1. $\vec{N} = N_0\left(\frac{3}{5}\hat{i} + \frac{4}{5}\hat{j}\right)$ $\quad \vec{W} = -300\,\hat{j}$

$\vec{P} = -P\,\hat{k}$ $\quad \vec{r}_{AB} = \frac{-16}{5}\hat{i} + \left(2 + \frac{12}{5}\right)\hat{j} + 3\hat{k}$

$= \frac{-16}{5}\hat{i} + \frac{22}{5}\hat{j} + \frac{15}{5}\hat{k}$

$= -3.2\hat{i} + 4.4\hat{j} + 3\hat{k}$

$\hat{u}_{AB} = -.5151\,\hat{i} + .7082\,\hat{j} + .4829\,\hat{k}$

$\Sigma \vec{F} = \vec{T}_{AB} + \vec{N} + \vec{W} + \vec{P} = 0$

x: $-.5151\,T_{AB} + \frac{3}{5}N_0 = 0$

y: $.7082\,T_{AB} + \frac{4}{5}N_0 - 300 = 0$

z: $+.4829\,T_{AB} - P = 0$

Mult x eqn by 4 $\quad -2.060\,T_{AB} + \frac{12}{5}N_0 = 0$

Mult y eqn by 3 $\quad 2.125\,T_{AB} + \frac{12}{5}N_0 = 900$ $\quad$ subtract

$4.185\,T_{AB} = 900$

$T_{AB} = 215\ N$

$N_0 = 185\ N$

$P = 104\ N$

2. $\hat{u}_{BE} = \dfrac{3\hat{i} - 6\hat{j} + 2\hat{k}}{7}$

$\vec{F}_B = 350\,\hat{u}_{BE} = 150\hat{i} - 300\hat{j} + 100\hat{k}$

$\vec{F}_C = \dfrac{500}{\sqrt{2}}\hat{i} - \dfrac{500}{\sqrt{2}}\hat{k}$

$\vec{F}_D = 600\left(\dfrac{1}{2}\right)\hat{i} + 600\,\dfrac{\sqrt{3}}{2}\hat{j}$

$$\boxed{\vec{F}_r = 803.6\hat{i} + 219.6\hat{j} - 253.6\hat{k}} \text{ lbs}$$

$\vec{r}_{AB} = 3\hat{i} + 2\hat{k}$
$\vec{r}_{AC} = 3\hat{i} - 2\hat{k}$
$\vec{r}_{AD} = 4\hat{i} - 4\hat{j}$
} use these to calculate moments about A

$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & 0 & 2 \\ 150 & -300 & 100 \end{vmatrix} = \hat{i}(600) - \hat{j}(300 - 300) + \hat{k}(-900) = 600\hat{i} - 900\hat{k}$$

$$\frac{500}{\sqrt{2}}\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & 0 & -2 \\ 1 & 0 & -1 \end{vmatrix} = \frac{500}{\sqrt{2}}\left[-\hat{j}(-3+2)\right] = \frac{500}{\sqrt{2}}\hat{j}$$

$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 4 & -4 & 0 \\ 300 & 600\frac{\sqrt{3}}{2} & 0 \end{vmatrix} = \hat{k}\left[2400\,\frac{\sqrt{3}}{2} + 1200\right] = 3278.5\,\hat{k}$$

$$\boxed{\vec{M}_A = 600\hat{i} + 354\hat{j} + 2379\hat{k}} \text{ in-lb}$$

3. $\vec{F}_r = -100\,\hat{i} + 50\,\hat{k}$ N

$$\Sigma \vec{M}_0 = \hat{i}(0) + \hat{j}\left[-50(.2) - 100(.15)\right] + \hat{k}\left[-100(.125)\right]$$

$$= -25\,\hat{j} - 12.5\,\hat{k} \quad N\cdot m$$

Since $\vec{F}_r \cdot \Sigma \vec{M}_0 \neq 0$, $\Rightarrow$ screw driver

$$\hat{u}_F = \frac{-100\hat{i} + 50\hat{k}}{\sqrt{100^2 + 50^2}} = -\frac{2}{\sqrt{5}}\hat{i} + \frac{1}{\sqrt{5}}\hat{k}$$

$$\vec{M}_{11} = \left(\vec{M}_0 \cdot \hat{u}_F\right)\hat{u}_F = (-12.5)\left(\frac{1}{\sqrt{5}}\right)\left[-\frac{2}{\sqrt{5}}\hat{i} + \frac{1}{\sqrt{5}}\hat{k}\right]$$

$$= 5\hat{i} - 2.5\hat{k}$$

$$\vec{M}_\perp = \vec{M}_0 - \vec{M}_{11} = -5\hat{i} - 25\hat{j} - 10\hat{k}$$

$$(x\hat{i} + y\hat{j} + z\hat{k}) \times \vec{F}_r = \vec{M}_\perp$$

$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ x & y & z \\ -100 & 0 & 50 \end{vmatrix} = -5\hat{i} - 25\hat{j} - 10\hat{k}$$

$\hat{i}$: $50y = -5$

$\hat{j}$: $50x + 100z = 25$

$\hat{k}$: $100y = -10$

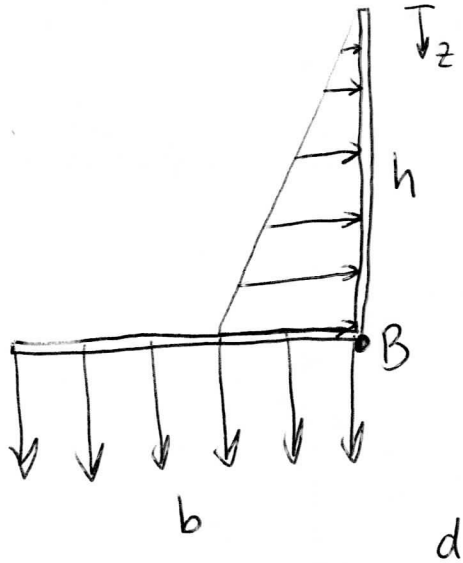
Screwdriver is $\vec{F}_r = -100\hat{i} + 50\hat{k}$

+ $\vec{M}_{11} = 5\hat{i} - 2.5\hat{k}$

located in $y = 0$ plane

along line given by $50x + 100z = 25$

4.




width of gate into page is $w$

$dF$ = force on strip at particular depth $z$; strip has vertical width $dz$ + width into page $w$

$$dF = P\,w\,dz \qquad P = \rho g z$$

$$dF = \rho g z\, w\, dz$$

$$\frac{dF}{dz} \equiv f(z) = \rho g w z$$

So $F_x = \frac{1}{2}(\rho g w h)h$ @ $z = \frac{2h}{3}$ ($\frac{h}{3}$ above B)

$F_z = \rho g w h b$ since that is a constant $f(x)$

located at $\frac{b}{2}$

For gate to open, moments about B must be equal for the two force distributions

$$\frac{1}{2}(\rho g w h)h\left(\frac{h}{3}\right) = \rho g w h b\left(\frac{b}{2}\right)$$

$$\frac{h^2}{3} = b^2$$

$$\boxed{\frac{h}{b} = \sqrt{3}}$$