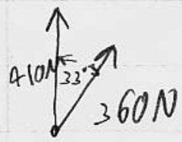
Homework 1 solutions:

1) 

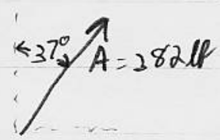
direction off vertical $= \operatorname{atan}\left[\dfrac{\cos(90°-33°)(360N)}{(410N + \sin(90°-33°)(360N))}\right]$

$= 15.4°$ off vertical

magnitude: $= \sqrt{(360N \cos 57°)^2 + [410N + 360N(\sin 57°)]^2}$

$= \sqrt{(196.0700N)^2 + (711.9214N)^2}$

$= 738.43N \rightarrow \boxed{738N \ \angle 15.4°}$

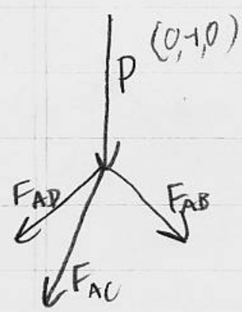
2) 

x component $= A_x = 382\,lb \cos(90°-37°) = 229.9\,lb$

$\boxed{\rightarrow 230.\,lb}$

y component $= A_y = 382\,lb \sin(90°-37°) = 305.1\,lb$

$\boxed{\rightarrow 305\,lb}$

3) 

unit vectors: AB: magnitude $= \sqrt{(220mm)^2 + (-192mm)^2 + 0^2}$

$= 292mm$

$\bar{U}_{AB}: \left(\frac{220}{292}\hat{i}, \frac{-192}{292}\hat{j}, 0\hat{k}\right)$

AC magnitude $= \sqrt{0^2 + (-192mm)^2 + (144mm)^2}$

$= 240mm$

$\bar{U}_{AC}: \left(0\hat{i}, \frac{-192}{240}\hat{j}, \frac{144}{240}\hat{k}\right)$

AD magnitude $= \sqrt{(-192mm)^2 + (-192mm)^2 + (-96mm)^2}$

$= 288mm$

$\bar{U}_{AD}: \left(\frac{-192}{288}\hat{i}, \frac{-192}{288}\hat{j}, \frac{-96}{288}\hat{k}\right)$

3 cont.)

Static equations:

$$\Sigma F_x = 0 = F_{AB}\left(\frac{220}{292}\right) + F_{AC}(0) + F_{AD}\left(\frac{-192}{288}\right)$$

$$\Sigma F_y = 0 = F_{AB}\left(\frac{-192}{292}\right) + F_{AC}\left(\frac{-192}{240}\right) + F_{AD}\left(\frac{-192}{288}\right) - P$$

$$\Sigma F_z = 0 = F_{AB}(0) + F_{AC}\left(\frac{144}{240}\right) + F_{AD}\left(\frac{-96}{288}\right)$$

given $|F_{AB}| = 146N$, by inspection $F_{AB} = -146N$
(member in compression)

from ΣF_x: $F_{AD} = F_{AB}\left(\frac{220}{292}\right)\left(\frac{288}{192}\right) = -165N$

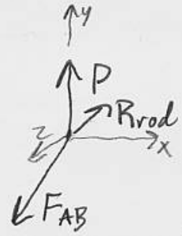
from this and ΣF_z: $F_{AC} = F_{AD}\left(\frac{96}{288}\right)\left(\frac{240}{144}\right) = -91\tfrac{2}{3}N$

substitute into ΣF_y:

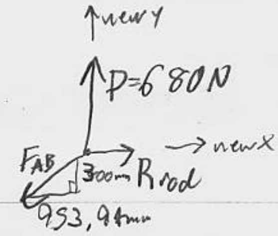
$$\underbrace{-146N\left(\frac{-192}{292}\right)}_{96N} \underbrace{- 91\tfrac{2}{3}N\left(\frac{-192}{240}\right)}_{+73\frac{1}{3}N} \underbrace{- 165N\left(\frac{-192}{288}\right)}_{+110N} - P = 0$$

$$\rightarrow \quad P = 279\tfrac{1}{3}N \quad \rightarrow \quad \boxed{P = 279N}$$

4) at A:



go to 2D: (planar problem)



$x^2+y^2+z^2 = 1m^2$; given $y=300mm$, $x=400mm$

$\rightarrow z = 866.0254mm$

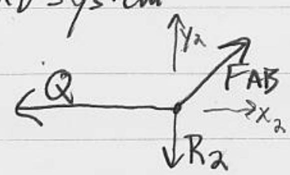
$\overline{F}_{AB} = F_{AB}\left(\frac{-953.94}{1000}\hat{i} + \frac{-300}{1000}\hat{j}\right)$ in planar coord. sys.

