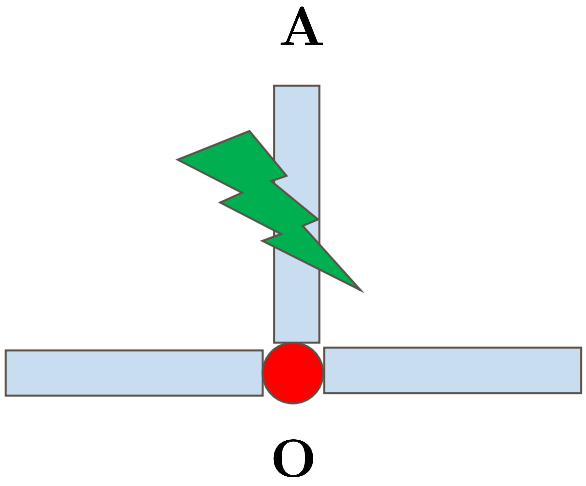
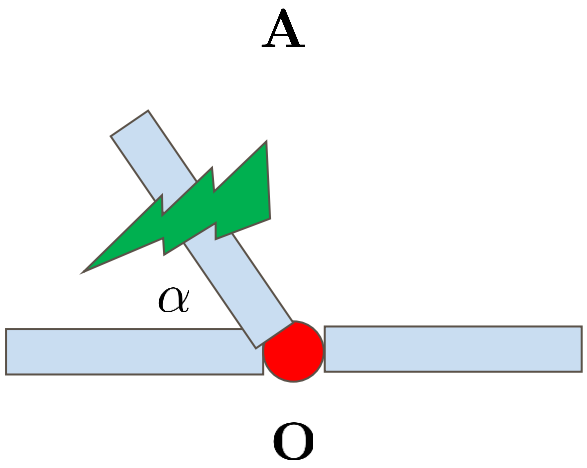
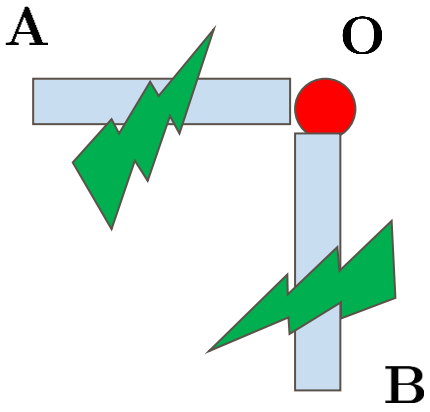
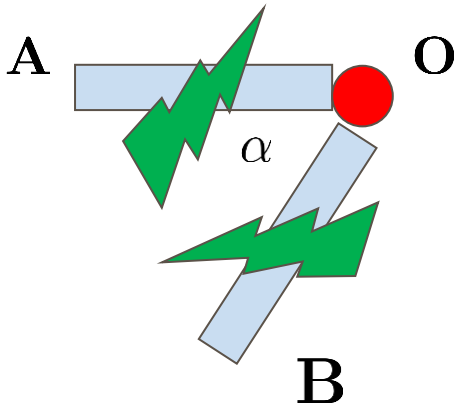
Zero-force member

