

Course Code: ESC106A
Course Title: Construction Materials and Engineering Mechanics

Lecture No. 21:
Free Body Diagram & Lami's Theorem

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Lecture Intended Learning Outcomes

At the end of this lecture, students will be able to:

- Define free body diagram
- Define and derive Lami's theorem
- Sketch the free body diagram for different structures in equilibrium



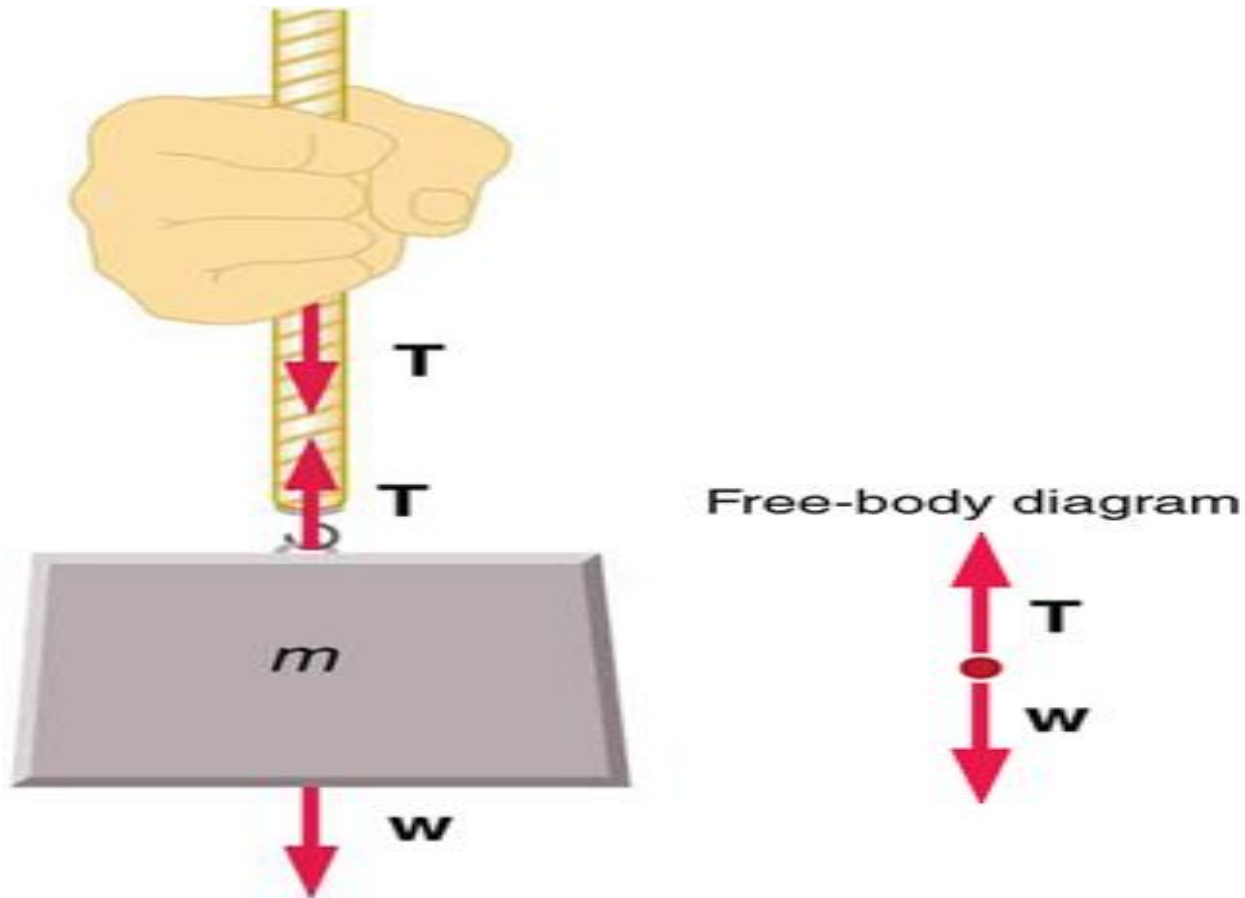
Contents

Free body diagram, Lami's theorem

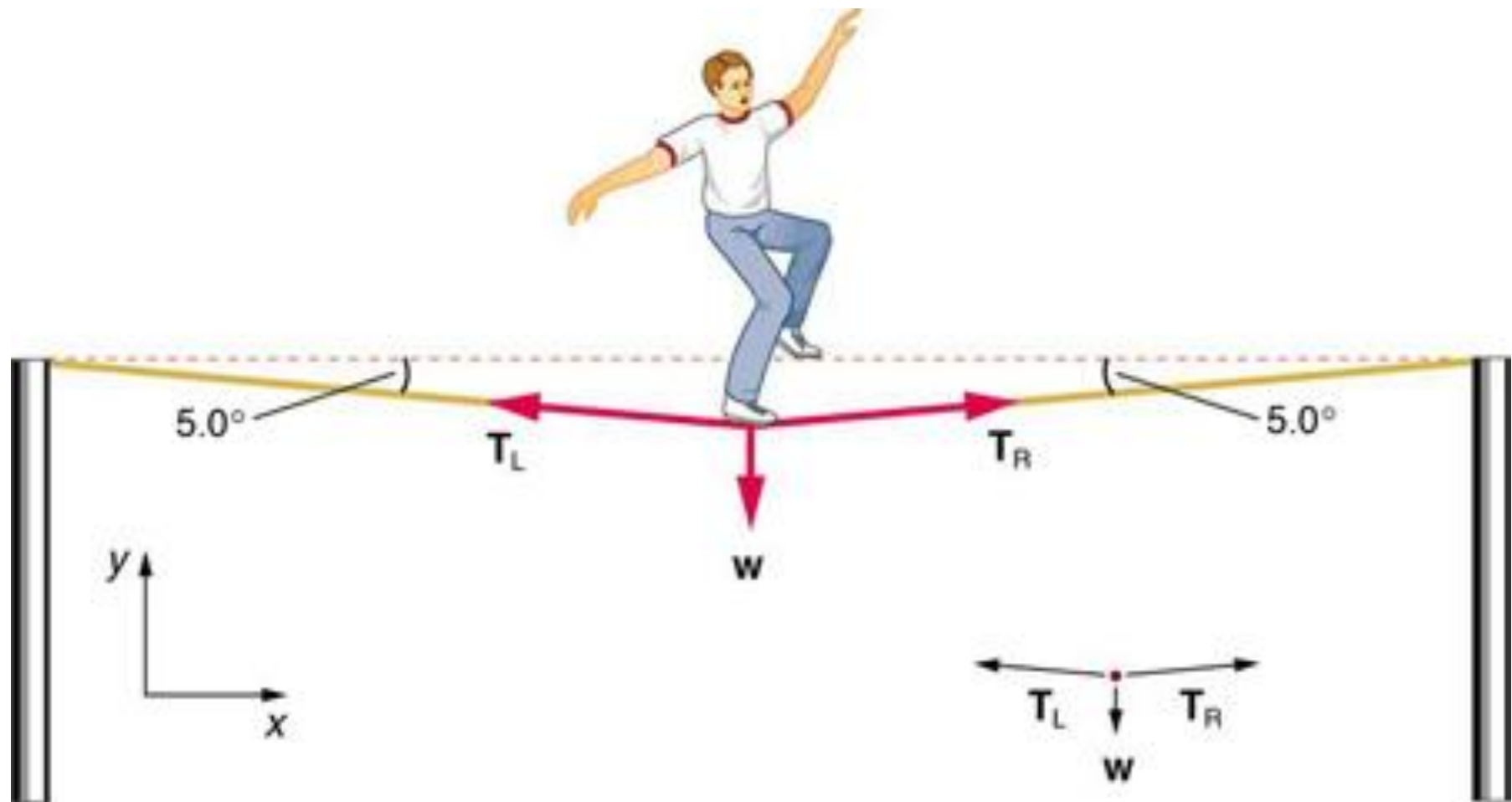


