# Engineering Mechanics : Statics

## Chapter 6: Structural analysis

# Chapter outline

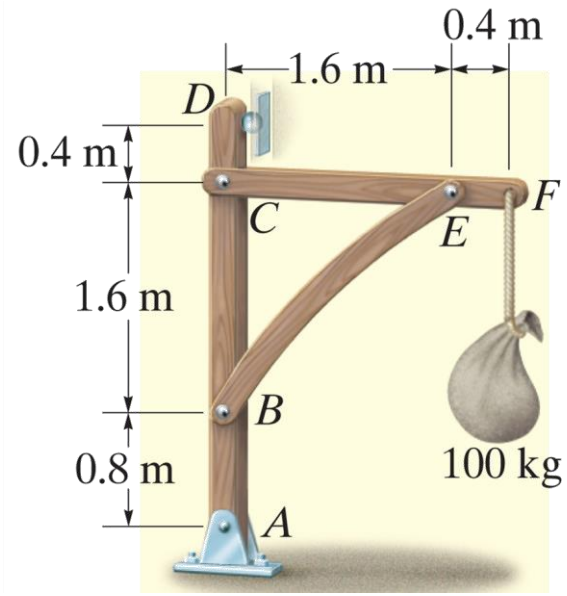
- Simple Trusses
- The Method of Joints
- The Method of Sections
- Exercise Problems
- Frames and Machines

# Analysis of Structures

- Trusses
  - Designed to support loads
  - Consist entirely of two-force members
- Frames
  - Designed to support loads
  - Include one or more multi-force members
- Machines
  - Designed to transmit and/or modify forces
  - Include one or more multi-force members

# Frames and machines

- Frames and machines are two common types of structures that have at least one multi-force member. (Recall that trusses have nothing but two-force members).

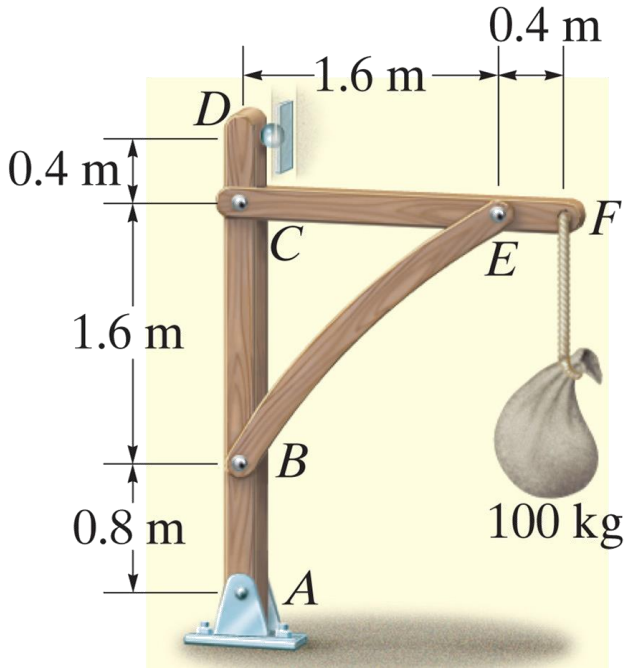



Frames are generally stationary and are used to support loads.

Machines contain moving parts and are designed to transmit and alter the effect of forces.

# Frames and machines

## APPLICATIONS




Frames are commonly used to support various external loads.

How is a frame different than a truss?

