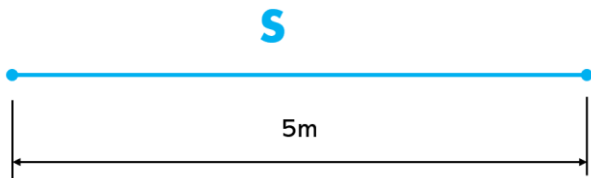


Chapter 2: Force Vectors 2 - D Vectors

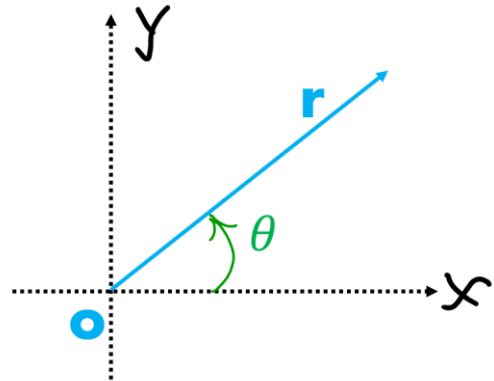
2.1.1 Scaler



- Completely specified by its magnitude

Vs

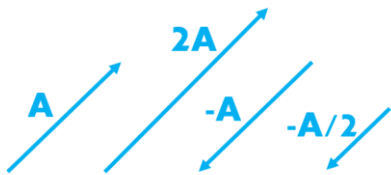
Vector



- Requires both a **magnitude** and a **direction**
- for its complete description.

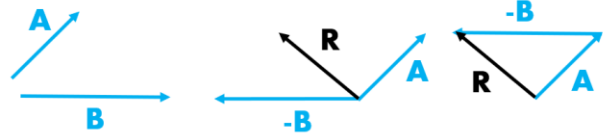
2.1.2 Quick Vector Operations

- **Scalar multiplication & division**



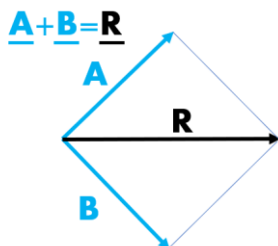
NB: Subtraction is a special case of addition, so the rules of vector addition also apply to vector subtraction.

$$\underline{A - B} = \underline{A} + \underline{(-B)} = \underline{R}$$

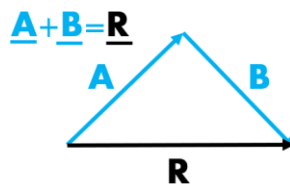


- **Vector addition**

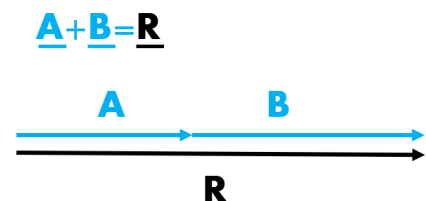
- Parallelogram Law



- Triangle Rule (Head to Tail)



- Colinear Sum



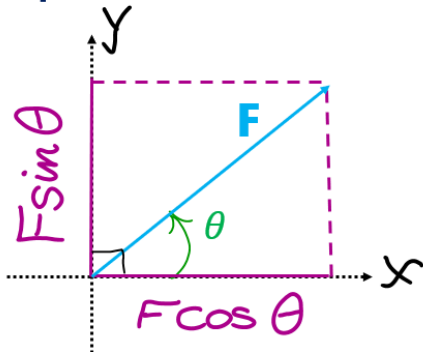
- **Vector addition Example:**

If $A=5m$ & $B=3m$ then $R=?$



2.1.3 How to Express a Vector?

A-Two Perpendicular Components

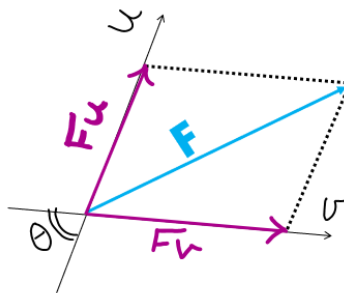


$$\underline{F} = F \cos \theta \underline{i} + F \sin \theta \underline{j} = F_x \underline{i} + F_y \underline{j}$$

