
PROJECT LEAD THE WAY
PLTW
Igniting imagination and innovation through learning.

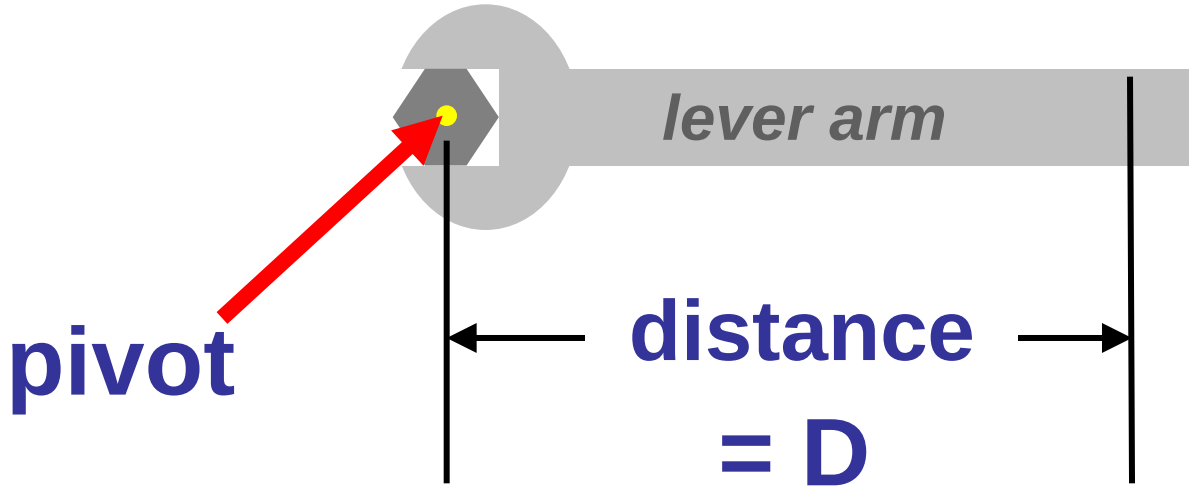
Moments

Moment

The *moment* of a force is a measure of the tendency of the force to **rotate** the body upon which it acts.

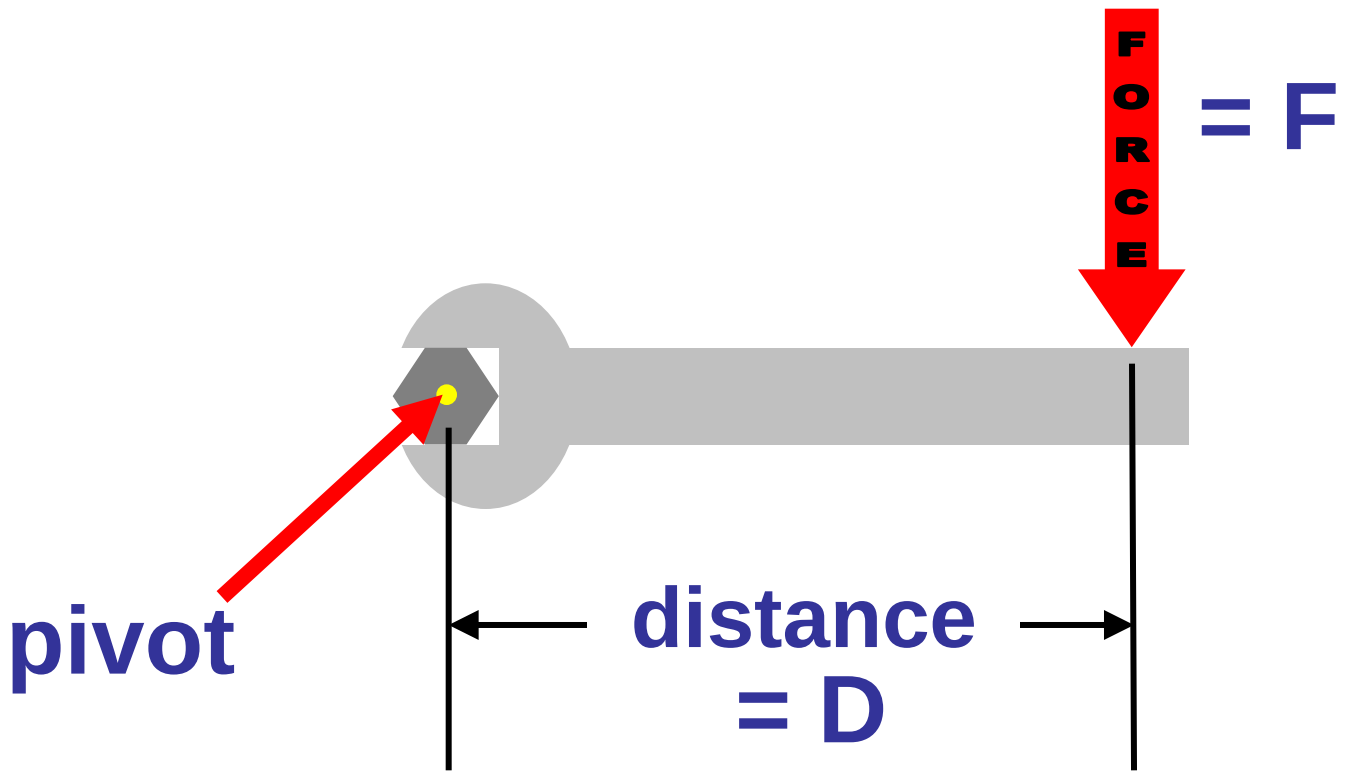
Terminology

= F



The distance must be <u>perpendicular</u> to the force.

