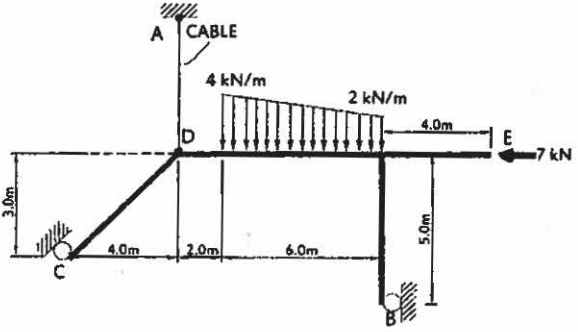
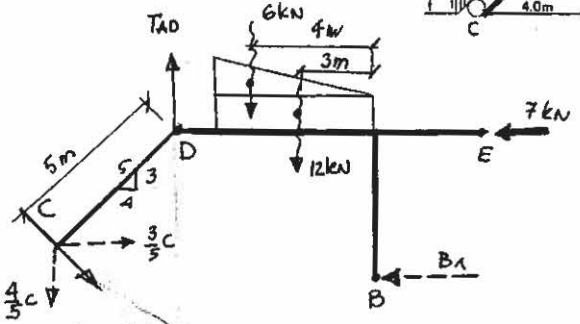
1.) The member shown is supported by a **vertical cable AD** and **rollers at both locations C and B.** For the given loading and if the system is in equilibrium:

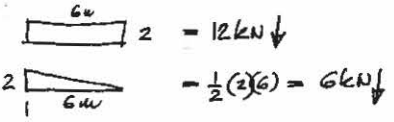
a) Draw a separate free body diagram of the entire body showing all forces

b) Determine the reaction forces at C and B, and the tension in cable AD.



(a)





1st solution

b) $\circlearrowleft \Sigma M_D = 0$ $\quad -C(5)+6(4)+12(5)+B_x(5)=0$

$5B_x - 5C + 84 = 0$ $\quad B_x - C + 16.8 = 0$ (1)

$\rightarrow \Sigma F_x = 0$ $\quad \frac{3}{5}C - 7 - B_x = 0$ $\quad \therefore B_x = \frac{3}{5}C - 7$ (2) sub into (1)

in (1) $\quad B_x - C + 16.8 = 0$

$(\frac{3}{5}C - 7) - C + 16.8 = 0$ $\quad -\frac{2}{5}C + 9.8 = 0$ $\quad \therefore C = 24.5\ kN \searrow$

in (2) $\quad \frac{3}{5}(24.5) - 7 - B_x = 0$ $\quad B_x = 7.7\ kN \leftarrow$

$\uparrow \Sigma F_y = 0$ $\quad -\frac{4}{5}C + T_{AD} - 6 - 12 = 0$ $\quad T_{AD} = 37.6\ kN\ (T)$

2nd solution

$\circlearrowleft \Sigma M_C = 0$ $\quad -T_{AD}(4) + 6(8) + 12(9) - 7(3) + B_x(2) = 0$

$-4T_{AD} + 2B_x + 135 = 0$ (1)

$\Sigma F_x = 0$ $\quad 3/5\ C + 0\ T_{AD} - B_x = 7$ (2)

$\Sigma F_y =$ $\quad -\frac{4}{5}C + T_{AD} + 0\ B_x = 18$ (3)

solve: $T_{AD} = 37.6\ kN\ (T)$, $C = 24.5\ kN \searrow$, $B_x = 7.7\ kN \leftarrow$

3rd solution

$\circlearrowleft \Sigma M_B = 0$ $\quad 3/5\,C(2) - \frac{4}{5}C(12) + T_{AD}(8) - 6(4) - 12(3) - 7(5) = 0$

