

Arch314

STRUCTURES I

Fall 2025
Recitation

FACULTY: Prof. Peter von Bülow
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Arch314: STRUCTURES I

Welcome to the Recitation session 09/19

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Office hours:
By appointment

[Click here to Schedule](#)

Please feel free to ask questions.

Arch314: STRUCTURES I

Welcome to the Recitation session 09/19

Outline:

- Quick **Recap** of the week
- Provide the solution for the assignment (Homework 4, 5)
- Answering students' questions
- Lab: **Equilibrium**

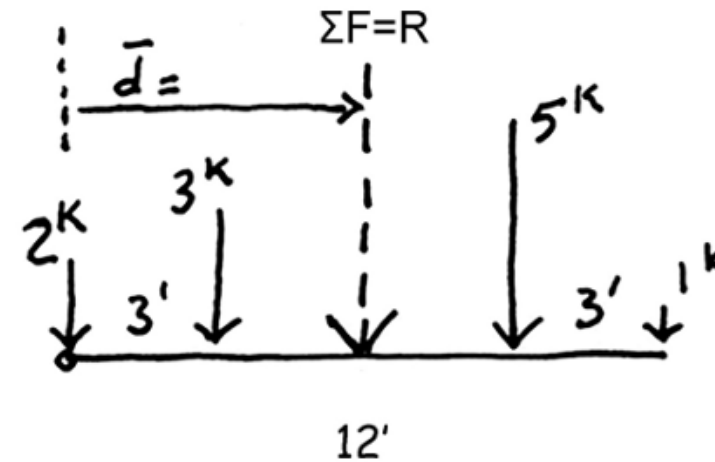
Please feel free to ask questions.

Recap of the week

Parallel Force Resultant

The resultant is a single force that has the same effect as a group of forces.

Since the resultant is equivalent to the group of forces, it can be used in place of the group.

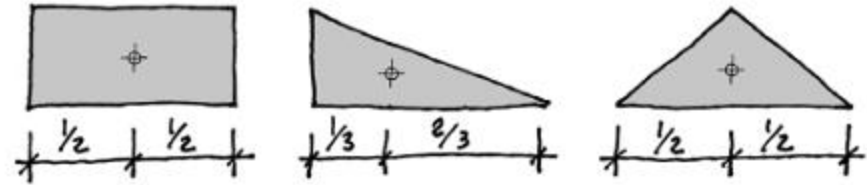


$$\sum (\mathbf{F} \times d) = \mathbf{R} \times \bar{d}$$

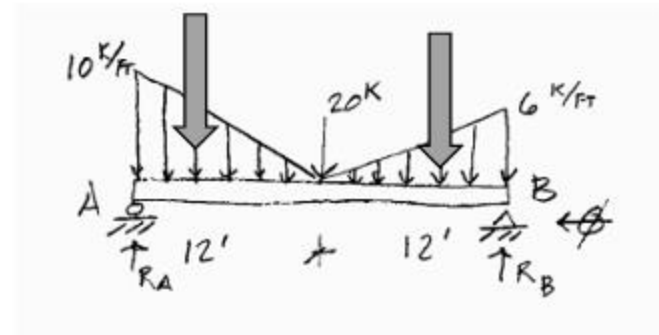
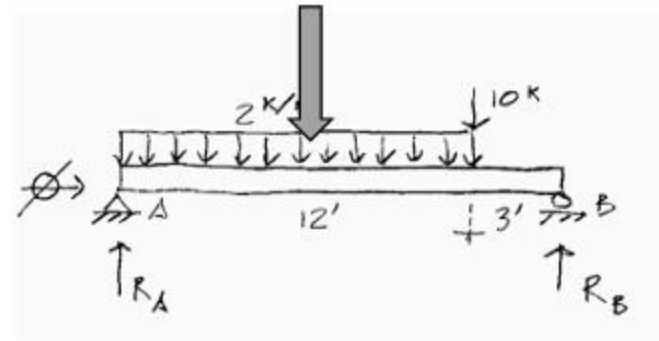
$$\mathbf{R} = \sum \mathbf{F}$$

