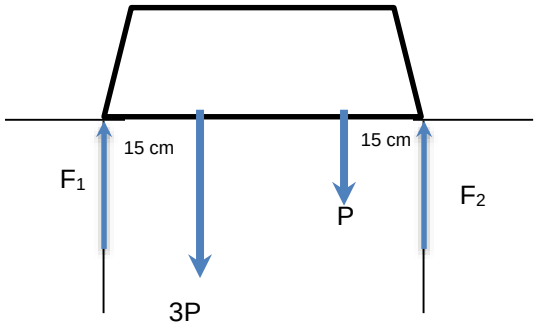
Popsicle Bridge Project

This project may be completed in teams of four.

Bridge Model

The bridge must span a minimum distance of 60 cm with a minimum 5cm width (you do not need to form a roadway) and may use a maximum of 100 standard sized popsicle sticks. Each popsicle stick must be numbered. Regular carpenters glue may be used to join the popsicle sticks together. The popsicle sticks may be cut and shaped as required.

The bridge will be loaded asymmetrically – 15 cm from one edge with a force 3P, and 45 cm from the same edge with a force P. Your bridge deck must be able to accommodate a 2cm diameter steel tube at these locations for applying the load.

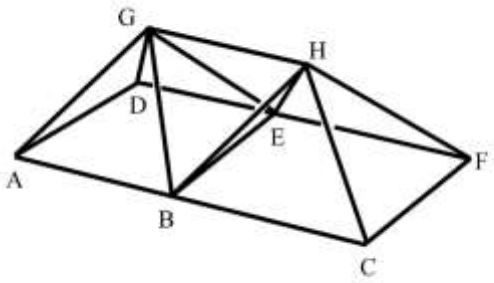


Sample Analysis

Refer to the following to learn how to analyze a truss:

http://youtu.be/qzmeFq8rckw
https://www.youtube.com/watch?v=56eTM36Z9-A

Then consider the following bridge. Treat all segments as congruent, light, two-force members. Assume loading of 100lb at H and 300lb at G. Assume roller joints at D (the origin) and A, C and F. Note the symmetry of the structure.



You will need to use the techniques of vector mechanics to express each force as a Cartesian vector and apply the equations of equilibrium. Then you will solve for the tensile and compressive forces in each member.

Bridge Analysis

A full equilibrium analysis of your model truss bridge must be done, using P=100N . You will want to keep your design simple so as not to over-complicate your analysis. If you use too many joints, it may be impossible to solve the equations. Use your analysis to identify and reinforce weak members. Your bridge will be tested to failure on the project due date.

Due dates:

Sample Analysis:	/25
Bridge Analysis:	/25
Model Bridge Testing	/25

Criteria:

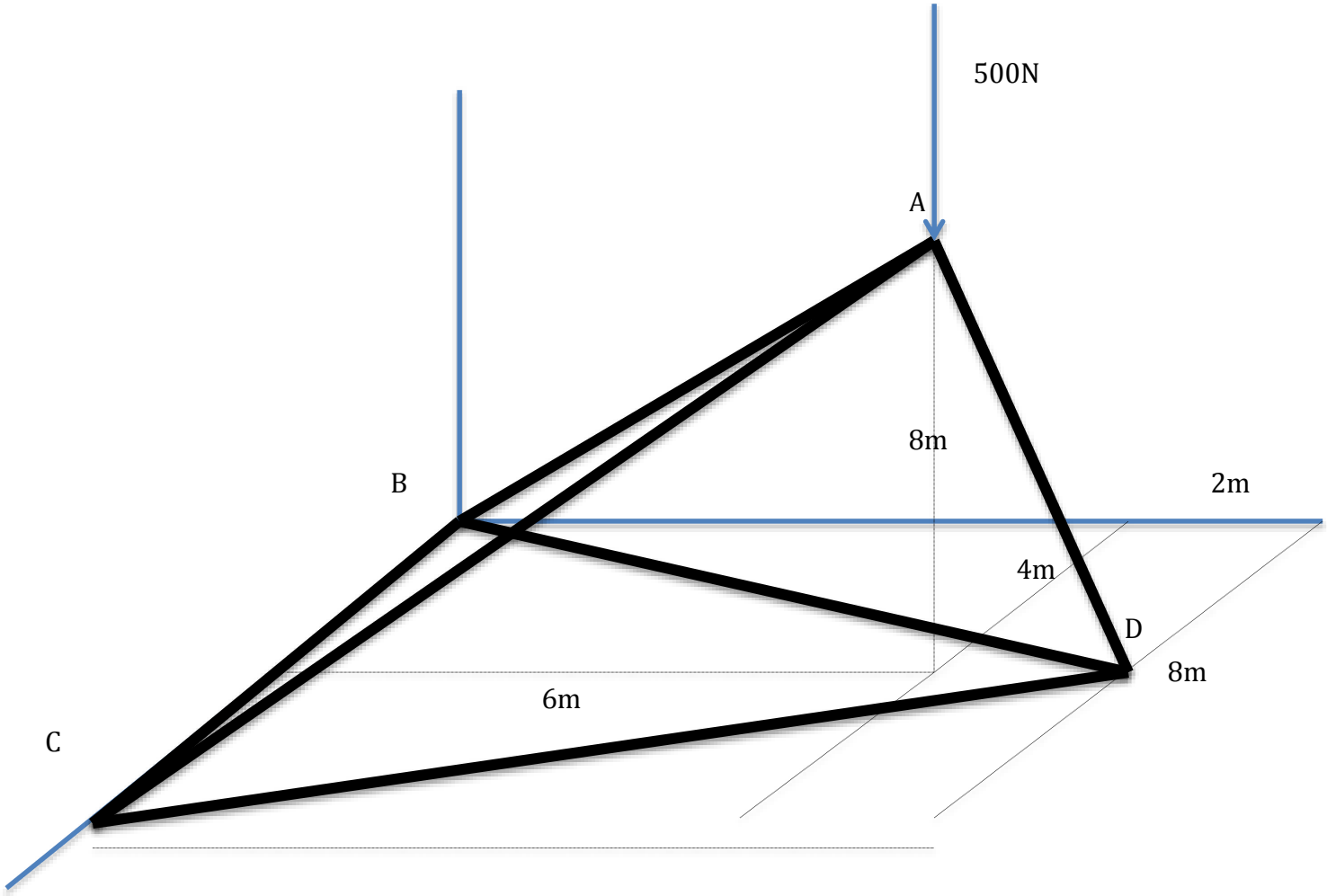
i) Analyses will be marked for:

- high quality FBD
- external force analysis-clear and correct
- internal force analysis
  - correct and very clear vector analysis of forces
  - clear presentation of equations
  - equations correct and solved correctly
- interpretation of solution

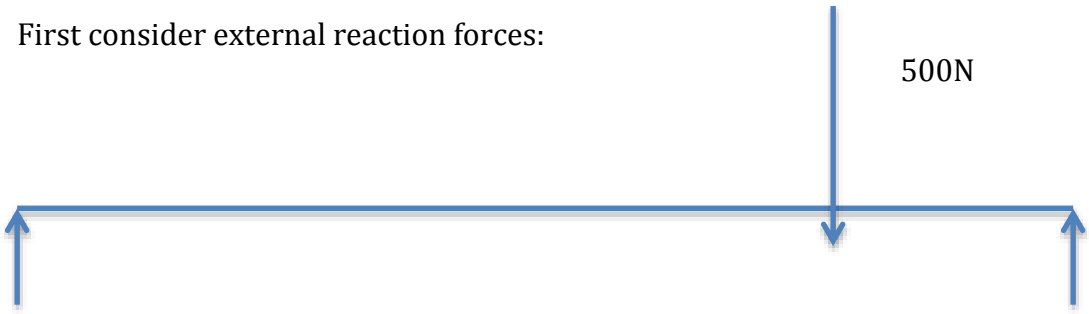
ii) Bridge Model will be marked for:

- consistency with proposed structure (from analysis report)
- careful construction
- successful load bearing
- ultimate strength

Truss Example: The truss below has roller supports at B, C, D. Find the reactions and internal force in each member



