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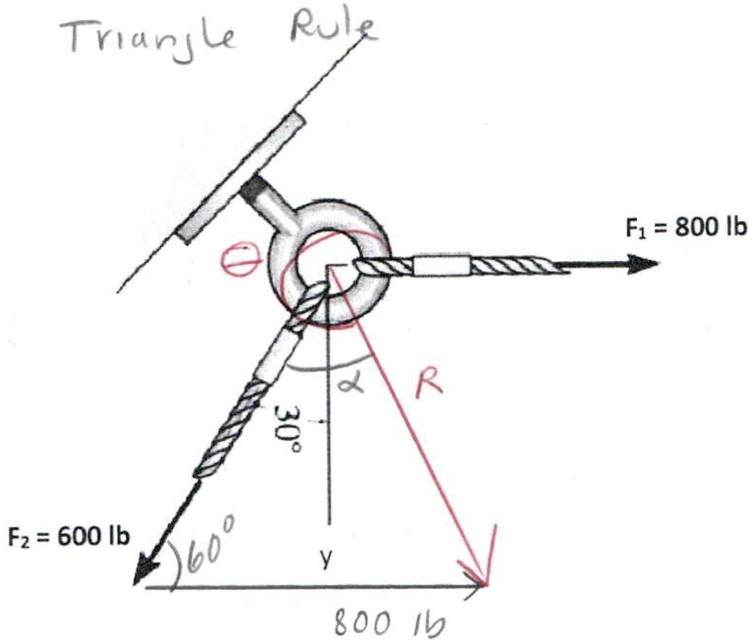
| CMGT 350 | Exam #1 | Fall 2022 |

**SHOW ALL WORK FOR FULL CREDIT. One page of notes (Front and Back) handwritten by You. Algebra and Trig Cheat sheets. All angles are to be measured CCW from the +x-axis. Final answer for all forces (vectors) are to be positive scalar, true direction. Round all answers to whole numbers (NO DECIMAL ANSWERS)**

**Name:** Solution

1. Determine the magnitude and direction of the resultant force for the forces acting on the hook using the parallelogram law or the triangle rule.

Triangle Rule




$\boxed{SAS}$ Law of Cosines

$$R = \sqrt{600\text{ lb}^2 + 800\text{ lb}^2 - 2(600\text{ lb})(800\text{ lb})\cos 60^\circ}$$

$$= 721 \text{ lb}$$

Law of Sines

$$\frac{\sin\alpha}{800\text{ lb}} = \frac{\sin 60^\circ}{721^\circ}$$

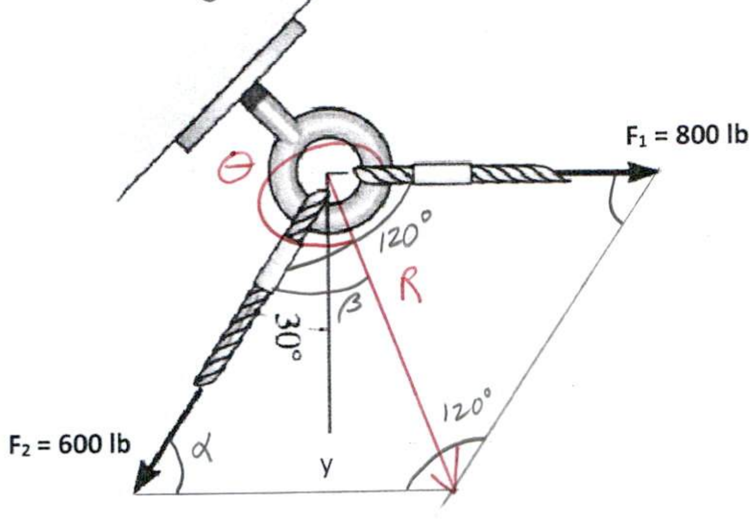
$$\alpha = \sin^{-1}\left(\frac{800\text{ lb}(\sin 60^\circ)}{721^\circ}\right) = 74^\circ$$

$$\theta = 270^\circ + 44^\circ = 314^\circ$$

$$\boxed{R = 721 \text{ lb} \;\; 314^\circ}$$

1. Determine the magnitude and direction of the resultant force for the forces acting on the hook using the parallelogram law or the triangle rule.

