

**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



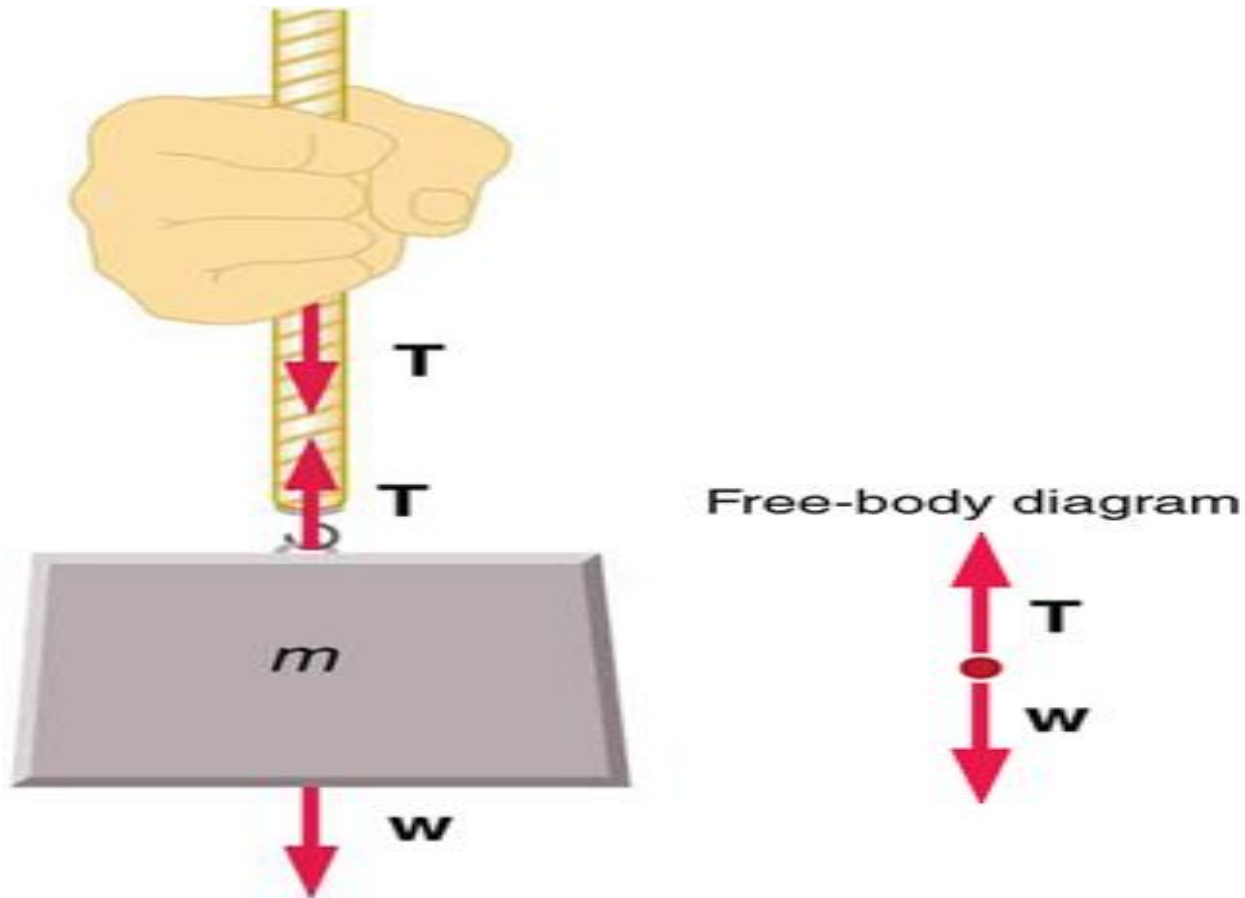
# Contents

Free body diagram, Lami's theorem

