	$\vec{r}_{A/B}$	$\hat{\lambda}_{A/B}$	$\vec{r}_{A/B} \times \vec{r}_{C/D}$
1	$2.4\hat{i} + 1.8\hat{j}$ m	$0.8\hat{i} + 0.6\hat{j}$	$6.48\hat{i} - 8.64\hat{j} - 0.96\hat{k}$ m^2
2	$-300\hat{i} + 160\hat{j}$ mm	$-0.88\hat{i} + 0.47\hat{j}$	$\vec{0}$ mm^2 //
3	$-3\hat{j}$ m	$-\hat{j}$	$-9\hat{i} - 4.5\hat{k}$ m^2
4	$-12\hat{i}$ in	$-\hat{i}$	$96\hat{j}$ in^2
5	$6.5\hat{i} + 8\hat{j} - 2\hat{k}$ ft	$0.62\hat{i} + 0.76\hat{j} - 0.19\hat{k}$	$40\hat{i} - 24.5\hat{j} + 32\hat{k}$ ft^2

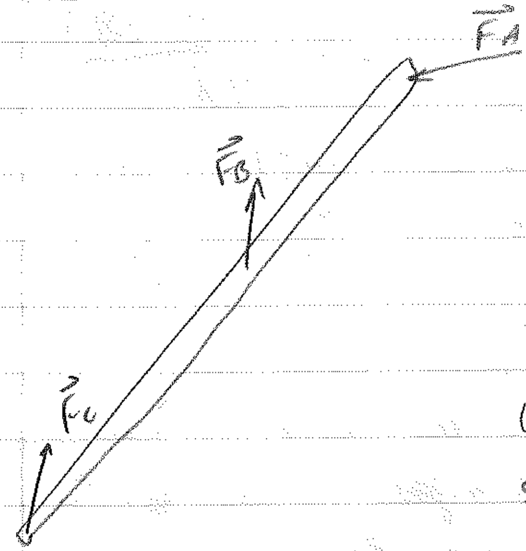
	$\vec{r}_{A/B} \cdot \hat{\lambda}_{C/D}$
1	-0.199 m
2	-340 mm
3	-2.619 m
4	0 $\perp$
5	-5.622 ft

2) CD is <u>NOT</u> a 2-Force member.

Find M.

Equilibrium of each part

<u>FBD ABC</u>



Positions (mm)	Forces (N)
$\vec{r}_{A/B} = 90\hat{i} + 180\hat{j}$	$\vec{F}_A = -240\hat{i}$
—	$\vec{F}_B = F_B\hat{j}$
$\vec{r}_{C/B} = -160\hat{i} - 320\hat{j}$	$\vec{F}_C = F_{cx}\hat{i} + F_{cy}\hat{j}$

We don't need F_B, so lets see if we can avoid it.

$\Sigma F_x = 0 = -240 + F_{cx}$ $\qquad F_{cx} = 240\ N$

$\Sigma F_y = 0 = F_B + F_{cy}$

$$\Sigma \vec{M}_B = \vec{0} = \vec{r}_{A/B} \times \vec{F}_A + \vec{r}_{C/B} \times \vec{F}_c$$

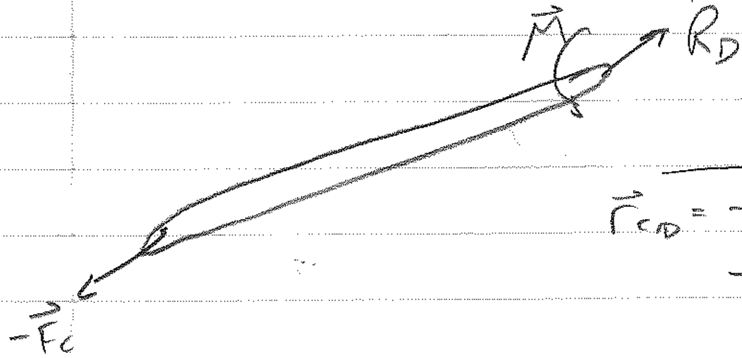
$$= (90\hat{i} + 180\hat{j}) \times -240\hat{i} + (-160\hat{i} - 320\hat{j}) \times (F_{cx}\hat{i} + F_{cy}\hat{j})$$