Parallelogram Law




$$2\alpha + 2(120^\circ) = 360^\circ$$

$$\alpha = \frac{120^\circ}{2} = 60^\circ$$

$\boxed{SAS}$ Law of Cosines

$$R = \sqrt{600\ lb^2 + 800\ lb^2 - 2(600\ lb)(800\ lb)\cos 60^\circ}$$

$$= \sqrt{1{,}000{,}000\ lb^2 - 480{,}000}$$

$$= \sqrt{520{,}000\ lb^2}$$

$$= 721\ lb$$

Law of Sines

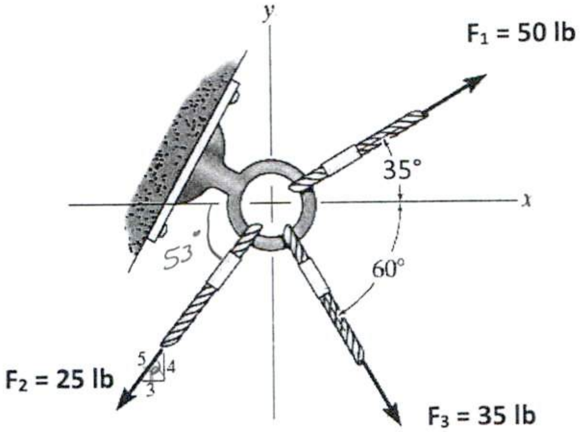
$$\frac{\sin\beta}{800\ lb} = \frac{\sin 60^\circ}{721\ lb}$$

$$\beta = \sin^{-1}\left(\frac{800\ lb(\sin 60^\circ)}{721\ lb}\right) = 74^\circ$$

$$\theta = 270^\circ + 44^\circ = 314^\circ$$

$$\boxed{R = 721\ lb\ \measuredangle\ 314^\circ}$$

2. Determine the magnitude and direction of the resultant force for the concurrent coplanar force system shown by completing the following:




$\alpha = \tan^{-1} \frac{4}{3} = 53°$

| Force (lb) | Direction (Θ) | Fx = F Cos Θ | Fy = F Sin Θ |
|---|---|---|---|
| 50 | 35° | 41 | 29 |
| 25 | 180° + 53° = 233° | −15 | −20 |
| 35 | 300° | 18 | −30 |
| | Σ | 44 | Σ −21 |

Magnitude

Rx = ∑Fx = 44 lb →

Ry = ∑Fy = −21 lb = 21 lb ↓

Resultant lies in QUAD 4

$R = \sqrt{R_x^2 + R_y^2} = \sqrt{44\text{ lb}^2 + 21\text{ lb}^2} = 49\text{ lb}$