Moments Formula



Moment = Force x Distance

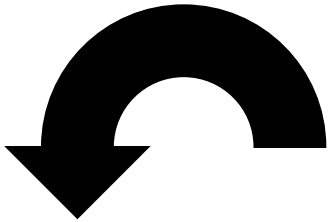
Units for Moments

	Force	Distance	Moment
English Customary	**Pound force (lbf)**	**Foot (ft)**	**lb-ft**
SI	**Newton (N)**	**Meter (m)**	**N-m**

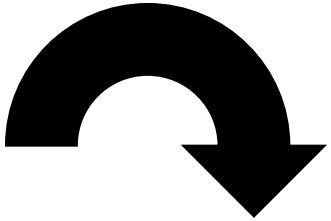
Rotation Direction

In order to add moments, it is important to know if the direction is clockwise (CW) or counterclockwise (CCW).

CCW is **positive**.



CW is **negative**.



Right-Hand Rule

Curl your fingers to match the direction of rotation.

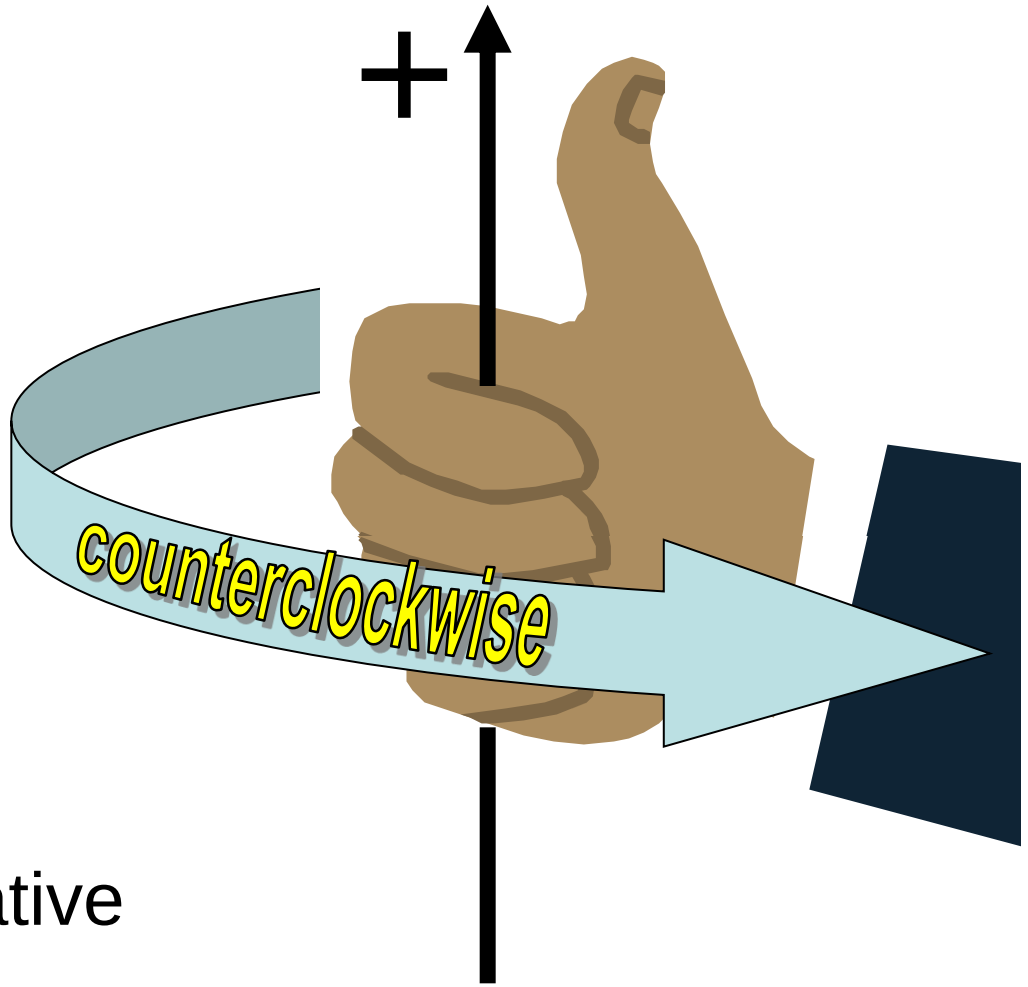
Thumb is pointing . . . .

