87. (Third problem in **Cluster 2**)
Our analysis of spool 2 is exactly as in the solution of part (b) of the previous problem, but with a_f replaced with $-a_s$. The negative sign is due to the wording of the problem (which refers to a "downward acceleration a_s"):

$$\begin{aligned} T - Mg &= Ma_1 \\ TR_1 &= I_1\alpha_1 = I_1\left(\frac{-a_s - a_1}{R_1}\right) \end{aligned}$$

In our analysis of spool 1, we pay close attention to signs: positive (downward) a_s corresponds to clockwise (conventionally taken to be negative) rotation of spool 1; hence, $R_2\alpha_2 = -a_s$. For spool 1, we therefore have

$$\sum \tau_z = -TR_2 = I_2\alpha_1 = I_2\left(\frac{-a_s}{R_2}\right) \ .$$

(a) Simultaneous solution (certainly non-trivial) of these three equations yields

$$a_1 = -\frac{g}{1 + \dfrac{1}{\dfrac{MR_1^2}{I_1} + \dfrac{MR_2^2}{I_2}}} \ .$$

The problem asks for the magnitude of this (which eliminates the negative sign).

(b) This amounts to eliminating the $\frac{MR_2^2}{I_2}$ term in the expression for a_1 .