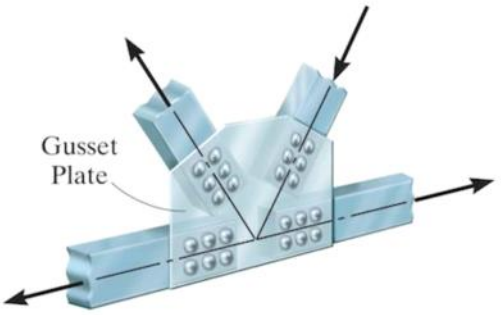
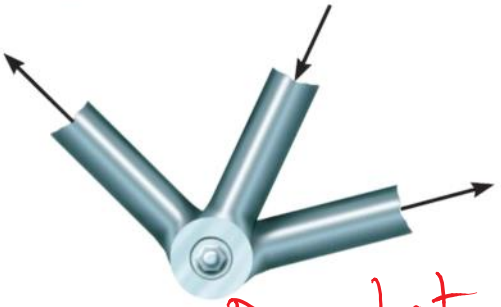
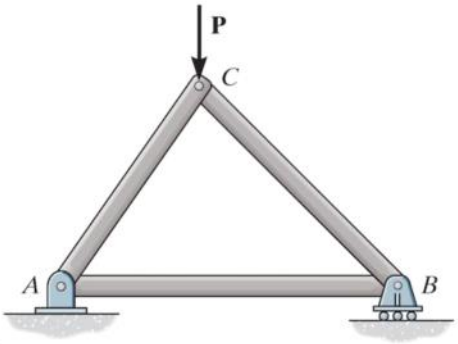
Thursday, February 23, 2017 12:43 PM

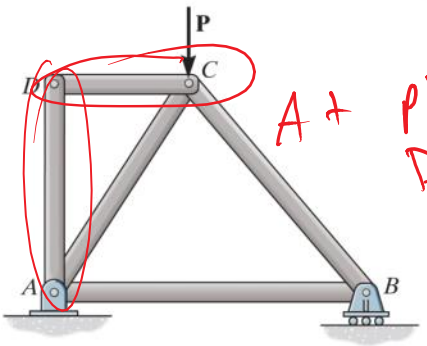
Truss joints

- Bolting or welding of the ends of the members to a gusset plates or passing a large bolt through each of the members
- Properly aligned gusset plates equivalent to pins (i.e., no moments) from coplanar, concurrent forces
- Simple trusses built from triangular members









At pin D, what is D_y?

A) P
B) −P
C) P/2
D) −P/2
E) None

FBD of Pin

$\rightarrow D_x = 0$

$\downarrow D_y = 0$

Zero-force members

$D_y = 0$

Thursday, February 23, 2017 12:43 PM

Method of joints

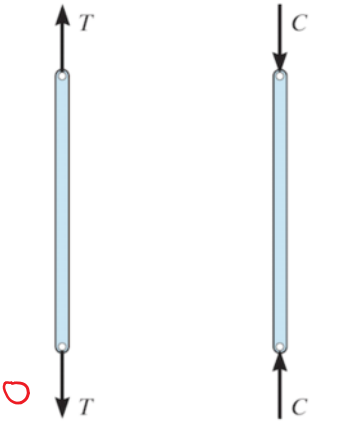
Or, pins (or, method of pins)

- Entire truss is in equilibrium if and only if all individual pieces (truss members and connecting pins) are in equilibrium.
- Truss members are two-force members: equilibrium satisfied by equal, opposite, collinear forces.
  - Tension: member has forces elongating.
  - Compression: member has forces shortening.
- Pins in equilibrium: $\sum F_x = 0$ and $\sum F_y = 0$

Procedure for analysis:

- Free-body diagram for each joint
- Start with joints with at least 1 known force and 1-2 unknown forces.
- Generates two equations, 1-2 unknowns for each joint.
- Assume the unknown force members to be in *tension, i.e. the forces "pull" on the pin*. Numerical solutions will yield positive scalars for members in tension and negative scalar for members in compression.

