Construction Free-Body Diagrams for Planar Bodies

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General procedure for the Analysis of Planar Bodies in Static Equilibrium

- Choose the free body to isolate;
- Draw a **Free Body Diagram (FBD)** of the body;
  - Isolate the body from all of its surroundings,
  - Magnitudes and directions of all known and unknown forces acting on the body should be included and clearly indicated,
  - Indicate dimensions on the FBD,
- Write the **equations of equilibrium** and solve the equations for the unknown quantities.

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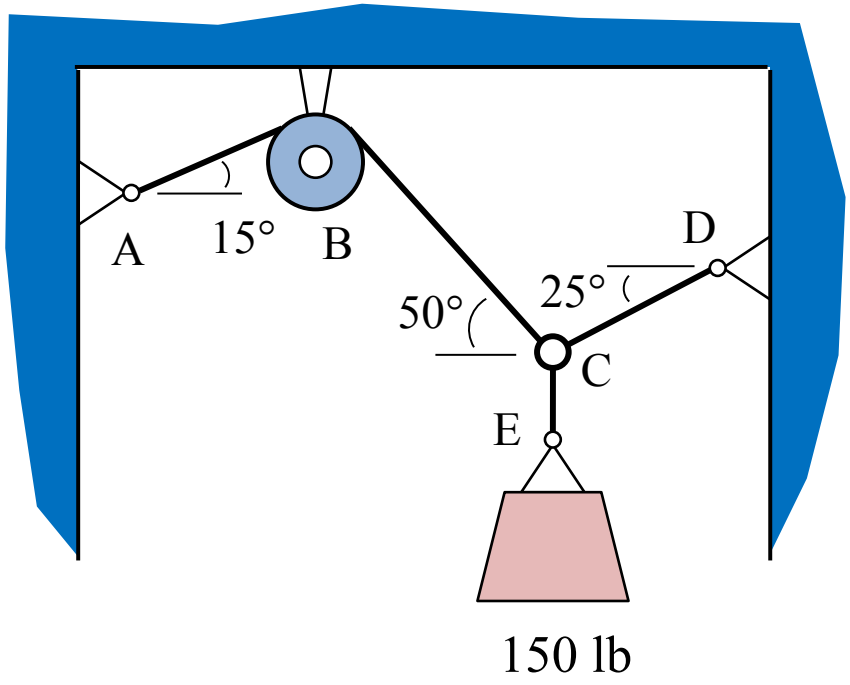
- Dimensions should be indicated on the FBD.