Free body diagram

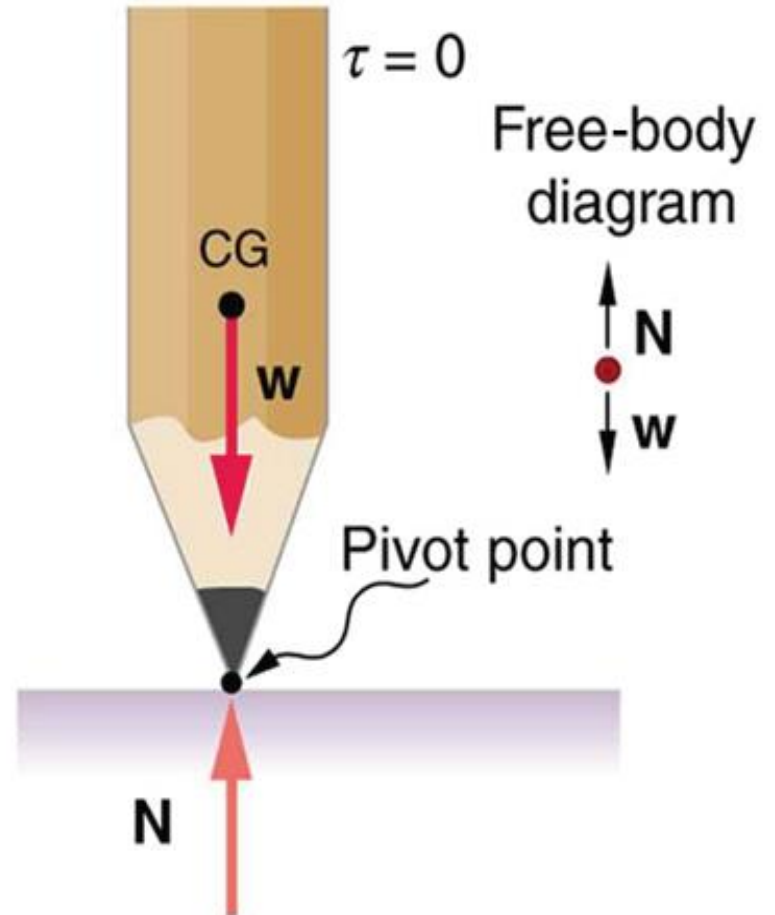
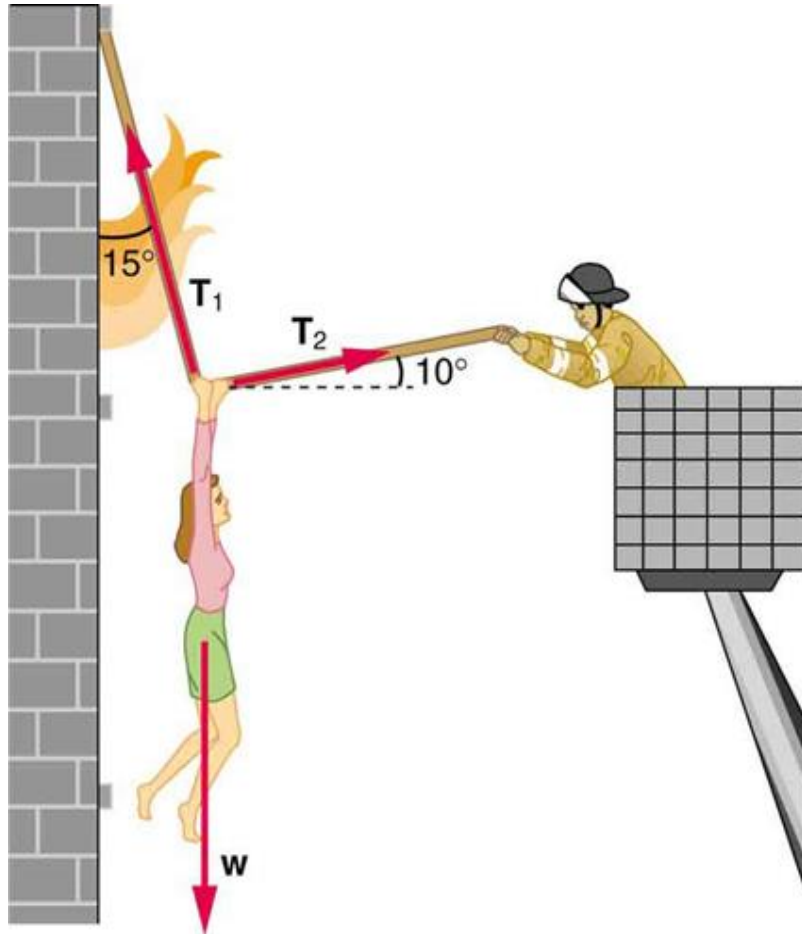
- It is a sketch or a diagram in which a body is shown with all external forces acting on it by making it free or detached or isolated from its surrounding bodies.