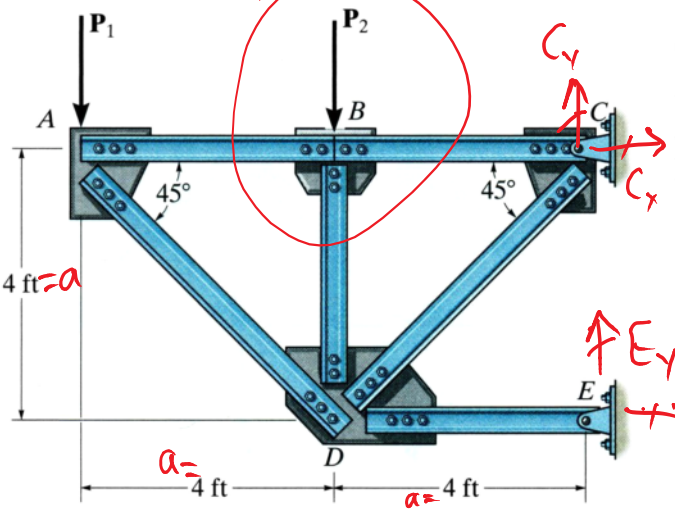
$\Sigma F_x = 0$
$\Sigma F_y = 0$



Tension Compression

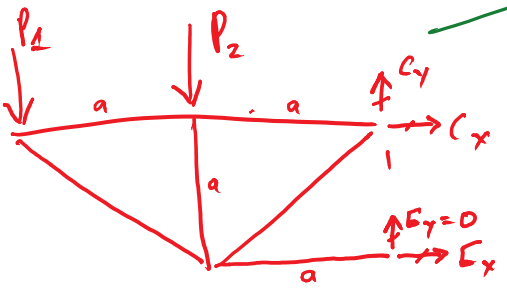
What sense of load should be assumed for ~~unknown forces~~)

A) Tension
B) Comp.
C) Else

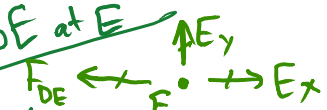


Example 1)
The truss, used to support a balcony, is subjected to the loading shown. Approximate each joint as a pin and determine the force in each member. State whether the members are in tension or compression.

1) Start with reaction forces.
(Note that DE is a 2-force member $\Rightarrow E_y = 0$)



FBE at E



$\Sigma F_y = 0 \Rightarrow E_y = 0$

$\Sigma M_C = 0 = a \cdot P_2 + 2a \cdot P_1 + a \cdot E_x$

$$E_x = -2P_1 - P_2$$

$\Sigma F_x = 0 = -F_{DE} + E_x$ @E

$\Rightarrow E_x = F_{DE} = -2P_1 - P_2$

compression

$\Sigma F_x = 0 = C_x + E_x = 0 \Rightarrow C_x = -E_x = 2P_1 + P_2$

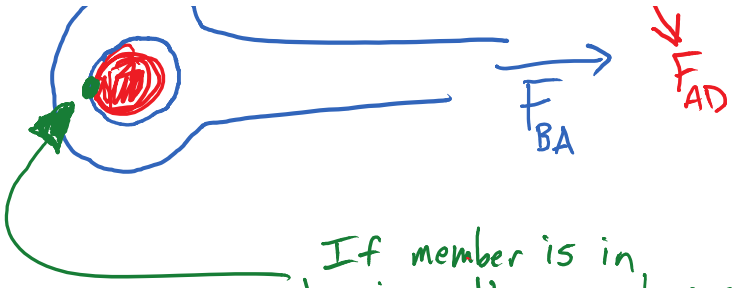
$\Sigma F_y = -P_1 - P_2 + C_y + E_y = 0 \Rightarrow C_y = P_1 + P_2$

Joint A

$\Sigma F_y = -P_1 - F_{AD} \cdot \sin 45° = 0$

$$F_{AD} = \frac{-P_2}{\sin 45°} = \frac{-P_1}{\sqrt{2}/2} = -P_1 \cdot \sqrt{2}$$

compression



If member is in tension, the member contacts the pin here. See that the force on the pin must act to the right.

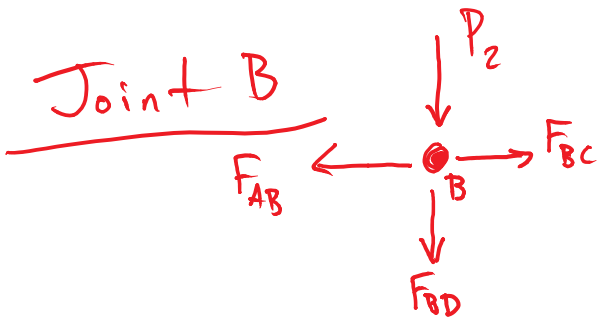
compression

$\Sigma F_x = F_{AB} + F_{AD}\cdot\cos 45^\circ = 0$

$\Rightarrow F_{AB} = -F_{AD}\cdot\frac{\sqrt{2}}{2} = -(-P_1\cdot\sqrt{2})\frac{\sqrt{2}}{2}$