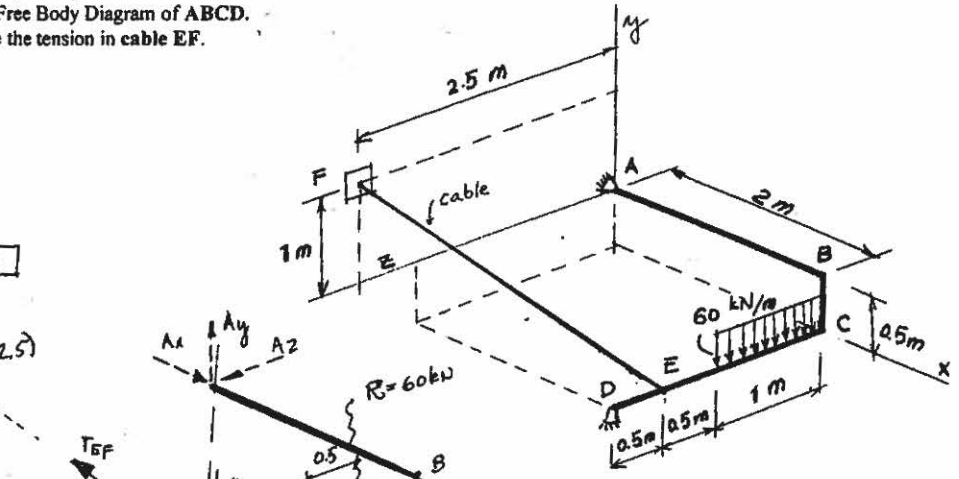
$\Sigma F_y = 0$

$\Sigma F_x = 0$

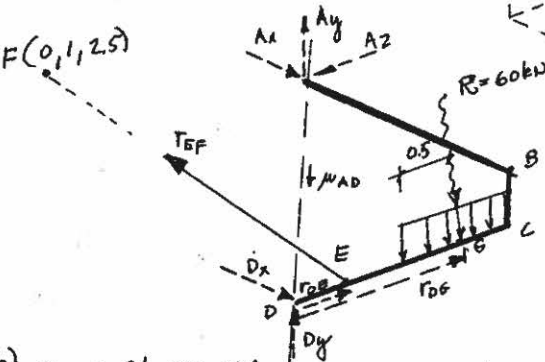
2. The member ABCD (AB is parallel to x, BC is parallel to y and CD is parallel to z axis), has negligible weight and is supported by a ball-and socket at A, by a ball-and socket at D which has been modified to provide reactions only in the x and y direction, and by cable EF.

a) Draw the Free Body Diagram of ABCD.

b) Determine the tension in cable EF.



a) FBD



since only require T_{EF} - take ΣM_{AD} - a line through remaining unknowns:

$\Sigma M_{AD} = 0$ or $\Sigma(\underline{u}_{AD} \cdot \underline{r} \times \underline{F}) = 0$

b) $\underline{u}_{AD} = \frac{2\underline{i} - 0.5\underline{j} + 2\underline{k}}{\sqrt{2^2+0.5^2+2^2}} = \frac{2\underline{i} - 0.5\underline{j} + 2\underline{k}}{\sqrt{8.25}} = 0.983\,\underline{i} - 0.174\,\underline{j} + 0.696\,\underline{k}$

$\underline{T}_{EF} = T_{EF}\,\underline{u}_{EF} = T_{EF}\frac{-2\underline{i} + 1.5\underline{j} + 1\underline{k}}{\sqrt{2^2+1.5^2+1^2}} = \frac{T_{EF}}{\sqrt{7.25}}(-2\underline{i} + 1.5\underline{j} + 1\underline{k}) = T_{EF}(-0.7428\,\underline{i} + 0.557\,\underline{j} + 3.714\,\underline{k})$

$\underline{W} = -60\underline{j}\,(kN)$, $\underline{r}_{DC} = -1.5(m)\underline{k}$, $\underline{r}_{DE} = -0.5\underline{k}\,(m)$

$\Sigma M_{AD}^{W} + \Sigma M_{A}^{T_{EF}} = 0$

$$\frac{1}{2.872}\begin{vmatrix} 2 & -0.5 & 2 \\ 0 & 0 & -1.5 \\ 0 & -60 & 0 \end{vmatrix} + \frac{T_{EF}}{2.693}\cdot\frac{1}{2.872}\begin{vmatrix} 2 & -0.5 & 2 \\ 0 & 0 & -0.5 \\ -2 & 1.5 & 1 \end{vmatrix} = 0$$

$$-(2)(-60)(-1.5) + \frac{T_{EF}}{2.693}\left[(-2)(-0.5) - (2)(1.5)(-1.5)\right] = 0$$