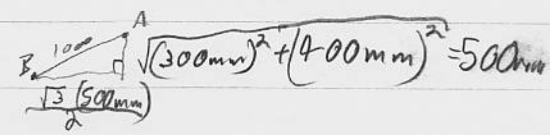
$\sum F_{x(new)} = 0 = -F_{AB}(.95394) + R_{rod}$

$\sum F_{y(new)} = 0 = 680N - .300\,F_{AB}$

$\rightarrow F_{AB} = 2266\tfrac{2}{3}N \rightarrow 2270N$

at B: rotate to new 2D system

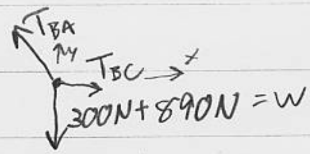




$\sum F_{x_2} = 0 = -Q + F_{AB}\frac{\sqrt{3}\,250mm}{1000mm}$

$Q = 981.495N \rightarrow 981N$

5) at B:



$\overline{w} = -1190N\hat{j}$

$\overline{T}_{BC} = T_{BC}\left(\frac{28.8m}{\sqrt{(12m)^2+(28.8m)^2}}\hat{i} - \frac{12m}{\sqrt{\quad}}\hat{j}\right)$

$\overline{T}_{BA} = T_{BA}\left(\frac{-16.8m}{\sqrt{(16.8m)^2+(9.9m)^2}}\hat{i} + \frac{9.9m}{\sqrt{\quad}}\hat{j}\right)$

$\sum F_x = 0 = T_{BC}\left(\frac{28.8}{31.2}\right) - T_{BA}\left(\frac{16.8}{19.5}\right) \rightarrow T_{BA} = T_{BC}\left(\frac{28.8}{31.2}\right)\left(\frac{19.5}{16.8}\right)$

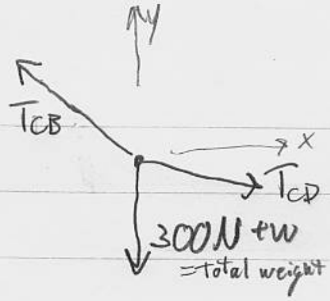
$\sum F_y = 0 = T_{BC}\left(\frac{-12}{31.2}\right) + T_{BA}\left(\frac{9.9}{19.5}\right) - 1190N$

$= -T_{BC}\left(\frac{12}{31.2}\right) + T_{BC}\left(\frac{9.9}{19.5}\right)\left(\frac{28.8}{31.2}\right)\left(\frac{19.5}{16.8}\right) - 1190N$

$1190N = T_{BC}\left(\frac{9.9\times 28.8}{31.2\times 16.8} - \frac{12}{31.2}\right)$

$\rightarrow T_{BC} = 7468.3N$

at C: $T_{CB} = T_{BC} = 7468.3N$



$$\overline{T_{CB}} = T_{CB}\left(\frac{-28.8m}{31.2m}\hat{i} + \frac{12m}{31.2m}\hat{j}\right)$$
$$\overline{T_{CD}} = T_{CD}\left(\frac{7.2m}{\sqrt{(7.2m)^2+(1.32m)^2}}\hat{i} + \frac{-1.32m}{\sqrt{\quad}}\hat{j}\right)$$

$$\sum F_x = 0 = T_{CB}\left(\frac{-28.8}{31.2}\right) + T_{CD}\left(\frac{7.2}{7.32}\right)$$
$$\rightarrow T_{CD} = T_{CB}\left(\frac{7.2}{7.32}\right)\left(\frac{31.2}{28.8}\right)$$

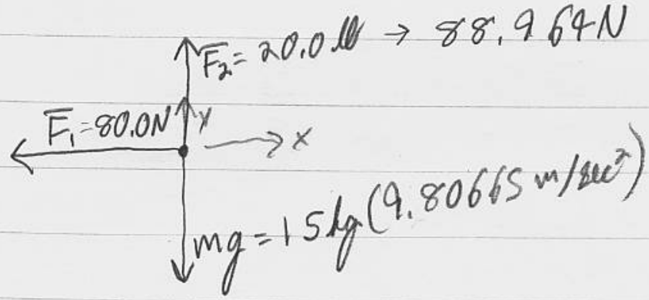
$$\sum F_y = 0 = -300N - w - \left(\frac{1.32}{7.32}\right)T_{CD} + T_{CB}\left(\frac{12}{31.2}\right)$$

$$w = -300N - \left(\frac{1.32}{7.32}\right)\left(\frac{7.2}{7.32}\right)\left(\frac{31.2}{28.8}\right)T_{CB} + T_{CB}\left(\frac{12}{31.2}\right)$$

$$= 7468.3N\left[\left(\frac{12}{31.2}\right) - \left(\frac{1.32}{7.32}\right)\left(\frac{7.2}{7.32}\right)\left(\frac{31.2}{28.8}\right)\right] - 300N$$

$$= 1137N \rightarrow$$

6) a)



b) $w = mg = 15kg(9.80665\ m/sec^2) = 147.1\ N$

Total of $\boxed{-80.0N \text{ in } x}$, $88.964N - 147.1N$ in $\boxed{y = -58.1N}$

$\boxed{\text{for } 98.9N \text{ in } 126° \text{ off } +y \text{ axis}}$

c)