$\boxed{F_{AB} = P_1}$ Tension

Joint B



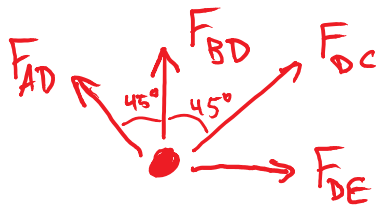
$\Sigma F_y = -P_2 - F_{BD} = 0$

$\Rightarrow \boxed{F_{BD} = -P_2}$ compression

$\Sigma F_x = -F_{AB} + F_{BC} = 0$

$\boxed{F_{BC} = F_{AB} = P_1}$ Tension

Joint D



$\Sigma F_x = 0$

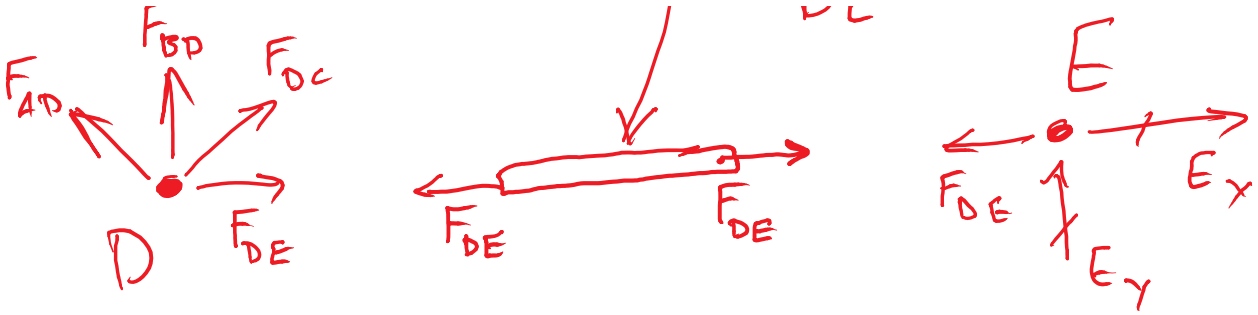
$\Rightarrow -F_{AD}\cdot\sin 45^\circ + F_{DC}\cdot\sin 45^\circ + F_{DE} = 0$

$-(-P_1\sqrt{2})\frac{\sqrt{2}}{2} + F_{DC}\cdot\frac{\sqrt{2}}{2} + (-2P_1 - P_2) = 0$

$P_1 + F_{DC}\frac{\sqrt{2}}{2} - 2P_1 - P_2 = 0$

$\boxed{F_{DC} = (P_1 + P_2)\sqrt{2}}$

Tension


F_{BD}
F_{AD}
F_{DC}
D
F_{DE}
F_{DE}
F_{DE}
E
F_{DE}
E_x
E_y

Thursday, February 23, 2017 12:43 PM

We will determine the force in each member of the truss and indicate whether the members are in tension or compression.

1) What kind of reaction forces operate at *A* and *C*?

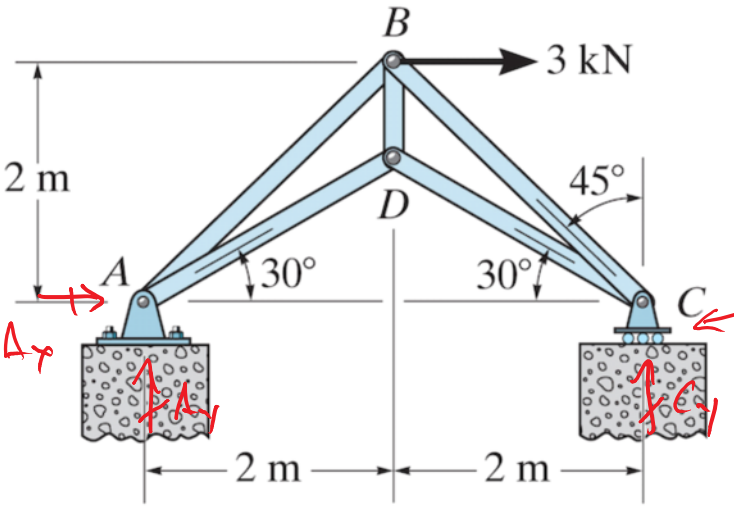
A. A_x, C_x, all others zero

B. A_y, C_y, all others zero

C. A_x, A_y, all others zero

D. A_x, A_y, ~~C_y~~, all others zero

E. A_x, A_y, C_x, C_y, all others zero



roller

Thursday, February 23, 2017 12:43 PM

We will determine the force in each member of the truss and indicate whether the members are in tension or compression.

