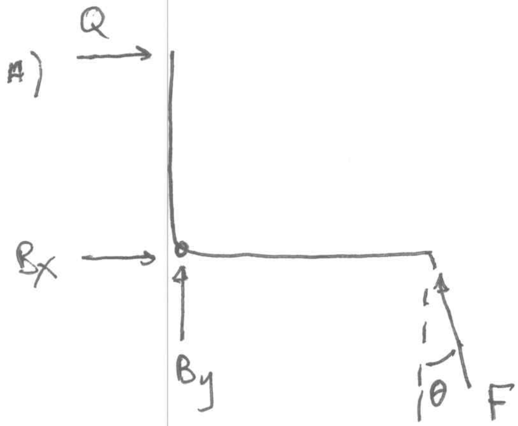
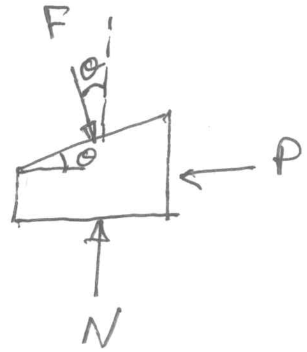
1)

A)





B) $P = \frac{Qh}{d} \tan\theta$

2) See solution on next page

3)

A) Magnitude is $\frac{20}{3}N$ and location is $\bar{x}_1 = 1.5M$

B) Magnitude is $20N$ and location is $\bar{x}_2 = 3m$

C) Total resultant force is $\bar{F} = \bar{F}_1 + \bar{F}_2 = \frac{20}{3} + 20 = \frac{80}{3}N$

Location of resultant is

$$\bar{x}\bar{F} = \bar{x}_1 \bar{F}_1 + \bar{x}_2 \bar{F}_2 = (1.5)(\tfrac{20}{3}) + (3)(20)$$

$$\Rightarrow \quad \bar{x}\left(\tfrac{80}{3}\right) = 70 \quad \Rightarrow \quad \bar{x} = \tfrac{21}{8}\ m$$

Problem 2

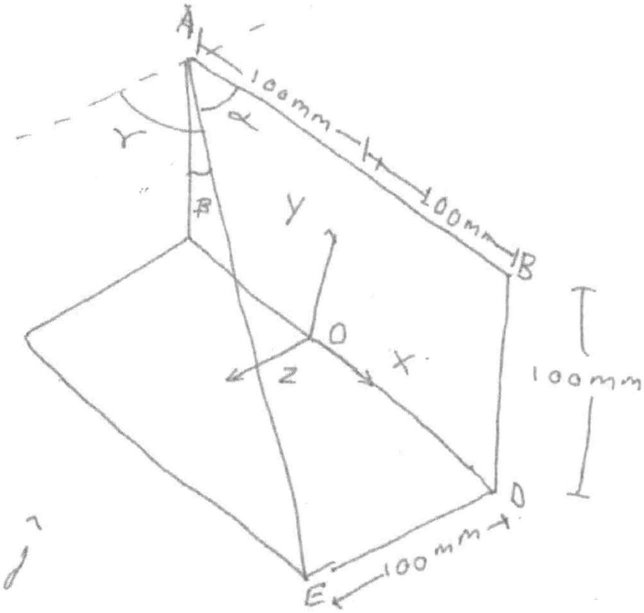
Given $|\vec{T}| = 500N$

Tension can be represented as.

$T = (500 \cos\alpha)\,\hat{i}$

$- (500 \cos\beta)\,\hat{j}$

$+ (500 \cos\gamma)\,\hat{k}$



$$= \left(500 \times \frac{0.2}{\sqrt{0.2^2 + 0.1^2 + 0.1^2}}\right)\hat{i}$$

$$- \left(500 \times \frac{0.1}{\sqrt{0.2^2 + 0.1^2 + 0.1^2}}\right)\hat{j}$$

$$+ \left(500 \times \frac{0.1}{\sqrt{0.2^2 + 0.1^2 + 0.1^2}}\right)\hat{k}$$

$$\boxed{T = 408.25\,\hat{i} - 204.12\,\hat{j} + 204.12\,\hat{k}}$$

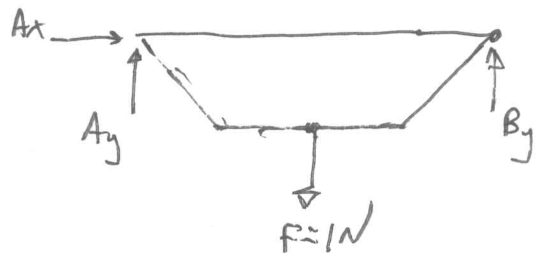
$$\boxed{\vec{OA} = -0.1\,\hat{i} + 0.1\,\hat{j}}$$

$\text{Moment} = \vec{OA} \times \vec{T}$

$= (-0.1\,\hat{i} + 0.1\,\hat{j}) \times (408.25\,\hat{i} - 204.12\,\hat{j} + 204.12\,\hat{k})$

