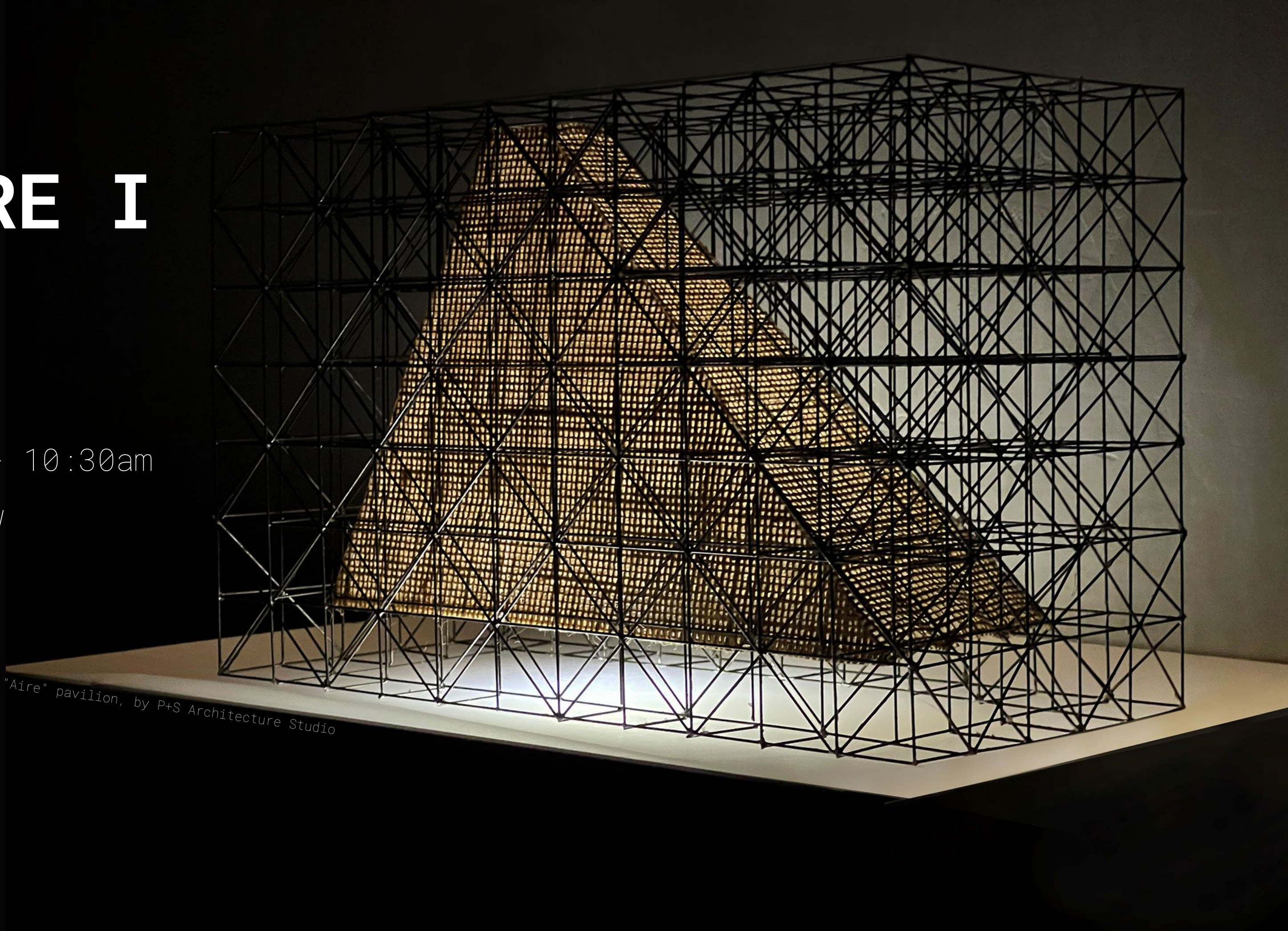
STRUCTURE I

ARCH-314

Friday(s): 9:30am - 10:30am

West Review



"Aire" pavilion, by P+S Architecture Studio

Today:

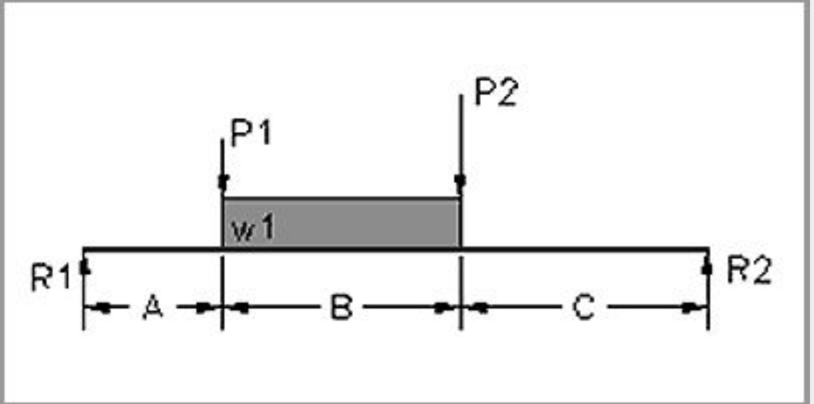
- Problem set No.4
- Problem set No.5
- Lab Activity: Parallel Force Systems

PROBLEM NO.4

Sum the moments about each end of the beam to determine the end reactions of the parallel force system shown. Check that the sum of vertical forces is zero.

DATASET: 1 -2- -3-

Distance A	6 FT
Distance B	12 FT
Distance C	4 FT
Force P1	5 KIPS
Force P2	1 KIPS
Force w1	0.9 KLF



PROBLEM NO.4

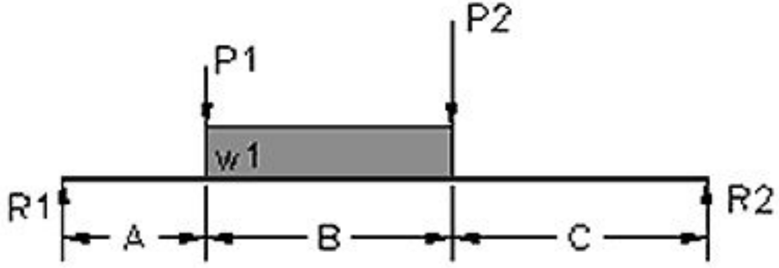
Question 1: Total force from distributed load: W1

$$P_w = W_1 \times B$$

$$P_w = Force\ W_1 \times Distance\ B$$

$$P_w = 0.9\ KLF \times 6\ FT$$

$$\boxed{P_w = 10.8\ KIPS}$$



Sum the moments about each end of the beam to determine the end reactions of the parallel force system shown. Check that the sum of vertical forces is zero.

DATASET: 1 -2- -3-

Distance A	6 FT
Distance B	12 FT
Distance C	4 FT
Force P1	5 KIPS
Force P2	1 KIPS
Force w1	0.9 KLF

PROBLEM NO.4

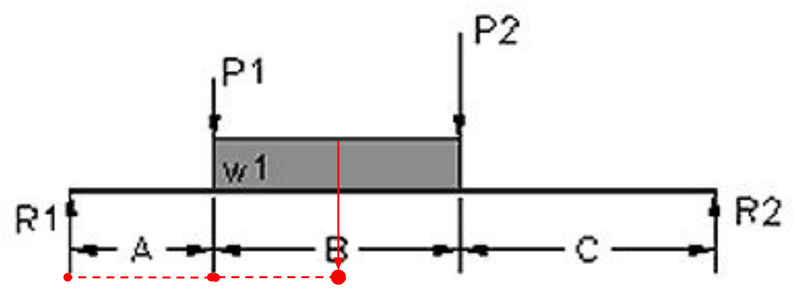
Question 2: **Distance of total load W1 from left reaction**

$$d_w = d_A + \frac{d_b}{2}$$

$$d_w = \text{Distance } A \times \frac{\text{Distance } B}{2}$$

$$d_w = 6\ FT + \frac{12\ FT}{2}$$

$$\boxed{d_w = 12\ FT}$$



Sum the moments about each end of the beam to determine the end reactions of the parallel force system shown. Check that the sum of vertical forces is zero.