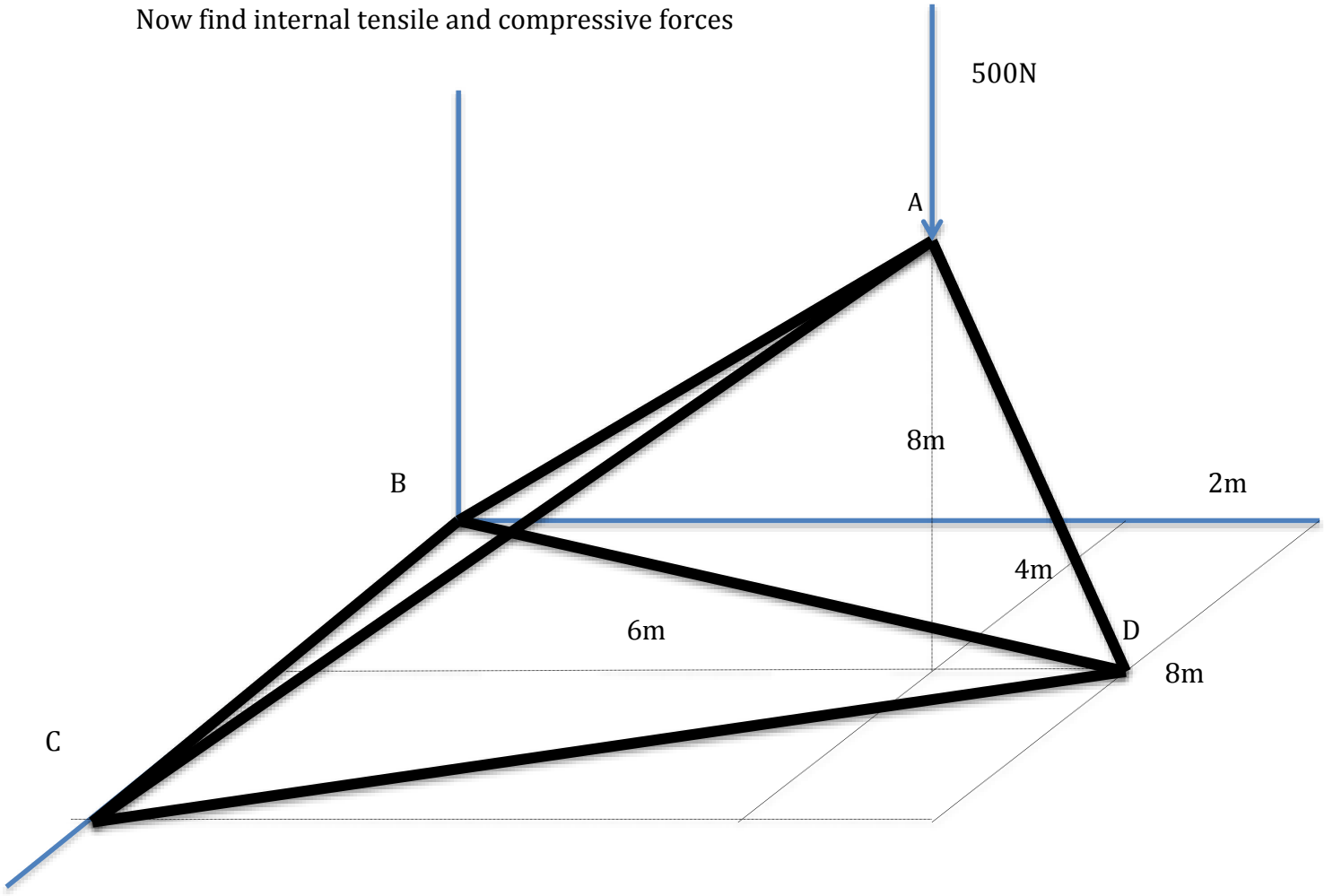
First consider external reaction forces:



Moments about CB axis:

