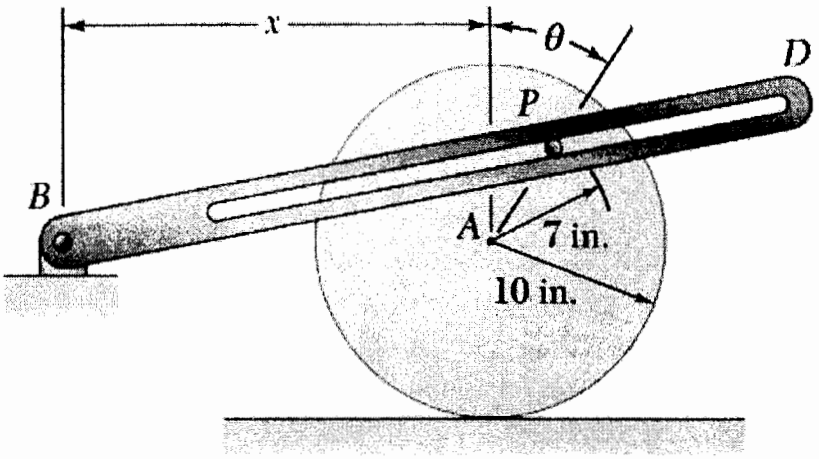
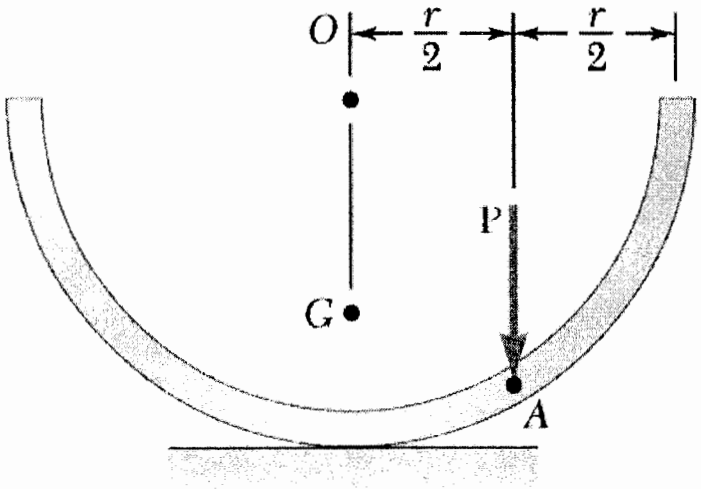
※ 考生請注意：本試題可使用計算機

1. [25%] Pin P is attached to the wheel shown and slides in a slot cut in bar BD. The wheel rolls to the right without slipping with a constant angular velocity of 20 rad/s. Considering the case when x = 24 in. and $\theta = 0$, analytically determine
   (a) the angular velocity of the bar and the relative velocity of pin P with respect to the bar
   (b) the Coriolis acceleration of pin P
   (c) the angular acceleration of the bar and the relative acceleration of pin P with respect to the bar



2. [25%] A half section of a uniform thin pipe of mass m is at rest when a force **P** is applied as shown. Assuming that the section rolls without sliding, analytically determine
   (a) its centroidal moment of inertia (the distance from O to G is $2r/\pi$)
   (b) its initial angular acceleration
   (c) the minimum value of the coefficient of static friction consistent with the motion



(背面仍有題目,請繼續作答)

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3. [25%]

Chaos is a state of apparent disorder and irregularity— its evolution in time, though governed by simple and exact laws, is highly sensitive to starting conditions. Small variations in these conditions produce widely different results, in such a way that the long term behavior of chaotic systems cannot be predicted.

Chaotic systems share the following features: they are deterministic, sensitive to initial conditions, unpredictable, and unrepeatable. In a mathematical sense, a deterministic system is fundamentally straightforward and can be modeled with a formula, and there are no random elements involved. For a chaotic system, infinitesimally small changes to the initial conditions in an otherwise perfect experiment will produce widely different results. This sensitivity to initial conditions is popularly known as "the butterfly effect." Furthermore, no two experiments produce the same results, and it is impossible to predict the outcome of an experiment.

In chaos theory, the "butterfly effect" is the sensitive dependence on initial conditions, where a small change at one place in a deterministic nonlinear system can result in large differences to a later state. The name of this effect, coined by Edward Lorenz, is derived from the theoretical example of a hurricane's formation being contingent on whether or not a distant butterfly had flapped its wings several weeks before.

In the area of dynamical systems, a double pendulum contains a pendulum attached to the end of another pendulum and is a simple physical system that exhibits rich dynamic behavior. The motion of a double pendulum is governed by a set of coupled ordinary differential equations. For certain energies its motion is chaotic. Swinging the pendulum with high energy results in motion that cycles chaotically between normal modes. This means that for certain parameter ranges, a slight change in one of the initial starting conditions can have a dramatic effect on the subsequent motion of the pendulum.

After reading the above four-paragraph essay, please do the following:

(a) Translate the second paragraph into **Chinese**.

(b) Compare, by using more than 100 **English** words, the phenomenon described in the fourth paragraph to that described in the third paragraph. (Discuss the similarities and differences between the two systems.)

(c) Make a schematic drawing of the system described in the fourth paragraph. Then indicate the initial conditions for the system on your drawing. (The masses, dimensions, and mass distributions of the elements of the system are given. They do not need to be indicated as initial conditions on your drawing.)

4. [25%] You must use *the principle of virtual work* to solve this problem. The cargo box of the truck has a loaded mass of m and is elevated by the application of a couple M, as shown in the figure. The horizontal slots allow the linkage to unfold as the cargo box is elevated. Determine the upward acceleration of the box in terms of h for a given value of M. Neglect the mass of the links.