$$\bar{d} = \frac{\sum (\mathbf{F} \times d)}{\sum \mathbf{F}}$$

Recap of the week



Load Distribution through the Centroid



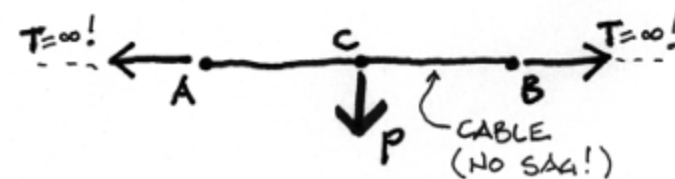
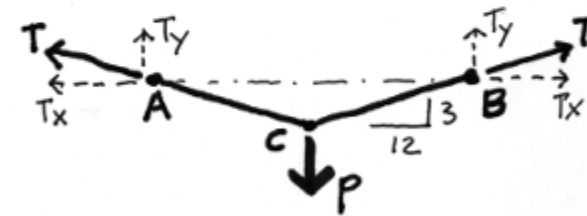
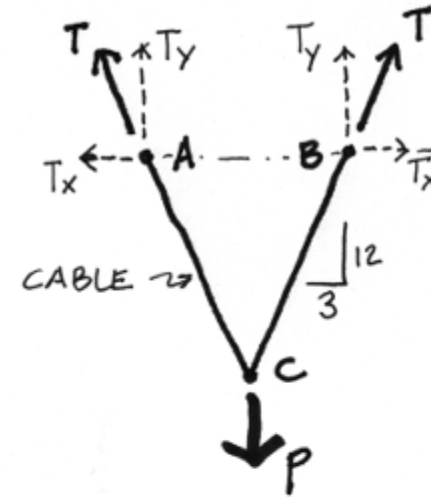
Recap of the week

Cables

Both the sag and the load determine the force in the cable.

The less the sag, the higher the force in the cable.

The vertical component of the cable force in the case shown remains constant. $T_y = P/2$. But since the resultant follows the direction of the cable, T_x becomes greater as sag decreases. With no sag, T_x is infinite!



Recap of the week

Solving Cables Forces

even supports – symmetric loading

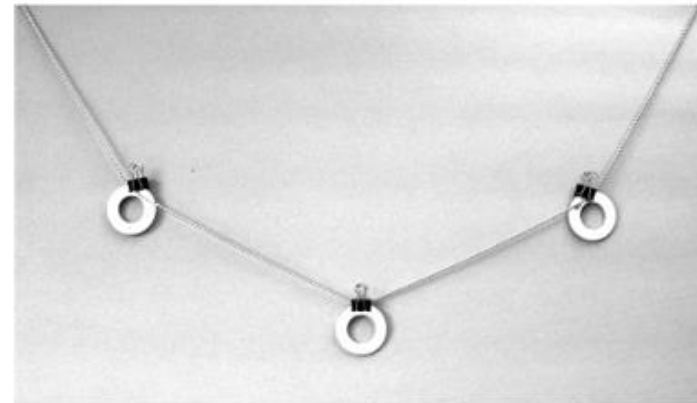
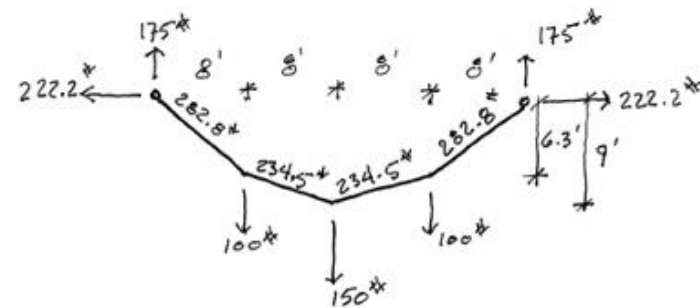
Procedure:

1. Solve all external forces (reactions)
 - If symmetric, then the reactions at each end are equal
 - Use 3 equilibrium equations to solve

$$\sum F_x = 0 \quad \sum F_y = 0 \quad \sum M = 0$$

- The moment is also 0 at any point in the cable since the cable cannot support flexure,
2. Start at reactions and move inward
 - Draw FBD of system from reaction inward
 - Slope is proportional to forces
 - Use force equations to solve at cut
 - Find forces and slope of each section

$$\sum F_x = 0$$
$$\sum F_y = 0$$



Provide the solution for the assignment – HW4

- Problem:

5. Parallel Force Systems

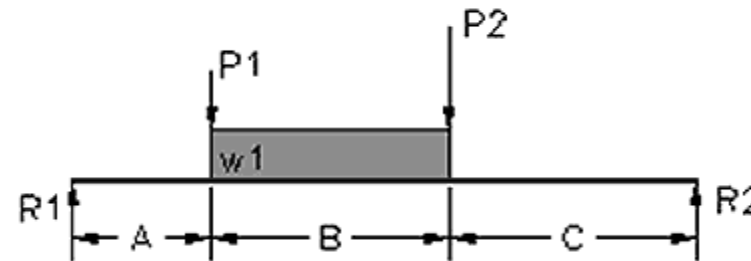
Sum the moments about each end of the beam to determine the end reactions of the parallel force system shown. Check that the sum of vertical forces is zero.

DATASET: 1

-2-

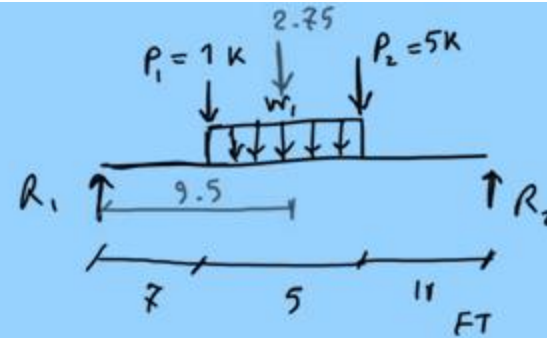
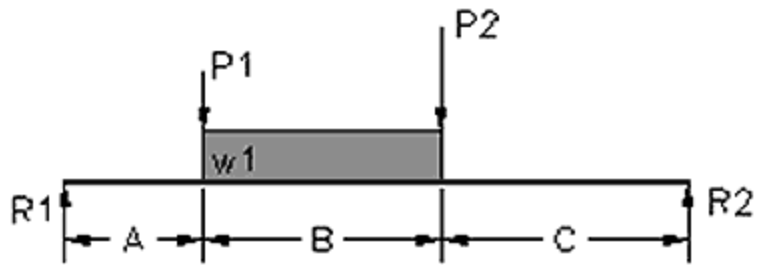
-3-

Distance A	7 FT
Distance B	5 FT
Distance C	11 FT
Force P1	1 KIPS
Force P2	5 KIPS
Force w1	0.55 KLF



#	Question	Your Response
1	Total force from distributed load: W1	<input type="text"/> KIPS
2	Distance of total load W1 from left reaction	<input type="text"/> FT
3	Total applied downward force	<input type="text"/> KIPS
4	Left End Reaction (R1)	<input type="text"/> KIPS
5	Right End Reaction (R2)	<input type="text"/> KIPS

