine (a) the velocity of B relative to A after it has slid d = 3 ft down the inclined surface of the wedge, (b) the corresponding velocity of A.

4.) 14.43 – Three spheres, each of mass m, can slide freely on a frictionless, horizontal surface. Spheres A and B are attached to an inextensible, inelastic cord (length l) and are at rest in the position shown when sphere B is struck squarely by sphere C which is moving to the right with a velocity $\mathbf{v}_O$. Knowing that the cord is slack when sphere B is struck by sphere C and assuming perfectly elastic impact between B and C, determine (a) the velocity of each sphere immediately after the cord becomes taut, (b) the fraction of the initial kinetic energy of the system which is dissipated when the cord becomes taut.

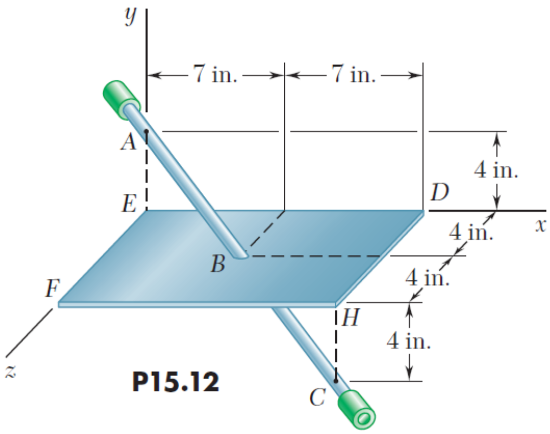
5.) 14.49 – Three identical small spheres (W = 2 lb each), can slide freely on a horizontal frictionless surface. Spheres B and C are connected by a light rod and are at rest in the position shown when sphere B is struck squarely by sphere A which is moving to the right with a velocity $\mathbf{v}_O = (8\,\text{ft/s})\mathbf{x}$. Knowing that θ = 45° and that the velocities of spheres A and B immediately after the impact are $\mathbf{v}_A = (0,0,0)$ and $\mathbf{v}_B = (6\,\text{ft/s})\mathbf{x} + (v_B)_y\mathbf{y}$, determine $(v_B)_y$ and the velocity of C immediately after impact.

HW 9 – (CH 15 – Kinem's of RBs (veloc)) ---

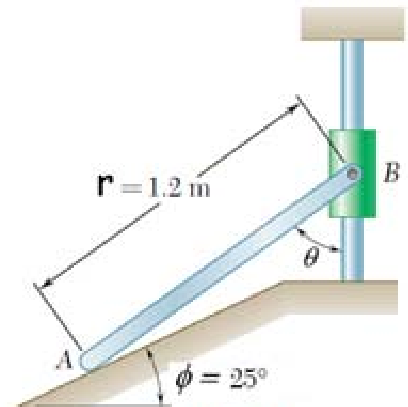
15.5*, 15.12, 15.40*, 15.55*, 15.84* (use radial/transverse for 15.40, 55, & 84)