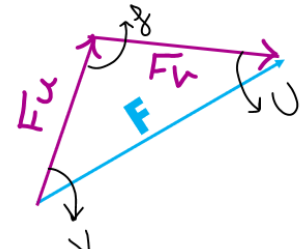
$$\tan^{-1} \theta = \frac{F_y}{F_x} \quad F = \sqrt{F_x^2 + F_y^2}$$

B-Two Random Components

Parallelogram Law:



Triangle Rule (head to tail):



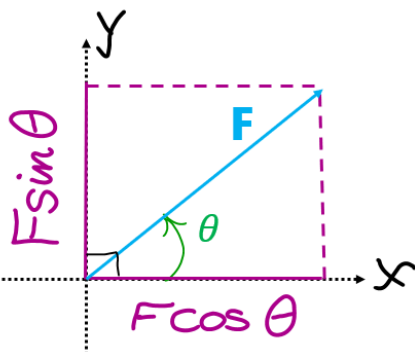
Cosine Rule

$$F = \sqrt{F_v^2 + F_u^2 - 2F_v F_u \cos f}$$

Sine Rule

$$\frac{F}{\sin f} = \frac{F_v}{\sin V} = \frac{F_u}{\sin U}$$

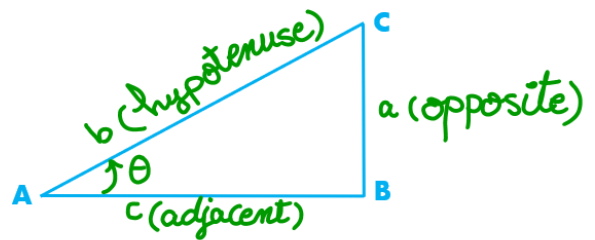
A-Two Perpendicular Components



$$\underline{F} = \underline{i} + \underline{j} = \underline{i} + \underline{j}$$

$$\tan^{-1} \theta = \quad F =$$

Review:



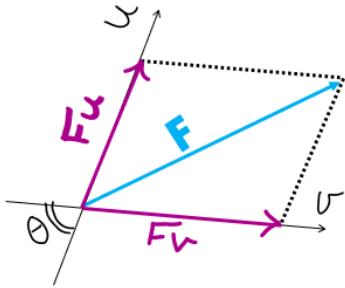
Pythagoras:

We'll be needing the basic rules of triangles' Geometry along with the basic trigonometric functions.

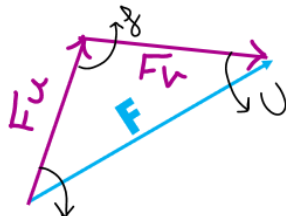


B-Two Random Components

Parallelogram Law:



Triangle Rule (head to tail):

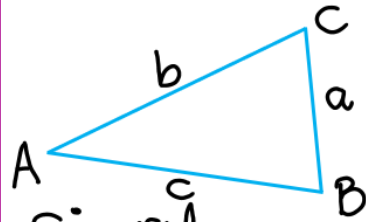


Cosine Rule

$$F =$$

Sine Rule

Review:



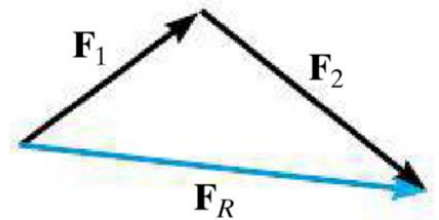
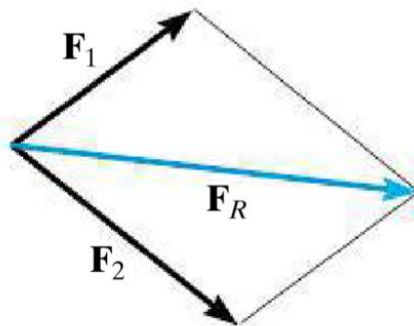
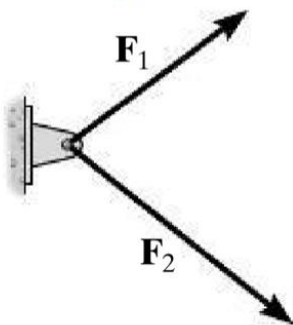
Sine rule:

Cosine rule:

2.1.3 & 2.1.4 Forces' Resultant

The **Resultant** of Forces is the vectorial $\sum \mathbf{F}'s$

Parallelogram Law:



Cartesian Summation:

$$\text{If } F_1 = x_1\mathbf{i} + y_1\mathbf{j} \quad , \quad F_2 = x_2\mathbf{i} + y_2\mathbf{j} \quad , \quad F_n = x_n\mathbf{i} + y_n\mathbf{j}$$

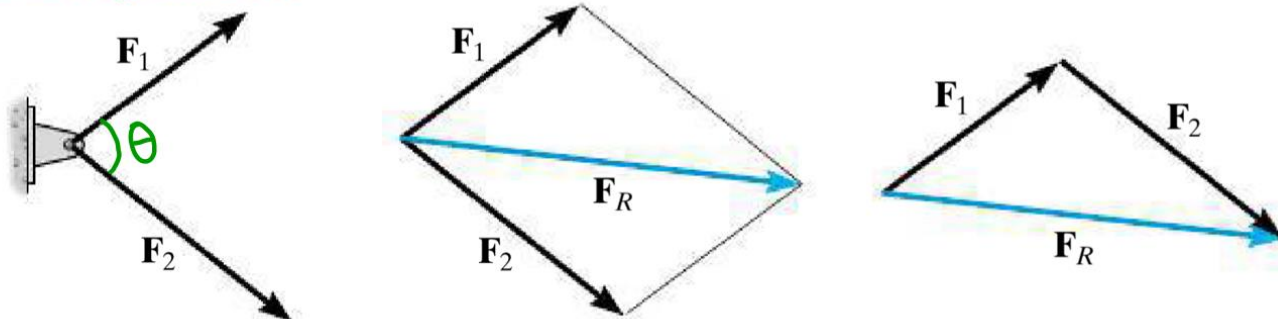
$$\therefore R = (x_1 + x_2 + \dots + x_n)\mathbf{i} + (y_1 + y_2 + \dots + y_n)\mathbf{j}$$



2.1.3 & 2.1.4 Forces' Resultant

The **Resultant** of Forces is the vectorial $\sum F'$ s

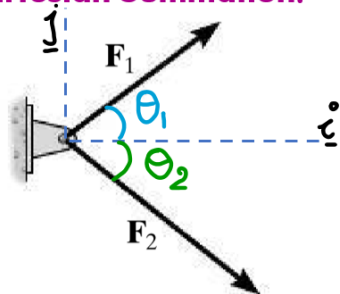
Parallelogram Law:



$$\underline{F}_R =$$

The **Resultant** of Forces is the vectorial $\sum F'$ s

Cartesian Summation:



$$\underline{F}_1 =$$

$$\underline{F}_2 =$$

$$\therefore \underline{R} =$$

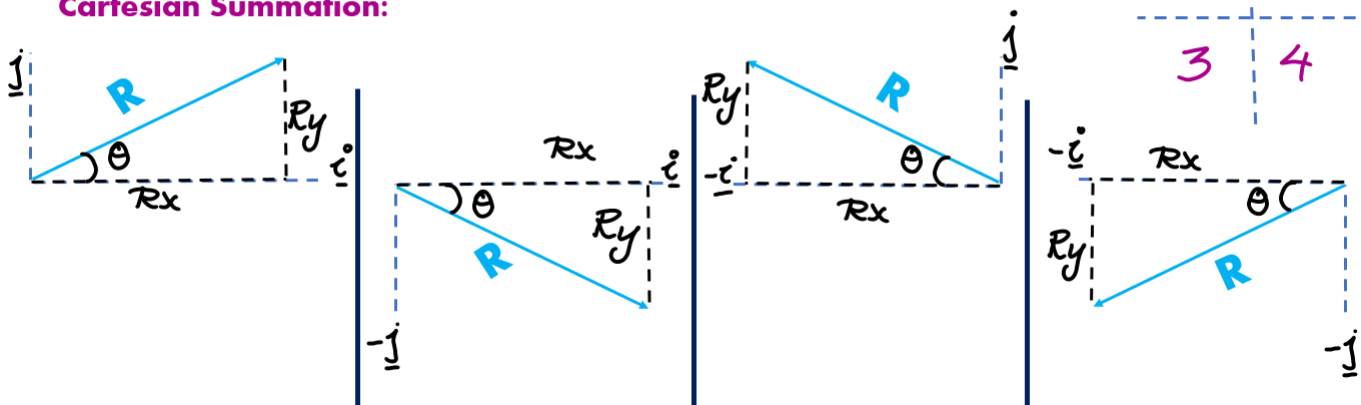
$$= (\quad) \underline{i} + (\quad) \underline{j}$$