Provide the solution for the assignment- HW4



w_1 : distributed load
0.55 kLF



① point load = $0.55 \times 5 = 2.75\text{ K}$ Q1

② distance = $7 + \frac{5}{2} = 9.5\text{ FT}$ Q2

③ Total applied downward Force: $1 + 2.75 + 5 = 8.75\text{ K}$ Q3

④ $\sum M_{@2} = -$

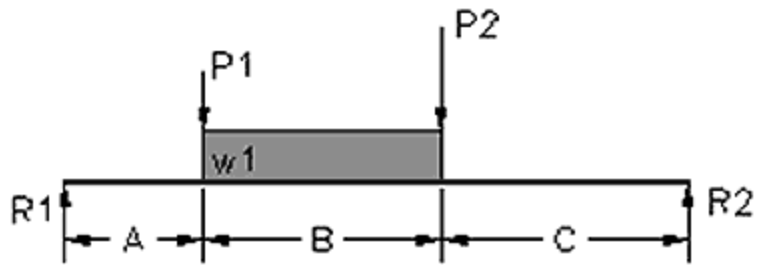
$$R_1 \times (11 + 5 + 7) - P_1 \times (11 + 5) - F_1 \times (11 + \frac{5}{2}) - P_2 \times (11) = -$$

$$R_1 \times 23 - 1 \times 16 - 2.75 \times 13.5 - 5 \times 11 = -$$

$$\rightarrow R_1 = 4.70109$$

Q4

Provide the solution for the assignment- HW4



$$\textcircled{5} \quad \sum M_{e_1} = .$$

$$P_1 \times A + F_1 \times \left(A + \frac{B}{2}\right) + P_2 \times (A + B) - R_2 (A + B + C) = .$$
$$1 \times (7) + 2.75 \times (9.5) + 5 \times (12) - R_2 (23) = .$$
$$\rightarrow \boxed{R_2 = 4.0489}$$