DATASET: 1 -2- -3-

Distance A	6 FT
Distance B	12 FT
Distance C	4 FT
Force P1	5 KIPS
Force P2	1 KIPS
Force w1	0.9 KLF

PROBLEM NO.4

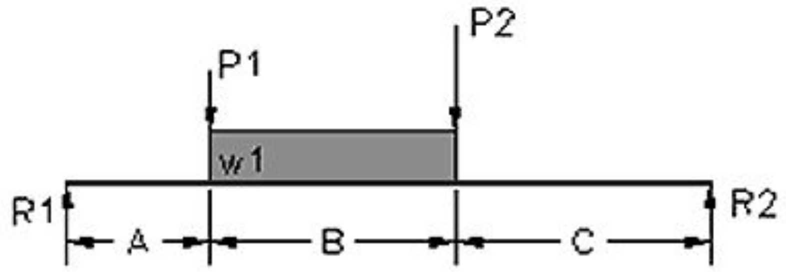
Question 3: Total applied downward force

$$Total\ applied\ downward\ force = P_1 + P_2 + P_w$$

$$= Force\ P_1 + Force\ P_2 + Question\ 1$$

$$= 5\ KIPS + 1\ KIPS + 10.8\ KIPS$$

$$= 16.80\ KIPS$$



Sum the moments about each end of the beam to determine the end reactions of the parallel force system shown. Check that the sum of vertical forces is zero.

DATASET: 1 -2- -3-

Distance A	6 FT
Distance B	12 FT
Distance C	4 FT
Force P1	5 KIPS
Force P2	1 KIPS
Force w1	0.9 KLF

PROBLEM NO.4

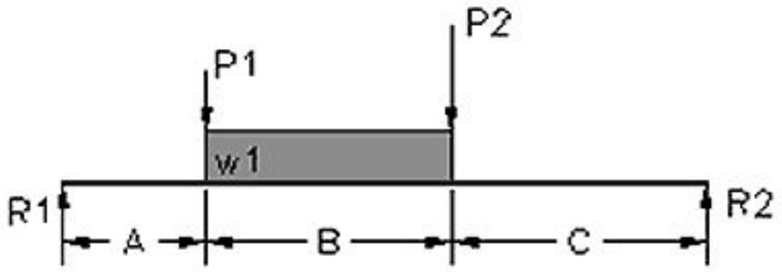
Question 5: Right End Reaction (R2)

$$\sum M_{R1} = 0$$

$$\left(R_1 \times 0\right) + \left(P_1 \times 6\right) + \left(P_w \times 12\right) + \left(P_2 \times 18\right) - \left(R_2 \times 22\right) = 0$$

$$\left(R_1 \times 0\right) + (5 \times 6) + (10.8 \times 12) + (1 \times 18) - \left(R_2 \times 22\right) = 0$$

$$\Rightarrow R_2 = 8.07\text{KIPS}$$



Sum the moments about each end of the beam to determine the end reactions of the parallel force system shown. Check that the sum of vertical forces is zero.

DATASET: 1 -2- -3-

Distance A	6 FT
Distance B	12 FT
Distance C	4 FT
Force P1	5 KIPS
Force P2	1 KIPS
Force w1	0.9 KLF

PROBLEM NO.4

Question 4: Left End Reaction (R1)

$$\sum_{R_2} = 0$$

$$\Rightarrow \left(R_2 \times Distance\ R_2\ from\ R_2\right) + \left(P_W \times Distance\ of\ P_w\ from\ R_2\right) \left(P_2 \times Distance\ P_2\ from\ R_2\right) + \left(P_1 \times Distance\ P_1\ from\ R_1\right) - \left(R_1 \times Distance\ R_1\ from\ R_2\right) = 0$$

PROBLEM NO.4

Question 4: Left End Reaction (R1)

$$\sum M_{R2} = 0$$

$$(R_2 \times 0) - (P_2 \times 4) - (P_w \times 10) - (P_1 \times 16) + (R_1 \times 22) = 0$$