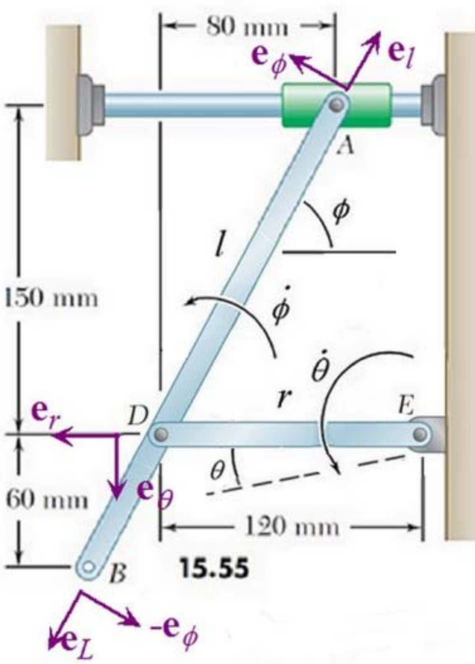
P15.5



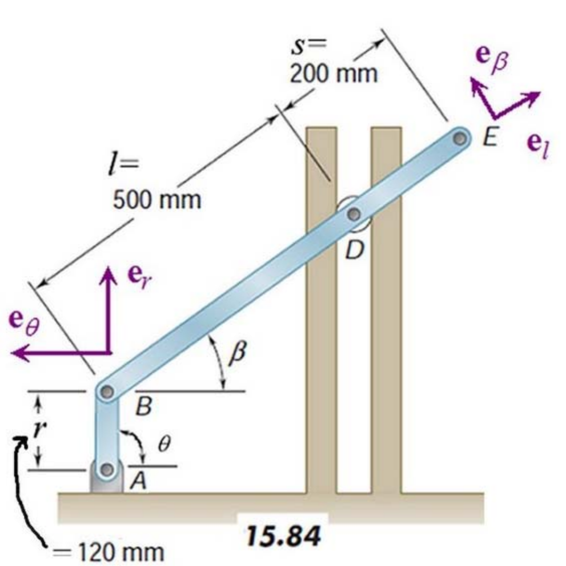
P15.12



P15.40



15.55



15.84

1.) 15.5 – A grinder has a rated speed of $\dot{\theta}_r = 3600\,\text{rpm}$. When turned on the unit reaches its rated speed in $t_1 = 5\,\text{s}$. When turned off it coasts to rest in $t_2 = 70\,\text{s}$. Assume uniformly accelerated motion and compute the number of revolutions the motor executes (a) in reaching its rated speed, (b) in coasting to rest.

2.) 15.12 – The assembly shown consists of the straight rod ABC which passes through and is welded to the grectangular plate DEFH. The assembly rotates about the axis AC with a constant angular velocity of 9 rad/s. Knowing that the motion when viewed from C is counterclockwise, determine the velocity and acceleration of corner F.

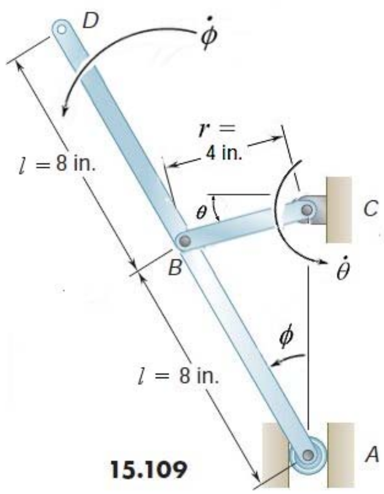
3.) 15.40 – Collar B moves up at constant velocity $v_B = 1.5\,\text{m/s}$. Rod AB has length $r = 1.2\,\text{m}$. The incline is at angle $\phi = 25^\circ$. Compute an expression for the angular velocity of rod AB, $\dot{\theta}$ and the velocity of end A of the rod (v_A) as a function of v_B, l, ϕ, θ. Then compute numerical answers for $\dot{\theta}$ & v_A with $\theta = 50^\circ$.

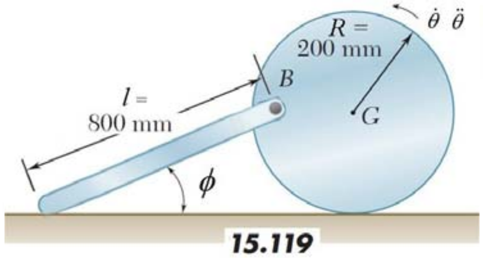
4.) 15.55 – Collar A moves to left (v_A). Derive expressions for angular velocity of rod ADB ($\dot{\phi}$) & velocity of point B $\mathbf{v}_B$ in terms of $r, l, L, \dot{\theta}, \dot{\phi}, v_A$ (where AD $= l$, DE $= r$, AB $= L$). Then compute numerical answer with given values ($v_A = 900$ mm/s) & in position shown. (θ = 0, ϕ = (must be computed))

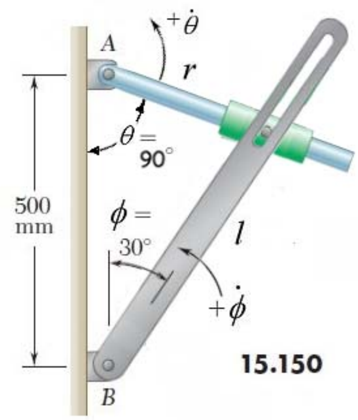
5.) 15.84 – Rod BDE is partially guided by a roller at D which moves in a vertical track. Angular velocity of crank AB is $\dot{\theta}$. Write expressions for the angular velocity of rod BDE ($\dot{\beta}$) & velocity of point E ($\mathbf{v}_E$) in terms of $r, l, s, \dot{\theta}$, θ, β (write as v_{Ex} & v_{Ey}). Then compute a numerical answer for given values in position shown (lengths as shown in figure, $\dot{\theta} = -5$ rad/s (CW), $\beta = 25^{\circ}$, θ = 90°). Note r = AB, l=BD, and all angles are measured from right horizontal.