Most errors in mechanics problems result from a mistake in the FBD

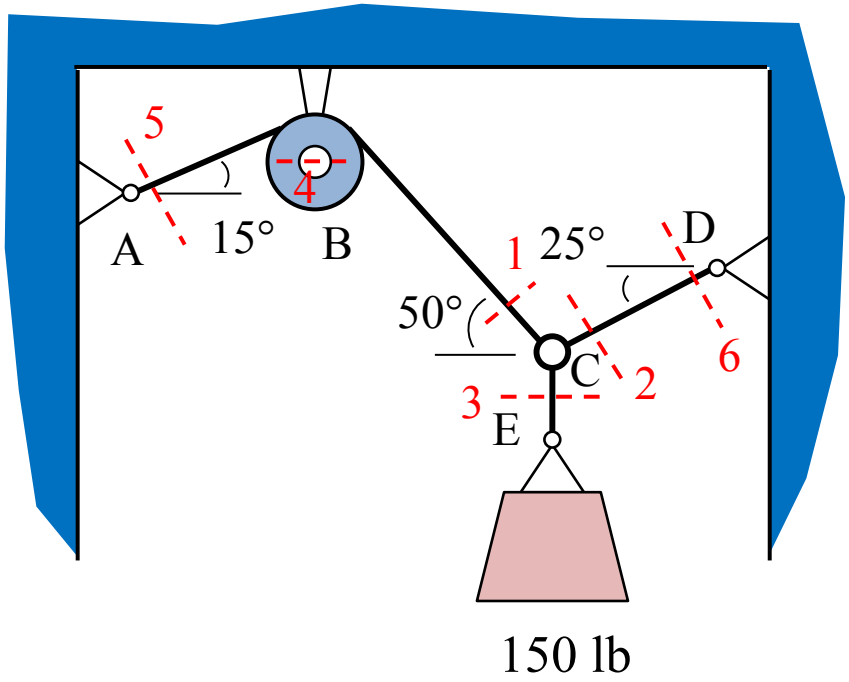
Consider the two-dimensional system



The system consists of a light, flexible, and inextensible rope connecting:

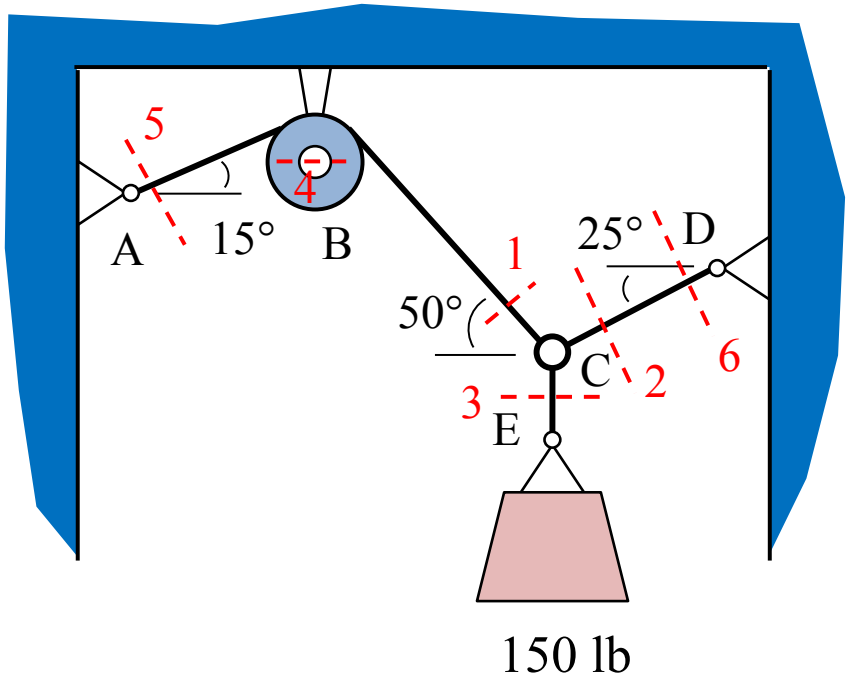
- A 150 lb weight to a ring at C;
- The ring at C to the right hand wall at D;
- The ring at C to the left hand wall at point A running over a frictionless pulley at B.

