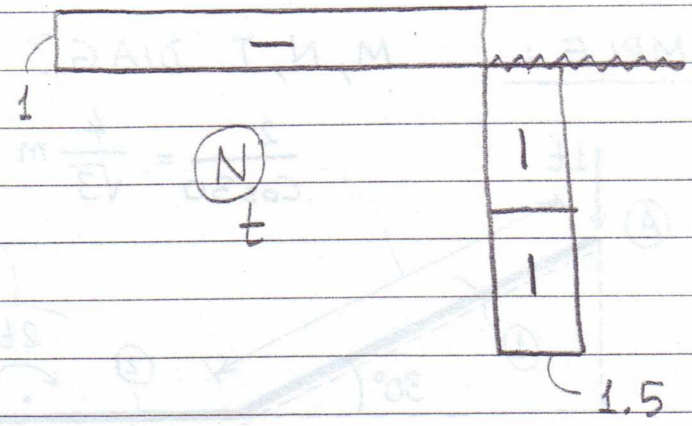
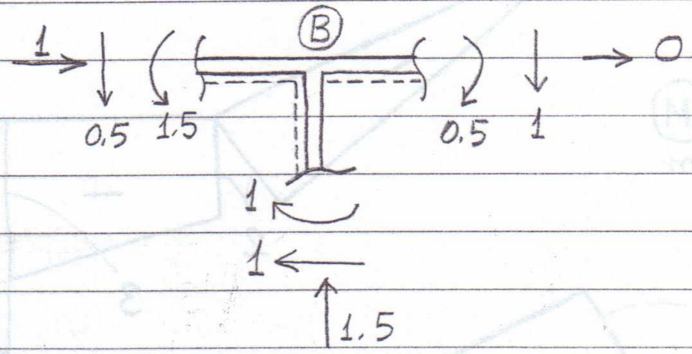



EE must be satisfied in each joint.
As example, take joint B:

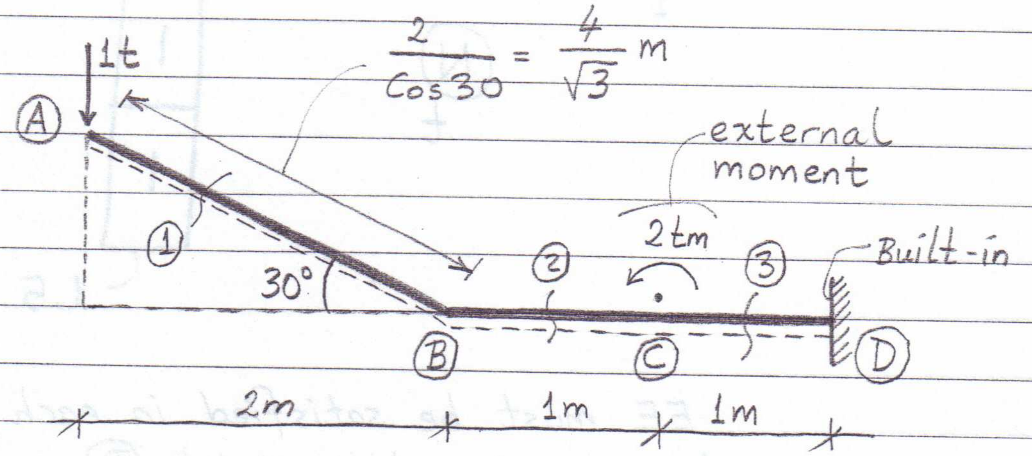


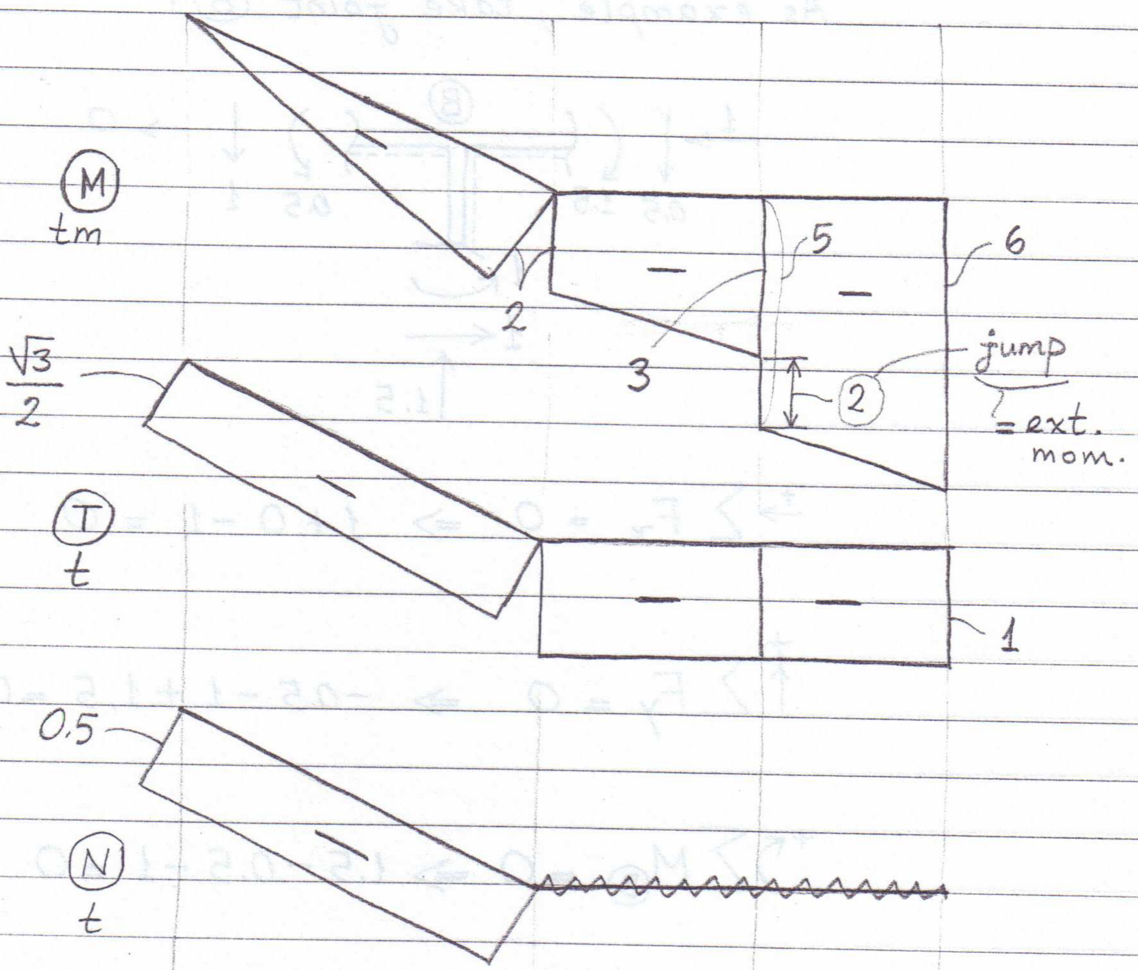

$\overset{+}{\rightarrow} \sum F_x = 0 \Rightarrow 1 + 0 - 1 = 0$ OK ✓

$\overset{+}{\uparrow} \sum F_y = 0 \Rightarrow -0.5 - 1 + 1.5 = 0$ OK ✓

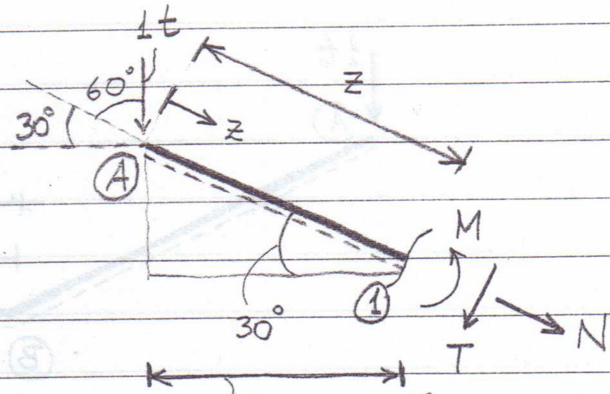
$\overset{+}{\circlearrowleft} \sum M_{B} = 0 \Rightarrow 1.5 - 0.5 - 1 = 0$ OK ✓

EXAMPLE: M, N, T DIAG?