Q5

$\textcircled{6}$ check the sum of vertical forces

$$\sum F_y = .$$

$$R_1 - P_1 - F_1 - P_2 + R_2 = .$$

$$4.70 - 1 - 2.75 - 5 + 4.0489 = 0 \quad \checkmark$$

Provide the solution for the assignment – HW5

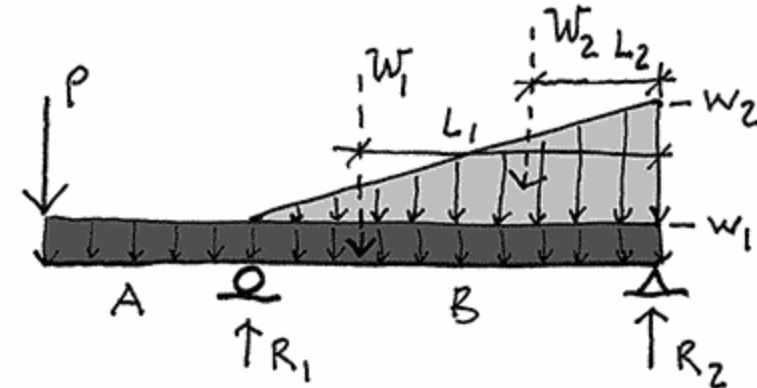
6. Equilibrium of Rigid Bodies

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

DATASET: 1 -2- -3-

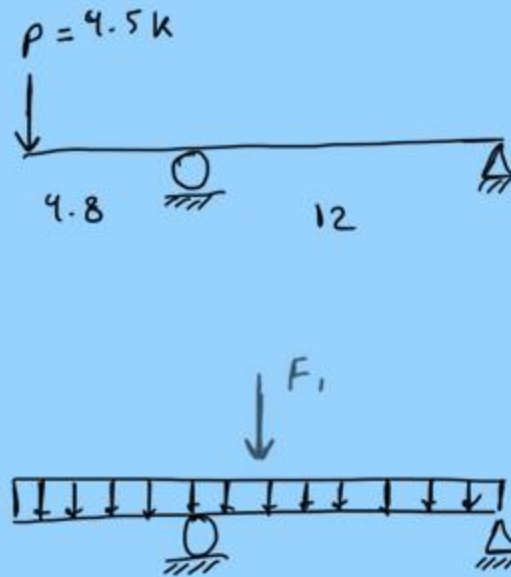
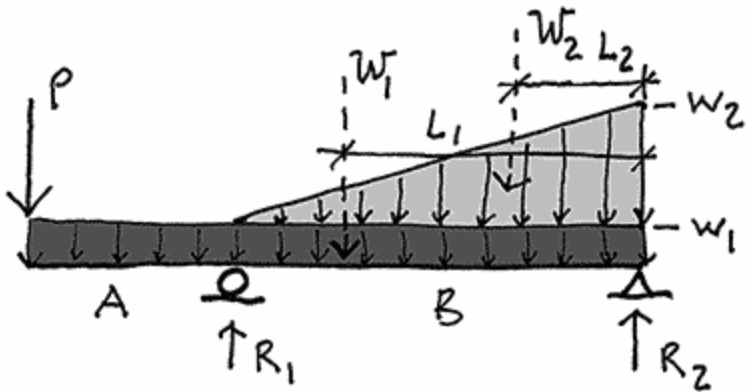
Point Load, P	4.5 KIPS
Uniform Load, w_1	198 PLF
Triangular Load, w_2	347.6 PLF
Length A	4.8 FT
Length B	12 FT

• Problem:



#	Question	Your Response
1	TOTAL force of the uniform load: W_1	<input type="text"/> KIPS
2	Distance from centroid of the uniform load to R_2 : (L_1)	<input type="text"/> FT
3	TOTAL force of the triangular load: W_2	<input type="text"/> KIPS
4	Distance from centroid of the triangular load to R_2 : (L_2)	<input type="text"/> FT
5	TOTAL load on the member	<input type="text"/> KIPS
6	Reaction force: R_1 (down is - : up is +)	<input type="text"/> KIPS
7	Reaction force: R_2 (down is - : up is +)	<input type="text"/> KIPS

Provide the solution for the assignment- HW5



$w_1 = 198 \text{ PLF}$
 uniform load

① $F_1 = 198 \times (A+B)$
 $= 198 \times (9.8 + 12) = 3326.4$
LBS
= 3.3264 kips

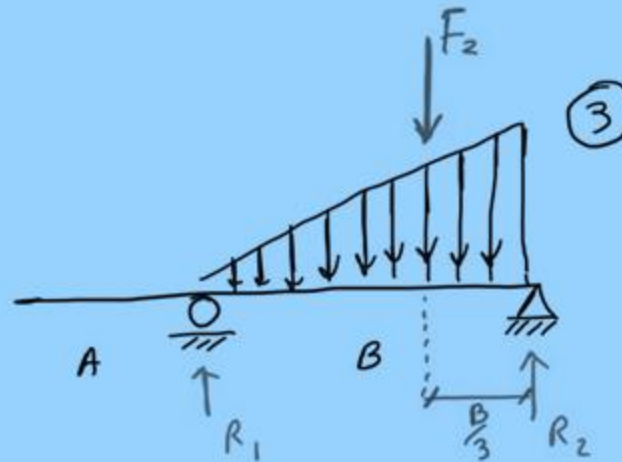
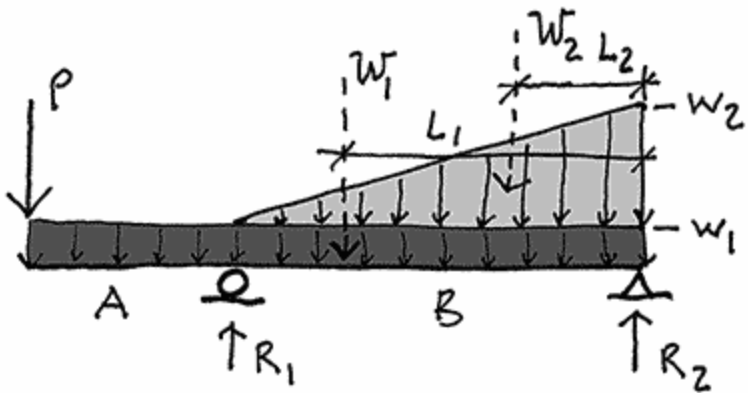
② distance of F_1

$$\frac{A+B}{2} = \frac{9.8+12}{2} = 8.4$$

Q1

Q2

Provide the solution for the assignment- HW5



③ $w_2 = 347.6 \text{ PLF}$
Triangular Load

$$F_2 = \frac{B \times w_2}{2} = \frac{12 \times 347.6}{2} = 2085.6 \text{ LBS}$$

