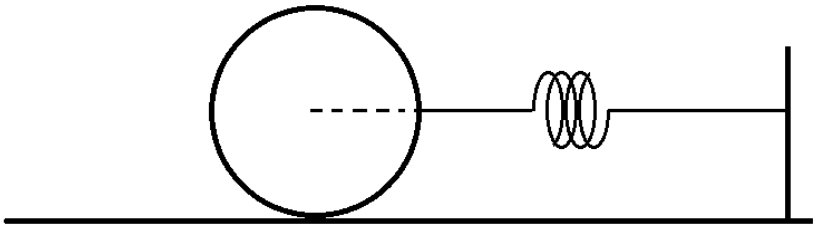
10-4)

A solid cylinder (mass M and radius R) on a table has a mechanism that attaches a spring (of constant k) to its central axis. The other end of the spring is fixed, so that the spring is horizontal. The cylinder is able to roll on the table without slipping. Let's pull the mass to one side and release it so that it rolls back and forth.



Show that the motion of the center of mass is simple harmonic, and find the frequency of oscillation, ω.

HINT: There are two ways (at least) to do this. Each involves comparing information about this system to the simple harmonic oscillator we know, the mass on a spring.

If you can get the force/torque equation to look like

$-kx = ma_x$

or you can get the energy budget to look like

$^1/_2mv^2 + {}^1/_2kx^2 = E_{TOTAL,}$

then the motion is simple harmonic. Comparison with

$\omega = (k/m)^{1/2}$

should then give you the frequency of oscillation.