$$0\hat{k} = 43{,}200\,\hat{k} - 160\,F_{cy}\hat{k} + 320\,F_{cx}\hat{i}$$

$$F_{cy} = \frac{43{,}200 + 320 \cdot 240}{160} = \underline{750\ N} \qquad F_{cy}$$

$(F_B = -F_{cy}$, so $F_B = -750\ N)$

FBD CD



Position (mm)	Forces (N)
$\vec{r}_{CD} = -300\hat{i} - 125\hat{j}$	$\vec{F}_C = -240\hat{i} - 750\hat{j}$
—	$\vec{R}_D = R_{Dx}\hat{i} + R_{Dy}\hat{j}$

$\vec{M} = M\hat{k}$

$$\Sigma \vec{M}_D = \vec{0} = \underbrace{(-300\hat{i} - 125\hat{j})}_{\vec{r}_{CD}} \times \underbrace{(-240\hat{i} \times -750\hat{j})}_{-\vec{F}_C} + \underbrace{M\hat{k}}_{\vec{M}}$$

$$\vec{0} = 195{,}000\,\hat{k} + M\hat{k}$$

$$M = -195 \text{ Nm}$$

Sign seems right, direction force on C of CD will be ~ 120 down to right. Mult by lever arm gives 120 × 250 ~ 30 Nm. The reason magnitude is off, is B is NOT a pivot. B slides, so this is a "funky" lever arm.

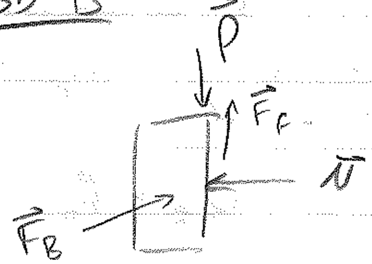
3) There are <u>NO</u> 2-Force members.

Equilibrium, Friction

Solve for both up and down P impending motion.

a) Pressure down

<u>FBD B</u>



$\mu = 0.25$

<u>Forces</u>

$\vec{P} = -P\hat{j}$

$\vec{N} = -N\hat{i}$

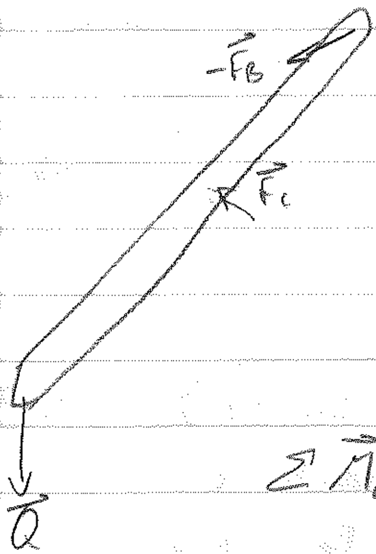
$\vec{F}_f = \mu N \hat{j}$

$\vec{F}_B = F_{Bx}\hat{i} + F_{By}\hat{j}$

$\sum F_x = 0 = -N + F_{Bx} \qquad N = F_{Bx}$

$\sum F_y = 0 = -P + \mu_s N + F_{By}$

FBD AB



Position (mm)	Force (N)
$\vec{r}_{Q/B} = -300\hat{i} - 519.6\hat{j}$	$\vec{Q} = -100\hat{j}$
$\vec{r}_{C/B} = -80\hat{i} - 138.6\hat{j}$	$\vec{F}_c = F_c(-0.866\hat{i} + 0.5\hat{j})$
—	$-\vec{F}_B = -F_{Bx}\hat{i} - F_{By}\hat{j}$

Exactly 3 unknowns!
All answers unchanged by friction direction.

