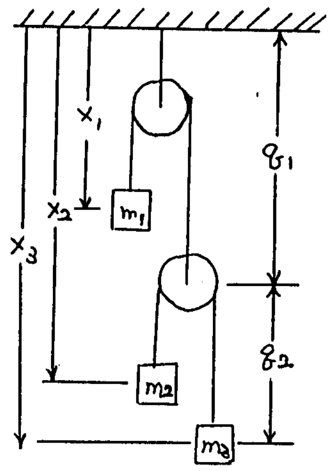
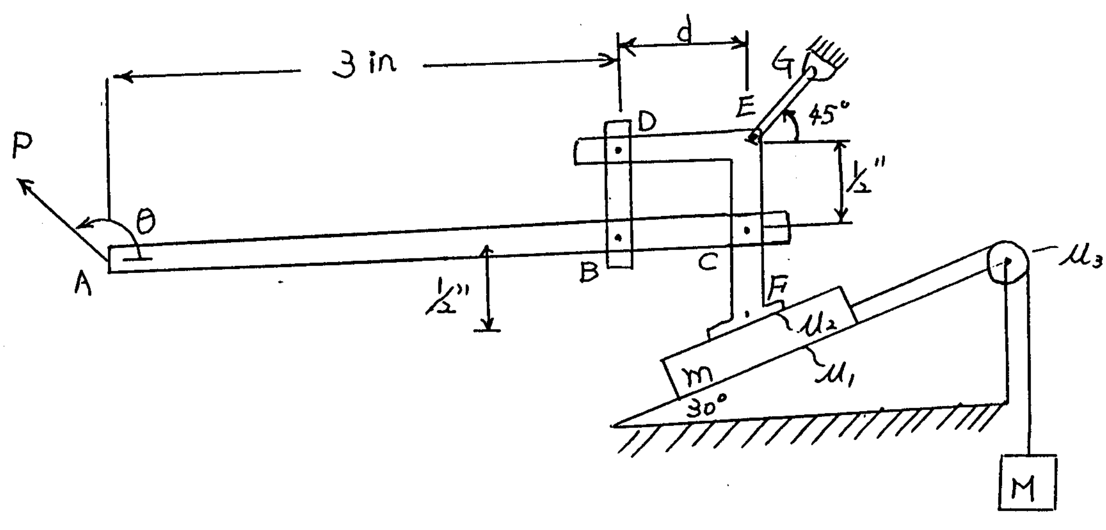
1. The three weights of mass $m_1$, $m_2$, and $m_3$, respectively, are the only massive elements of the system of weights, pulleys, and inextensible strings shown.
   (1) Write down the equation(s) of constraint satisfied by the coordinates $x_1$, $x_2$, and $x_3$ shown.
   (2) Calculate the $x_i$ in terms of the $q_j$ and shown that the $q_j$ satisfy the equation(s) of constraint identically. Hence, the $q_j$ are generalized co-ordinates.
   (3) Construct Lagrange's equations of motion.
   (4) Dynamically uncouple Lagrange's equations when $m_1=6$, $m_2=1$, $m_3=5$.

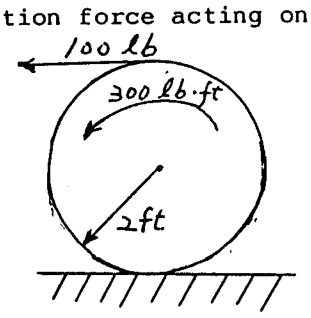



2. The machine shown is made up of rigid members and is designed to apply force through the rotatable pad F to the mass m resting on the $30^{\circ}$ incline. This may be accomplished by applying a force P at A.
   (1) Knowing that the coefficient of friction between the pad F and mass m is $\mu_2 = 1$, find the admissable range of load application angle so that the machine does exert a force on mass m as the mass m begins to slide up the incline. Note that the pad and mass are not attached.

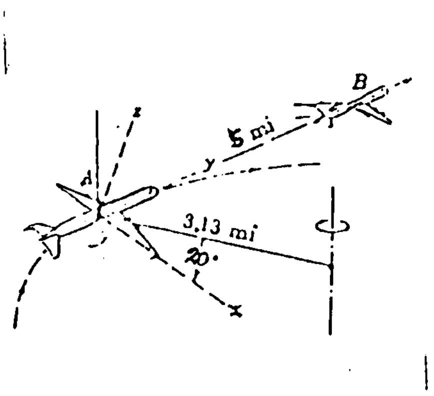
   (2) For P = 1000 lbs., $\mu_1 = \mu_2 = 1$ and $\theta = 5^{\circ}$, find d. Then determine the mass M on the cable necessary to start sliding. The calbe runs over a rough pulley, $\mu_3 = 0.5$, of radius, r = 1/8".



3. The 644 lb cylinder rolls without slipping when subjected to the force and couple shown. Determine the acceleration of its mass center and the magnitude and direction of the friction force acting on it.




4. Aircraft A is flying in a horizontal circle of 3.13 mi radius at a constant speed of 300 mi/hr and is banked at the correct angle which is 20 deg. The velocity of a second aircraft B flying horizontally in a straight line at a constant speed of 400 mi/hr momentalrily becomes collinear with the velocity of A when the two aircraft are 5 mi apart in the positions whown. Use the x-y-z frame of reference attached to A and determine the velocity and acceleration of B as observed from and relative to x-y-z at this instant.




5. The two hinged links are released from rest with OA in the horizontal position shown. Calculate the velocity of end B along the horizontal surface for the instant when OA reaches the vertical position. Link OA has twice the weight of link AB, and both may be treated as slender bars. Neglect all friction and the mass of the small roller at B.