2) How many unknown forces on joint *B*?

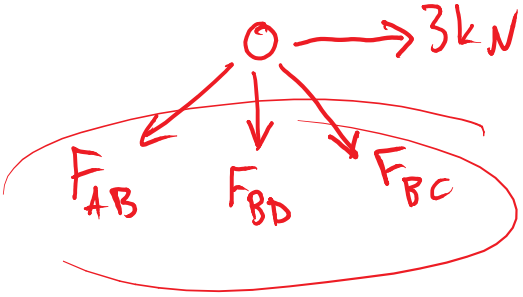
A. 0

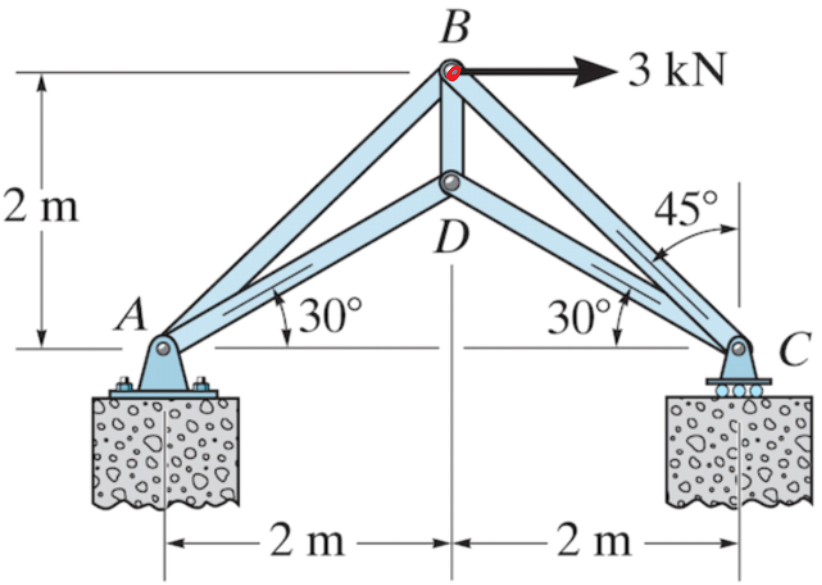
B. 1

C. 2

D. 3

E. 4



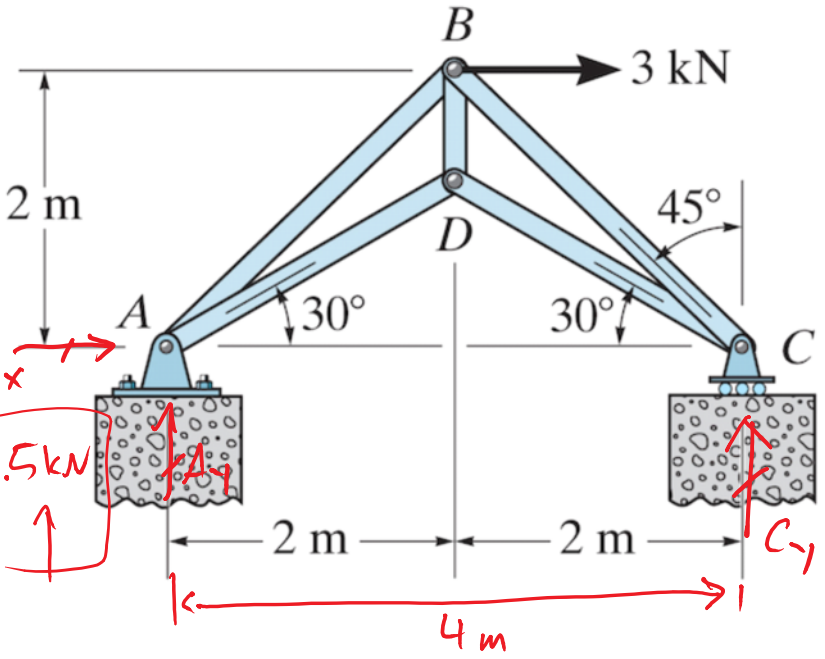


Thursday, February 23, 2017 12:43 PM

We will determine the force in each member of the truss and indicate whether the members are in tension or compression.

