Consider the multibody system shown in the diagram. As in homework #2, the orientations of the bodies are specified relative to the inertial frame $R$ (absolute angles) using a 3-2-1 body-fixed rotation sequence. Also, the positions of the mass centers of all the bodies are to be specified using relative coordinates as indicated by the vectors in the diagram. Vectors $s_i$ $(i = 1, \ldots, 8)$ represent translation vectors for the bodies relative to their adjacent, lower-numbered body and are expressed in the lower-numbered body frame. So, for example, since $B_1$ is the lower-numbered body of $B_7$,

$$s_7 = \sum_i x_{7i} n_{1i}.$$ 

The vectors that are fixed in the bodies of the system are expressed in the bodies they are fixed in. So, for example,

$$q_8 = \sum_i q_{8i} n_{7i}.$$

Complete the following:

a) Find the inertial components of the position vector of $G_3$, the mass-center of body $B_3$. Express the results in matrix-vector form.

b) Find the inertial components of the velocity of $G_3$, the mass-center of body $B_3$. Express the results in matrix-vector form using the body-fixed angular velocity components. Then, identify the partial velocity matrices associated with $\dot{x}_{1i}$, $\dot{x}_{2i}$, $\dot{x}_{3i}$, $\dot{\theta}_1$, $\dot{\theta}_2$, and $\dot{\theta}_3$. 