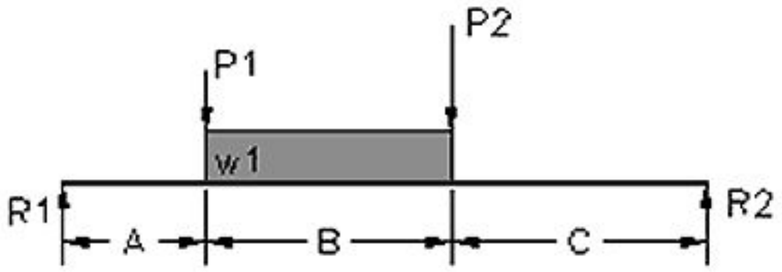
$$(R_2 \times 0) + (4) + (10.8 \times 10) - (5 \times 18) + (R_2 \times 22) = 0$$

$$\Rightarrow R_1 = 8.72 \text{KIPS}$$

$$\sum F_y = 0$$

$$R_1 - P_1 - P_w - P_2 = 0$$

$$8.72 - 5 - 10.8 - 1 + 8.07 = 0$$



Sum the moments about each end of the beam to determine the end reactions of the parallel force system shown. Check that the sum of vertical forces is zero.

DATASET: 1 -2- -3-

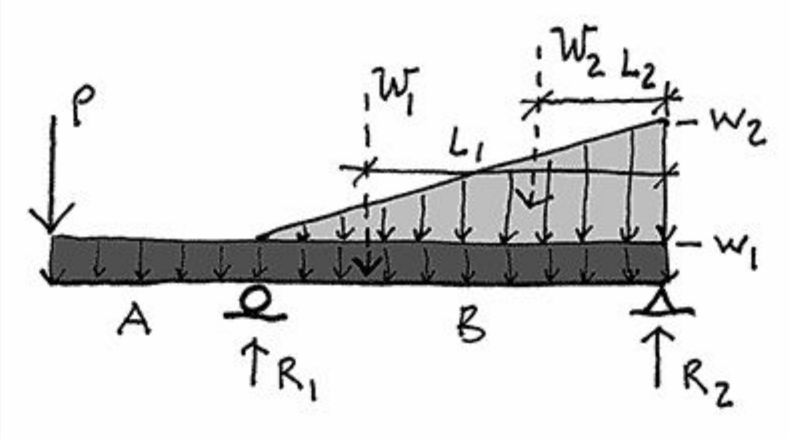
Distance A	6 FT
Distance B	12 FT
Distance C	4 FT
Force P1	5 KIPS
Force P2	1 KIPS
Force w1	0.9 KLF

PROBLEM NO.5

Determine the support reactions at A and B that will hold the beam in equilibrium.

DATASET: 1 -2- -3-

Point Load, P	4.2 KIPS
Uniform Load, w1	180 PLF
Triangular Load, w2	520.8 PLF
Length A	6.3 FT
Length B	21 FT



PROBLEM NO.5

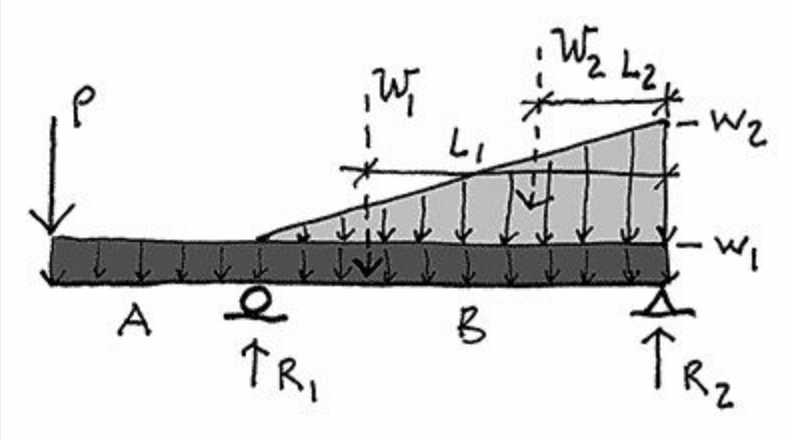
Question 1: TOTAL force of the uniform load: W1

$$F_{w1} = PLF \times \, lenght_{w1}$$

$$= 180 \times (21 + 6.3)$$

$$= \frac{4914 \; lbs}{1000}$$

$$\boxed{F_{w1} = 4.914 \; KIPS}$$



Determine the support reactions at A and B that will hold the beam in equilibrium.