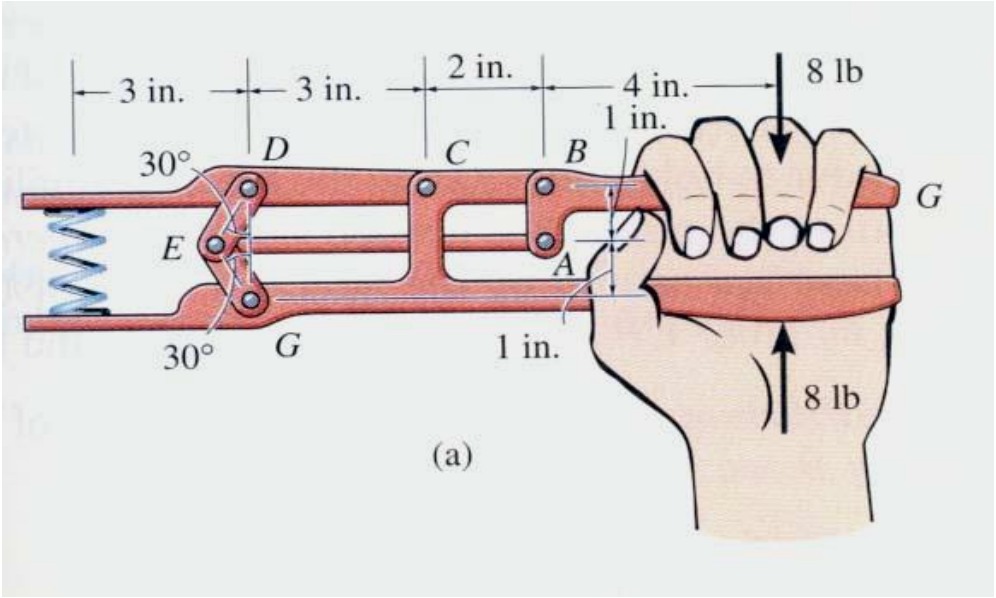
Forces are not necessarily applied at the joints, hence some members might not be two-force members (recall that trusses contain only two-force members)

How can you determine the forces at the joints and supports of a frame?

By method of joints.

# Frames and machines

## APPLICATIONS (continued)

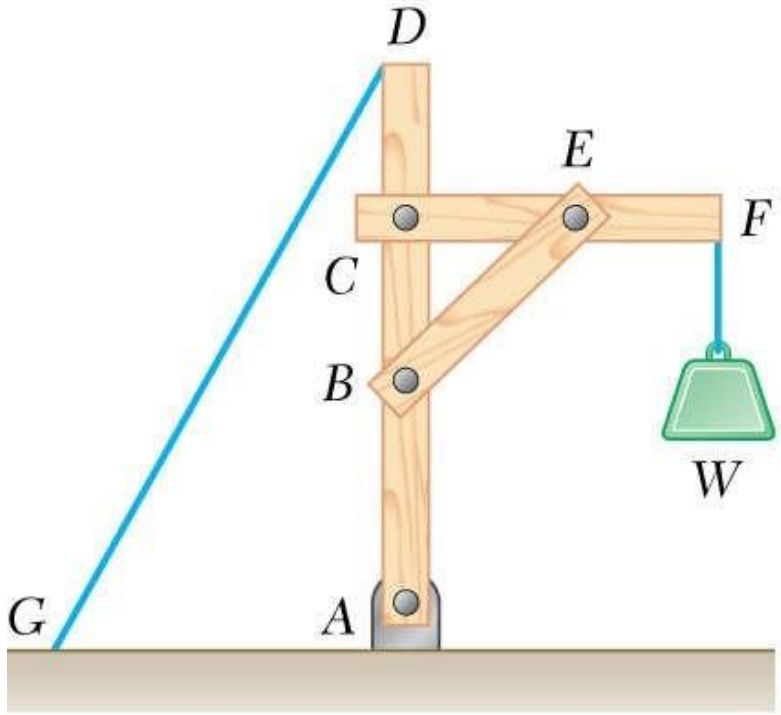



Machines, like these above, are used in a variety of applications. How are they different from trusses and frames?

How can you determine the loads at the joints and supports? These forces and moments are required when designing the machine members.

# FRAMES

- Contain at least one multi-force member
- Objective: Find some or all forces acting on members and/or find support reactions

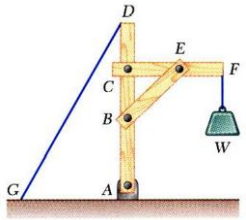



(a)

# FRAMES

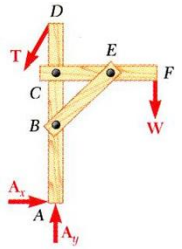
Frames

**Frames** are structures with at least one **multi-force** member,
i.e. atleast one member that has **3 or more** forces acting on it at different points.