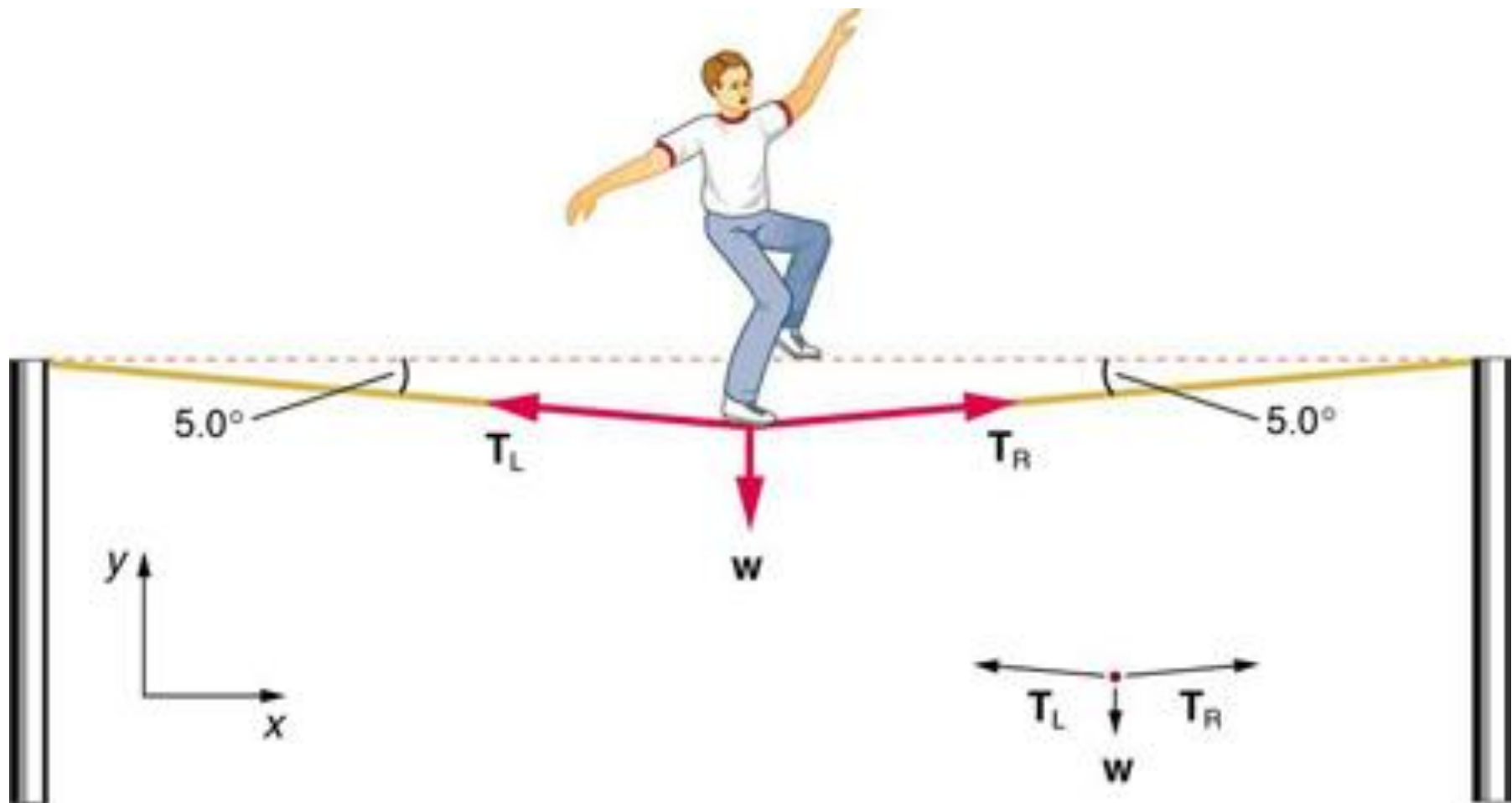


# Free body diagram

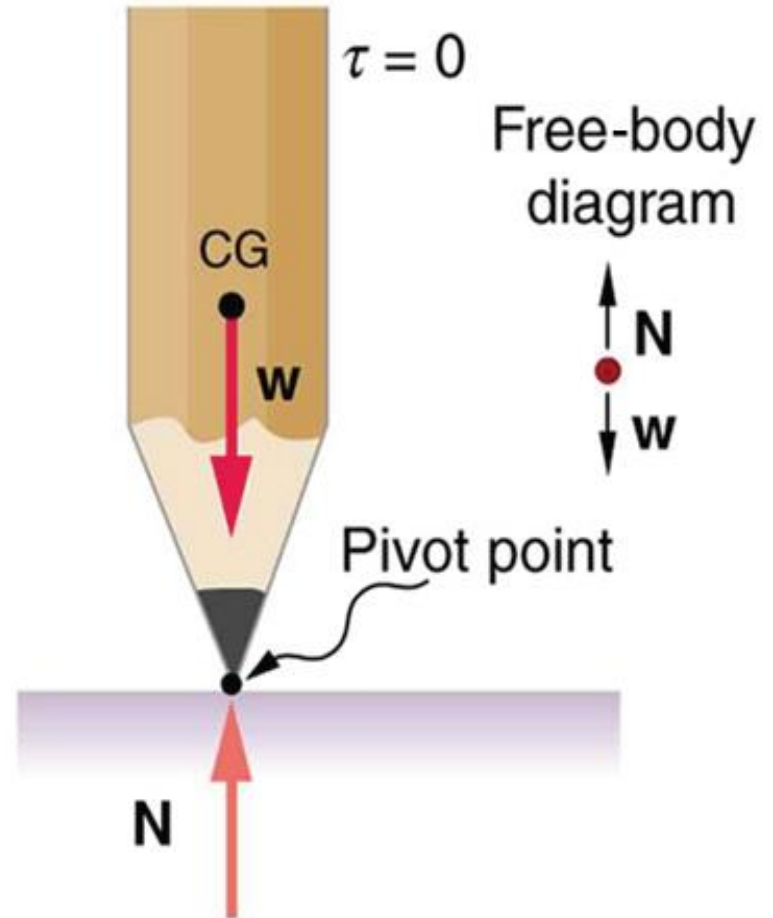
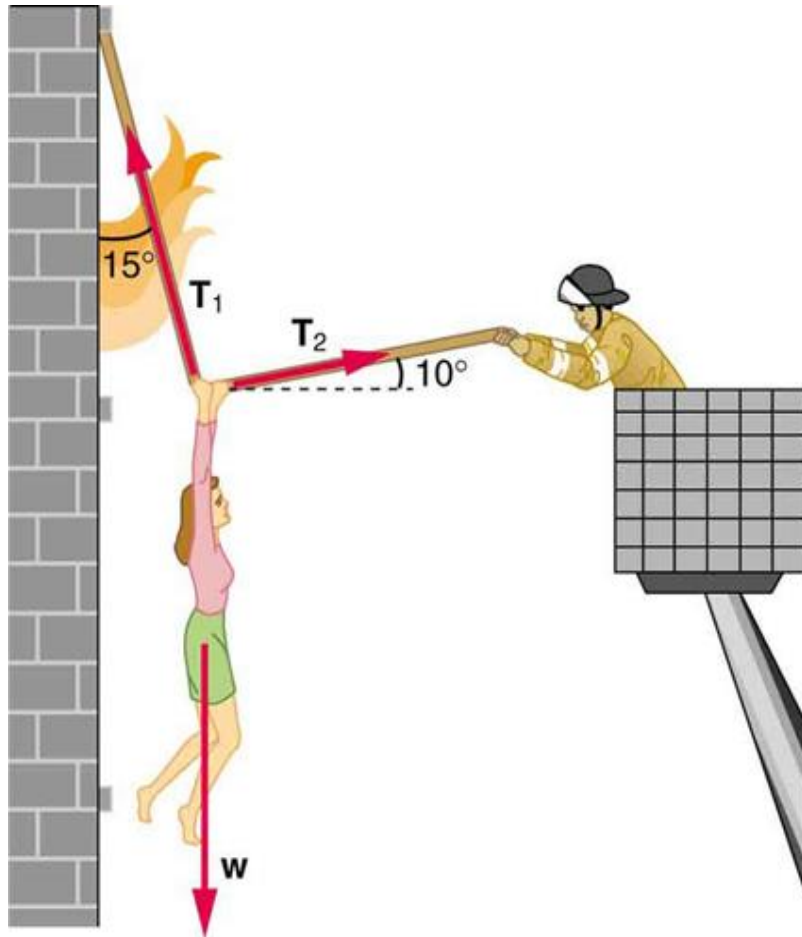
- It is a sketch or a diagram in which a body is shown with all external forces acting on it by making it free or detached or isolated from its surrounding bodies.