2.0856 KIPS

Note:

$$1 \text{ KIPS} = 1000 \text{ LBS}$$

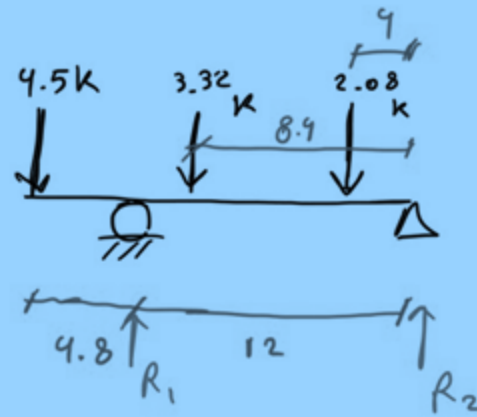
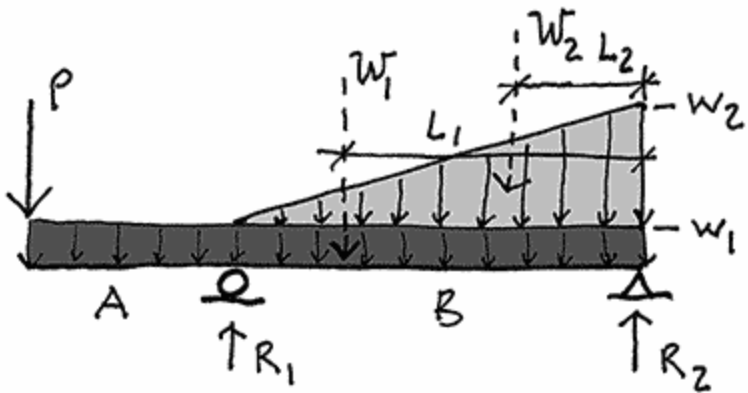
④ distance of F_2

$$\frac{B}{3} = \frac{12}{3} = 4 \text{ FT}$$

Q3

Q4

Provide the solution for the assignment- HW5



⑤ Total Load on the member

$$= P + F_1 + F_2$$

$$= 4.5 + 3.32 + 2.08 = 9.9\text{ k}$$

Q5

⑥ $\sum M_{O_2} = \cdot$

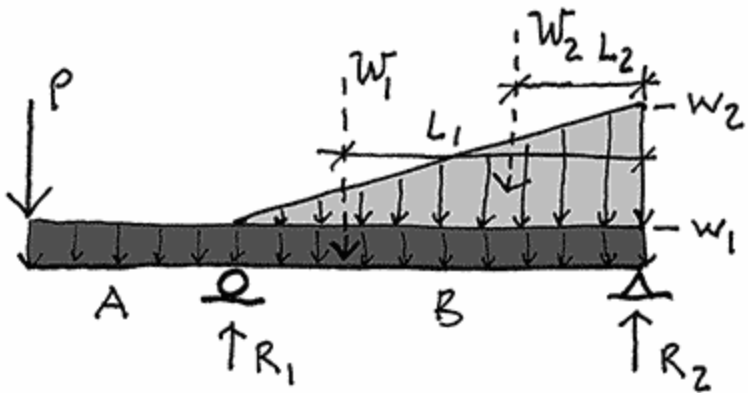
$$-F_2 \times 4 - F_1 \times \left(\frac{12+4.8}{2}\right) + R_1 \times 12 - 4.5(12+4.8) = \cdot$$

