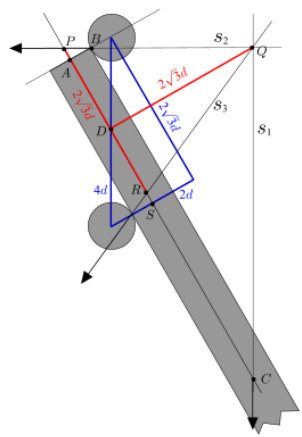
Problem 3. Bars and rod *(5 points)*

With $\mu = \frac{1}{2}$, the resultant force of the normal force and friction force forms an angle $\arctan\frac{1}{2}$ with the surface normal (assuming that the rod is as short as possible and hence, at the threshold of slipping). There are three forces applied to the rod — the gravity force mg applied to the centre of mass C, and the two forces due to the bars. At equilibrium, the three lines s_1, s_2, and s_3, defined by these three forces need to intersect at a single point Q (otherwise, with respect to the intersection point of two lines, the torque of the third force would cause a rotation of the rod). This configuration is depicted in Figure.



Since the friction force forms angle $\arctan\frac{1}{2}$ with the surface normal, hence $\angle DPQ = \angle DRQ = \arctan 2$, hence $AP = RS = \frac{1}{4}d$ (see Figure). From the geometry of the blue triangle, $AS = 2\sqrt{3}d$; due to $AP = RS$, $PR = AS = 2\sqrt{3}d$ and $PD = \sqrt{3}d$. Now, let us recall that $\tan\angle DPQ = 2$, hence $DQ = PR = 2\sqrt{3}d$. From the geometry of the blue triangle, $\angle DCQ = 30°$, so that $DC = DQ/\tan 30° = 6d$. Now we can finally express

$$AC = CD + DP - PA = 5\frac{3}{4}d + \sqrt{3}d \Rightarrow$$

$$L = 2AC = (11{,}5 + 2\sqrt{3})d \approx 14.96d.$$