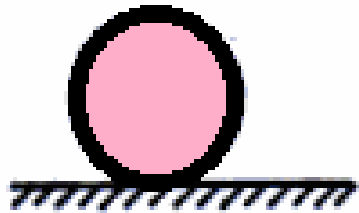
# Free body diagram



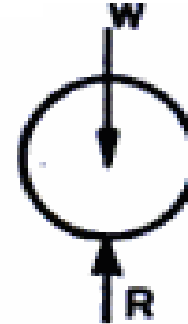
# Free body diagram



# Free Body Diagram for few Typical Cases



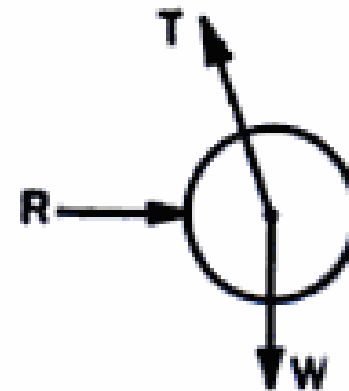
Ball



FBD

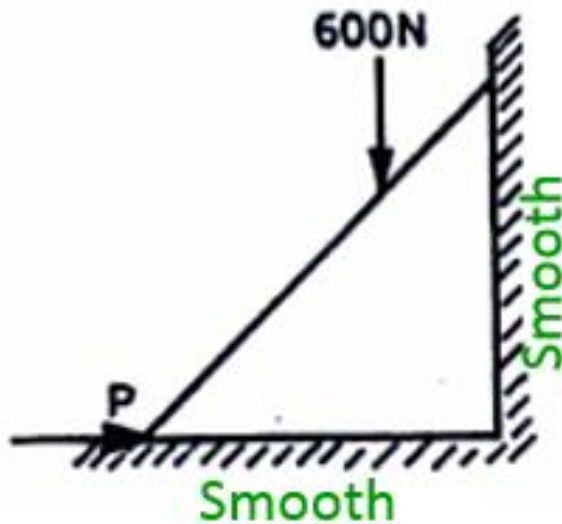


Ball

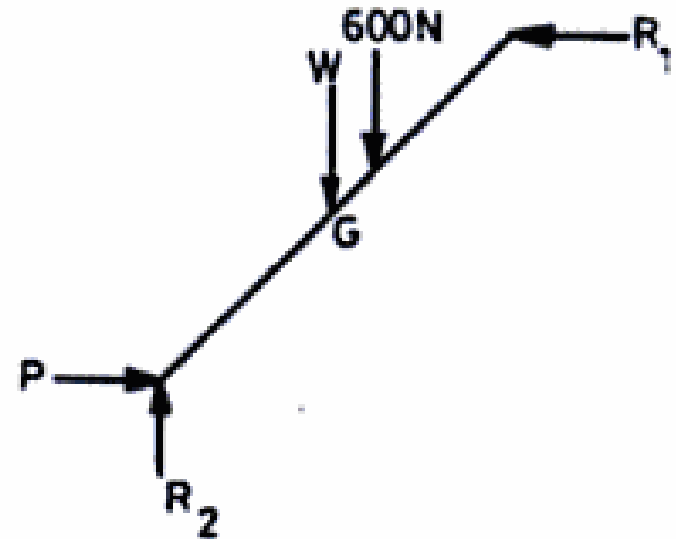


FBD

# 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.”*

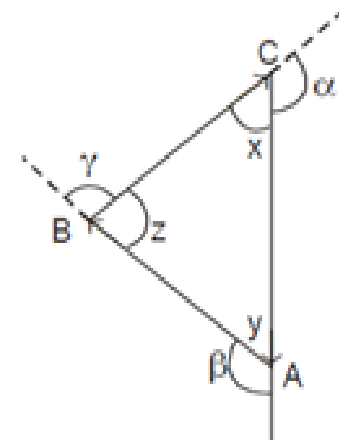
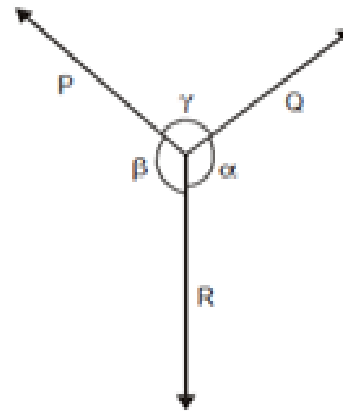
$$\frac{P}{\sin \alpha} = \frac{Q}{\sin \beta} = \frac{R}{\sin \gamma}$$

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

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

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

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



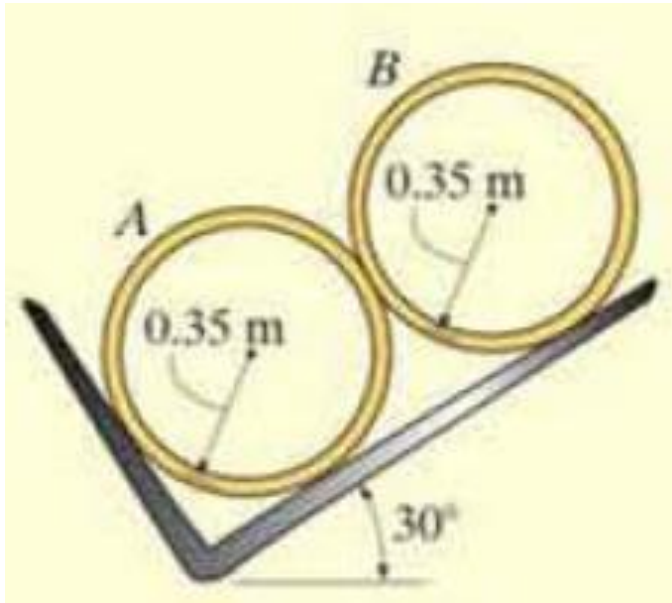
$$\frac{P}{\sin \alpha} = \frac{Q}{\sin \beta} = \frac{R}{\sin \gamma} = \text{constant}$$