$= (20.4\,\hat{i} + 20.4\,\hat{j} - 20.4\,\hat{k})$ N-m

(4) (A)



(B) $A_x = 0$

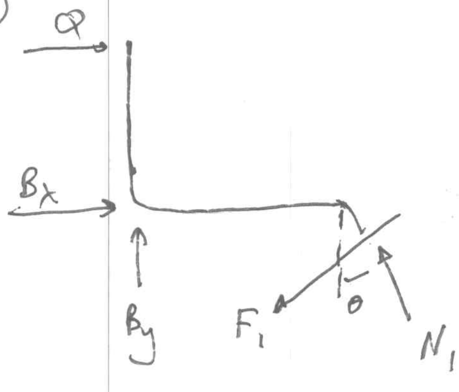
$A_y = B_y = \frac{1}{2} N$

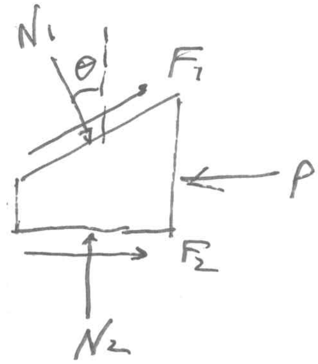
(C) Force in CE $= \frac{1}{\sqrt{2}}$ in tension.

(D) Force in CD $= 0$

(E) Force in CD $= 0$

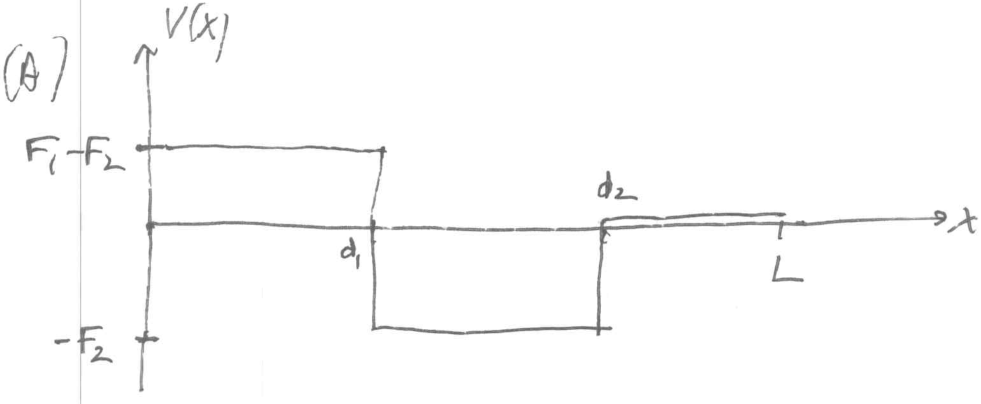
(5) (A)

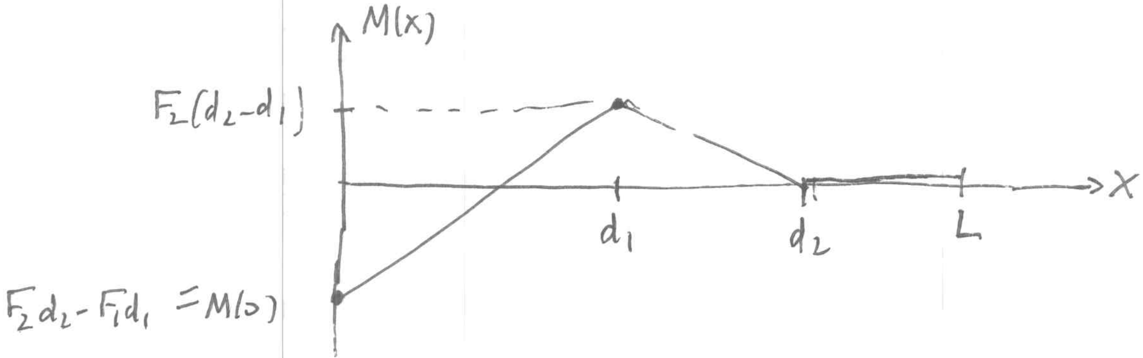




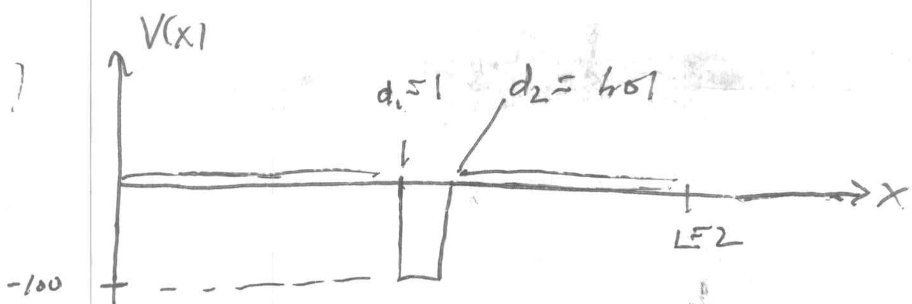
(B) Set $\mu_1 = 0$ and you should recover the results from Problem 1. Only choice (4) has this property so it is the correct choice.