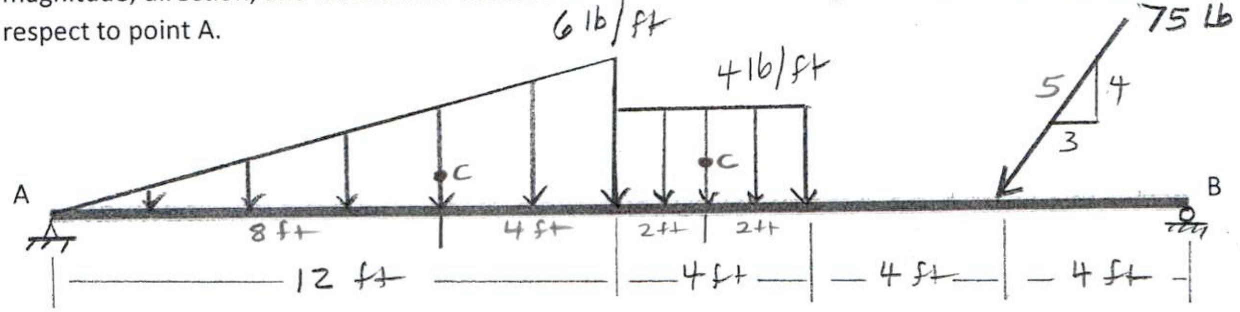
Direction

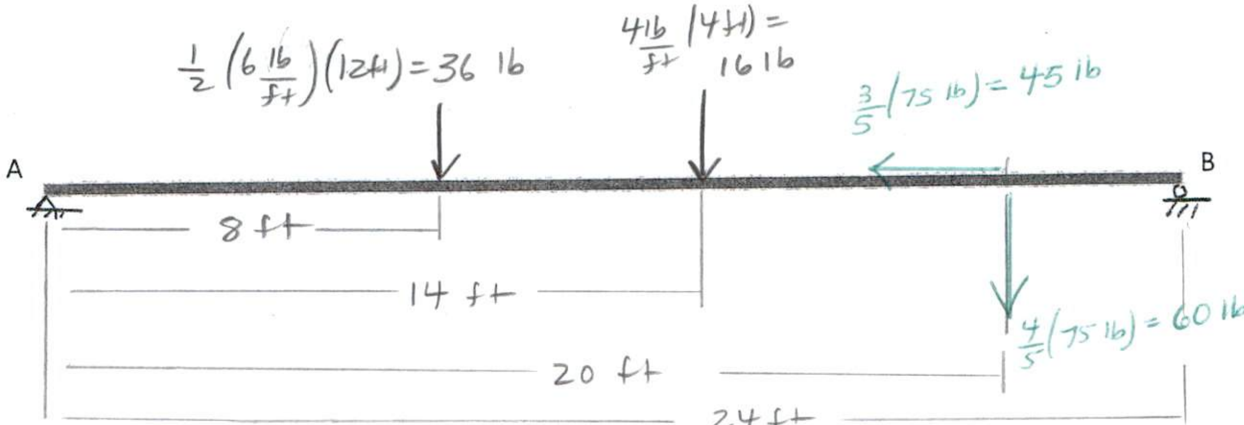
$\alpha = \tan^{-1} \left| \frac{R_y}{R_x} \right| = \tan^{-1} \left| \frac{21}{44} \right| = 26°$

Θ = 360° − 26° = 334°

ANS: R = 49 lb ∡ 334°

3. Redraw the beam diagram on the beam shown below by replacing the distributed loads with their equivalent concentrated forces and resolve the 75 lb force into x and y components. Determine the magnitude, direction, and location for the resultant for the loads acting on the beam. Locate resultant with respect to point A.




Magnitude

$R_x = \sum F_x =$ $-45$ lb $=$ 45 lb $\leftarrow$

$R_y = \sum F_y =$ $-36$ lb $- 16$ lb $- 60$ lb $=$ 112 lb $=$ 112 lb $\downarrow$

Resultant lies in QUAD 3

$R = \sqrt{R_x^2 + R_y^2} =$ $\sqrt{45\ lb^2 + 112\ lb^2} = 121$ lb

Direction

$\alpha = \tan^{-1}\left|\frac{R_y}{R_x}\right| = \tan^{-1}\left|\frac{112\ lb}{45\ lb}\right| = 68^\circ$

$\theta =$ $180^\circ + 68^\circ = 248^\circ$

Location

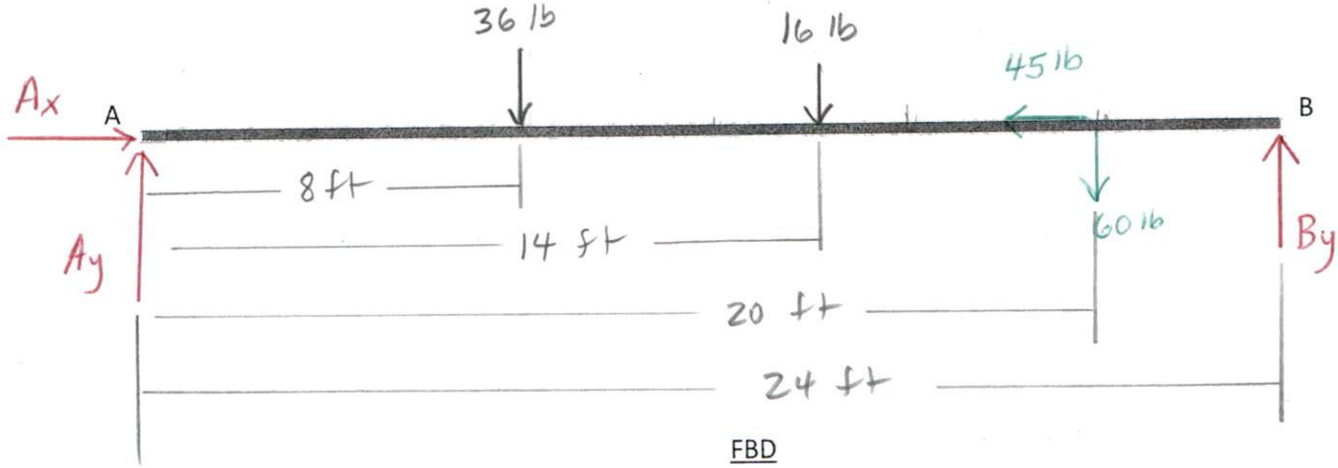
$R_y\,\bar{x} = \sum M_A$

$112\ lb\ \bar{x} = 36\ lb(8ft) + 16\ lb(14\ ft) + 60\ lb(20ft)$

$\bar{x} = \frac{1712\ lb.ft}{112\ lb} =$ 15 ft to the right of pt. A

$\boxed{R = 121\ lb\ \measuredangle\ 248^\circ \text{ located 15 ft to the right of pt. A}}$

4. Using the beam diagram shown below, draw the Free Body Diagram for the force system in problem 3 and solve for the reactions at the supports A and B. You may use the original force system given or the resultant determined in problem 3.




