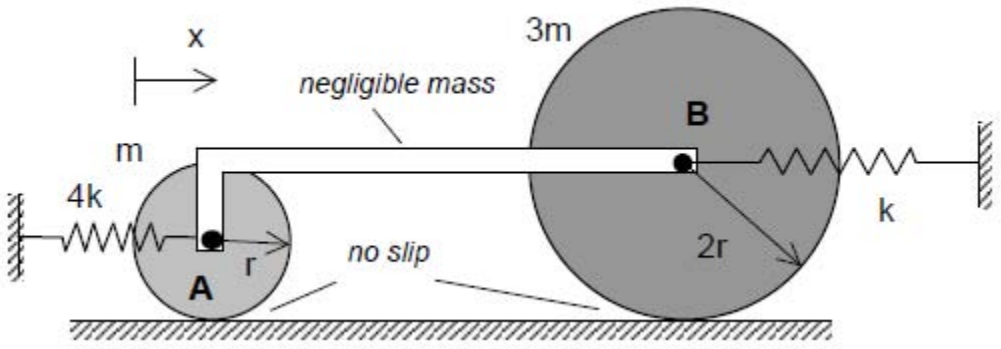
Homework H.6.A

Given: Two homogeneous wheels, having masses of m and $3m$ and outer radii of r and $2r$, respectively, are connected by a rigid, L-shaped bar, where the mass of the bar is negligible compared to the mass of the wheels. The two wheels roll without slipping on a rough, horizontal surface. Two springs, having stiffness of $4k$ and k, connect points A and B, respectively, to ground, where A and B are the centers of the two wheels. The coordinate x gives the position of Point A measured from the position at which the two springs are unstretched, with x being measured positive to the right (as shown below).

Find: For this problem:
(a) Derive the single differential equation of motion (EOM) for the system in terms of the coordinate x; and
(b) Determine the natural frequency of free oscillation for the system.



Use the following parameters in your analysis: $m = 20$ kg, $k = 500$ N/m, and $r = 0.5$ m.