$$- 2.08(4) - 3.32(8.4) + R_1 \times 12 - 4.5(16.8) = \cdot$$

$$\rightarrow \underline{R_1 = 9.3173}\text{ k}$$

Q6

Provide the solution for the assignment- HW5



$$\sum M_{@i} = 0$$

$$-4.5 \times 4.8 + 3.32(12 - 8.4) + 2.08(12 - 4) - R_2 \times 12 = 0$$

$$6.992 = R_2 \times 12 \rightarrow \boxed{R_2 = 0.5827}$$

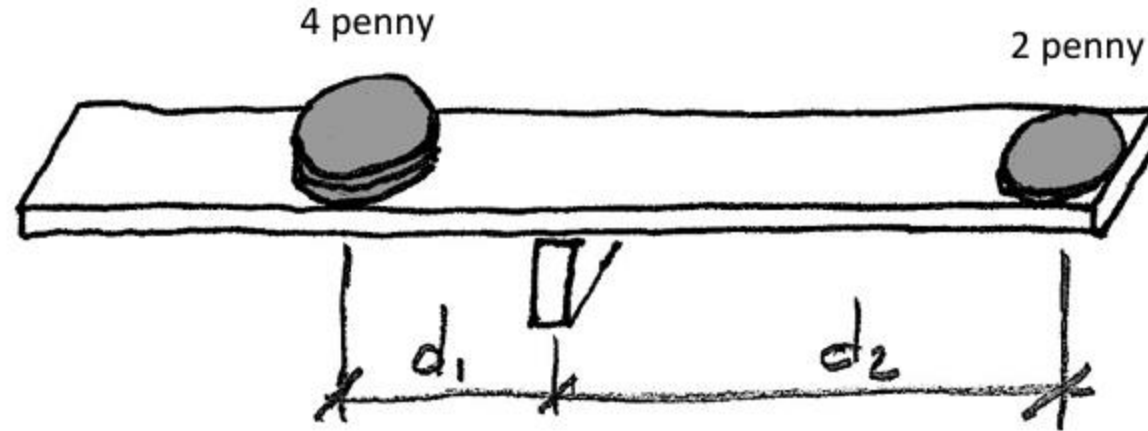
⑦ check $\sum F_y = 0$

$$R_1 + R_2 \stackrel{?}{=} \text{Total load on member}$$

$$9.3173 + 0.58 = 9.9 \text{ k} \quad \text{o.k.} \checkmark$$

Q7

Lab: Equilibrium



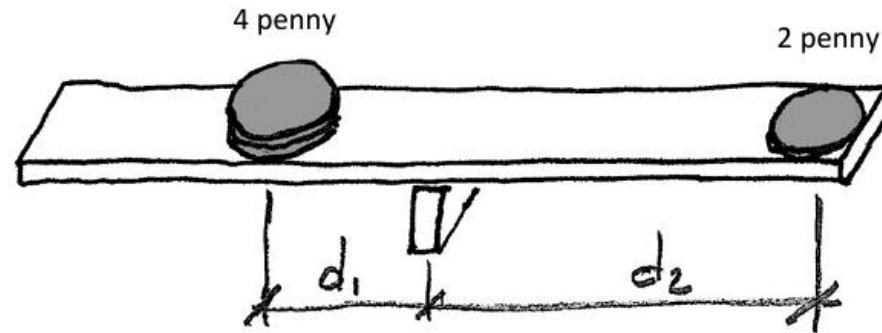
Description

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

Lab: Equilibrium



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 (d_2). You can adjust the pennies to an even distance.
3. Calculate a point on the opposite side of the balance (d_1) where 4 pennies will balance the 2 using Archimedes' equation. $d_2 \times 2 = d_1 \times 4$ so, $d_1 = d_2 \times 2/4$
4. Place 4 pennies at your calculated distance d_1 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 d_1 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.

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Thank you.

Any question?

Please feel free to ask questions.