$$= \quad \underline{i} + \quad \underline{j}$$

$$\theta =$$

The **Resultant** of Forces' direction is the angle(θ) with the x-axis:

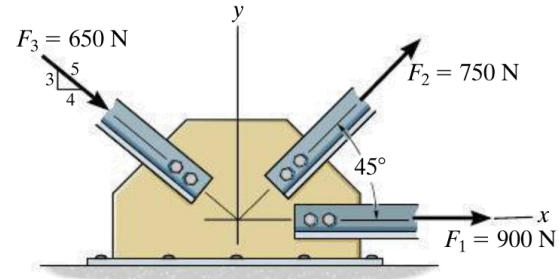
Cartesian Summation:



Problems: Type I- Get the components of a force

1.1 Cartesian Resolution

2-32. Resolve each force acting on the gusset plate into its x and y components and express each force as a Cartesian vector.

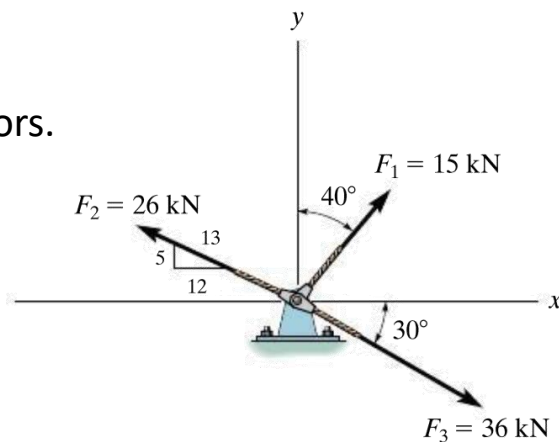


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1.1 Cartesian Resolution

2-47. Express **F1**, **F2**, and **F3** as Cartesian vectors.

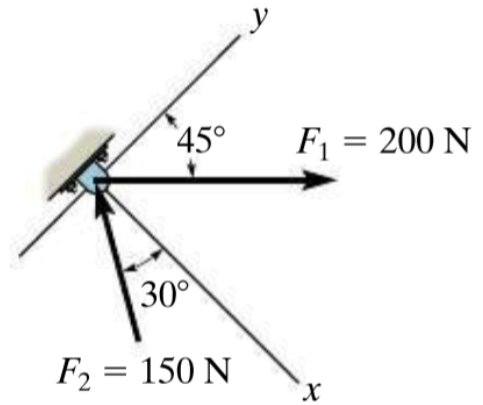


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1.1 Cartesian Resolution

2-43. Determine the x & y components of F_1 & F_2 .

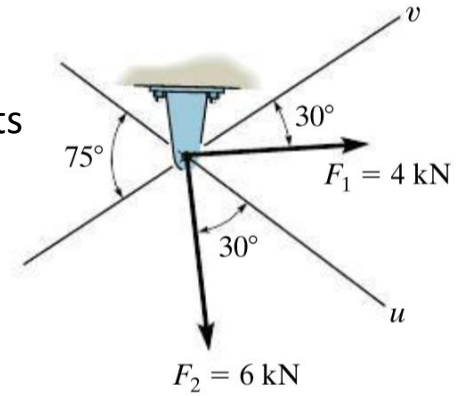


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1.2 Parallelogram & Triangle Rules

2-2, 2-3. Resolve the forces F_1 & F_2 into components acting along the u and v axes and determine the magnitudes of the components.



