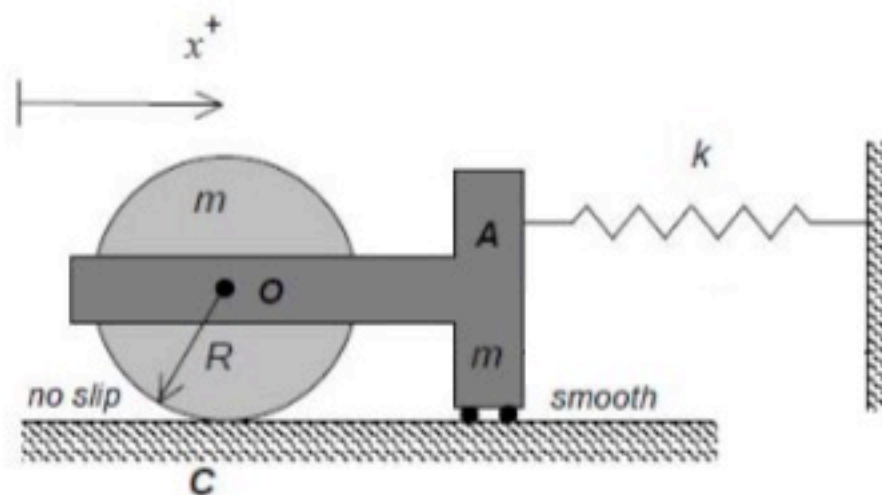


## Section 6.B - bonus question #1

**Given:** A homogeneous wheel of mass  $m$  and outer radius  $R$  rolls without slipping on a horizontal surface. Block A (also having a mass of  $m$ ) is pinned to the center  $O$  of the wheel and is able to slide without friction on the same horizontal surface. A spring (of stiffness  $k$ ) is connected between block A and ground. Let  $x$  represent the motion of block A measured positively to the right. When  $x = 0$  m, the spring is unstretched.

**Find:** For this problem:

- Draw individual free body diagrams for block A and the wheel;
- Derive the single differential equation of motion for the system in terms of the coordinate  $x$ , its time derivatives, and the following parameters:  $m$ ,  $R$  and  $k$ ;
- Determine numerical values for: the undamped natural frequency  $\omega_n$ ;
- Determine the response of the system  $x(t)$  for  $t > 0$ , assuming the system is released when the springs are unstretched with  $\dot{x}(0) = v_0$ .



Use the following parameters in your analysis:  $m = 4$  kg,  $k = 2250$  N/m,  $R = 0.1$  m and  $v_0 = 8$  m/s.