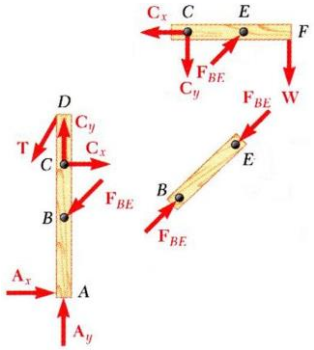



Frame analysis involves determining:

(i) External Reactions

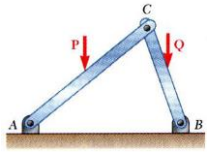


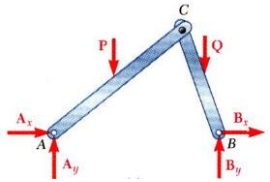

(ii) Internal forces at the joints

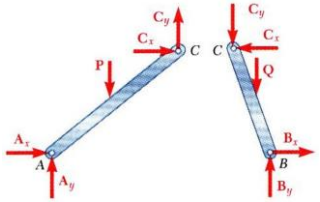



Note:

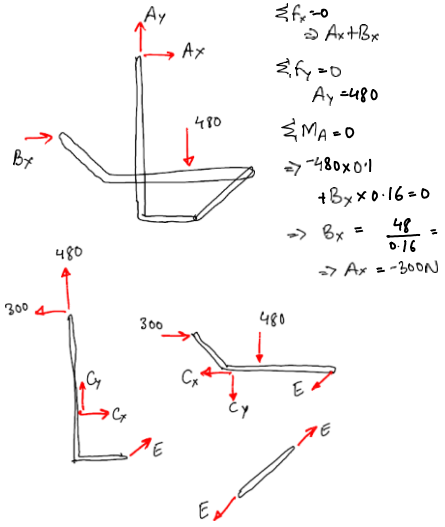
- Follow Newton's 3rd Law

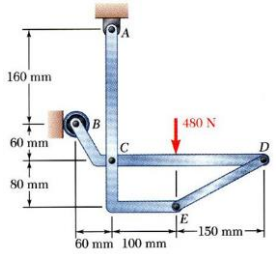


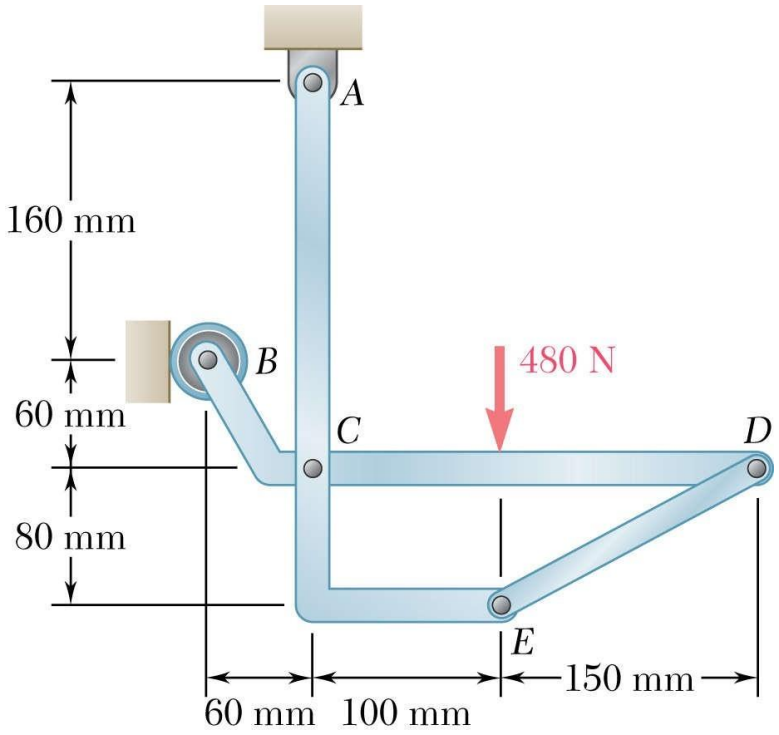
# FRAMES

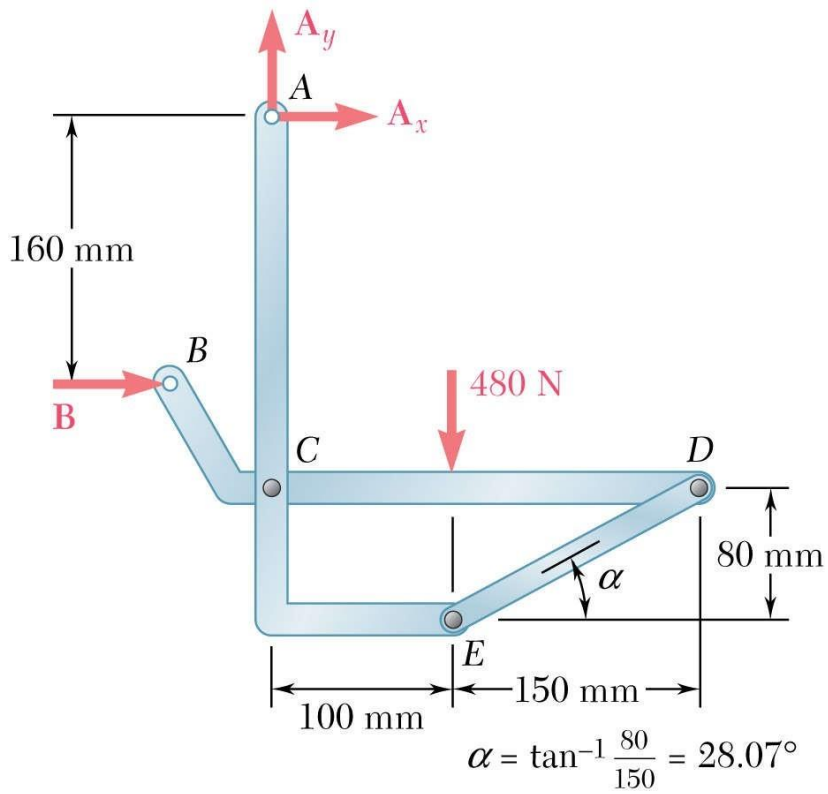