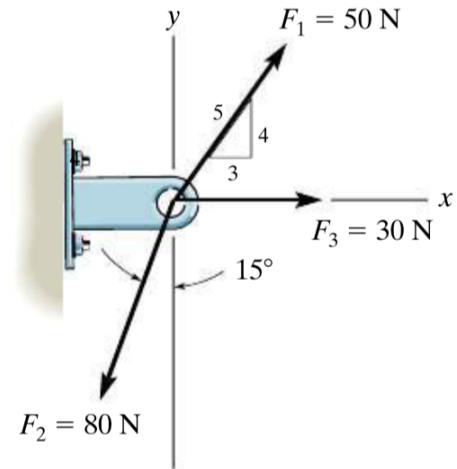
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Problems: Type **II**- Get the components of a force

2.1 Cartesian Resolution

2-45. Express each of the three forces acting on the support in Cartesian vector form and Determine the magnitude of the resultant force and its direction , measured clockwise from positive x axis.

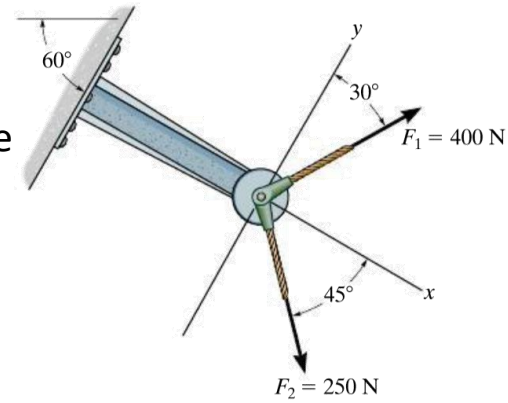


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2.1 Cartesian Resolution

2-35. Determine the magnitude of the resultant force and its direction measured counterclockwise from the positive x axis.



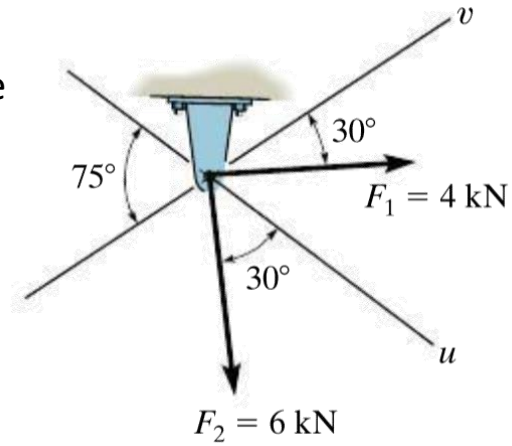
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2.2 Parallelogram & Triangle Rules

2-1. Determine the magnitude of the resultant force $F_R = F_1 + F_2$ and its direction, measured clockwise from the positive u axis.



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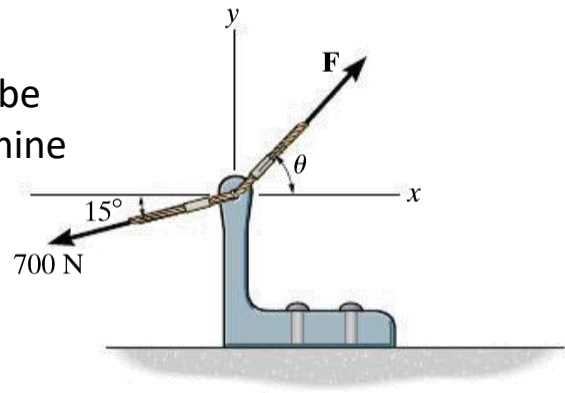




Problems: Type **III**- Get the components of a force

3.1 Cartesian Resolution

2-5. If the magnitude of the resultant force is to be 500 N, directed along the positive y-axis, determine the magnitude of force F and its direction θ .

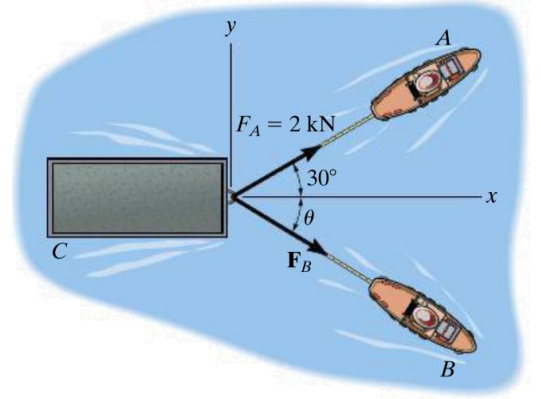


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3.1 Cartesian Resolution

2-25. If the resultant force of the two tugboats is 3 kN, directed along the positive X-axis, determine the required magnitude of force F_B and its direction θ .