3) What is the reaction force at C_y?

A. 3.0 kN ↑
B. 1.5 kN ↑
C. 0
D. 1.5 kN ↓
E. 3.0 kN ↓



$\Sigma M_A = 0$

$C_y \cdot (4\text{m}) - (3\text{kN})(2\text{m}) = 0$ A_x

$C_y = 3\text{kN} \cdot \frac{2}{4} = 1.5\text{kN}$

Thursday, February 23, 2017 12:43 PM

We will determine the force in each member of the truss and indicate whether the members are in tension or compression.

4) What are the sums of forces along x on joint C? (For your FBD, use the convention where we first assume all forces are in tension)

A. $F_{CD}\cos 30° + F_{CB}\sin 45° = 0$

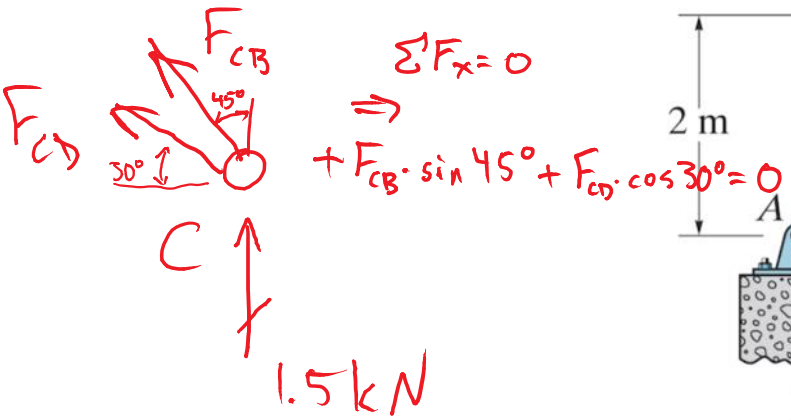
B. $-F_{CD}\cos 30° + F_{CB}\sin 45° = 0$

C. $F_{CD}\sin 30° + F_{CB}\cos 45° = 0$

D. $-F_{CD}\sin 30° + F_{CB}\cos 45° = 0$

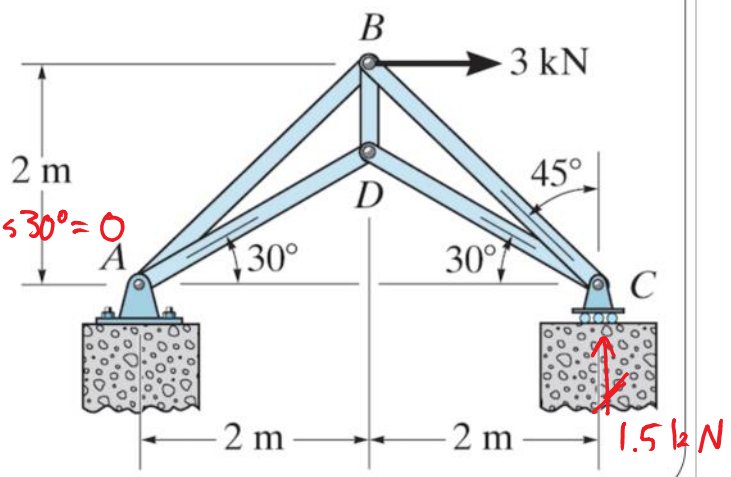
E. None of the above

in the x-direction



$\Sigma F_x = 0 \Rightarrow$

$+F_{CB}\cdot\sin 45° + F_{CD}\cdot\cos 30° = 0$



Thursday, February 23, 2017 12:43 PM

We will determine the force in each member of the truss and indicate whether the members are in tension or compression.

5) What are the sums of forces along y on joint C? (For your FBD, use the convention where we first assume all forces are in tension)

A. $1.5\text{ kN} + F_{CD}\cos 30° - F_{CB}\cos 45° = 0$

B. $1.5\text{ kN} + F_{CD}\cos 30° + F_{CB}\cos 45° = 0$

C. $1.5\text{ kN} + F_{CD}\sin 30° - F_{CB}\cos 45° = 0$

D. $1.5\text{ kN} + F_{CD}\sin 30° + F_{CB}\cos 45° = 0$

E. None of the above