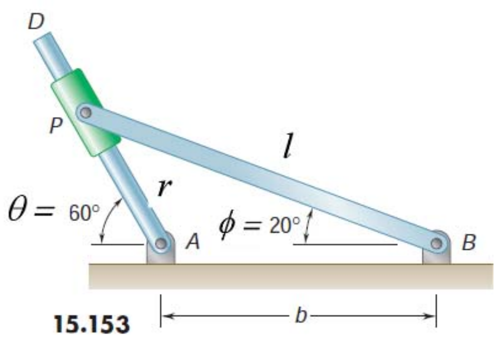
HW 10 – (CH 15 – Kinem's of RBs (accel)) --

15.109*, 15.119* (SKIP), 15.150*, 15.153*
Use radial/transverse coordinates for each of the problems.









1.) 15.109 – Crank BC ($r = 4"$) has constant angular velocity ($\dot{\theta} = 45\,\text{rpm}, \text{CW}$). First find expressions for $\dot{\phi}$ and velocity of point A (v_A) in terms of $r, l, \theta, \phi,$ & $\dot{\theta}$. Then obtain expressions for $\ddot{\phi}$ & the acceleration of point A (a_A) in terms of $r, l, \theta, \phi, \dot{\theta},$ and $\dot{\phi}$. Then obtain numerical answers for $\dot{\phi}, v_A, \ddot{\phi},$ and a_A using the given values and a position where θ = 0 (you must evaluate the value of ϕ when θ = 0).

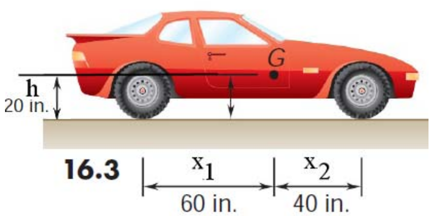
2.) 15.119 (SKIP) – Disk G (R = 0.2 m) rolls ($\dot{\theta}$ = 8 rad/s CCW, $\ddot{\theta}$ = 2 rad/s^2 CW) without slip on the surface shown. Distance BG is r (BG = r = 0.16 m). Rod AB has length l. Find an expression for the acceleration of A (a_A) in terms of l, R, r, $\dot{\theta}$, & $\ddot{\theta}$ (not ϕ which is not given and depends on other variables). Then evaluate a_A at the instant shown (BG is horizontal).

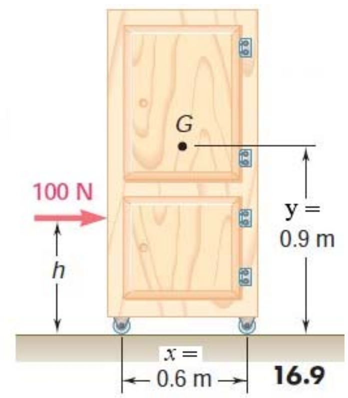
3.) 15.150 – Pin P is attached to the collar shown; the motion of the pin is guided by a slot cut in rod BD and by the collar that slides on rod AE. The rods both rotate constant angular velocities ($\omega_{AE} = \dot{\theta} = -8$ rad/s CW, $\omega_{BD} = \dot{\phi} = -3$ rad/s, CW). First obtain $\dot{r}$ & $\dot{l}$ in terms of $\theta, \dot{\theta}, \phi, \dot{\phi}, r,$ & l. Then get the velocity of pin P (V_P) (you'll need to use the expressions for $\dot{r}$ & $\dot{l}$. The final answer should be in terms of in terms of $\theta, \dot{\theta}, \phi, \dot{\phi}, r,$ & l. Then obtain numerical answers for given values & configuration given (θ = 90, ϕ = 30). You will need to use geometry to obtain values for r and l.

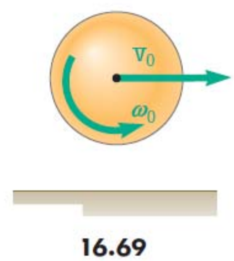
4.) 15.153 – Two rotating rods are connected by slider block P. Rod AD rotates with a constant angular velocity ($\dot{\theta}$ = 10 rad/s, CW). Find angular velocity of the rod BP ($\dot{\phi}$) and the relative velocity of the slider block P with respect to rod AD ($v_{P/AD}$, which is $\dot{r}$) in terms of $\theta, \phi, r, l, \& \dot{\theta}$. You will need to use geometry to obtain expressions for r & l in terms of $\theta, \phi, \& b$. Then obtain numerical answers given values & configuration shown (b = 0.3 m).