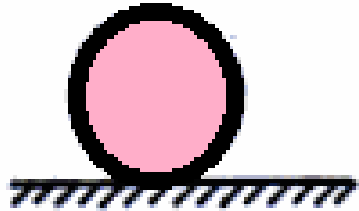
Free body diagram



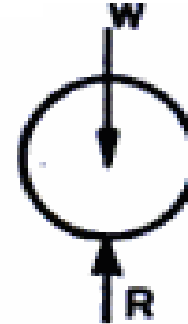
Free body diagram



Free Body Diagram for few Typical Cases



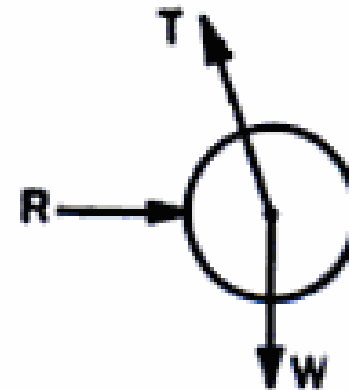
Ball



FBD

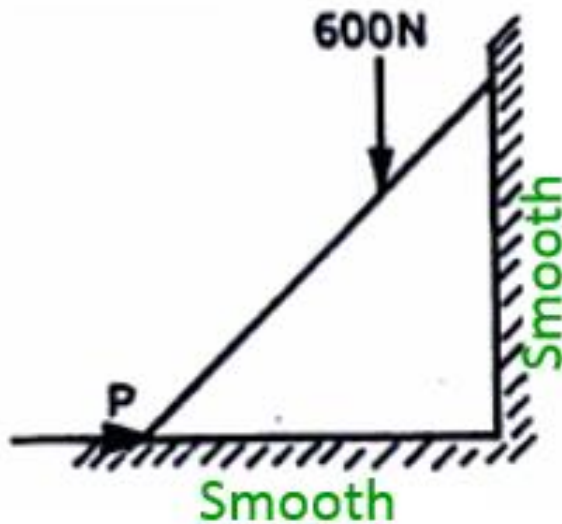


Ball

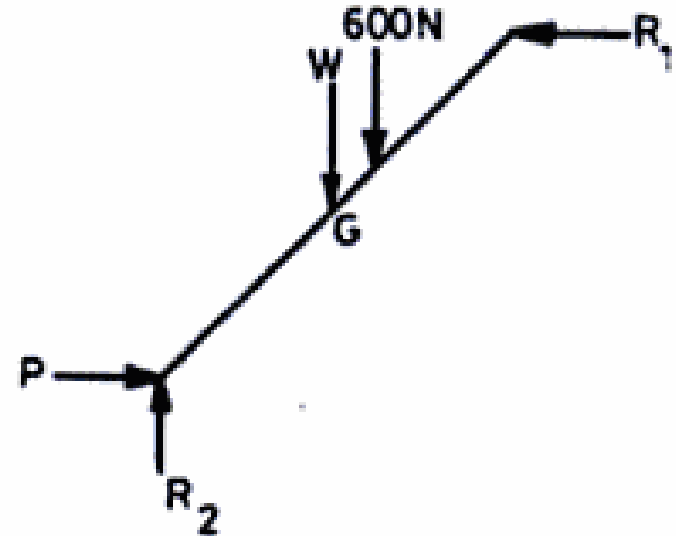


FBD

Free Body Diagram for few Typical Cases



Ladder



FBD

Lami's theorem

- “If a body is in equilibrium under the action of three forces, each force is proportional to the sine of angle between the other forces.”*