Up = Positive

Down = Negative

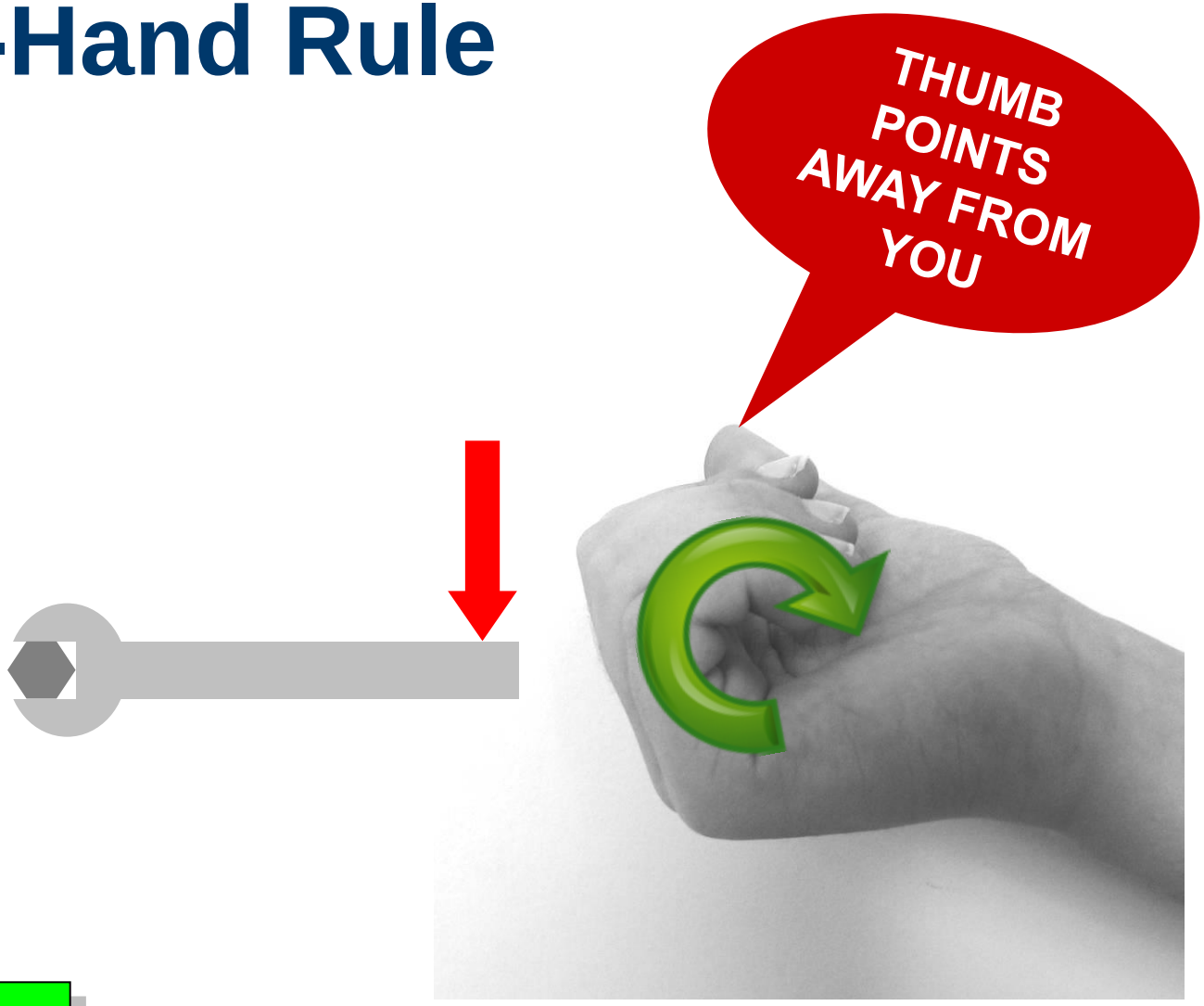
Toward You = Positive

Away from You = Negative



Right-Hand Rule

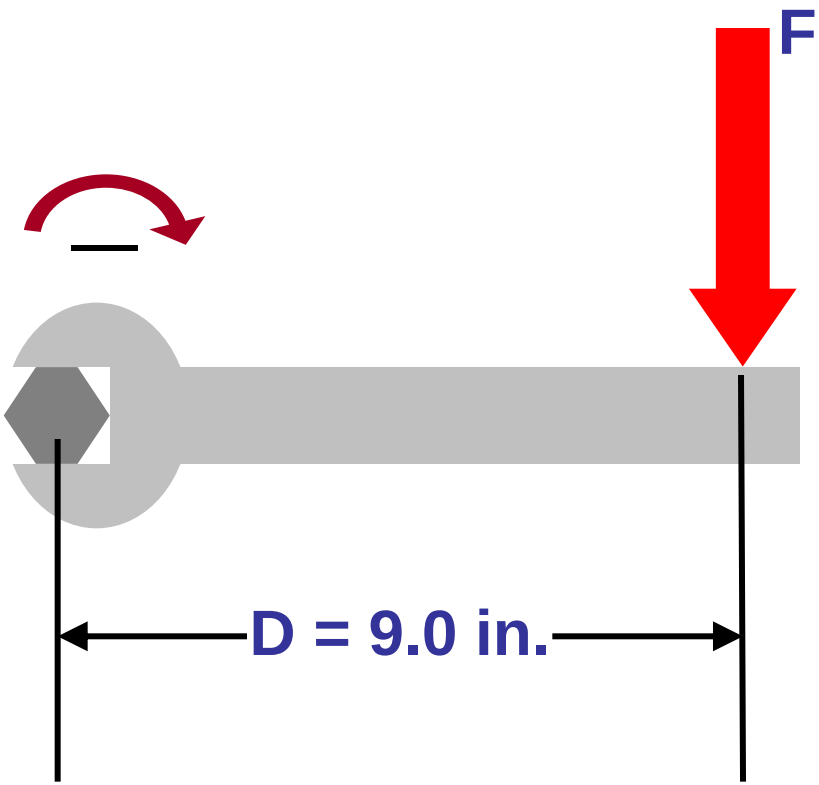
Right-Hand Rule



NEGATIVE

Moment Calculations

Wrench



M = -(F x D)

Use the right-hand rule to determine positive and negative.

D = 9.0 in. = .75 ft

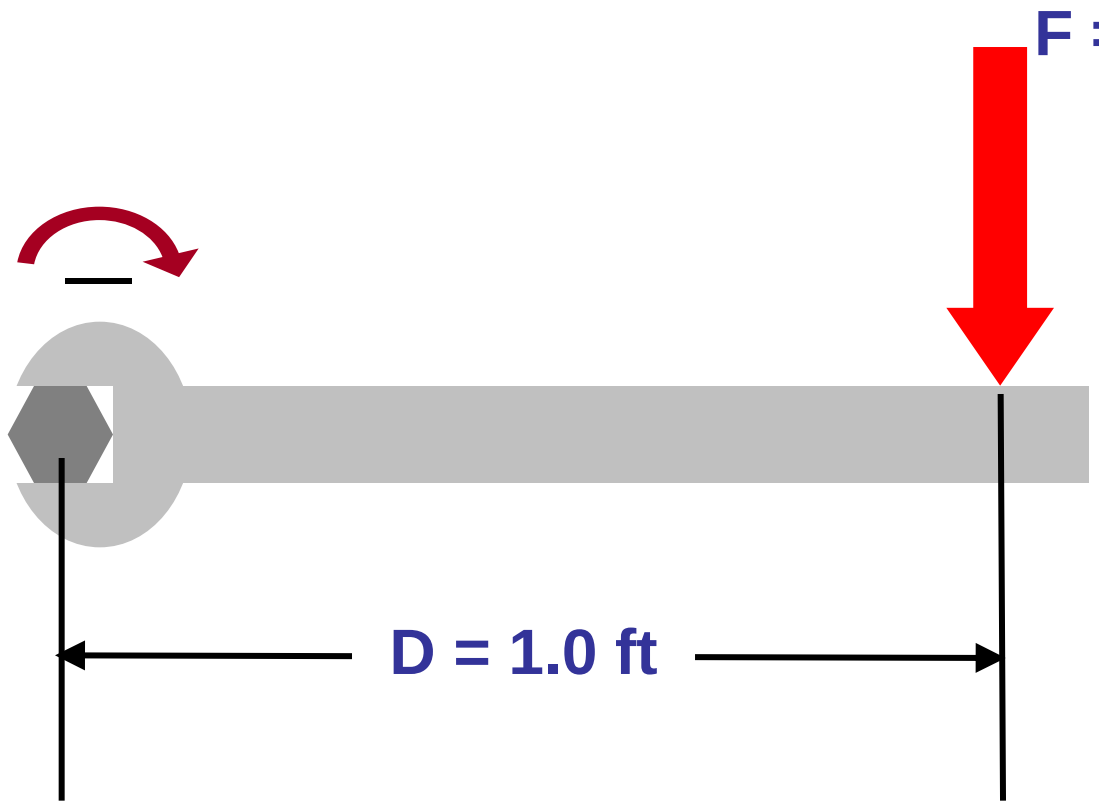
M = -(20. lb x .75 ft)

