Decimals have a point.

Distributed Loads

- Up to this point, all the forces we have considered have been point loads
- Single forces which are represented by a vector
- Not all loading conditions are of that type
Distributed Loads

- Consider how your ears feel as you go deeper into a swimming pool.
- The deeper you go, the greater the pressure on your ears.

Distributed Loads

- If we consider how this pressure acts on the walls of the pool, we would have to consider a force (generated by the pressure) that was small at the top and increased as we went down.
Distributed Loads

- This is known as a distributed force or a distributed load.
- It is represented by a series of vectors which are connected at their tails.

Distributed Loads

- One type of distributed load is a uniformly distributed load
Distributed Loads

- This load has the same intensity along its application.
- The intensity is given in terms of Force/Length.

The total magnitude of this load is the area under the loading diagram.
So here it would be the load intensity time the beam length.
Distributed Loads

- If, for analysis purposes, we wanted to replace this distributed load with a point load, the location of the point load would be in the center of the rectangle.

- We do this to solve for reactions.
- For a uniform load, the magnitude of the equivalent point load is equal to the area of the loading diagram and the location of the point load is at the center of the loading diagram.
A second type of loading we often encounter is a triangular load.

A triangular load has an intensity of 0 at one end and increases to some maximum at the other end.
Distributed Loads

- You will often see the intensity represented with the letter w.

The magnitude of an equivalent point load will again be the area under the loading diagram.
Distributed Loads

- For a triangle, this would be $\frac{1}{2}$ the base times the maximum intensity.

The location of the equivalent point load will be $\frac{2}{3}$ of the distance from the smallest value in the loading diagram.
Distributed Loads

- There are other types of loading diagrams but these will be sufficient for now.

![Triangular Load Diagram](image)

Distributed Loads

- You may see a diagram that appears to be a trapezoidal loading.

![Trapezoidal Load Diagram](image)
Distributed Loads

- In this case, we can divide the loading diagram into two parts, one a rectangular load and the other a triangular load.

![Diagram showing trapezoidal load](image)

Now you have two loads that you already have the rules for.

![Diagram showing resolution of trapezoidal load](image)
Distributed Loads

- Take care to note that the maximum intensity of the triangular load is now reduced by the magnitude of the rectangular load.

Example Problem

- Given: The loading and support as shown
- Required: Reactions at the supports
Example Problem

- Isolate the selected system from all connections
- Start with the pin at A

![Distributed Loads Diagram]

Example Problem

- We have a pin, so we have an x and a y component of the reaction and we will assume that both of them are +

![Distributed Loads Diagram]
Example Problem

- Now we can remove the roller support at B recognizing that the direction of the reaction is \(+y\)

![Diagram showing forces and reactions](image)

Example Problem

- We now have all the reactions identified and can proceed with the analysis

![Diagram showing forces and reactions](image)
Example Problem

- The best idea is to now convert all distributed loads into point loads

![Diagram of distributed loads]

Example Problem

- Break the load into a rectangular load and a triangular load

![Diagram of distributed loads]
Example Problem

- For the rectangular load

![Rectangular Load Diagram](image1.png)

Example Problem

- For the triangular load

![Triangular Load Diagram](image2.png)
Example Problem

- We have three unknowns, $A_y$, $A_x$, and $B_y$
- Luckily we have three equilibrium constraints to solve for them

\[
\sum F_x = 0 \\
\sum F_y = 0 \\
\sum M = 0
\]

Summing the moments about A to solve for $B_y$.

\[
\sum F_x = 0 \\
\sum F_y = 0 \\
\sum M = 0
\]
Example Problem

- Writing the expression for the sum of the moments around A

\[ \sum M = 0 = - (4.5 \text{ ft})(900 \text{ lb}) - (7.67 \text{ ft})(200 \text{ lb}) + (9 \text{ ft})(B_y) \]

Example Problem

- Isolating and solving for \( B_y \)

\[ \frac{(4.5 \text{ ft})(900 \text{ lb}) + (7.67 \text{ ft})(200 \text{ lb})}{(9 \text{ ft})} = B_y \]

\[ 620.37 \text{ lb} = B_y \]
Example Problem

- Sum of the forces in the y-direction

\[ \sum F_y = 0 = A_y - 900lb - 200lb + B_y \]

\[ 0 = A_y - 900lb - 200lb + 620.37lb \]

\[ A_y = +900lb + 200lb - 620.37lb \]

\[ A_y = 479.63lb \]

Since the magnitude of our solution came out positive, we assumed the correct direction
Example Problem

- Now our final constraint condition

\[ \sum F_x = 0 = A_x \]
\[ 0 = A_x \]
\[ A_x = 0 \text{lb} \]

So our complete solution to the problem is

\[ A_x = 0 \text{lb} \]
\[ A_y = 479.63 \text{lb} \]
\[ B_y = 620.37 \text{lb} \]
F4–37. Determine the resultant force and specify where it acts on the beam measured from A.

F4–38. Determine the resultant force and specify where it acts on the beam measured from A.
F4–39. Determine the resultant force and specify where it acts on the beam measured from A.

![Beam diagram with distributed load](image)

**F4–39**

Homework

- Problem 4-145
- Problem 4-148
- Problem 4-153