2.004 MODELING DYNAMICS AND CONTROL II Spring 2003

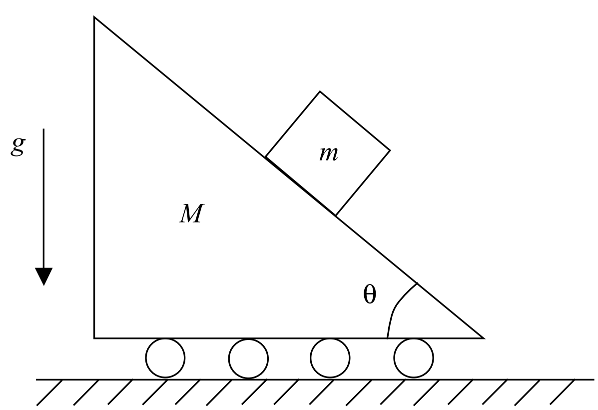
ProblemSet No. 5

Problem 1

A particle of mass m slides without friction on a smooth inclined plane M which, itself, is freeto slidewithout frictionon asmo oth horizontal surface.

(a)Select acompleteand independent set ofgeneralized coordinate(s).

(b) Derivethego verning equation(s) of motionusing momentum principles.

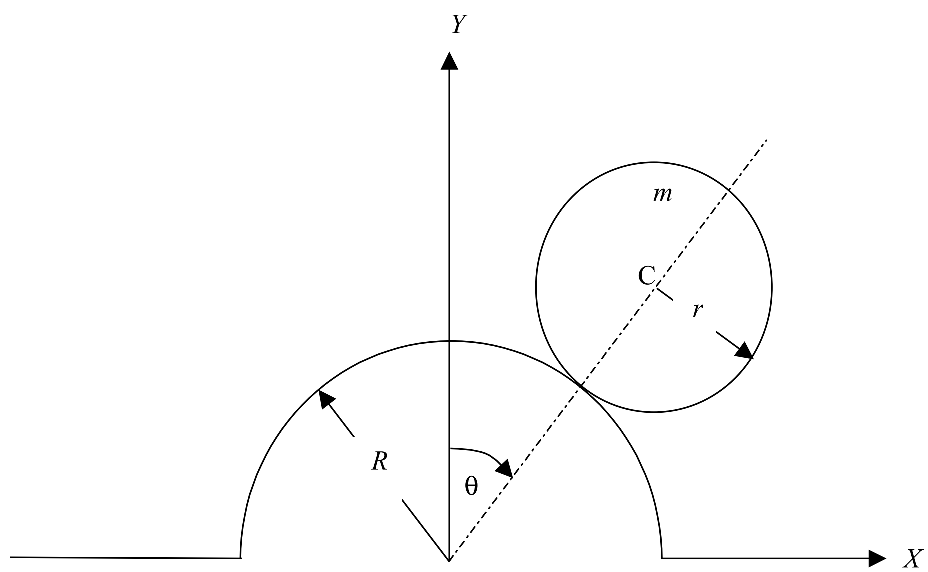


Problem 2

A disk or radius r and mass m rolls without slipping on the surface of a stationary half-cylinder of radius R, as shown below. Because of the rolling constraint, this is a one-degree-of-freedomsystem, and theangle θ is a convenient generalized coordinate.

(a) Expressthe angular velocity of thedisk in terms of $\dot{\theta}$.

(b) Calculate the kineticenergyof the disk.



Problem 3

Falling Rod. A rigid rod AB has length L, mass m, and centroidal moment of inertia $I_C = mL^2/12$. The rod is constrained to remain in the plane of the sketch and is completely located by giving the coordinates x and y of the mass center C, with respect to an inertial reference system, and the angle θ that the rod makes with the vertical. The rod is placed with the end B in contact with the floor and the angle θ equal to 30 degrees and released from rest. Assume that, as the rod falls under the influence of gravity, the end B always remains in contact with the floor, and that there is no frictional force between the floor andthe rod at B.

(a) The generalized coordinates x, y, and θ are complete but not independent under the constraints described below. Select a set of complete *and independent* generalized coordinates to describethe location ofthe falling rod.

(b) Derivetheequation(s) ofmotion. Itisnot necessarytosolv etheequation(s).

(c) Determine the angular acceleration $\ddot{\theta}$ of the rod immediately after it is released from rest.

(d) Determine the force between the floor and the rod at B, immediately after the rod is released fromrest.

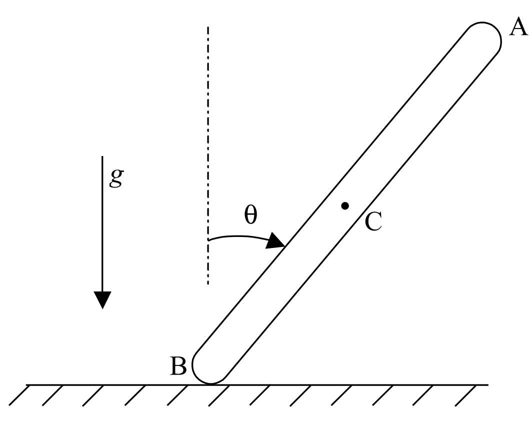


Figure 1: Rod falls under the influence of gravity