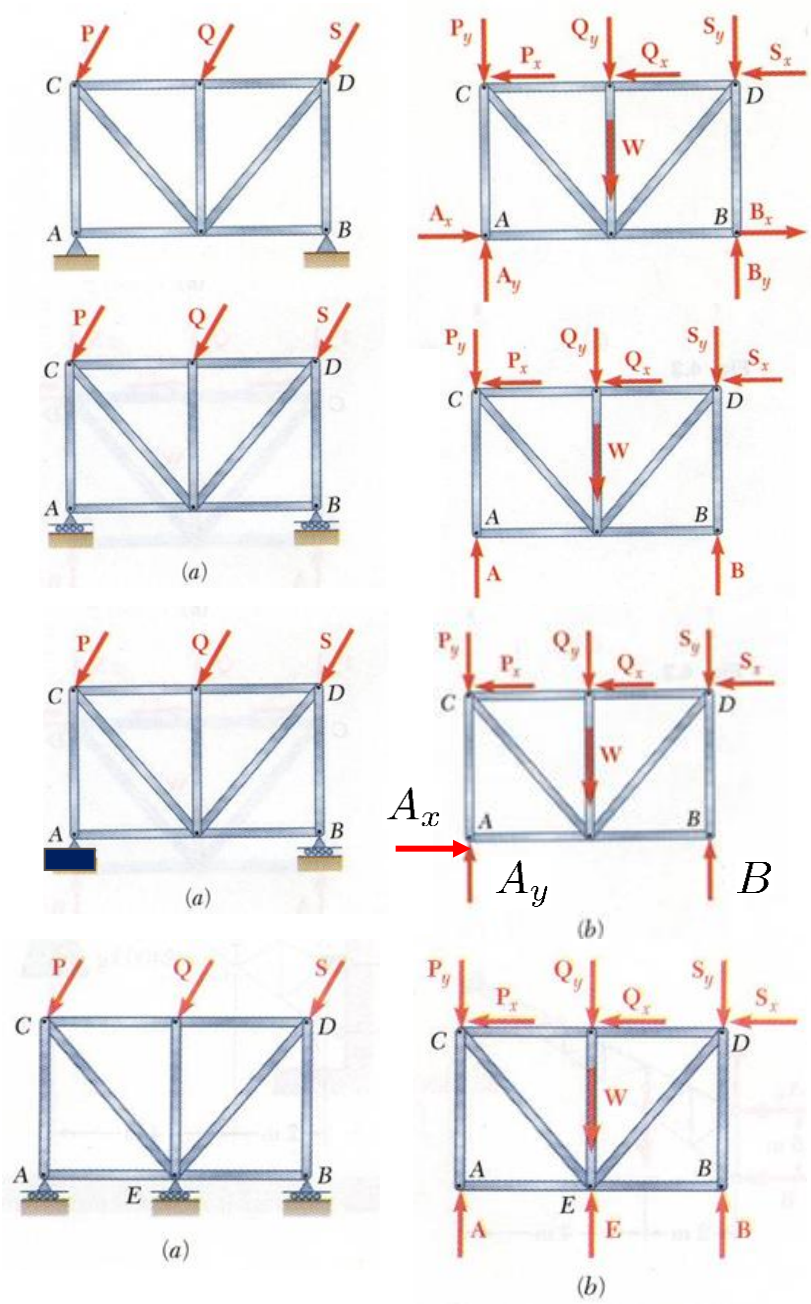








System Constraints



$$m = 9, n = 6 \rightarrow 2n - m >? <? =? r$$

$$2n - m = 3$$

- More unknowns than equations ($2n < m + r$; over-constrained) $(r = 4)$

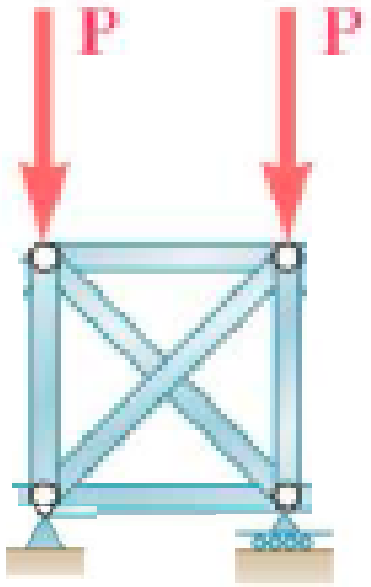
- Fewer unknowns than equations, partially constrained: $2n > m+r$ $(r = 2)$

- Equal number in unknowns and equations $2n = m+r$ $(r = 3)$

- Equal number unknowns and equations but it may be improperly constrained

$$2n - m = r, \quad r = 3$$

C30/ME85 Million Dollar Questions



Q1 Which of the following statements are true ?

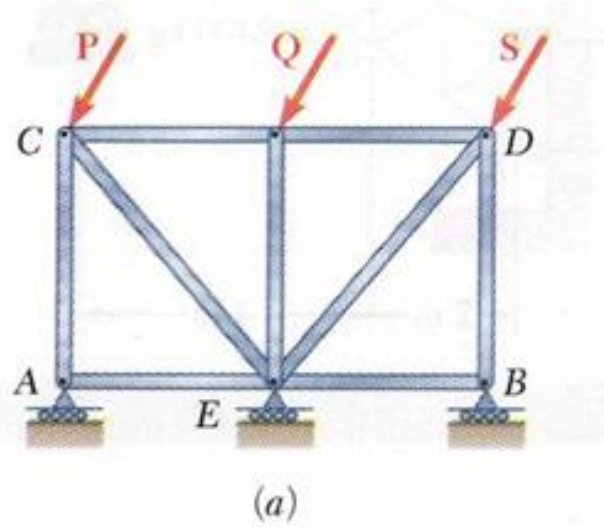
(a) This system is statically determinant;

(b) This system is statically indeterminant (over-constrainted);

(c) This is a simple truss system;

(d) This is a partially constrained system.