M = -15 lb-ft

(15 lb-ft clockwise)

Moment Calculations

Longer Wrench



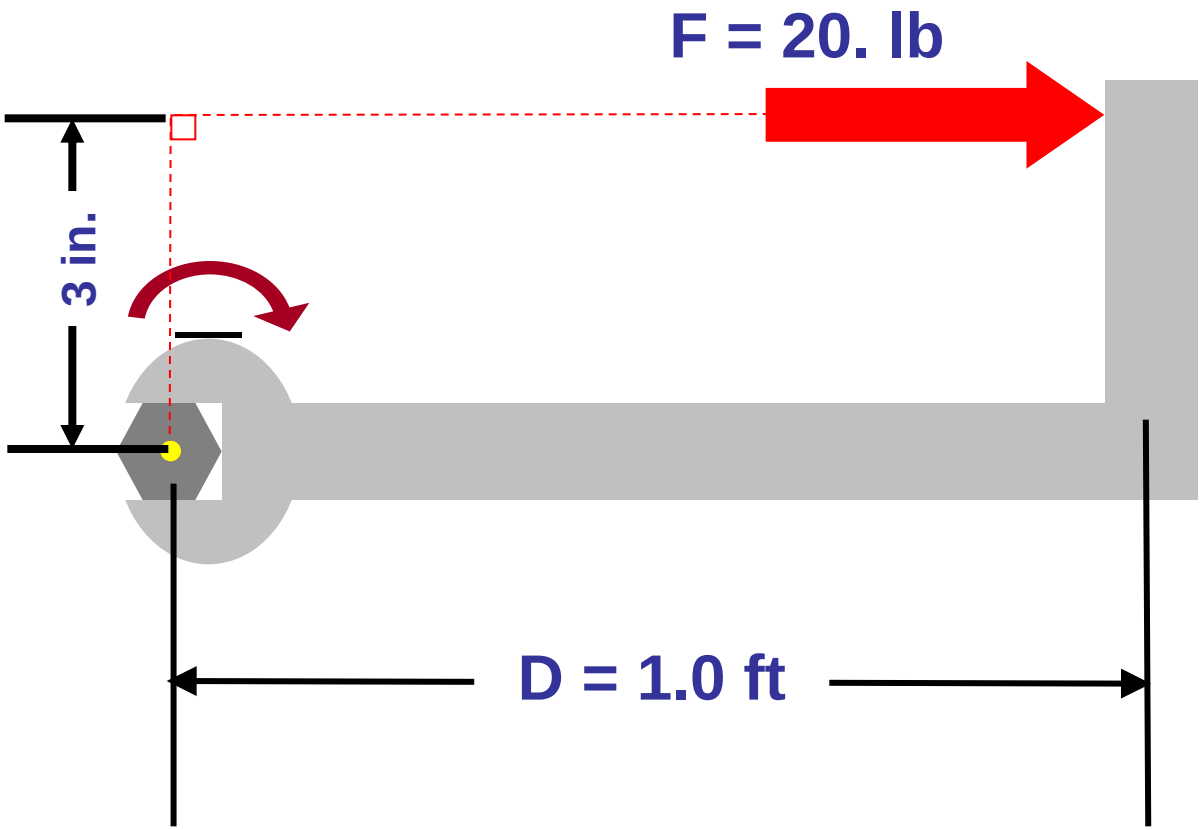
M = -(F x D)

M = -(20. lb x 1.0 ft)