$A_y$
$A_x$
480
$B_x$
$\sum f_x = 0$
$\Rightarrow A_x + B_x$
$\sum f_y = 0$
$A_y = 480$
$\sum M_A = 0$
$\Rightarrow -480 \times 0.1$
$+ B_x \times 0.16 = 0$
$\Rightarrow B_x = \frac{48}{0.16} =$
$\Rightarrow A_x = -300N$
480
300
$C_y$
$C_x$
E
300
480
$C_x$
$C_y$
E
E
E


A
160 mm
B
480 N
60 mm
C
D
80 mm
E
150 mm
60 mm
100 mm

# Frames: Method of analysis

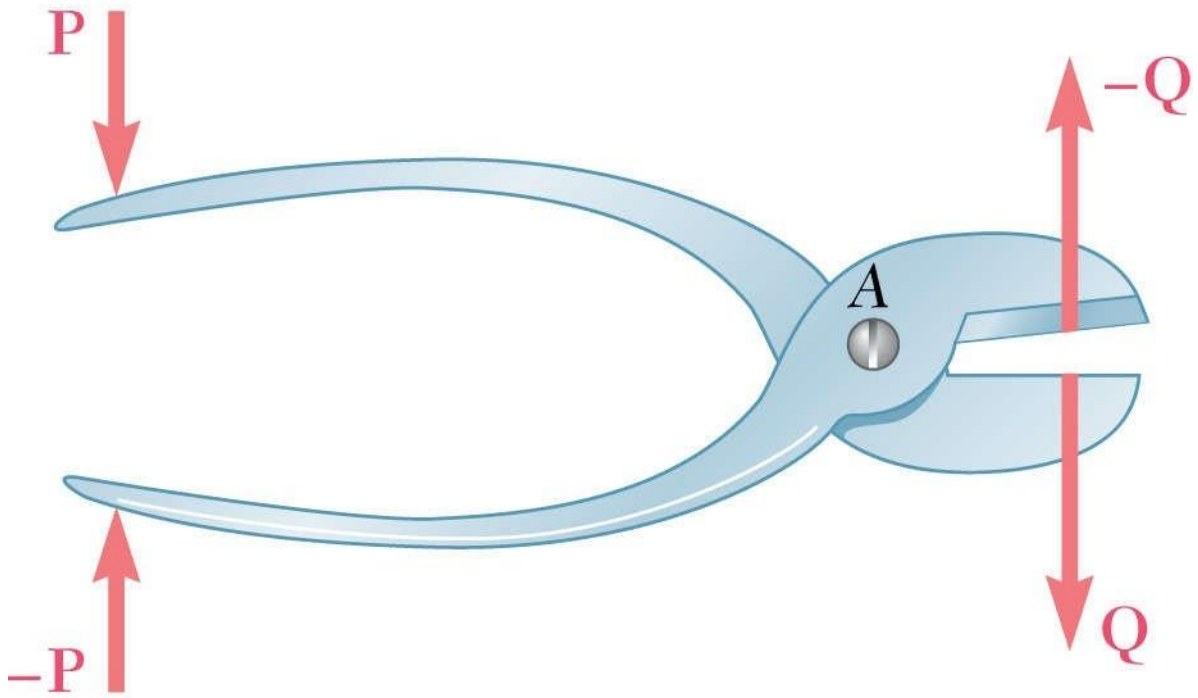
- Draw a FBD of the entire frame, showing applied loads and support reactions