DATASET: 1 -2- -3-

Point Load, P	4.2 KIPS
Uniform Load, w1	180 PLF
Triangular Load, w2	520.8 PLF
Length A	6.3 FT
Length B	21 FT

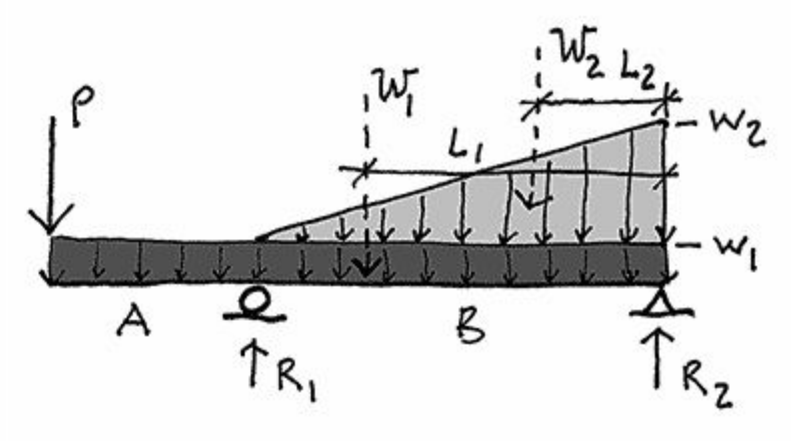
PROBLEM NO.5

Question 2: Distance from centroid of the uniform load to R2: (L1)

$$L_1 = \frac{Beam\ Lenght}{2}$$

$$L_1 = \frac{21\ FT + 6.3\ FT}{2}$$

$$\boxed{L_1 = 13.65\ FT}$$



Determine the support reactions at A and B that will hold the beam in equilibrium.

DATASET: 1 -2- -3-

Point Load, P	4.2 KIPS
Uniform Load, w1	180 PLF
Triangular Load, w2	520.8 PLF
Length A	6.3 FT
Length B	21 FT

PROBLEM NO.5

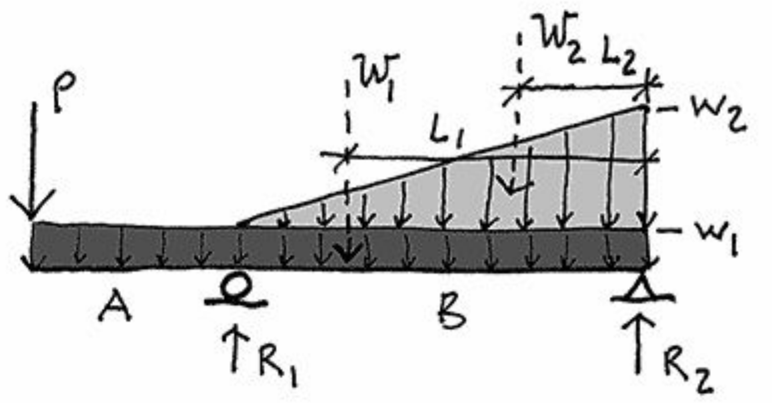
Question 3: **TOTAL force of the triangular load: W2**

