1. A stick of mass M and length L is placed on the smooth right angle shown in the following figure. Determine the position of equilibrium and the reaction forces as a function of angle α. (15%)

2. A nonconducting sphere of radius R has a total charge Q spread uniformly throughout its volume. Find the potential energy of the sphere. (15%)

3. A cylinder of mass M and radius R is rolling down a plane, as shown in the following figure. The inclination of the plane to the horizontal is α. The contact is rough so that no slipping can occur. The moment of inertia of the cylinder about the symmetry axis is $MR^2/2$. Determine the acceleration of the center of mass. (15%)

4. An ideal gas composed of N molecules, at absolute temperature T, occupies a container of volume V_1 separated from an empty container of volume V_2 by a removable partition. When the partition is removed, the gas occupies the whole volume $V_1 + V_2$. Determine the change of entropy. (15%)

5. Two strings (left and right) with different mass densities are connected at one point, which is chosen as the origin of the coordinates. The velocities of the transverse wave along the left and the right strings are measured to be V_L and V_R respectively. The incident wave coming from the left (moving in the $+x$

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direction) has the form

$$A_i \sin \left[w \left(t - \frac{x}{V_L} \right) \right]$$

where A_i is the amplitude of the incident wave and w is the angular frequency. Calculate (a) the amplitude of the reflected wave propagating back along the left string (moving in the $-x$ direction), and (b) the amplitude of the transmitted wave propagating along the right string (moving in the $-x$ direction). (15%)

6. A network consists of 20 identical resistors as shown in the following figure. The electrical resistance of each resistor is R. Find the equivalent resistance between point A and point B. (10%)
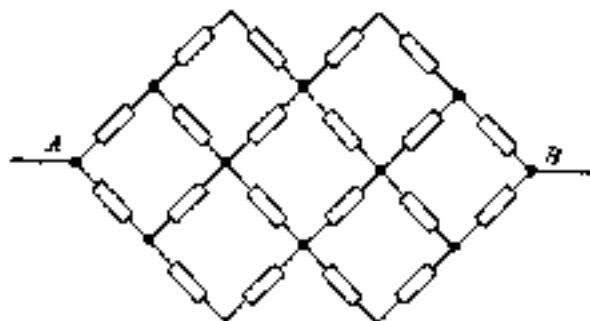
7. A long, straight, solid wire of radius R contains a hole of radius a along its length as shown in the following figure. The centers of the wire and of the hole are a distance d apart. The current I is distributed throughout the rest of the wire. Find the magnitude and the direction of the magnetic field INSIDE the hole. (15%)