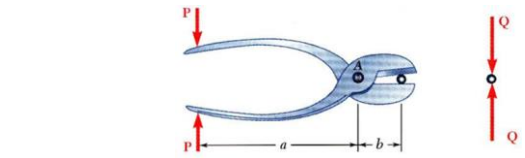
## MACHINES

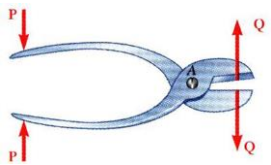
- Transmits or modifies forces
- Contain one or more multi-force members

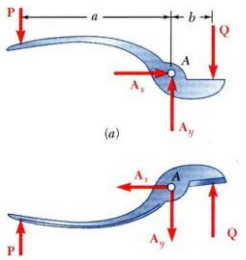


# MACHINES

- Machines are structures designed to transmit and modify forces. Their main purpose is to transform *input forces* into *output forces*.
- Machines are usually non-rigid internally. So we use the components of the machine as a free-body.
- Given the magnitude of ***P***, determine the magnitude of ***Q***.

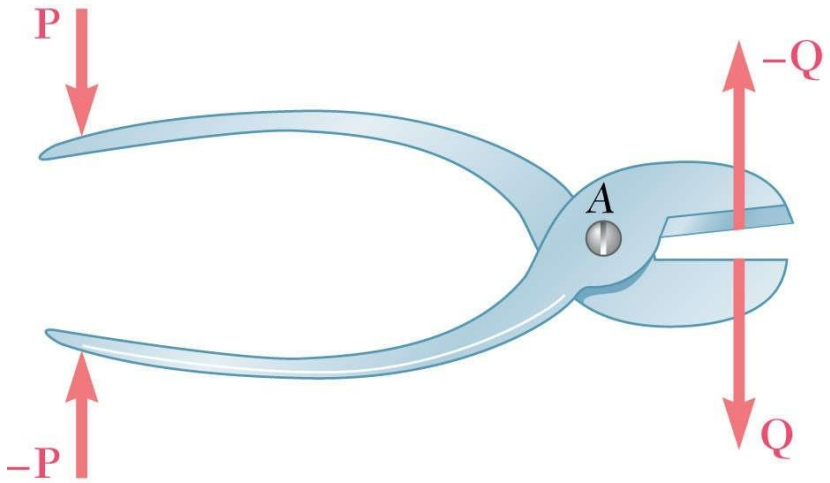


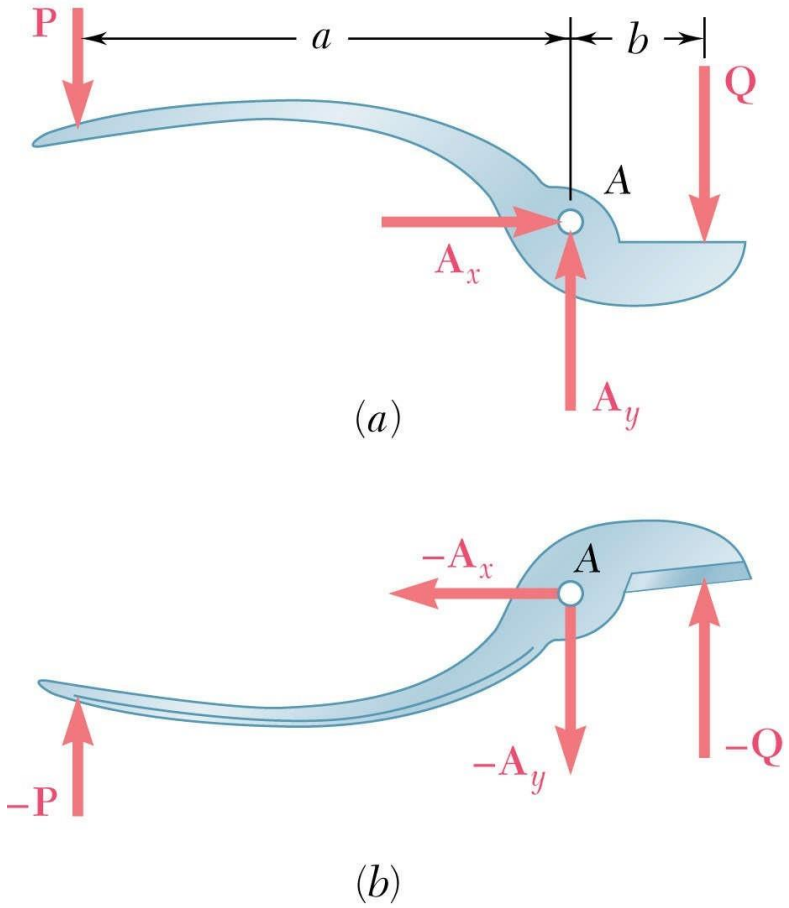