- part A-B:




$$z * \underbrace{\cos 30^\circ}_{\sqrt{3}/2}$$

$$\frac{\sqrt{3}}{2} z$$

$$\sum F_N = 0 \Rightarrow N + 1 * \cos 60^\circ = 0$$

$$\Rightarrow \boxed{N = -0.5\,t}$$

$$\sum F_T = 0 \Rightarrow T + 1 * \sin 60^\circ = 0$$

$$\Rightarrow \boxed{T = -\frac{\sqrt{3}}{2}\,t}$$

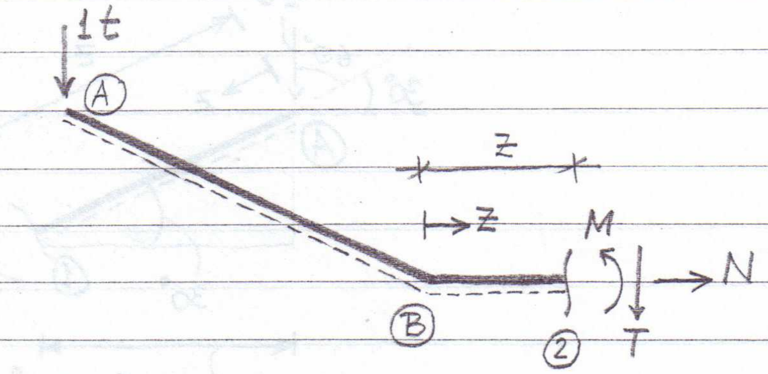
$$\sum M_{1} = 0 \Rightarrow M + 1 * \frac{\sqrt{3}}{2} z = 0$$

$$\Rightarrow \boxed{M = -\frac{\sqrt{3}}{2} z}$$ LINEAR

A: $z = 0 \Rightarrow M = 0$

B: $z = \frac{4}{\sqrt{3}} \Rightarrow M = -2\,tm$

## part B-C:




$$\sum F_N = 0 \Rightarrow \boxed{N = 0}$$

$$\sum F_T = 0 \Rightarrow T + 1 = 0$$

$$\Rightarrow \boxed{T = -1t}$$

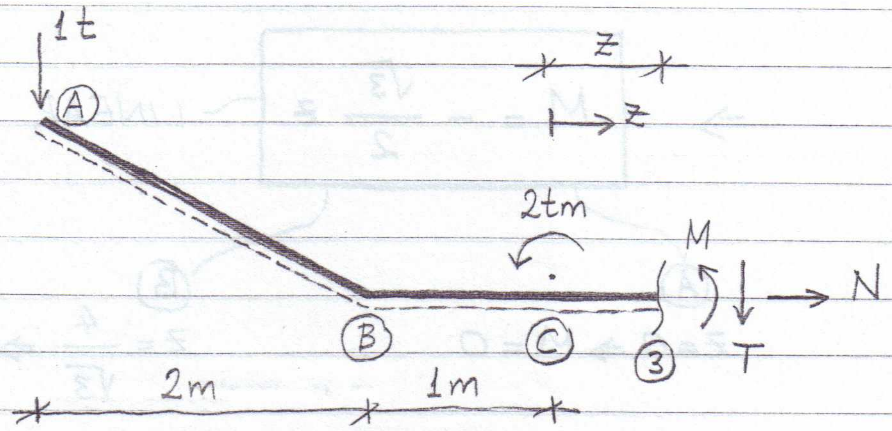
$$+\circlearrowleft \sum M_{2} = 0 \Rightarrow M + 1 * (z+2) = 0$$