Ans : **(b)** $m(6) + r(3) = 9 > 2n(4) = 8$



Q2: Which of the following statements are true ?

(a) The reaction force at the point A has two components;

(b) This system is statically determinant;

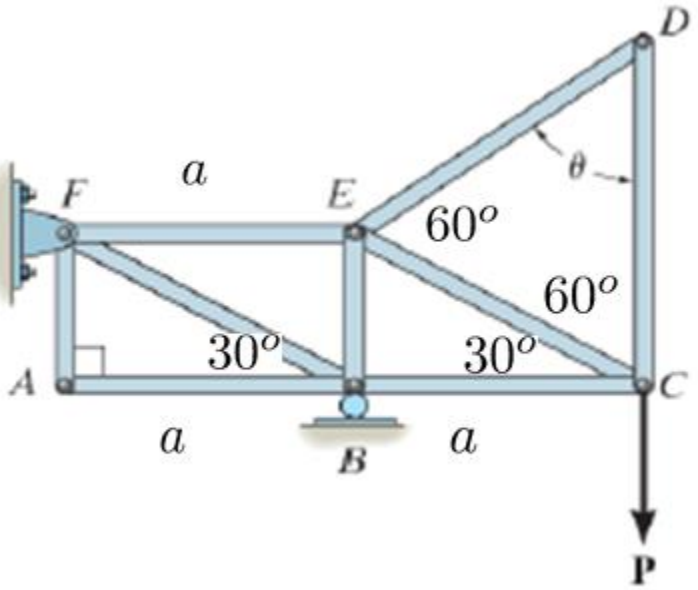
(c) This system is statically indeterminant (over-constrainted);

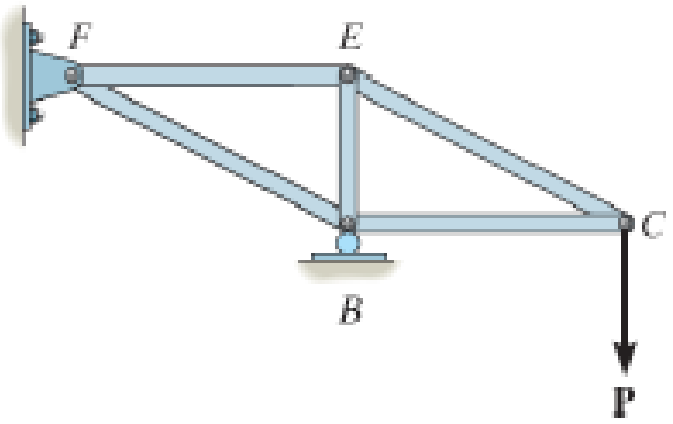
(d) This system is improperly constrianed;

Ans : (**d**) $m(9) + r(3) = 12 = 2n(6) = 12$

Q3. How many zero-force members in the structure shown in the figure?

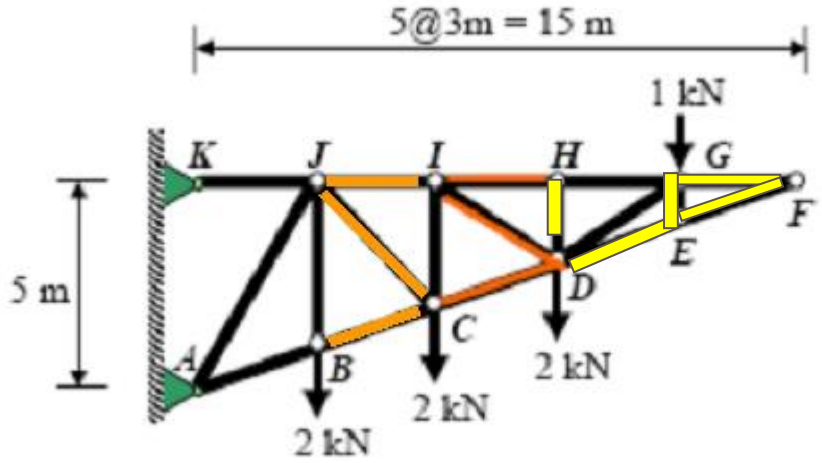
- (a) one;
- (b) two;
- (c) zero;
- (d) three;
- (e) four;
- (f) five.