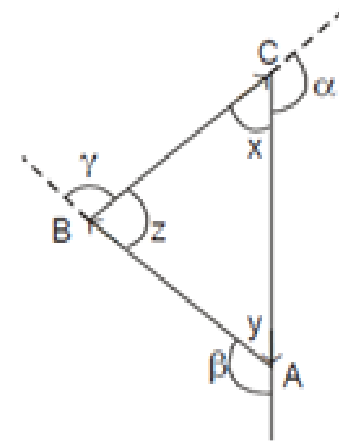
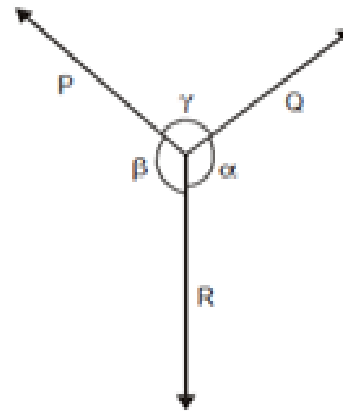
$$\frac{P}{\sin \alpha} = \frac{Q}{\sin \beta} = \frac{R}{\sin \gamma}$$

$$\frac{AB}{\sin x} = \frac{BC}{\sin y} = \frac{CA}{\sin z}$$

$$\sin x = \sin (180 - \alpha) = \sin \alpha$$

$$\sin y = \sin (180 - \beta) = \sin \beta$$

$$\sin z = \sin (180 - \gamma) = \sin \gamma$$



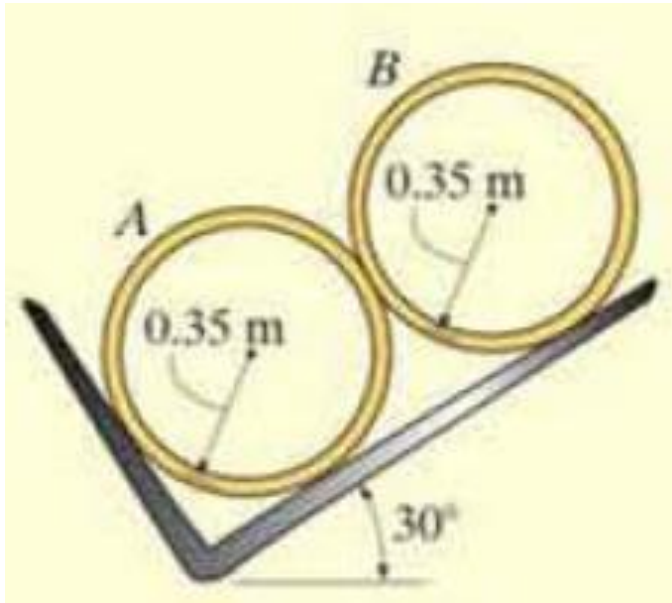
$$\frac{P}{\sin \alpha} = \frac{Q}{\sin \beta} = \frac{R}{\sin \gamma} = \text{constant}$$