# Example Problem

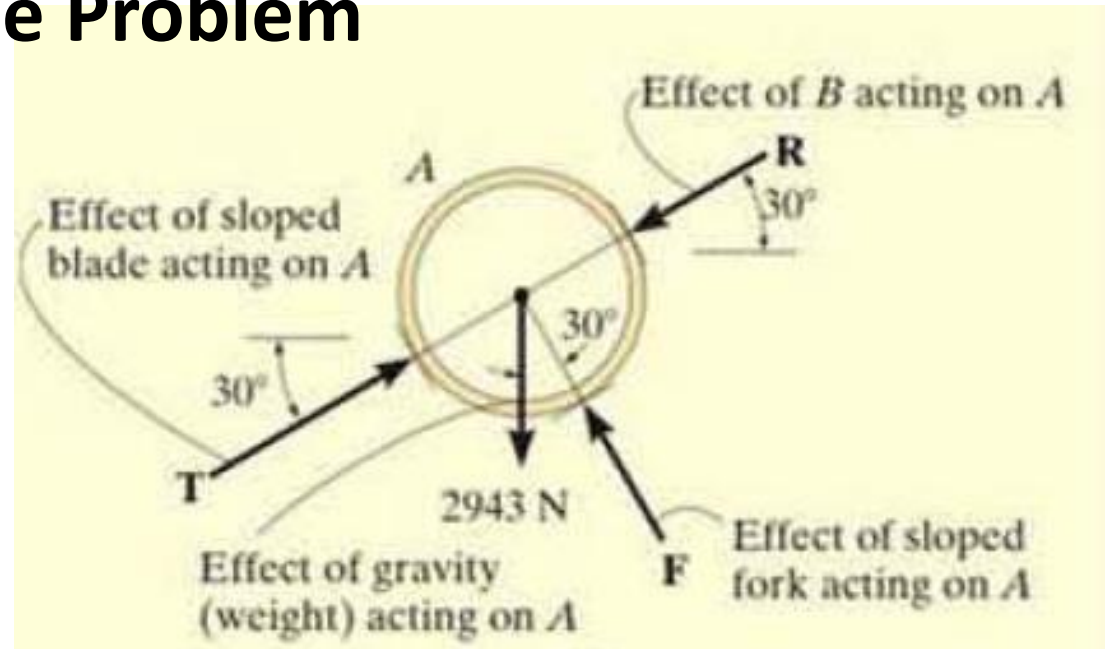
- Two smooth pipes, each having a mass of 300 kg. are supported by the forked tines of the tractor in Fig. Draw the free body diagrams for each pipe and both pipes together



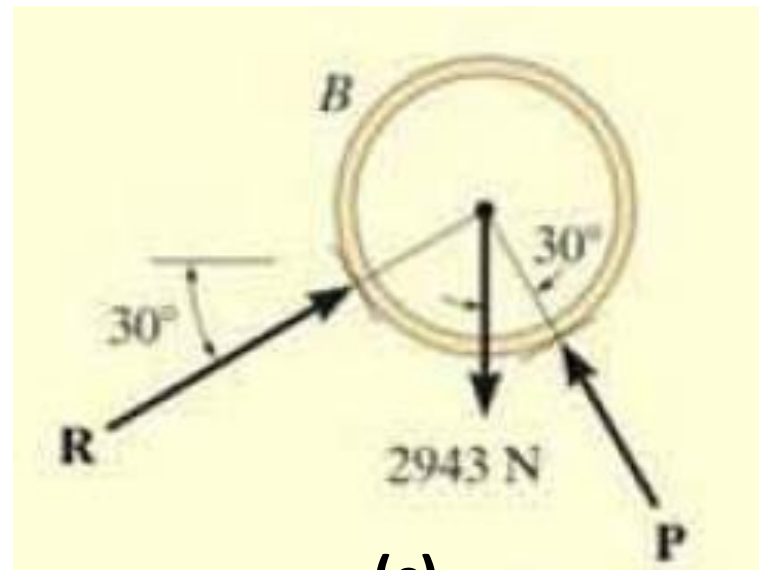
# Example Problem



(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