FBD

Equilibrium Equations

ccw +M
cw −M

$[\Sigma F_x = 0]$ $\quad A_x - 45\text{ lb} = 0$

$A_x = \underline{\underline{45\text{ lb}}} \rightarrow$

$[\Sigma M_A = 0]$ $\quad -36\text{ lb}(8\text{ ft}) - 16\text{ lb}(14\text{ ft}) - 60\text{ lb}(20\text{ ft}) + B_y(24\text{ ft}) = 0$

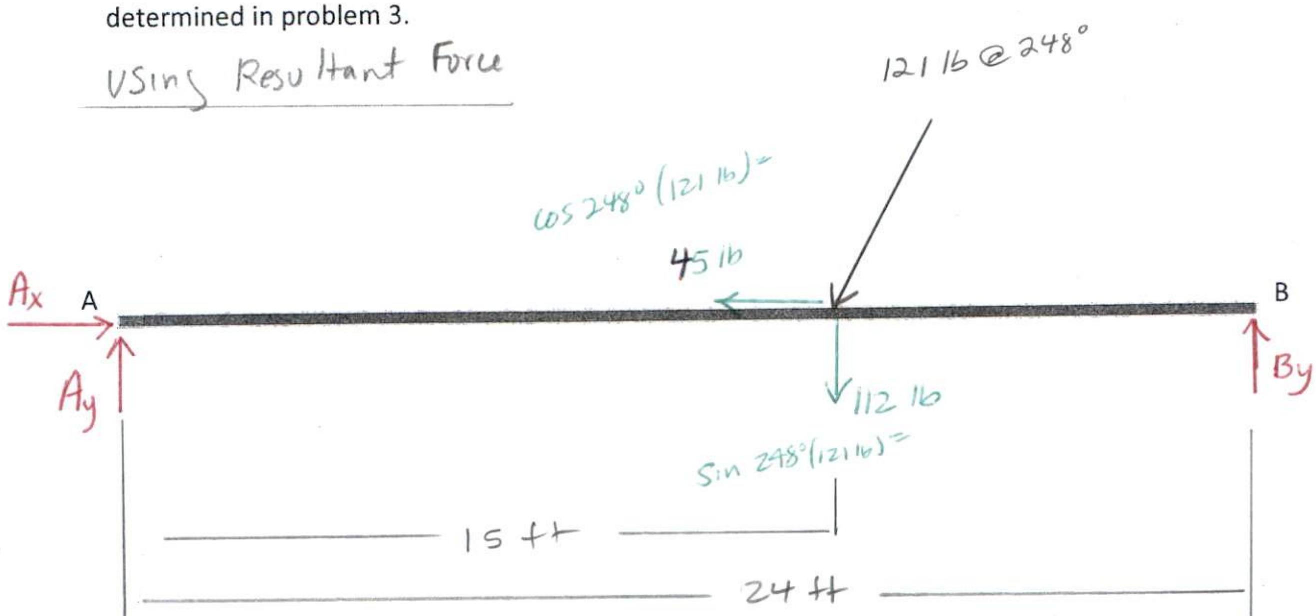
$$B_y = \frac{1712\text{ lb}\cdot\text{ft}}{24\text{ ft}} = \underline{\underline{71\text{ lb}}} \uparrow$$

$[\Sigma F_y = 0]$ $\quad A_y - 36\text{ lb} - 16\text{ lb} - 60\text{ lb} + B_y = 0$

$A_y = 112\text{ lb} - 71\text{ lb} = \underline{\underline{41\text{ lb}}} \uparrow$

4. Using the beam diagram shown below, draw the Free Body Diagram for the force system in problem 3 and solve for the reactions at the supports A and B. You may use the original force system given or the resultant determined in problem 3.

Using Resultant Force




FBD

Equilibrium Equations

CCW +M

CW −M

$[\Sigma F_x = 0]$ $\quad A_x - 45\text{ lb} = 0$

$$A_x = \underline{\underline{45\text{ lb}}} \rightarrow$$

$[\Sigma M_A = 0]$ $\quad -112\text{ lb}(15\text{ ft}) + B_y(24\text{ ft}) = 0$

$$B_y = \frac{1680\text{ lb}\cdot\text{ft}}{24\text{ ft}} = \underline{\underline{70\text{ lb}}} \uparrow$$

$[\Sigma F_y = 0]$ $\quad A_y - 112\text{ lb} + B_y = 0$

$$A_y = 112\text{ lb} - 70\text{ lb} = \underline{\underline{42\text{ lb}}} \uparrow$$