M = -20. lb-ft

Moment Calculations

L - Shaped Wrench



D = 3 in. = .25 ft

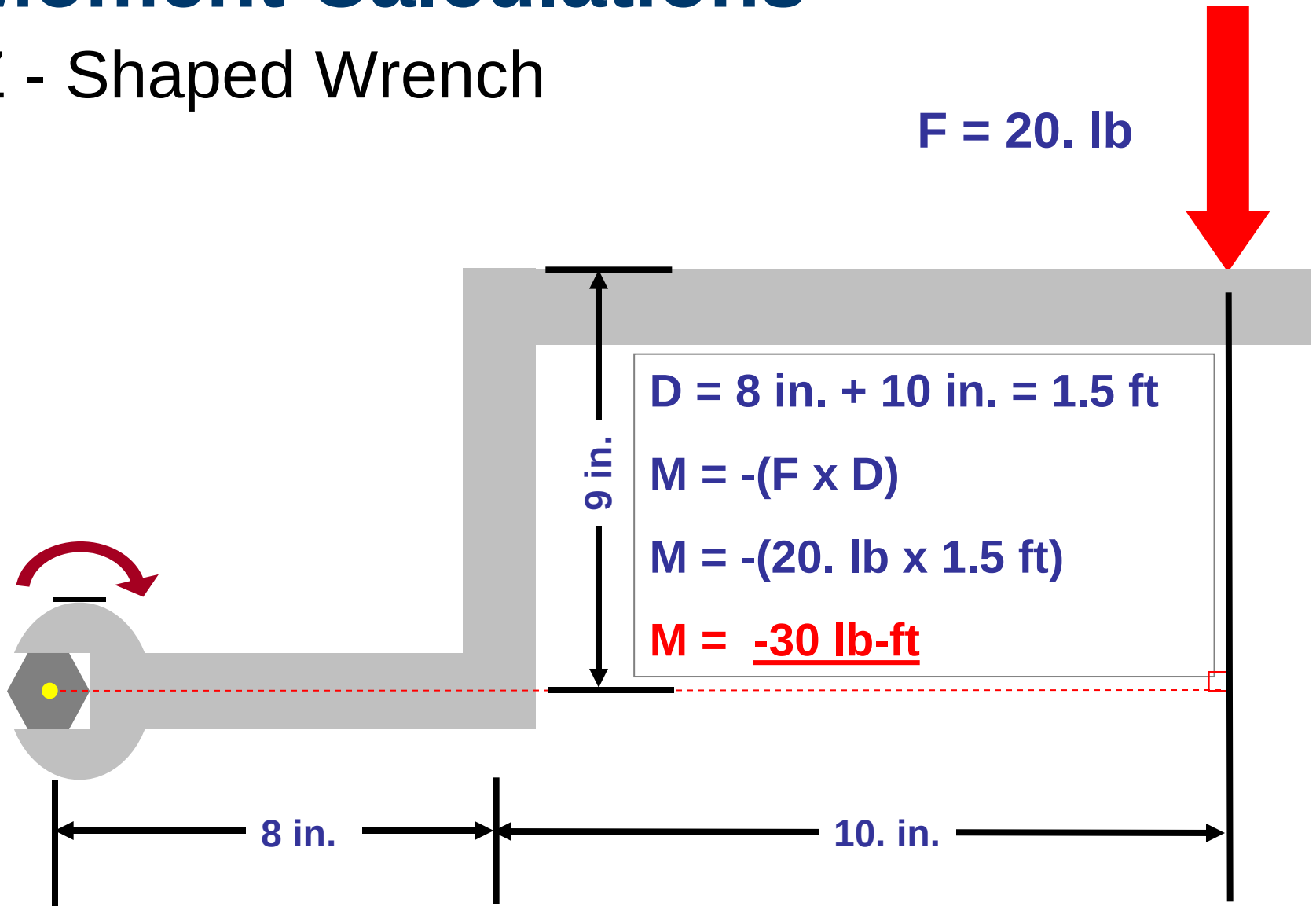
M = -(F x D)

M = -(20. lb x .25 ft)

M = -5 lb-ft

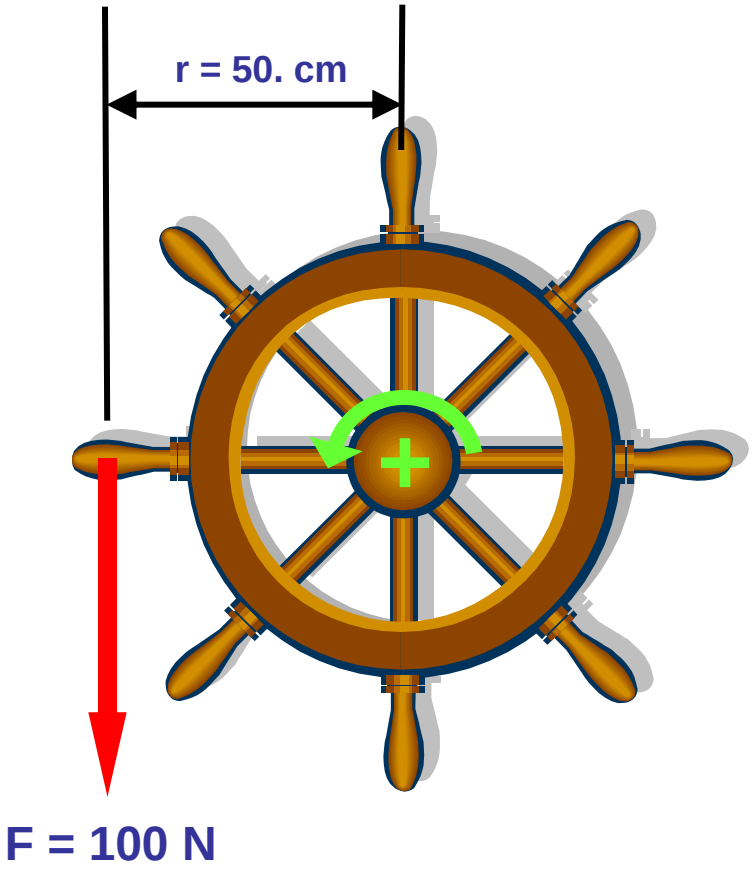
Moment Calculations

Z - Shaped Wrench



Moment Calculations

Wheel and Axle



D = r = 50. cm = 0.50 m

M = F x D

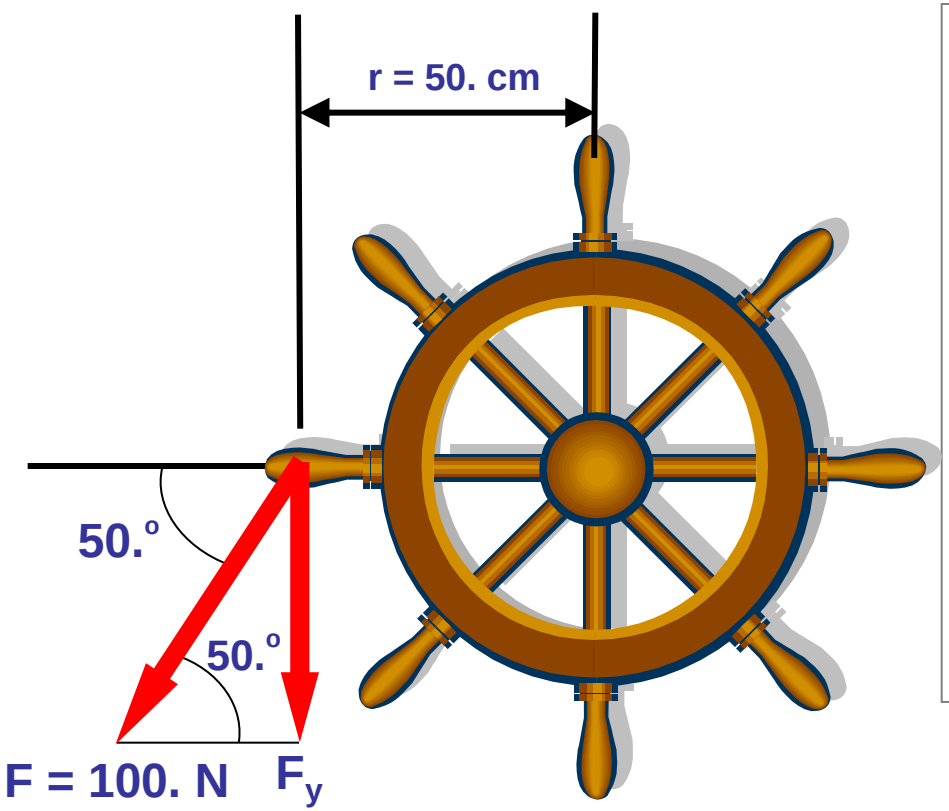
Use the right-hand rule to determine positive and negative.