$$F_{w_2} = \frac{PLF \times lenght_{w_2}}{2}$$

$$= \frac{520.8 \times 21}{2}$$

$$= \frac{5460}{1000}$$

$$F_{w_2} = 5.460\ KIPS$$



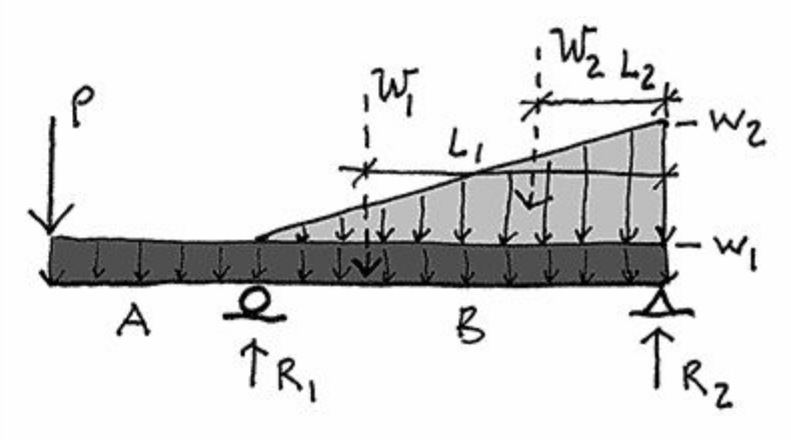
Determine the support reactions at A and B that will hold the beam in equilibrium.

DATASET: 1 -2- -3-

Point Load, P	4.2 KIPS
Uniform Load, w1	180 PLF
Triangular Load, w2	520.8 PLF
Length A	6.3 FT
Length B	21 FT

PROBLEM NO.5

Question 4: **Distance from centroid of the triangular load to R2: (L2)**



Determine the support reactions at A and B that will hold the beam in equilibrium.

DATASET: 1 -2- -3-

Point Load, P	4.2 KIPS
Uniform Load, w1	180 PLF
Triangular Load, w2	520.8 PLF
Length A	6.3 FT
Length B	21 FT

$$Center\ of\ \ Triangle = Center\ of\ \ Gravity$$

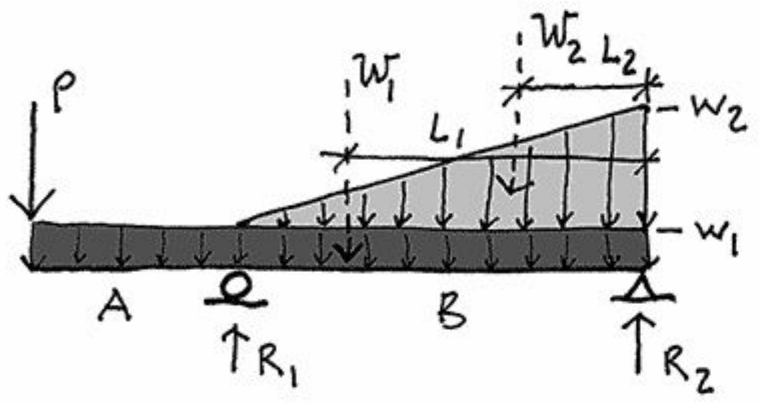
$$L_1 = \frac{Beam\ B_2\ Lenght}{3}$$

$$L_1 = \frac{21\ FT}{3}$$

$$\boxed{L_1 = 7\ FT}$$

PROBLEM NO.5

Question 5: TOTAL load on the member



Determine the support reactions at A and B that will hold the beam in equilibrium.

DATASET: 1 -2- -3-

Point Load, P	4.2 KIPS
Uniform Load, w1	180 PLF
Triangular Load, w2	520.8 PLF
Length A	6.3 FT
Length B	21 FT

$$F_{Total} = P + Fw_1 + F_{w_2}$$

$$= 4.2 + 4.914 + 5.460$$

$$F_{Total} = 14,574\ KIPS$$

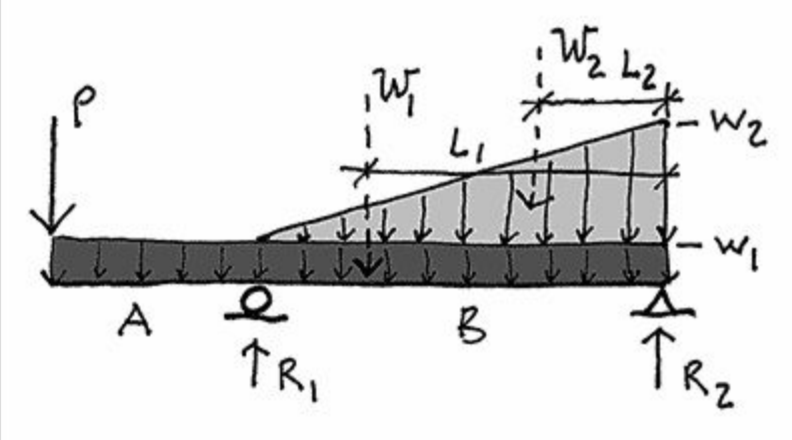
PROBLEM NO.5

Question 6: Reaction force: R1 (down is - : up is +)