## MACHINES

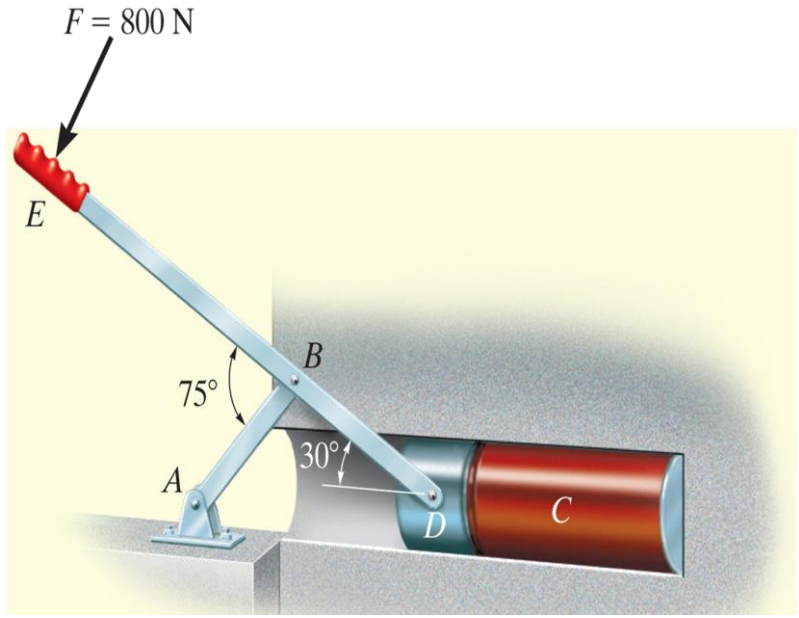
- Similar to method for frames



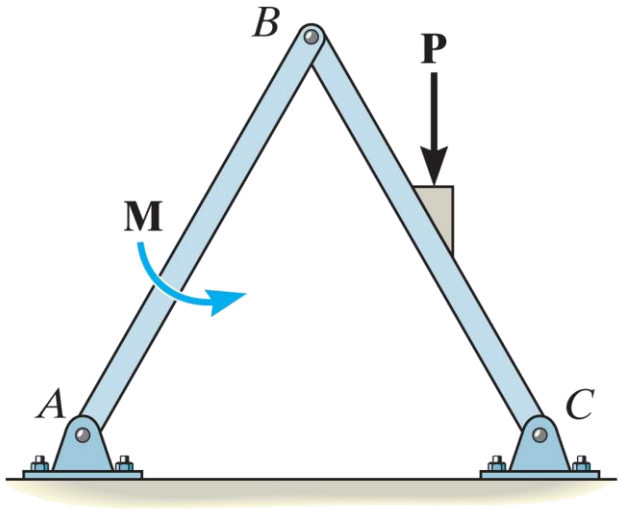



## TASKS

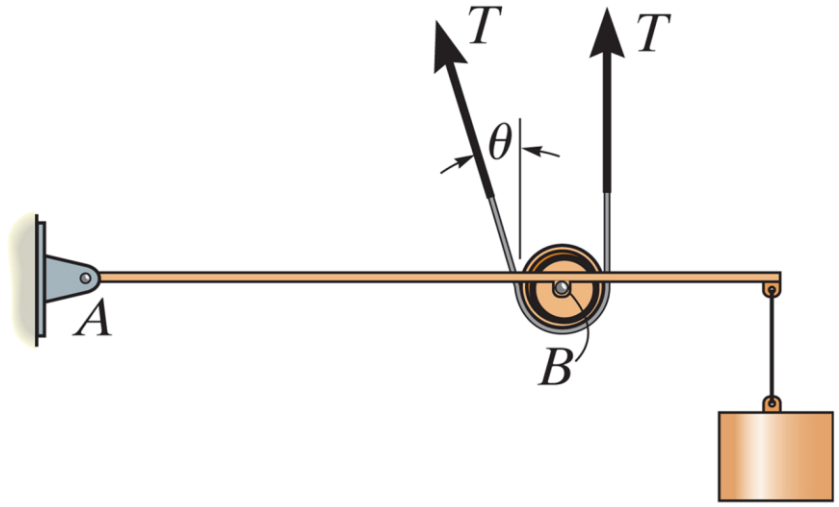
Plot the FBDs of all members of the following system:




(a)

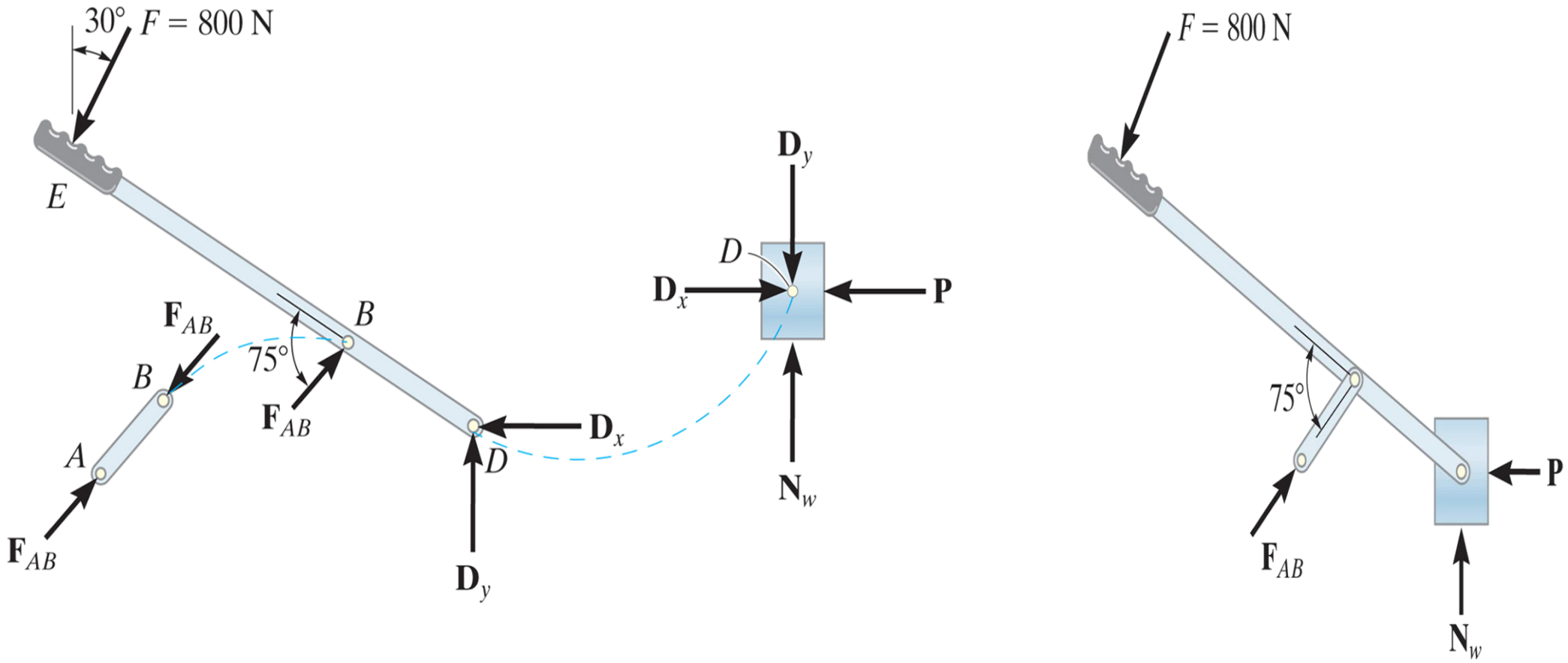



(b)