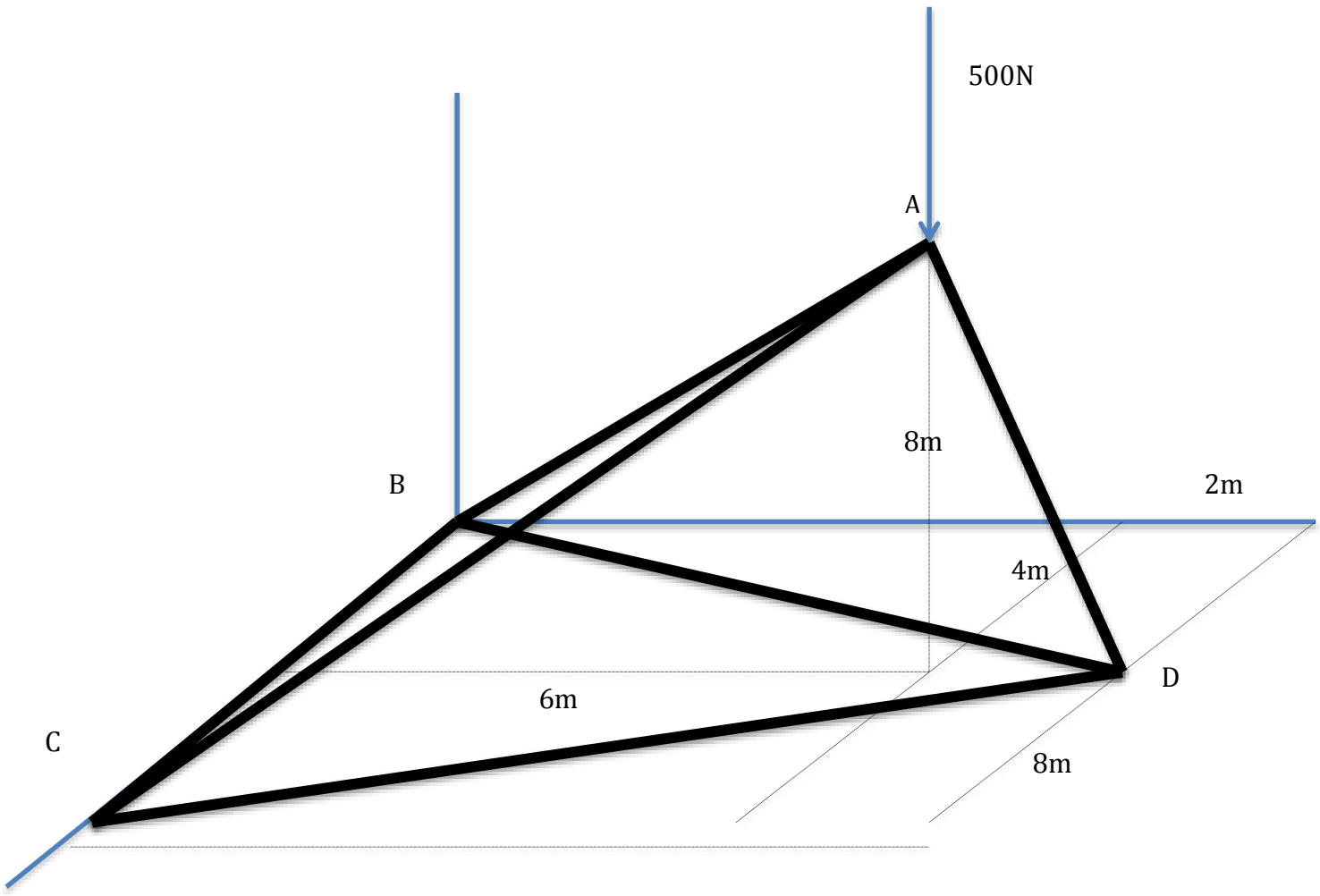
Forces-y:

Now find internal tensile and compressive forces



At C: $$\vec{R}_C + \vec{F}_{CB} + \vec{F}_{CA} + \vec{F}_{CD} = 0$$

Assume that all members are in tension. Note that symmetry implies $F_{BD}=F_{CD}$ $F_{BA}=F_{CA}$



At D: $\vec{R}_D + \vec{F}_{CD} + \vec{F}_{BD} + \vec{F}_{AD} = 0$

WolframAlpha computational... knowledge engine

-x-4/sqrt(80)*y-4/sqrt(110)*z=0,8/sqrt(80)*y+6/sqrt(110)*z=0,8/sqrt(110)*z+62.5=0,8/sq

Examples Random

Input:

$$\left\{-x-\frac{4}{\sqrt{80}}\,y-\frac{4}{\sqrt{110}}\,z=0,\ \frac{8}{\sqrt{80}}\,y+\frac{6}{\sqrt{110}}\,z=0,\ \frac{8}{\sqrt{110}}\,z+62.5=0,\ \frac{8}{\sqrt{68}}\,w+375=0,\ -\frac{16}{\sqrt{80}}\,s-\frac{2}{\sqrt{68}}\,w=0\right\}$$

Result:

$$\left\{-x-\frac{y}{\sqrt{5}}-2\sqrt{\frac{2}{55}}\,z=0,\ \frac{2\,y}{\sqrt{5}}+3\sqrt{\frac{2}{55}}\,z=0,\ 4\sqrt{\frac{2}{55}}\,z+62.5=0,\ \frac{4\,w}{\sqrt{17}}+375=0,\ -\frac{4\,s}{\sqrt{5}}-\frac{w}{\sqrt{17}}=0\right\}$$

Solution:

Fewer digits | More digits | Exact form | Step-by-step solution

$s \approx 52.4078432226513$, $w \approx -386.541152401656$,
$x \approx 7.8125$, $y \approx 52.4078$, $z \approx -81.9382$