Example Problem

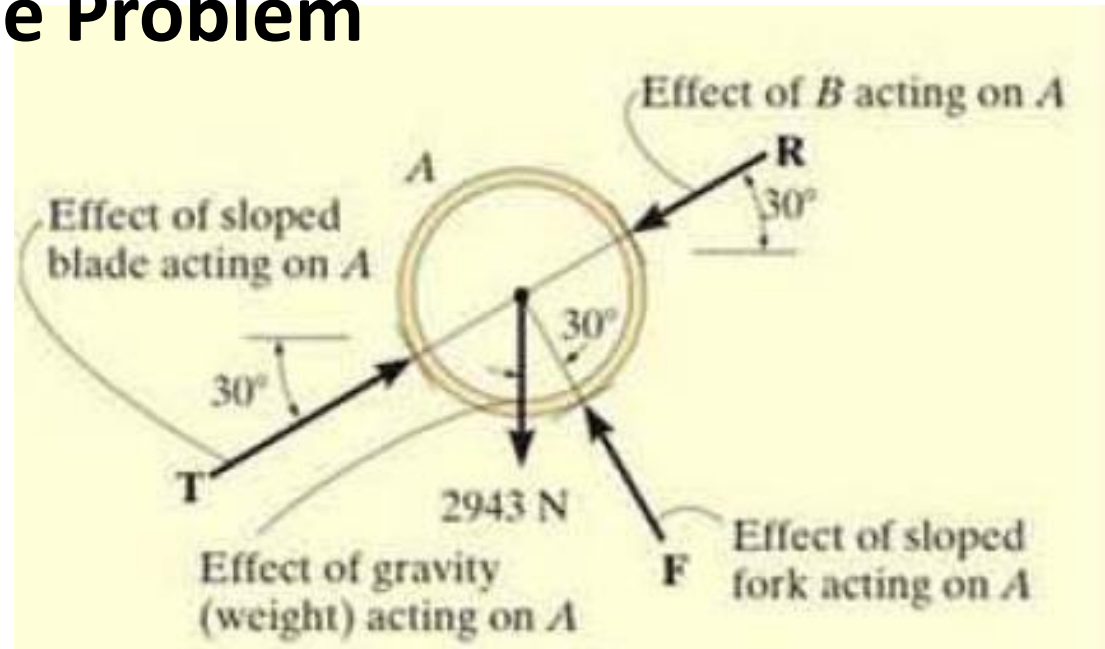
- Two smooth pipes, each having a mass of 300 kg. are supported by the forked tines of the tractor in Fig. Draw the free body diagrams for each pipe and both pipes together



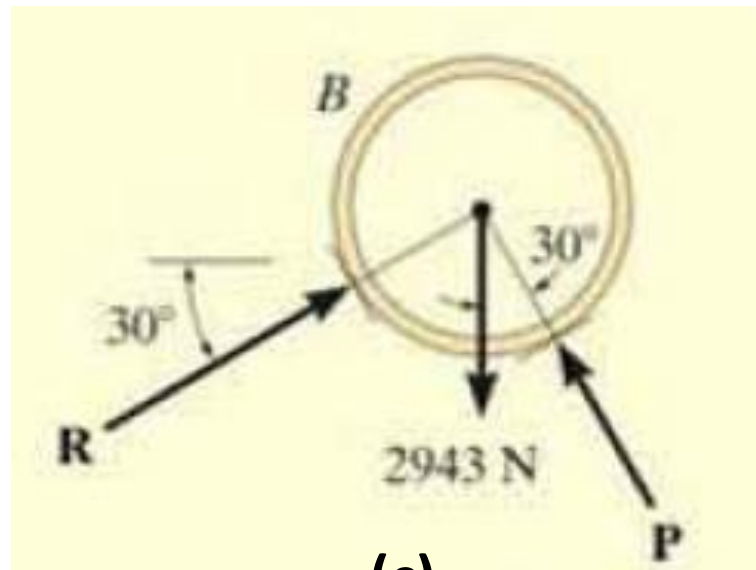
Example Problem



(a)



(b)



(c)

Summary

- Free body diagram is a sketch or a diagram in which a body is shown with all external forces acting on by making it free or detached or isolated from its surrounding bodies
- Lami's Theorem states that if a body is in equilibrium under the action of three forces, each force is proportional to the sine of angle between the other forces