M = 100 N x 0.50 m

M = 50 N-m

Moment Calculations

Wheel and Axle



$F_y = F\sin 50.° = (100.\ N)(.7660)$

$F_y = 76.\underline{60}\ N$

$D = r = 50.\ cm = 0.50\ m$

$M = F_y \times D$

$M = 76.\underline{60}\ N \times 0.50\ m$

$M = \underline{38\ N\text{-}m}$

What is Equilibrium?

The state of a body or physical system with an unchanging rotational motion.

- Two cases for that condition:
  1. Object is **not rotating**.
  2. Object is spinning at the **same speed**.
- In either case rotation forces are balanced.

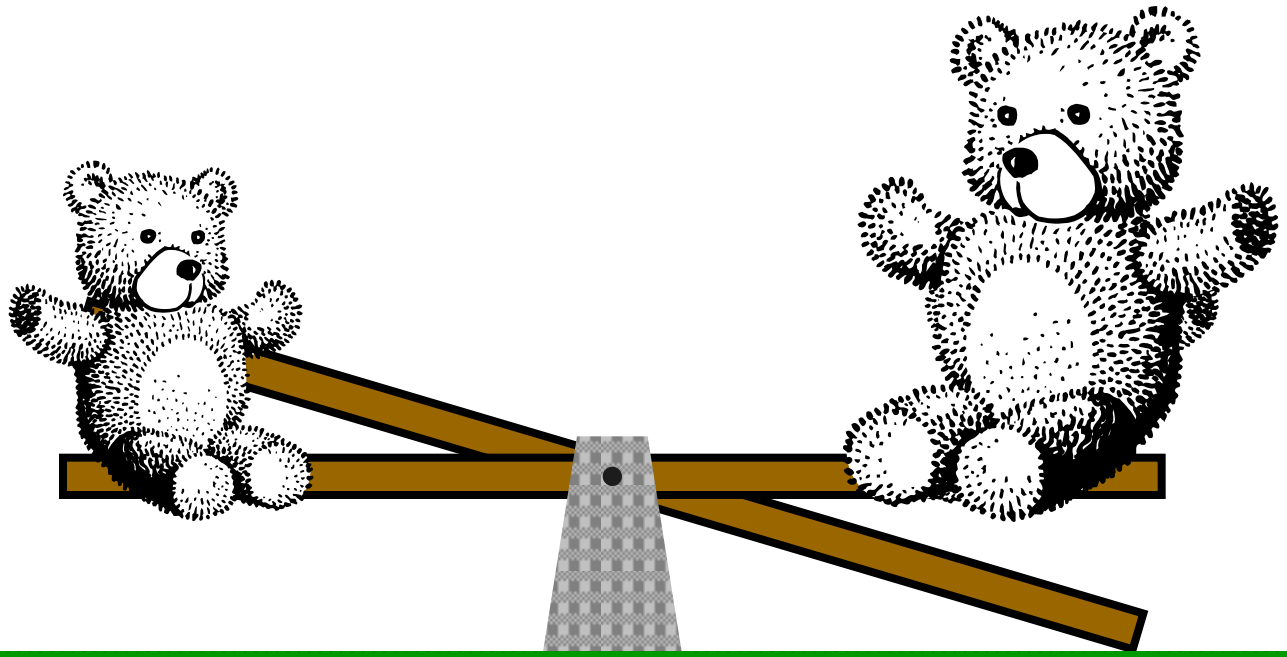
*The sum of all moments about any point or axis is **zero***.