$$\Rightarrow \boxed{M = -(z+2)}$$ LINEAR

B: $z = 0 \Rightarrow M = -2\,tm$

C: $z = 1 \Rightarrow M = -3\,tm$

## part C-D:



$$\sum F_N = 0 \Rightarrow \boxed{N = 0}$$

$$\sum F_T = 0 \Rightarrow T + 1 = 0 \Rightarrow \boxed{T = -1\,t}$$

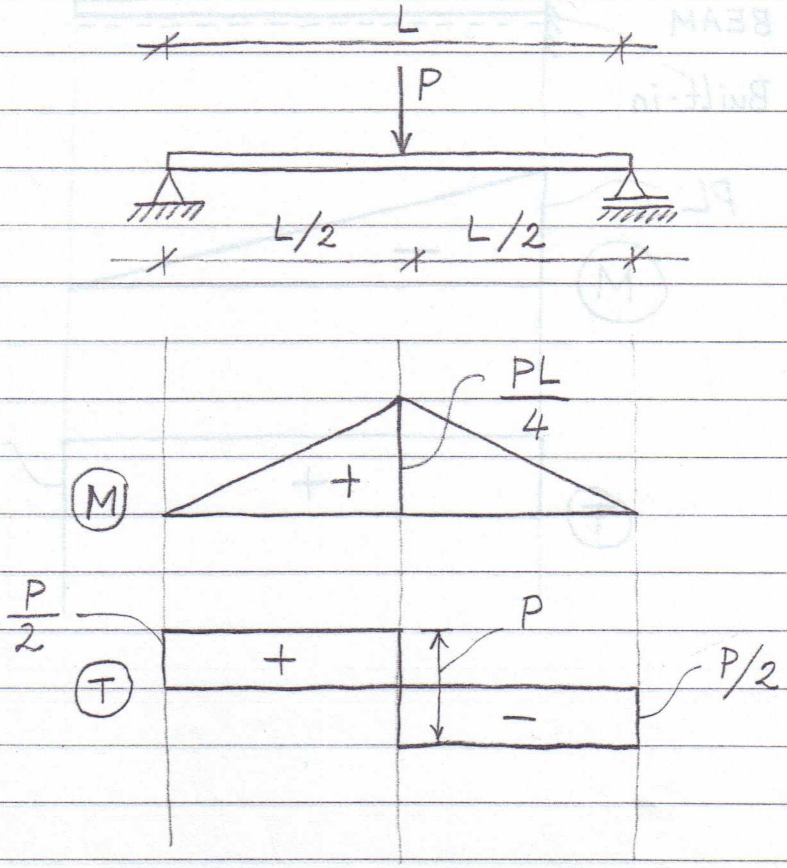
$$\overset{+}{\circlearrowleft} \sum M_{3} = 0 \Rightarrow M + 1 * (z+3) + 2 = 0$$