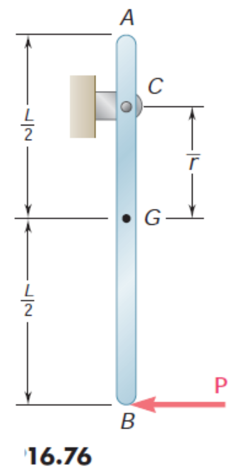
HW 11 – (CH 16 – 2D RB Kinetics) --

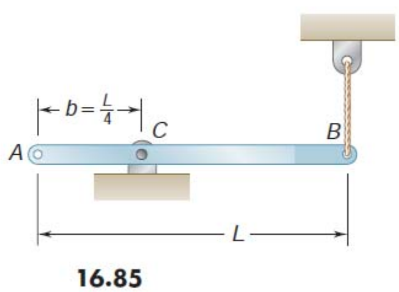
16.3*, 16.9*, 16.69*, 16.76*, 16.85*, 16.118*

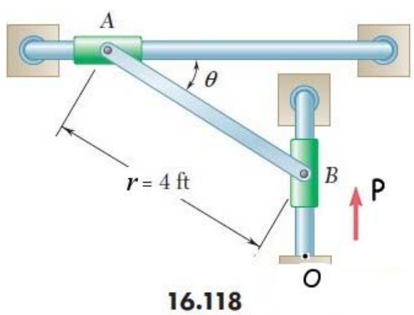












1.) 16.3 – The coefficient of static friction between a car's tires and level road is u_s = 0.80. Find the maximum possible acceleration a (in terms of μ & g) assuming (a) four-wheel drive, (b) rear-wheel drive, and (c) front-wheel drive.

2.) 16.9* – A cabinet (m = 20 kg) is mounted on casters that allow it to move freely (μ = 0) on the floor. A force (F = 100N) is applied as shown. Find (a) the acceleration of the cabinet ($a = a(F, m)$), (b) the range of values of h for which the cabinet will not tip. ($h = h(m, g, x, y, F)$)

3.) 16.69* – A sphere (mass m, radius r) is projected along a rough horizontal surface with the initial velocities v_O & ω_O. If the final velocity of the sphere is to be zero, express the following in terms of $g, v_O, r, \& \mu_k$, (a) the required magnitude of ω_O, (b) the time t_1 required for the sphere to come to rest, (c) the distance x the sphere will move before coming to rest.

4.) 16.76* – A uniform slender rod (length L = 900 mm, mass m = 4 kg) is suspended from hinge C. A horizontal force (P = 75 N) is applied at end B. Knowing that $r = 225\,\text{mm}$, find (a) the angular acceleration of the rod ($\alpha = \alpha(P, m, r, l)$), (b) the components of the reaction at C. (Cx & Cy as fcn of P, m, g, r, α)

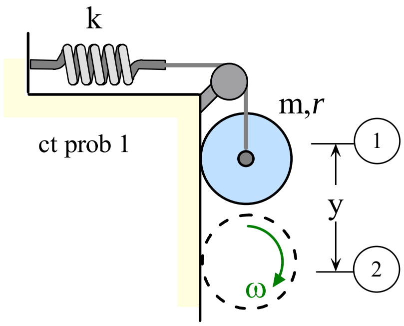
5.) 16.85* – A uniform rod (mass m, length L) is supported as shown. If the cable attached at end B suddenly breaks, determine (a) the acceleration of end B (a_B), (b) the reaction at the pin support. (as fcn of m, g)

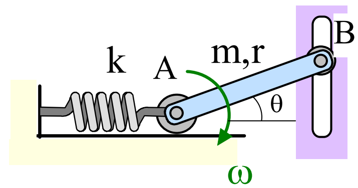
6.) 16.118* – The ends of a uniform rod AB (W = 20 lb, length r = 4 ft) are attached to massless collars that slide without friction along fixed rods. A vertical force P is applied to collar B when θ = 25°, causing the collar to start from rest with an upward acceleration of $a_B = 40\ \text{ft/s}^2$. Determine (a) the force P, (b) the reaction at A.