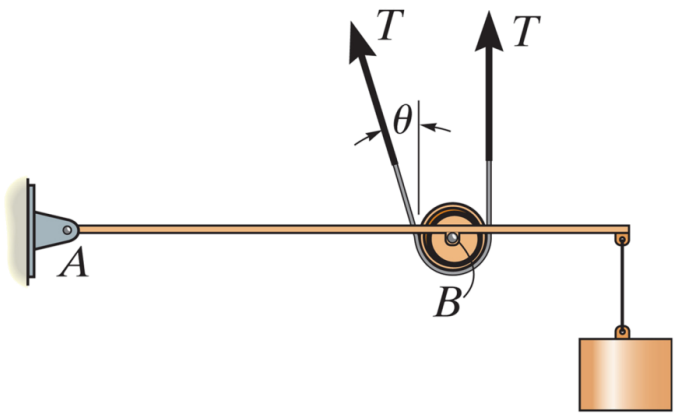



(c)

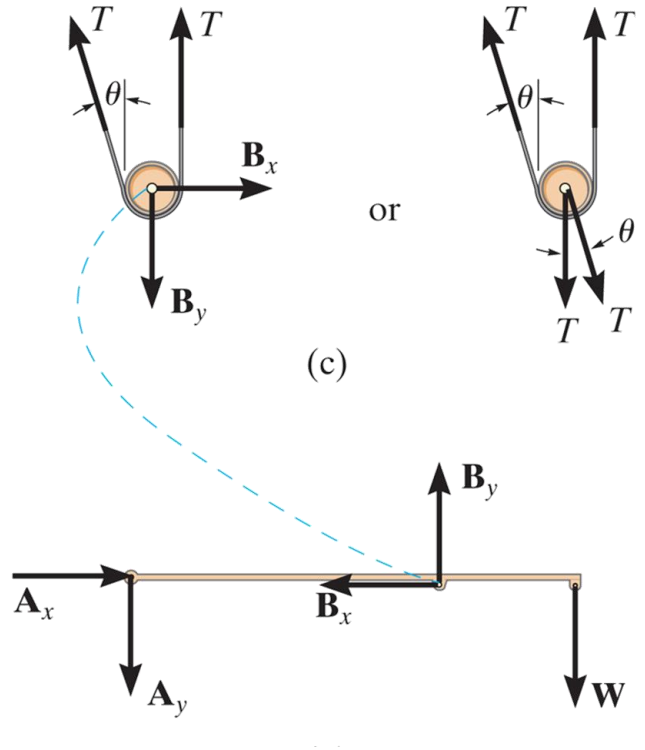
# TASKS



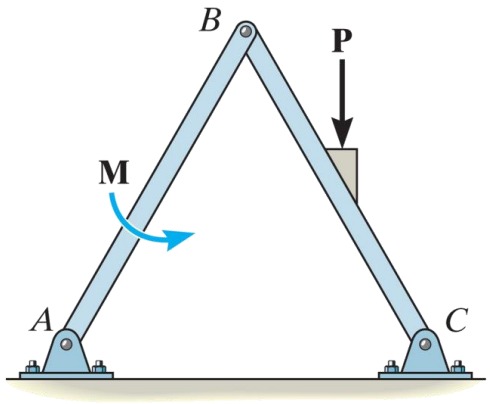
# TASKS



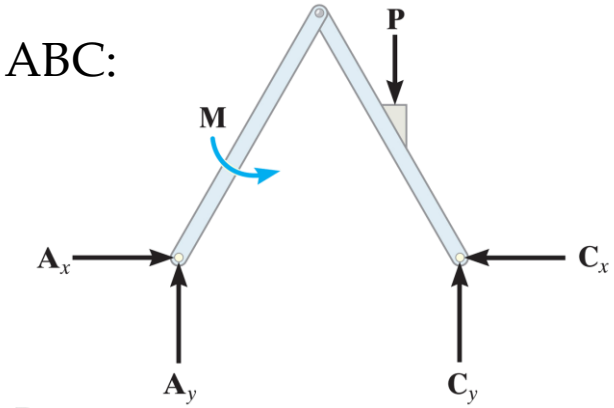

FBD of member AB as well as the pulley:



# TASKS




FBD of ABC:




FBD of member AB and BC: