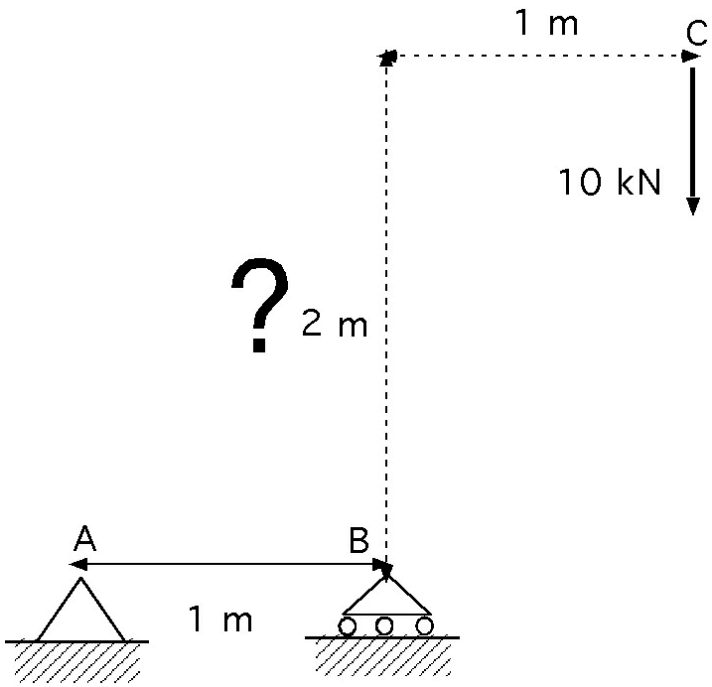
Problem M1

This is question is designed to provide you with a chance to revise material we met last term, and an opportunity to start thinking about structural design. You are asked to design a minimum mass truss structure that will be attached at points A, and B, 1 m apart on a horizontal floor in order to support a vertical load of 10 kN, without exceeding the strength (assume that the tensile and compressive strengths are the same) of the bars, at a distance 2 m above the floor and 1m to the right of the right hand support point (B).. The truss will be made of constant cross-section members of whatever material you choose to select. All of the bars will have the same cross-section. The following materials are available for selection. Select a material, and then choose an appropriate truss configuration and then estimate the mass of the truss, such that it will meet the design requirement. Explain your thought processes at each step.

Material	**Density, ρ,** (Mg/m^3)	**Modulus, E,** (GPa)	**CTE, α,** x 10^{-6} K^{-1}	**Price , p,** ($/Mg)	**Tensile Strength,** σ_f, (MPa)
Mild Steel	7.9	203	12	300	220
Aluminum alloy (2000 series)	2.8	71	24	1500	350
Titanium alloy Ti-6Al4V	4.5	120	9.0	8000	850
Carbon fiber composite*	1.5	70	3.0	100000	700
Wood (e.g spruce)*	0.6	12	4.0	300	30
Silicon Carbide (SiC)	3.0	410	4.0	50000	300



Note. Although the design objective is to minimize the mass of the structure, the credit for the question will be based on demonstrating a logical approach to selecting a material and a truss configuration, and then obtaining an estimate for the mass of the truss. Do not spend more than an hour on this question, and do not analyze multiple truss configurations. A useful exercise is to estimate what you think the mass of the truss will be before you do any analysis - developing an intuition for the correct size for structures is a useful skill to cultivate.