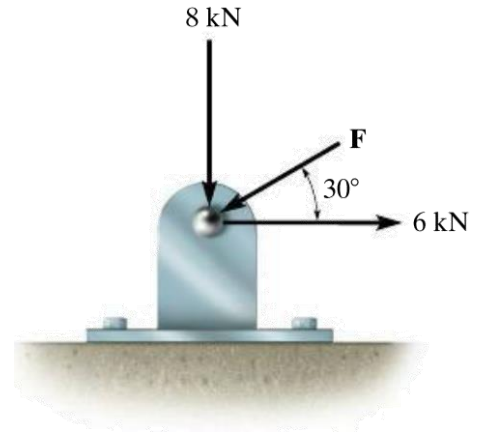
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3.1 Cartesian Resolution

2-28*. Determine the magnitude of force **F** so that the resultant **FR** of the three forces is as small as possible. What is the minimum magnitude of **FR**?



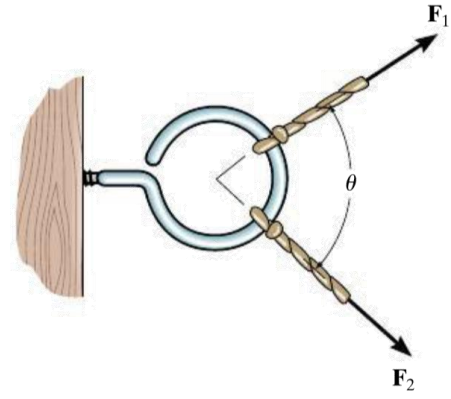
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3.2 Parallelogram & Triangle Rules

2-17. Two forces act on the screw eye. If $F_1 = 400\text{ N}$ and $F_2 = 600\text{ N}$, determine the angle θ ($0^\circ \leq \theta \leq 180^\circ$) between them, so that the resultant force has a magnitude of $F_R = 800\text{ N}$.

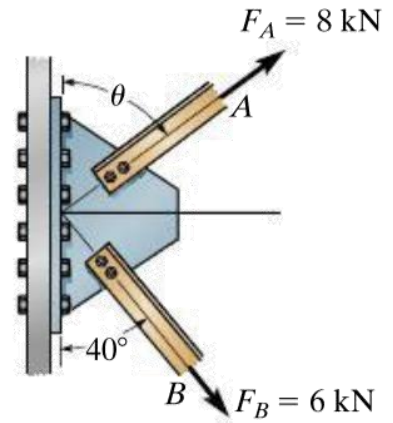


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Problems: Type **II&III**- Combination

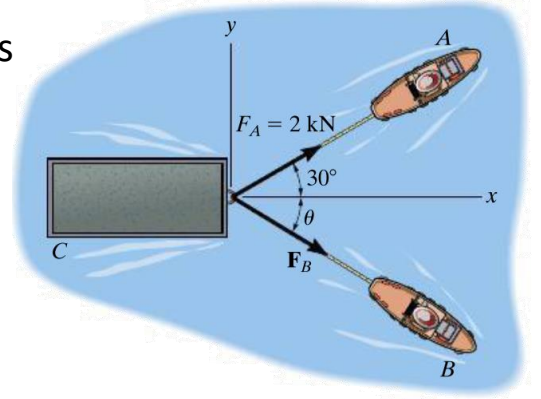
2-16. Determine the angle θ for connecting member A to the plate so that the resultant force of **FA** and **FB** is directed horizontally to the right. Also, what is the magnitude of the resultant force?



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2-27. If the resultant force of the two tugboats is required to be directed towards the positive x-axis, and \mathbf{F}_B is to be a minimum, determine the magnitude of \mathbf{F}_R and \mathbf{F}_B and the angle θ .



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