Department of Civil and Mechanical Engineering
United States Military Academy
The Nation's First Department of Engineering

CADET: Smart, I.M.

COURSE: CE-300

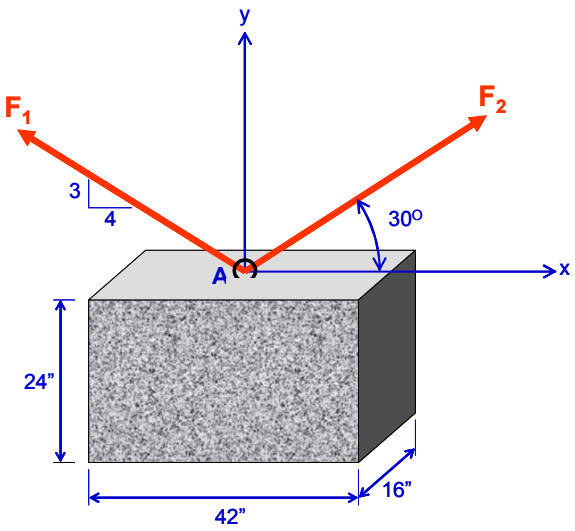
SECTION: Distance Education Pilot Project

DATE: 10 August 2006.

REQUIREMENT: Problem Set Format Example

Given:

A concrete block has the dimensions shown at right Two ropes are attached to the hook at Point A, and forces F_1 and F_2 are applied to the ropes as indicated. The density of concrete is γ = 150 pounds per cubic foot.



Required:

(a) How much does the block weigh?

(b) If F_1=1100 lb and F_2=1200 lb, what is the resultant of the two forces?

(c) If the block is lifted and suspended from the two ropes, what are the magnitudes of the forces F_1 and F_2? In other words, what values of F_1 and F_2 are required for the two forces and the weight of the block to be in equilibrium? Assume that the directions of the two forces remain unchanged.

Define Units:

Define kips as a custom unit $\text{kips} := 1000 \cdot \text{lbf}$

Define Variables:

length of the block $L_b := 42 \cdot \text{in}$

height of the block $h_b := 24 \cdot \text{in}$

width of the block $w_b := 16 \cdot \text{in}$

Force F_1 $F_1 := 1100 \cdot \text{lbf}$

Force F_2 $F_2 := 1200 \cdot \text{lbf}$

density of concrete $\gamma := 150 \cdot \frac{\text{lbf}}{\text{ft}^3}$

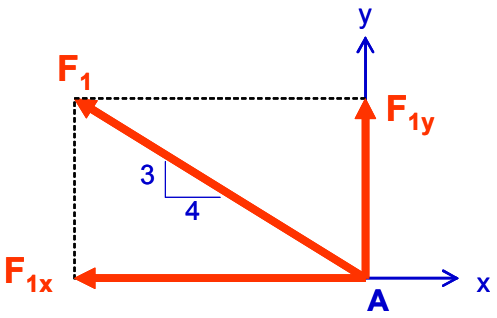
(a) Calculate the Weight of the Concrete Block

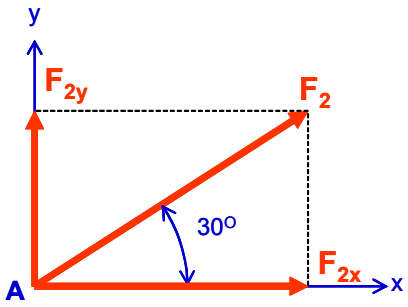
weight of block $W_b := \gamma \cdot L_b \cdot h_b \cdot w_b$

weight of block $W_b = 1.4 \times 10^3 \text{ lbf}$ $W_b = 1.4 \text{ kips}$

(b) Calculate the Resultant Force

Break each force into components





x-component of F_1 $F_{1x} := \frac{4}{5} \cdot F_1$

y-component of F_1 $F_{1y} := \frac{3}{5} \cdot F_1$

x-component of F_2 $F_{2x} := F_2 \cdot \cos(30 \cdot \text{deg})$

y-component of F_2 $F_{2y} := F_2 \cdot \sin(30 \cdot \text{deg})$

Calculate the resultant

x-component of F_R *(right is positive)*

$F_{Rx} := -F_{1x} + F_{2x}$

$F_{Rx} = 159.23 \text{ lbf}$

y-component of F_R *(up is positive)*

$F_{Ry} := F_{1y} + F_{2y}$

$F_{Ry} = 1.26 \times 10^3 \text{ lbf}$

magnitude of resultant

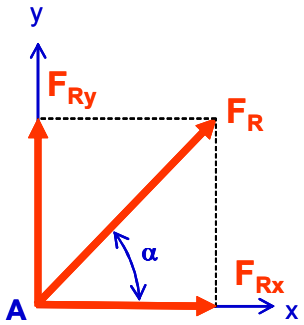
$F_R := \sqrt{F_{Rx}^2 + F_{Ry}^2}$

$F_R = 1.27 \times 10^3 \text{ lbf}$

direction of resultant

$\alpha := \text{atan}\left(\frac{F_{Ry}}{F_{Rx}}\right)$

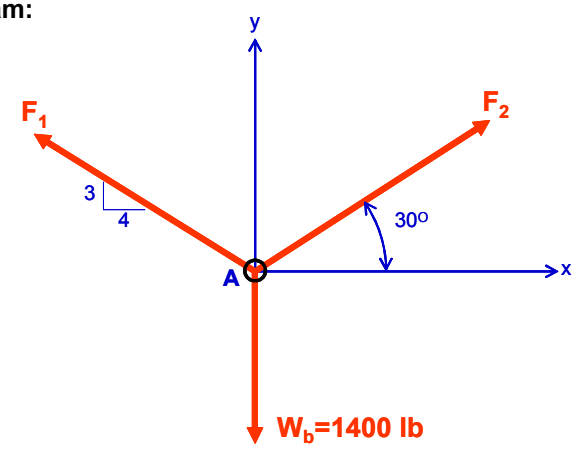
$\alpha = 82.798 \text{ deg}$



F_R=1270 lb ∠ 82.8 degrees thru A

(c) Calculate Magnitudes of the Forces F_1 and F_2 for Equilibrium

Free Body Diagram:



Equilibrium Equations

guess value for F_1 $F_1 := 1 \cdot lbf$

guess value for F_2 $F_2 := 1 \cdot lbf$

Given

$\Sigma F_x = 0$ (right is positive)

$$-F_1 \cdot \frac{4}{5} + F_2 \cdot \cos(30 \cdot deg) = 0$$

$\Sigma F_y = 0$ (up is positive)

$$F_1 \cdot \frac{3}{5} + F_2 \cdot \sin(30 \cdot deg) - W_b = 0$$

$$\text{Find}(F_1, F_2) = \begin{pmatrix} 1.318 \times 10^3 \\ 1.218 \times 10^3 \end{pmatrix} lbf$$

Final Results:

F_1=1318 lb 3/4 **thru A**

F_2=1218 lb **30 degrees thru A**

KEY CHARACTERISTICS OF THIS SAMPLE SOLUTION:

(1) Use the standard CE-300 Problem Set Heading.

(2) Always include a brief statement of the problem--what is given, and what is required.

(3) Define all of your variables and custom units up front, immediately following hte problem statement.

(4) Use appropriate secton headings to organize your work.

(5) Use pictures and diagrams to clarify your work whenever possible.

(6) Provide brief text explanations of key variables and equations.

(7) Highlight your answers in yellow.

CE-300 Mathcad Tutorial