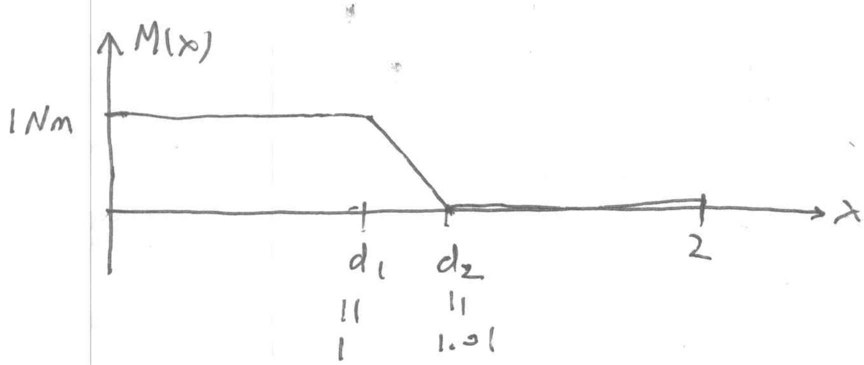
(6) (A)



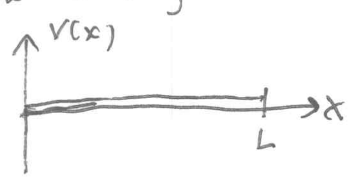


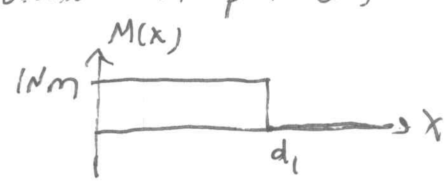
(B)





(c) This case with a point moment can be thought as the limiting case of the scenario in part (b)

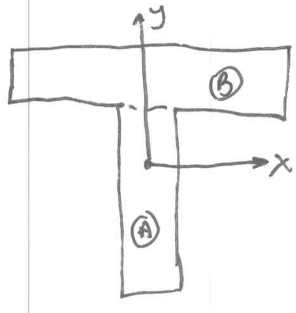




(7) $M(z) = \begin{cases} 50z & 0 \le z \le 2 \\ \cancel{100-50z} \; 100-50(z-2) & 2 \le z \le 4 \\ 0 & 4 \le z \le 10 \end{cases}$

(A) Maximum M is 100 Nm at z = 2m

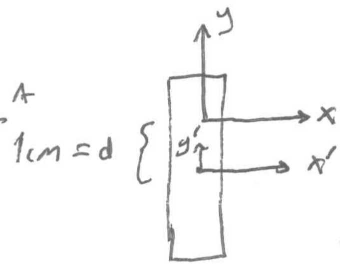
(B)



Moment of Inertia I_x of a rectangle about axes at its centroid is $\cancel{\frac{1}{12} b h^4}$

This should be (b*h^3)/12

Piece A



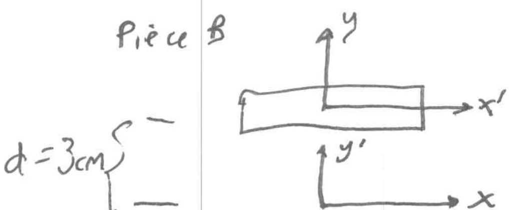
$I_{x'} = \cancel{\frac{1}{12}(4)(6)^4 = 432}$ 72 cm^4

By the parallel axis theorem

$I_x = I_{x'} + A d^2 = \cancel{432 + (24)(1)^2}$

$\rightarrow I_x = \cancel{456}$ 96 cm^4

Piece B



$I_{x'} = \cancel{\frac{1}{12}(8)(2)^4 = 10.67}$ 5.33 cm^4

By the parallel axis theorem

$I_x = I_{x'} + (16)(3)^2 = \cancel{154.67}$ 149.33 cm^4

Total inertia is

$I_x = I_{x,A} + I_{x,B} = \cancel{456 + 154.67 = 610.67}$ 245 cm^4

(C), (D) $\sigma_{max} = \frac{M_{max} \cdot y_{max}}{I_x} = \frac{(100 \, Nm)(4cm)}{\cancel{610.67} \; 245 \; cm^4} = \frac{(100)(4 \times 10^{-2})}{\cancel{610.67} \; 245 \times 10^{-8}} = \cancel{6.55 \times 10^5}$ 1.63 x 10^6 N/m^2

(D) The max in tension occurs at the bottom of the beam ~~at A~~ and the max in compression occurs at the top.

(E) The max stress is below the yield stress so the beam will not yield.