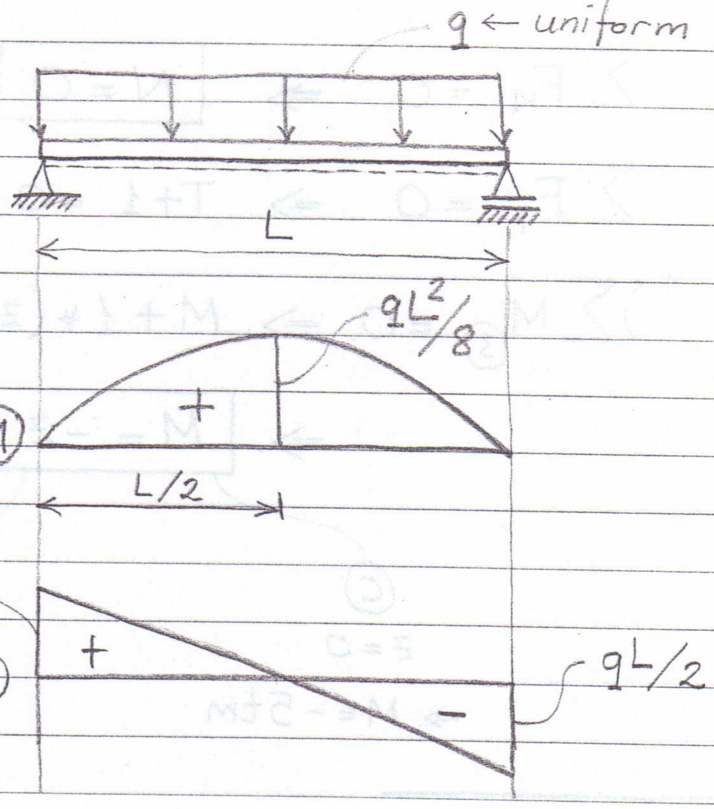
$$\Rightarrow \boxed{M = -z - 5}$$

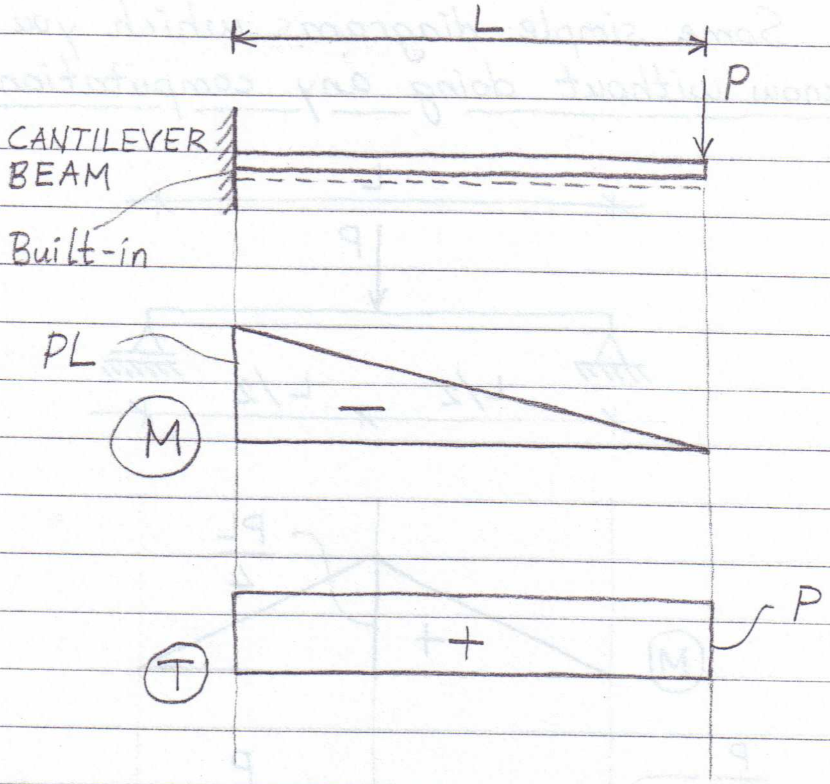
C: $z = 0 \Rightarrow M = -5\,tm$

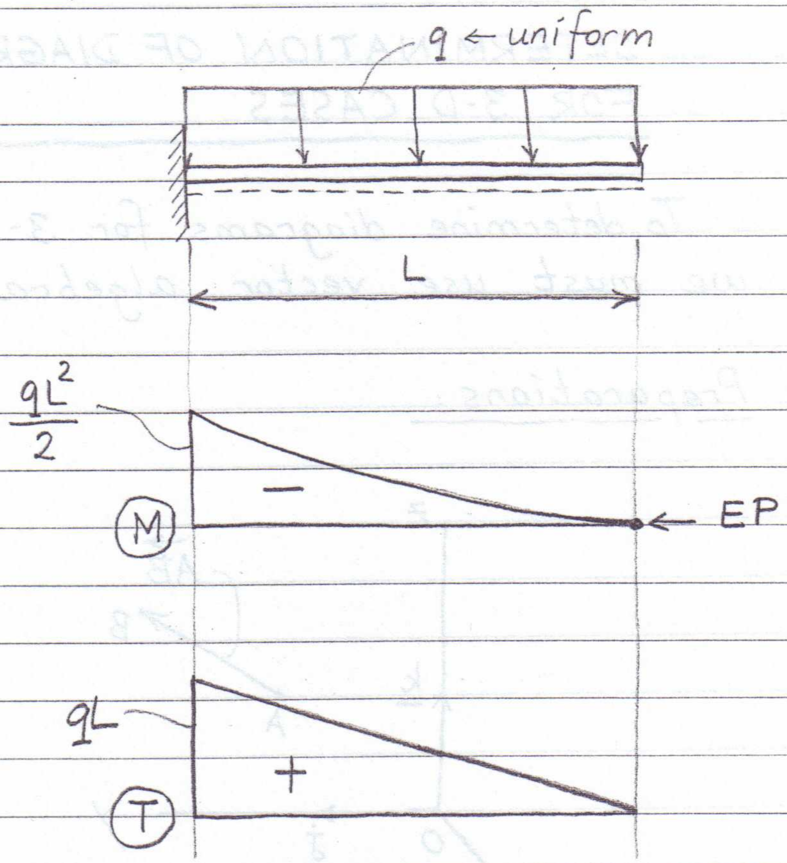
D: $z = 1 \Rightarrow M = -6\,tm$

*Some simple diagrams which you must know without doing any computations:*




q ← uniform
L
qL²/8
M
+
L/2
qL/2
+
T
−
qL/2

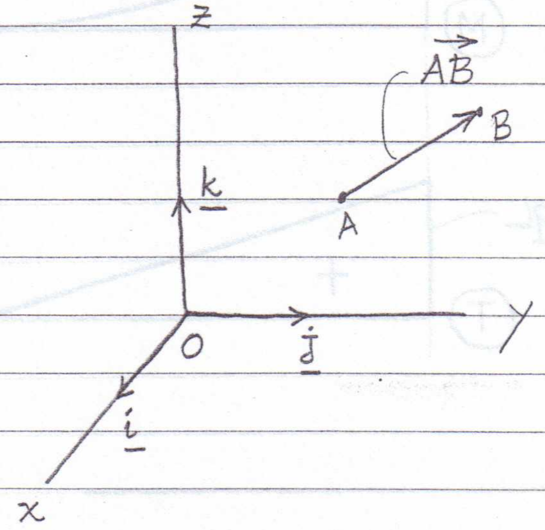

L
P
CANTILEVER
BEAM
Built-in
PL
−
M
P
+
T


q ← uniform
L
qL²/2
−
M
EP
qL
+
T

# DETERMINATION OF DIAGRAMS FOR 3-D CASES

To determine diagrams for 3-D cases we must use vector algebra

Preparations:




A, B → 2 pts in xyz system

$$\left.\begin{aligned} A &\rightarrow (A_1, A_2, A_3) \\ B &\rightarrow (B_1, B_2, B_3) \end{aligned}\right\} \text{coords. of } A \,\&\, B$$

$$\vec{AB} = (B_1 - A_1)\,\underline{i} + (B_2 - A_2)\,\underline{j} + (B_3 - A_3)\,\underline{k}$$

$$= [(B_1 - A_1), (B_2 - A_2), (B_3 - A_3)]$$

Example:

$A \rightarrow (-1, 1, 1)$

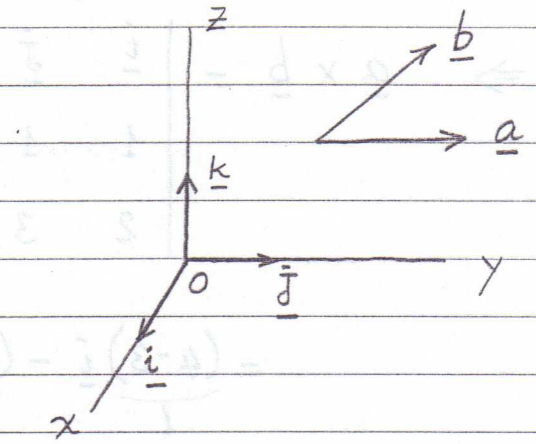
$B \rightarrow (2, 4, 5)$

$$\Rightarrow \quad \overrightarrow{AB} = \underbrace{(3, 3, 4)}_{3\underline{i} + 3\underline{j} + 4\underline{k}}$$

$\left.\begin{array}{l}\underline{a}\\ \underline{b}\end{array}\right)$ two vectors

$$\underline{a} = (a_1, a_2, a_3)$$

$$\underline{b} = (b_1, b_2, b_3)$$