$$\Sigma \vec{M}_B = \vec{0} = \vec{r}_{Q/B} \times \vec{Q} + \vec{r}_{C/B} \times \vec{F}_c$$

$$0\hat{k} = 30000\hat{k} - 160 F_c \hat{k}$$

$$\underline{F_c = 187.5 \text{ N}}$$

$$\Sigma F_x = 0 = -0.866 \cdot 187.5 - F_{Bx} \qquad \underline{F_{Bx} = 162.5 \text{ N}}$$

$$\Sigma F_y = 0 = -100 + 0.5 \cdot 187.5 - F_{By}$$

$$\underline{F_{By} = 6.25 \text{ N}}$$

$$\therefore N = 162.5$$

For impending motion down (Always use positive N for friction with slider)

$$P = \mu_s N + F_{By}$$

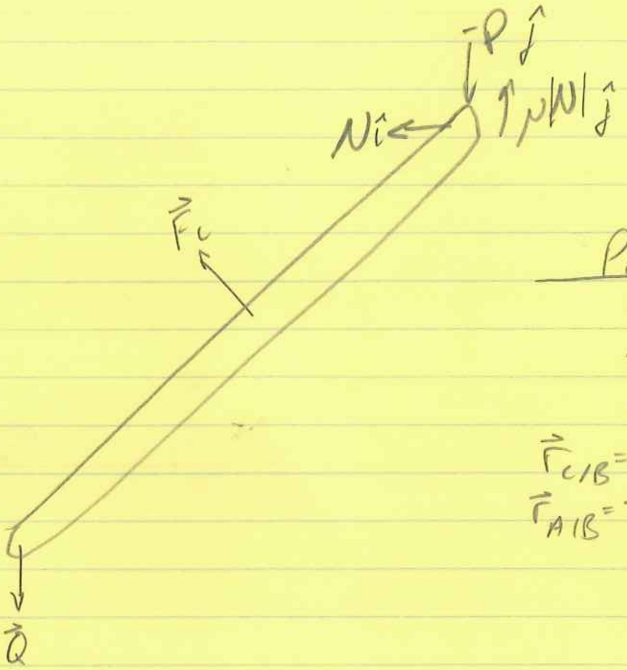
$$= \mu_s 162.5 + -6.25 = \underline{34.3 \text{ N}} \quad (\text{down})$$

For impending motion up

$$P = -0.25 \cdot 162.5 + -6.25 = \underline{-46.9 \text{ N}} \quad (46.9 \text{ up})$$

Flip sign for impending motion up.

3)



Position (mm)	Forces (N)
—	$\vec{P} = -P\hat{j}$
—	$\vec{N} = N\hat{i}$
—	$\vec{F}_f = \mu\|N\|\hat{j}$
$\vec{r}_{C/B} = -80\hat{i} - 138.6\hat{j}$	$\vec{F}_c = F_c(-0.866\hat{i} + 0.5\hat{j})$
$\vec{r}_{A/B} = -300\hat{i} - 519.6\hat{j}$	$\vec{Q} = -100\hat{j}$

$$\Sigma \vec{M}_B = \vec{0} = \vec{r}_{C/B} \times \vec{F}_c + \vec{r}_{A/B} \times \vec{Q}$$

$$\vec{0} = -160\, F_c\, \hat{k} + 30{,}000\, \hat{k}$$

$$F_c = 187.5\ N$$

$$\Sigma F_x = 0 = N + 0.866\, F_c$$

$$N = -162.4 \quad (N \text{ is to left})$$

$$\Sigma F_y = 0 = -P + 0.25\,|N| + \tfrac{1}{2} F_c - 100$$

$$P = \frac{162.4}{4} + \frac{187.5}{2} - 100 = \underline{34.2\ N}$$

For impending motion down, $\mu = -0.25$ means sliding down

$$P = \frac{-162.4}{4} + \frac{187.5}{2} - 100 = \underline{-46.9\ N}$$