Any part of the system may be isolated and many free-body diagrams can be drawn

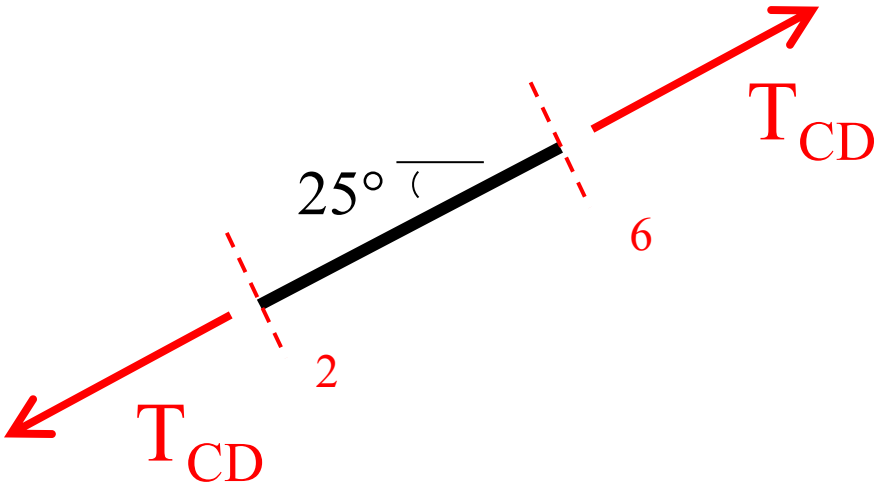


Consider imaginary cuts at sections 1 – 6

Concept of Tension



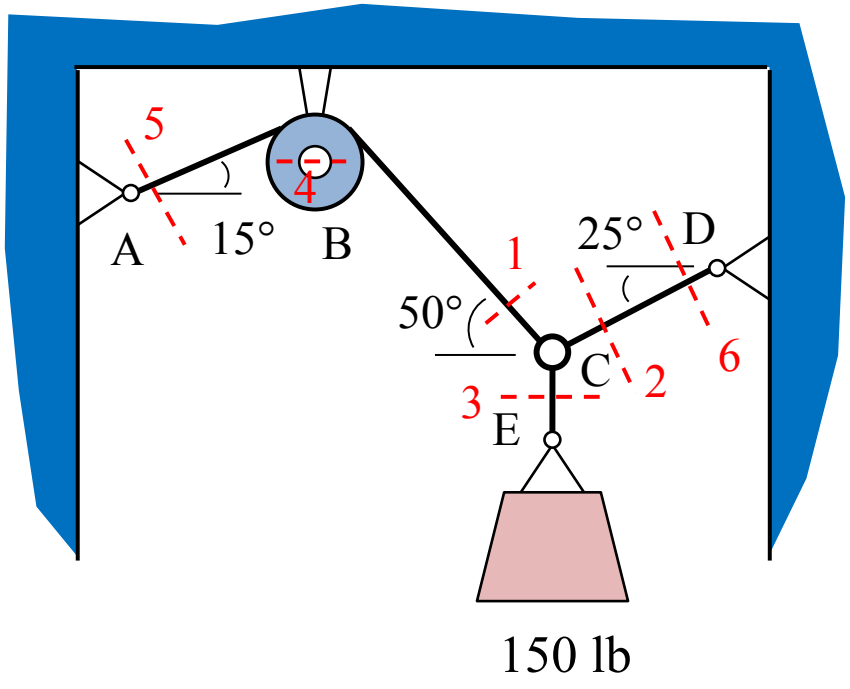
Free-Body diagram of body isolated by cuts 2 and 6



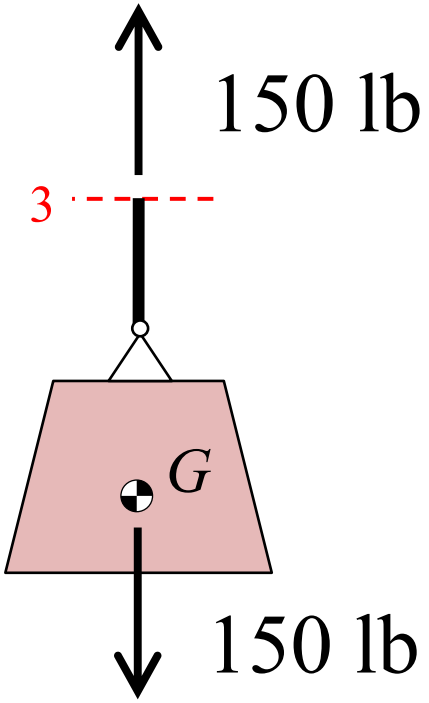
For equilibrium, the segment of rope must be pulled by forces that are equal, opposite, and along the line of the rope

The tension force in the rope (T_{CD}) is an unknown force and the direction of the force (25°) is known