we can perform the cross product of $\underline{a}$ & $\underline{b}$ as:

$$\underline{a} \times \underline{b} = \begin{vmatrix} \underline{i} & \underline{j} & \underline{k} \\ a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \end{vmatrix}$$

$$= \overbrace{(a_2 b_3 - a_3 b_2)}^{x\text{-comp. of } \underline{a} \times \underline{b}} \underline{i} - \overbrace{(a_1 b_3 - a_3 b_1)}^{y\text{-comp. of } \underline{a} \times \underline{b}} \underline{j} + \underbrace{(a_1 b_2 - a_2 b_1)}_{z\text{-comp. of } \underline{a} \times \underline{b}} \underline{k}$$

$$\Rightarrow \quad \underline{a} \times \underline{b} = \Big[ \overbrace{(a_2 b_3 - a_3 b_2)}^{\text{x-comp. of } \underline{a}\times\underline{b}}, -\underbrace{(a_1 b_3 - a_3 b_1)}_{\text{y-comp. of } \underline{a}\times\underline{b}},$$

$$\underbrace{(a_1 b_2 - a_2 b_1)}_{\text{z-comp. of } \underline{a}\times\underline{b}} \Big]$$

Example:

$\underline{a} = (1, 1, 1)$

$\underline{b} = (2, 3, 4)$

$$\Rightarrow \quad \underline{a} \times \underline{b} = \begin{vmatrix} \underline{i} & \underline{j} & \underline{k} \\ 1 & 1 & 1 \\ 2 & 3 & 4 \end{vmatrix}$$

$$= \underbrace{(4-3)}_{1} \underline{i} - \underbrace{(4-2)}_{2} \underline{j} + \underbrace{(3-2)}_{1} \underline{k}$$

$$\Rightarrow \quad \underline{a} \times \underline{b} = (1, -2, 1)$$

End of Preparations