- Draw the FBD and the effective F/M diagrams. Write the force & moment equations.
  - note a_{Gx}, a_{Gy}, and $\ddot{\theta}$ are not known though
- Write radial/transverse (r/t) acceleration kinematics for A (from pt O, thru mechanism).
  - Use to solve $\ddot{\theta}$ (or α).
- Write r/t acceleration of G (from O, thru mechanism).
  - Eqns look almost like that of A. Use $\ddot{\theta}$ from above. This solves a_{Gx} & a_{Gy}
- The rest is algebra.

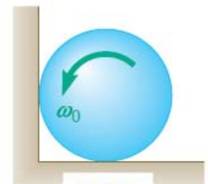
HW 12 – (CH 17 – 2D RB Energy/Momentum) ---

ct prob 1*, 17.39*mod, 17.59, 17.73, 17.104, 17.116 (REPLACE 17.17?)

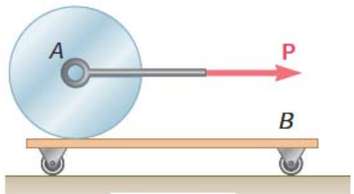




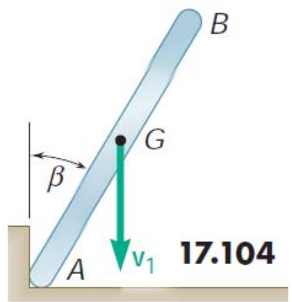
17.39



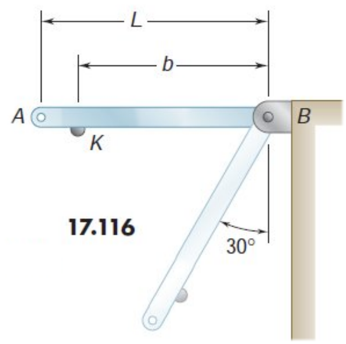
17.59



17.73



17.104



17.116

1.) ct prob 1 - a cylinder (mass m, radius r, I_G = .5mr2) has a cable attached to its center. The cable passes over a massless pully & connects to a spring (constant k). The cylinder is released from rest at position 1, where the spring is un-stretched. The mass rolls without slip down the vertical surface to position 2 which is distance y from position 1. Ignore friction. Compute total energy (T+V) at both positions (E1 and E2). Then use E1 & E2 to find rotational speed (ω) of the cylinder. Given: m, g, r, k, and y.

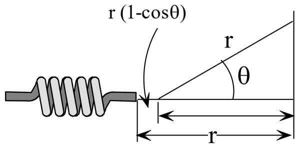
2.) 17.39* (mod) - end A of rod AB (mass m, length r) is tied to a spring (constant k) & constrained to move horizontally. End B is constrained to move vertically. The rod is released from rest (position 1 where angle = θ). Find angular velocity (ω) of rod & velocity of end B at position 2 (where θ = 0 & spring is un-stretched). Obtain result by first computing total energy at positions 1 and 2. Given: m, g, r, k and θ.

3.) 17.59 – A cylinder (mass m, radius r) with an initial angular velocity (ω_o, CCW) is placed in the corner formed by the floor and a vertical wall. The coefficient of kinetic friction between the cylinder and the wall and the floor is μ. Derive an expression for the time required for the cylinder to come to rest.

4.) 17.73 – A cylinder (radius r = 9 in, weight 3W = 18 lb) rests on a carriage (W = 6 lb). The system is at rest when a force (P = 2.5 lb) is applied as shown for t = 1.2s. The cylinder rolls without slip on the carriage and the wheels are massless. Compute the resulting velocity of (a) the carriage, (b) the center of the cylinder.

5.) 17.104 – The uniform slender rod AB (weight W = 5 lb, length l =30 in) forms an angle (β = 30°) with the vertical as it strikes the smooth corner shown with a vertical velocity (v_1 = 8 ft/s ↓) and no angular velocity. Assuming the impact is perfectly plastic, determine the angular velocity of the rod immediately after the impact.

6.) 17.116 – A slender rod (mass m , length l) is released from rest in a horizontal position as shown. It strikes the vertical surface and rebounds to form an angle θ = 30° with the vertical. (a) Determine the coefficient of restitution between knob K and the surface. (b) Show that the same rebound can be expected for any position of knob K.


r (1-cosθ)
r
θ
r