$$\sum M_{R2} = 0$$

$$-4.2 \times 27.3 + R1 \times 21 - 4.914 \times 13.65 - 5.460 \times 7 = 0$$

$$\Rightarrow R_1 = 10.4741\ KIPS$$



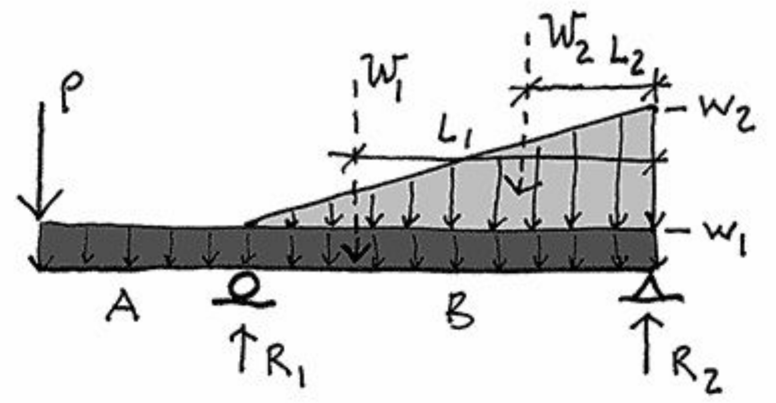
Determine the support reactions at A and B that will hold the beam in equilibrium.

DATASET: 1 -2- -3-

Point Load, P	4.2 KIPS
Uniform Load, w1	180 PLF
Triangular Load, w2	520.8 PLF
Length A	6.3 FT
Length B	21 FT

PROBLEM NO.5

Question 7: Reaction force: R2 (down is - : up is +)



Determine the support reactions at A and B that will hold the beam in equilibrium.

DATASET: 1 -2- -3-

Point Load, P	4.2 KIPS
Uniform Load, w1	180 PLF
Triangular Load, w2	520.8 PLF
Length A	6.3 FT
Length B	21 FT

$$\sum_{M_{R1}} = 0$$

$$-4.2 \times 6.3 + 4.914 \times (21 - 13.65) + 5.460 \times 14 - R_2 \times 21 = 0$$

$$\Rightarrow R_2 = 4.0999\ KIPS$$

Lab Activity

Equilibrium

Description

This project provides opportunity to experiment with the equilibrium of a balanced beam. It makes use of Archimedes' equations for forces on a lever to determine end reactions.

Goals

To observe balanced conditions using a beam balance.
To experiment with different combinations of balanced forces
To calculate the balanced forces using Archimedes' method

Procedure

1. Set up the beam balance with the fulcrum block at the center balance point.
2. Place 2 penny weights at one end. Use the ruled scale at the bottom of this page to measure the distance from the fulcrum to the center of the stack of pennies (d2). You can adjust the pennies to an even distance.
3. Calculate a point on the opposite side of the balance (d1) were 4 pennies will balance the 2 using Archimedes' equation. d2 x 2 = d1 x 4 so, d1 = d2 x 2/4
4. Place 4 pennies at your calculated distance d1 and verify that they balance the 2 pennies.
5. Calculate the moment caused by each stack of pennies around the fulcrum (in US pennyweight-inches).
6. Now, leaving the 2 penny stack at one end, spread the 4 pennies out next to each other and again find the balance point.
7. Observe that the center of the line of pennies still lies at d1 when the beam is balanced.
8. Finally, for the inverted case (point load on a simple beam) with P = 6 pwt at 2" from one end of the 12" beam, what would each end reaction be. Show this in a sketch.