$$-180 + \frac{T_{EF}}{\sqrt{7.25}}(0.5+1.5) = 0$$

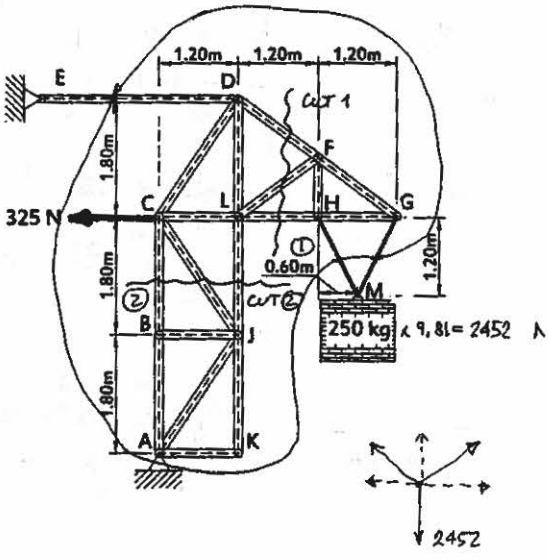
$$T_{EF} = 484.7$$

$$T_{EF} = 485\ kN\,(T)$$ ← tension

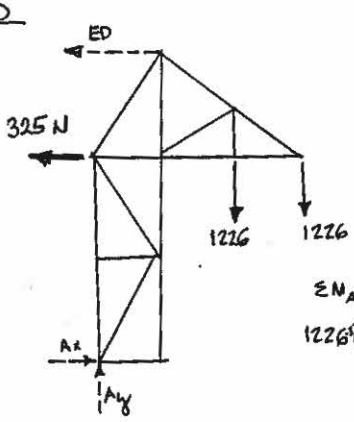
3. Shown is a truss supported by a **pin at A** and **pin-connected member ED**. All truss connections are pins. The truss is carrying a load of 250 kg by two cables **MH** and **MG**, and the truss is also carrying a force of 325 N at **C**. The truss is in equilibrium and the weight of the truss members is negligible.

a) Draw a free body diagram of the truss and determine the reactions at the two supports.

b) Using the ***method of sections***, determine the forces in the following members of the truss: **FD, FL, HL and CJ.** Please ensure that for every step of your analysis you have an accompanying free body diagram drawn. Also indicate if the forces are in tension or compression.



a) FBD



$\Sigma M_A = 0$

$1226(2.4) + 1226(3.6) - 325(3.6) - ED(5.4) = 0$

$7356 - 1170 - 5.4(ED) = 0$

$ED = 1146\ N \leftarrow$

$\rightarrow \Sigma F_x = 0 \quad Ax - 1146 - 325 = 0 \quad Ax = 1471\ N \rightarrow$

$\uparrow \Sigma F_y = 0 \quad Ay - 1226 \times 2 = 0 \quad Ay = 2452\ N \uparrow$

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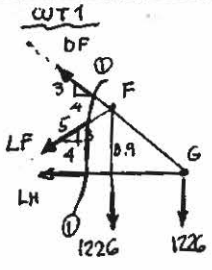
b) CUT 1



$\circlearrowleft \Sigma M_F = 0 \quad 1226(1.2) + LH(0.9) = 0$

$LH = -1635\ N$

$\therefore LH = 1635\ N\ (C)$

$\Sigma F_y = 0 \quad 1635 - \frac{4}{5}DF - \frac{4}{5}FL = 0$

$\therefore DF + FL = 2043.75\ N\ (1)$

$\Sigma F_x = 0 \quad -2452 + \frac{3}{5}DF - \frac{3}{5}FL = 0$

$\therefore DF - FL = 4087$

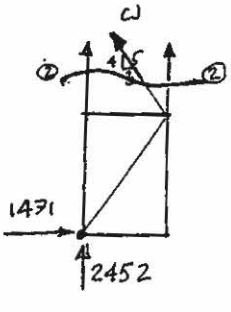
SOLVING :

$DF = 3095\ N\ (T)$

$FL = -1022\ N$

$FL = 1022\ N\ (C)$

CUT 2.



$\rightarrow \Sigma F_x = 0$

$CJ\ \frac{3}{5} - 1471 = 0$

$CJ = 2452\ N\ (T)$