Effect of the Weight of a Body



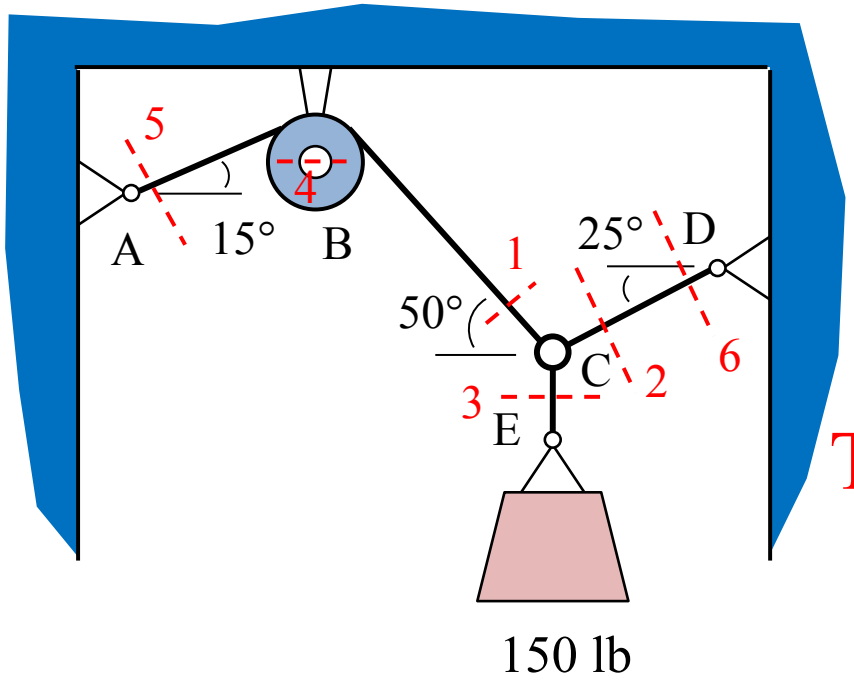
Free-Body diagram of body isolated by cut 3



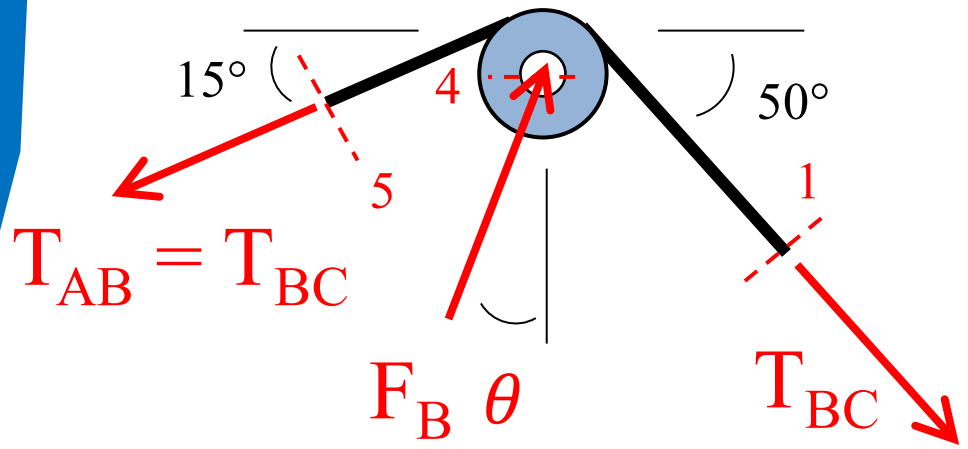
The weight of the body can be expressed as a resultant force acting at its center of gravity

Both the tension force in the rope (150 lb) and the direction of the force (vertical) are known