$$\Sigma M = 0$$

$$M_1 + M_2 + M_3 \ldots = 0$$

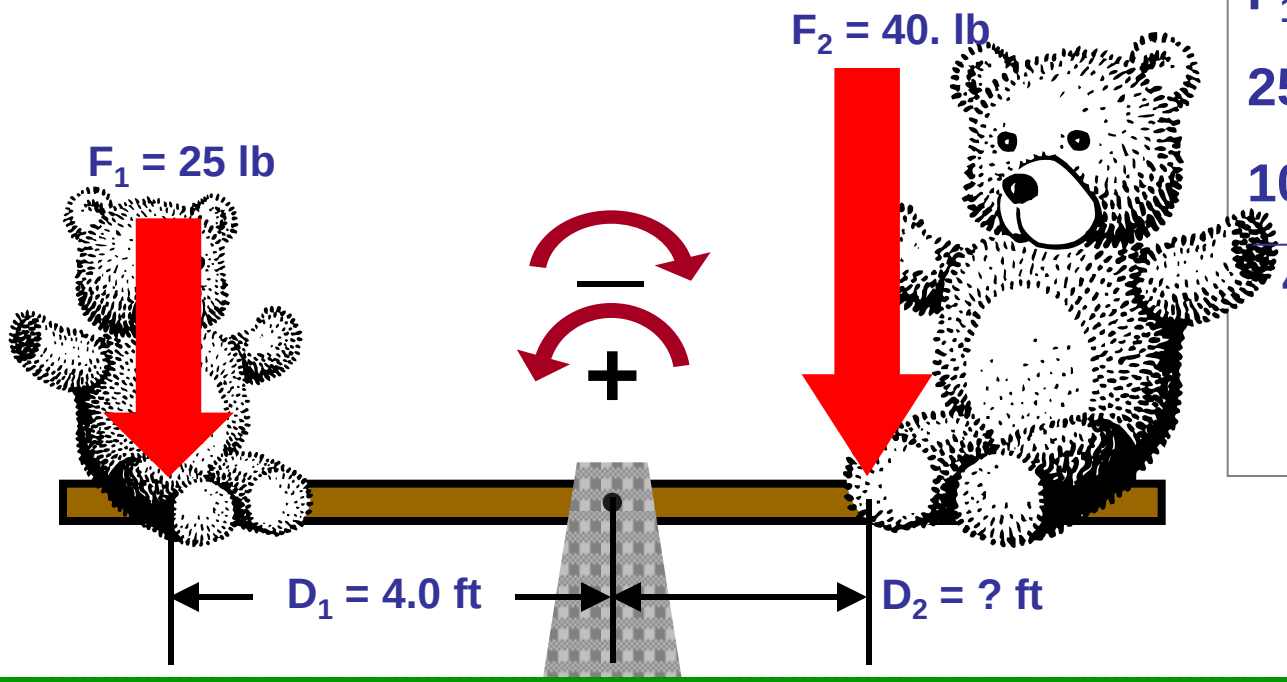
Moment Calculations

See-Saw



Moment Calculations

See-Saw



$\Sigma M = 0$

$M_1 + (-M_2) = 0$

Use the right-hand rule to determine positive and negative.

$M_1 = M_2$

$F_1 \times D_1 = F_2 \times D_2$

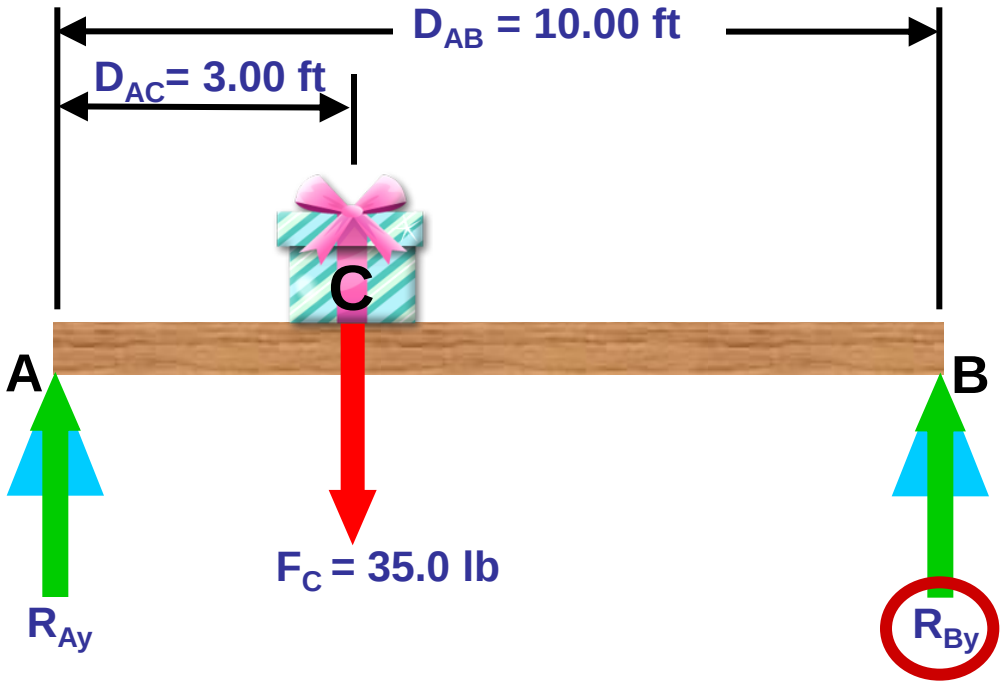
$25\ lb \times 4.0\ ft = 40.\ lb \times D_2$

$$\frac{100\ \cancel{lb}\text{-}ft}{40.\ \cancel{lb}} = \frac{40.\ \cancel{lb} \times D_2}{40.\ \cancel{lb}}$$

$D_2 = \underline{2.5\ ft}$

Moment Calculations

Loaded Beam



Select A as the pivot location. Solve for R_{By}

$\Sigma M = 0$

$M_B + (-M_C) = 0$

$M_B = M_C$

$R_{By} \times D_{AB} = F_C \times D_{AC}$

$R_{By} \times 10.00\ ft = 35.0\ lb \times 3.00\ ft$

$$\frac{R_{By} \times 10.00\ ft}{10.00\ ft} = \frac{105\ lb\text{-}ft}{10.00\ ft}$$

