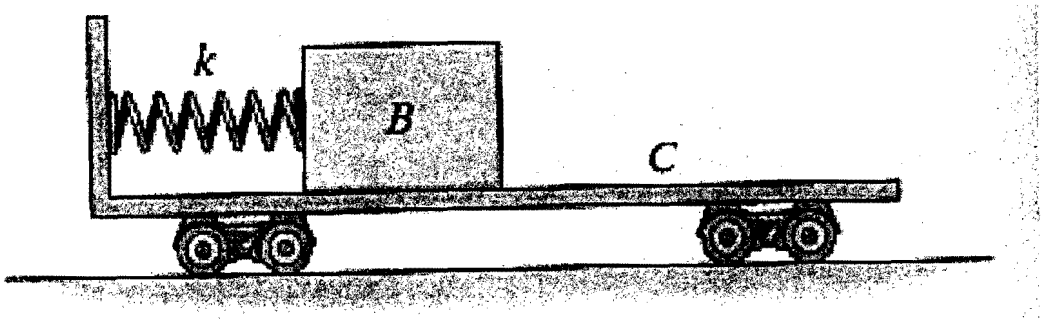
1. Derive the following equations for a system of particles:
   (a) Show that the sum of all the external forces acting on the system of particles is equal to the total mass of the particles times the acceleration of its center of mass G; that is $\sum \vec{F} = m\vec{a}_G$ (15%)
   (b) Show that the sum of the moments about point O of all the external forces acting on a system of particles is equal to the time rate of change of the total angular momentum of the system about point O; that is:

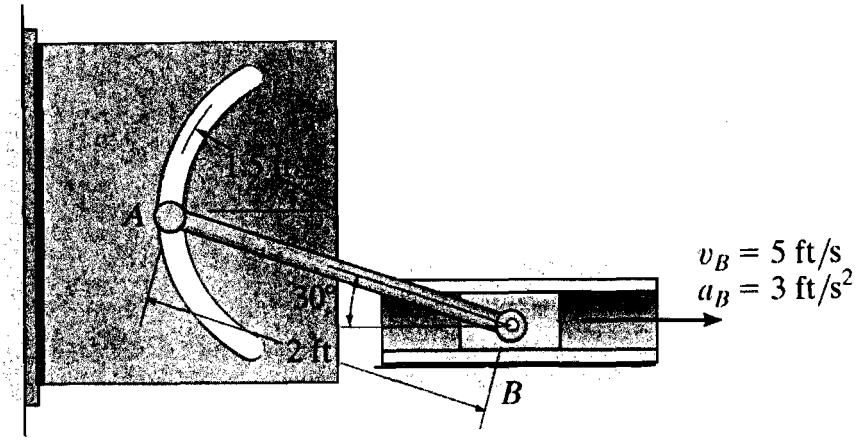
   $$\sum \vec{M}_O = \dot{\vec{H}}_o \qquad (15\%)$$

2. The block has a mass of m_b (kg) and rests on the smooth surface of the cart having a mass of m_c (kg), as shown in the Figure. If the spring with spring constant k (N/m), which is attached to the cart and not connected to the block, is compressed s (m) and the system is released from rest, determine the speed of the block with respect to the cart after the spring becomes undeformed. (Neglect the mass of cart's wheels and spring) (20%)

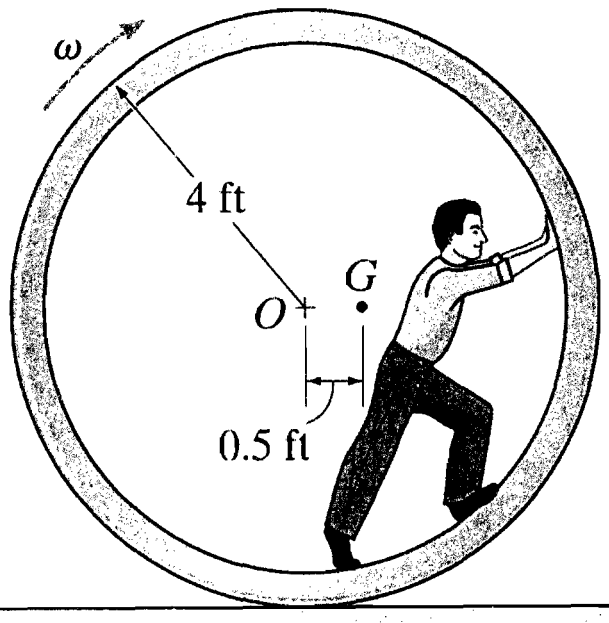


3. The slider block moves with a velocity of $v_B = 5\,\text{ft/s}$ and acceleration of $a_B = 3\,\text{ft/s}^2$. Determine the acceleration of A at the instant shown in the figure. (15%)

(背面仍有題目,請繼續作答)



4. The circular concrete culvert rolls with an angular velocity of $\omega = 0.5$ rad/s when the man is at the position shown in the figure. At this instant the center of gravity of the culvert and the man is located at point *G*, and the radius of gyration about *G* is $k_G = 3.5$ ft. Determine the angular acceleration of the culvert. The combined weight of the culvert and the man is 500 lb. Assume that the culvert rolls without slipping, and the man does not move within the culvert. (15%)



5. Determine the differential equation of motion for the damped vibratory system shown in the figure. What type of motion occurs? (20%)