Tension Force in Ropes over Pulleys



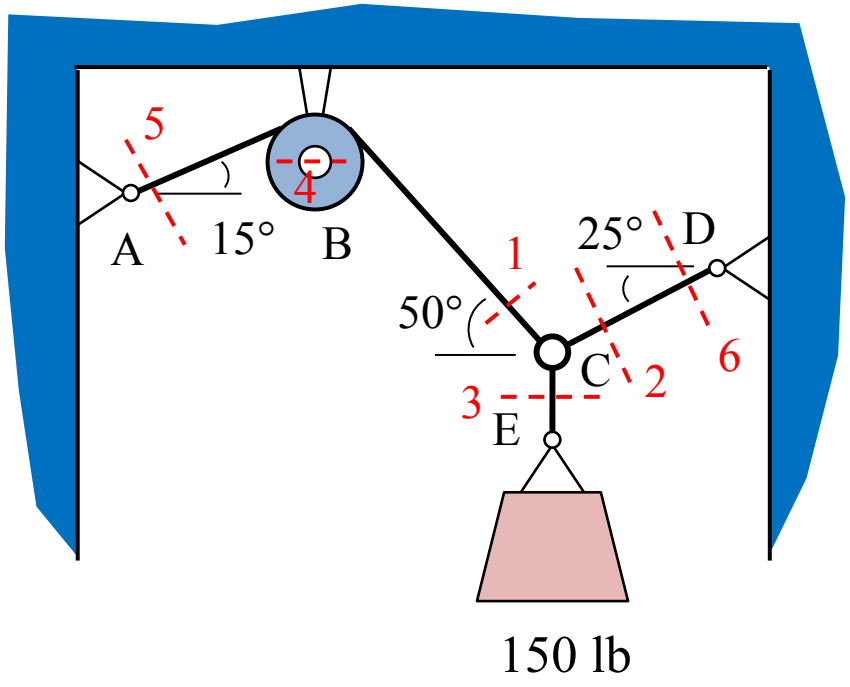
Free-Body diagram of body isolated by cuts 1, 4, and 5



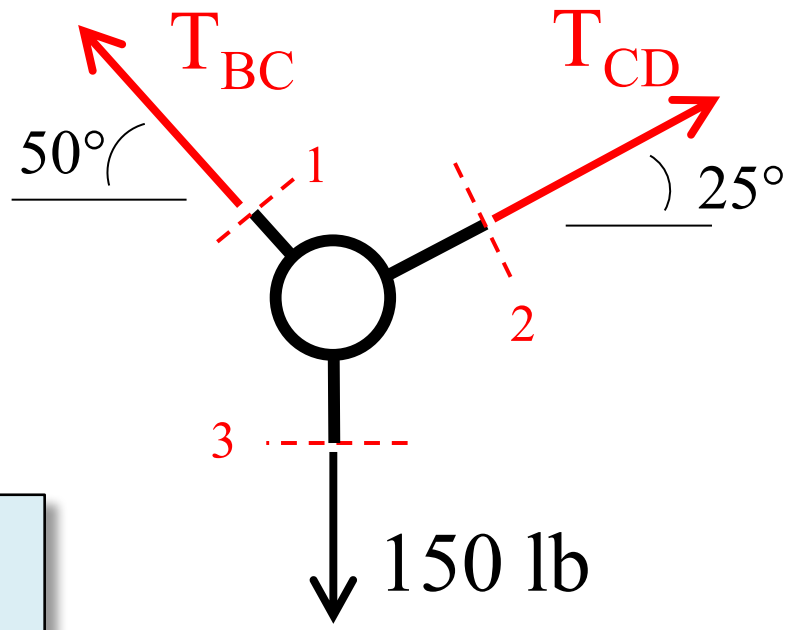
For an ideal pulley, $T_{AB} = T_{BC}$
The reactive force at the pulley axle consists of an unknown force and direction

The tension force in the rope (T_{BC}) is unknown and the magnitude (F_B) and direction (θ) of the pulley axle reaction force are unknown

Free-Body Diagram of Ring at C



Free-Body diagram of body isolated by cuts 1, 2, and 3



One rope tension (150 lb) is known. Two rope tension forces (T_{BC} and T_{CD}) are unknown. All three rope directions are known

Free Body Diagram Notes