$R_{By} = 10.5$ lb

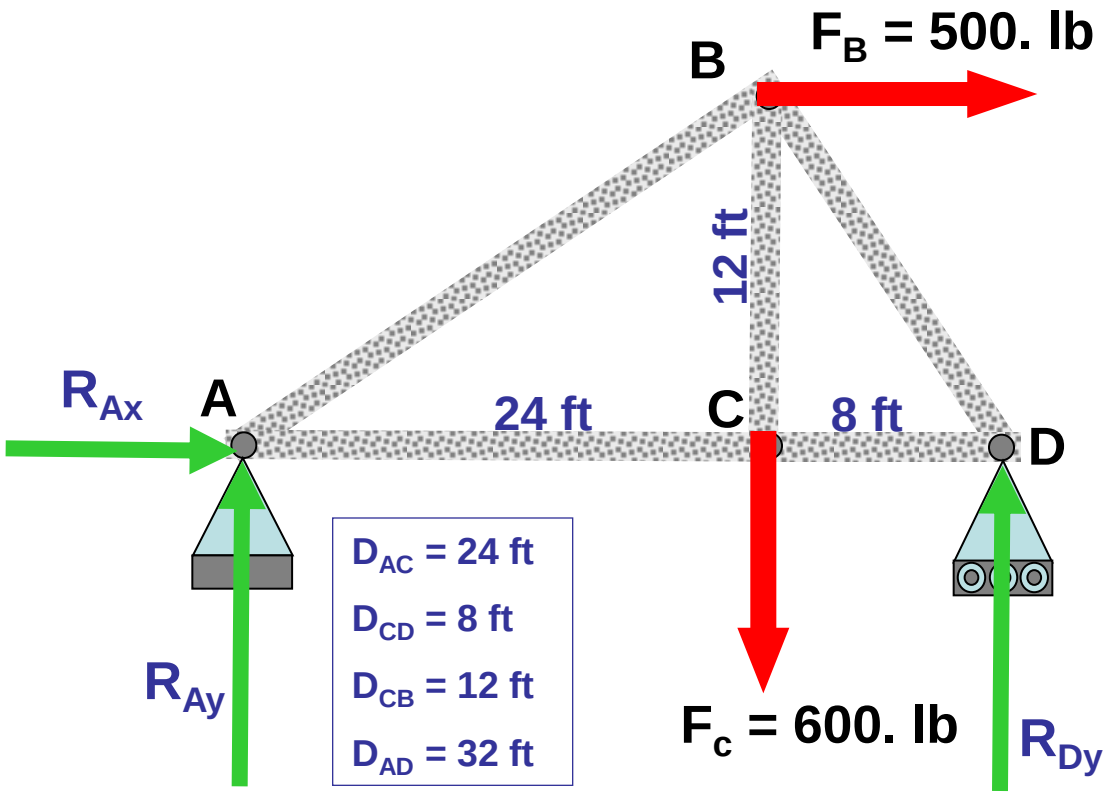
$R_{Ay} + R_{By} = 35.0$ lb

$R_{Ay} = 35.0$ lb – 10.5 lb =

24.5 lb

Moment Calculations

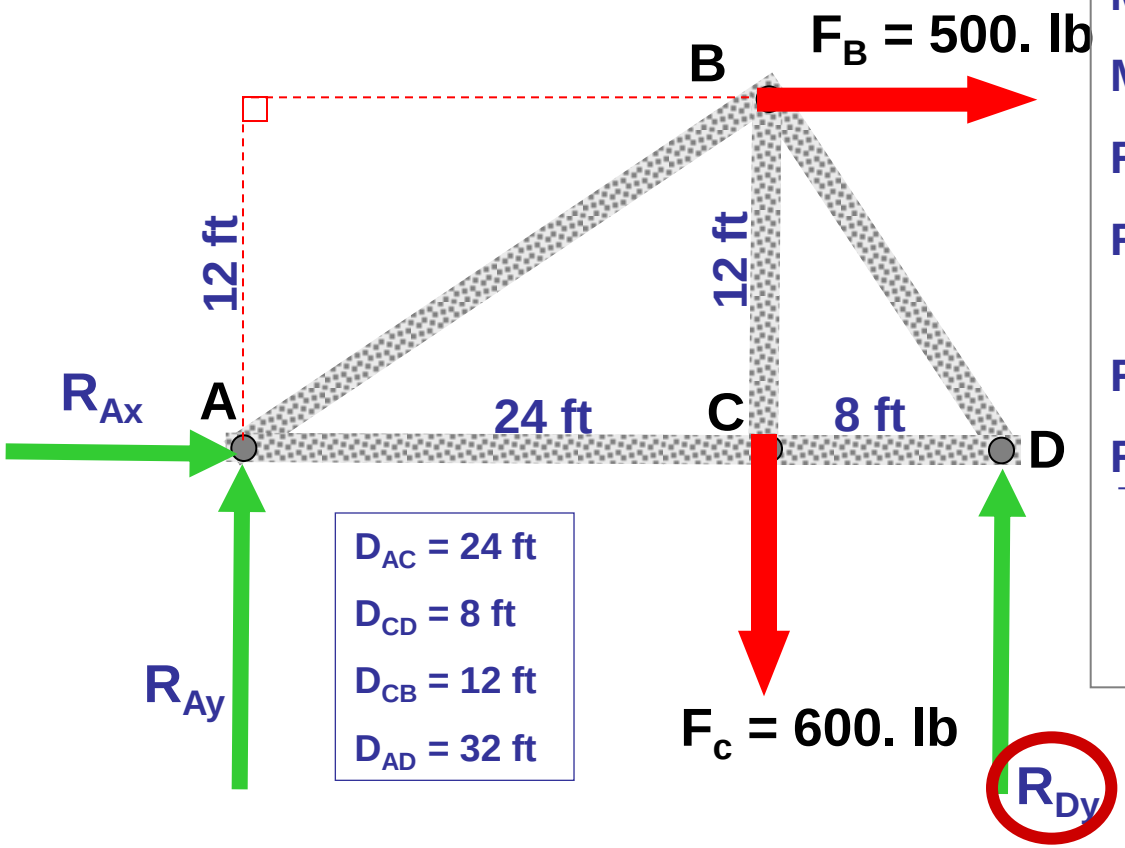
Truss



Replace the pinned and roller supports with reaction forces.

Moment Calculations

Truss



Select A as the axis of rotation. Solve for R_{DY}

$\Sigma M = 0$

$M_D - M_B - M_C = 0$

$M_D = M_B + M_C$

$R_{Dy} \times D_{AD} = (F_B \times D_{CB}) + (F_C \times D_{AC})$

$R_{Dy} \times 32 \text{ ft} = (500. \text{ lb} \times 12 \text{ ft}) + (600. \text{ lb} \times 24 \text{ ft})$

$R_{Dy} \times 32 \text{ ft} = 6000 \text{ lb-ft} + 14400 \text{ lb-ft}$

$$\frac{R_{Dy} \times 32 \text{ ft}}{32 \text{ ft}} = \frac{20400 \text{ lb-ft}}{32 \text{ ft}}$$

$$R_{DY} = 640 \text{ lb}$$