Answer: (e)

Q4. How many zero-force members in the following structure ?



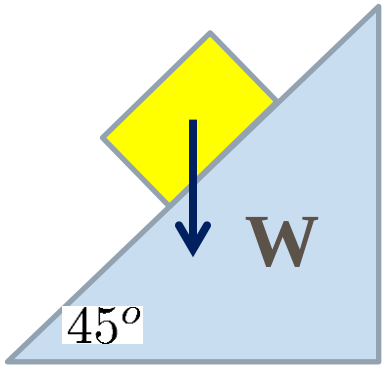
Ans: (B)

(A) 4, (B) 5, (C) 6, (D) 7, (E) 8

Q5. Consider that

$$W = 0.1N; \quad \tan 45^o = 1, \mu_s = \tan \phi_s = 0.3, \ \mu_k = \tan \phi_k = 0.2 \ .$$

Which of the following statements are true ?

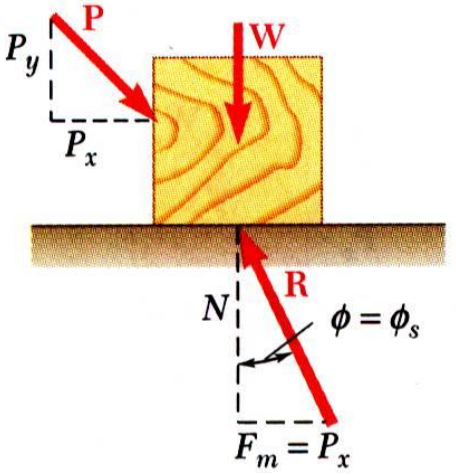


- (a) The block will move down;
- (b) The block will move up;
- (c) The block will be in equilibrium;
- (d) The friction force $F_f = \mu_s W \cos 45^o$;

Ans: (a)

Q6: The angle of static friction is the

(a) An angle between the resultant of normal reaction and the limiting friction;
(b) Ratio of limiting friction and normal reaction;
(c) Ratio of minimum friction force to friction force acting when the body is in motion,
(d) Ratio of minimum friction force to friction force acting when the body is just in motion, or
(e) Ration of static and kinetic friction.

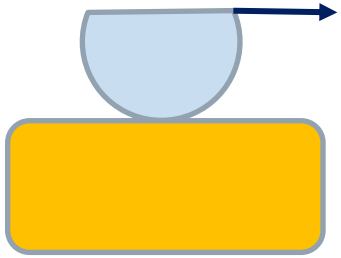


Ans: (A)

- Motion impending

Q7. A semi-circular disc rests on a horizontal surface with its top flat surface horizontal and circular portion touching down.
The disc is pulled by a horizontal force applied at one edge,
and it always remains horizontal. When the disc is about to move, the disc

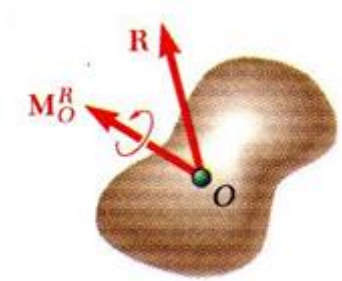
A. remains horizontal;
B. slants up towards the direction of pull;
C. slants down towards the direction of pull;
D will move unpredictably.

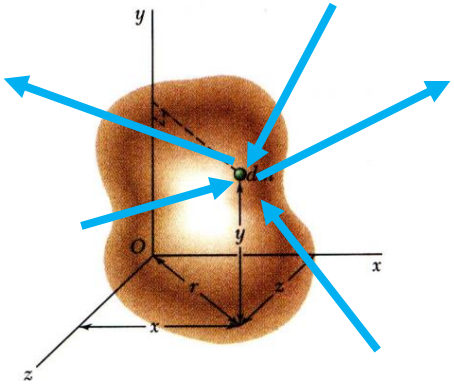


Ans: (C)

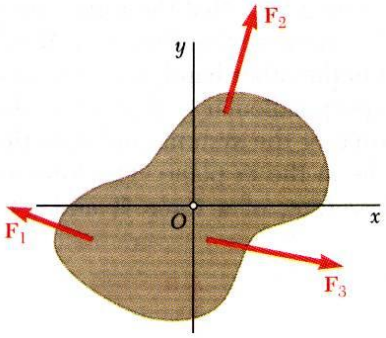
Q8. Which of the following sets of forces cannot be resolved into a single resultant force?

Ans: (C)

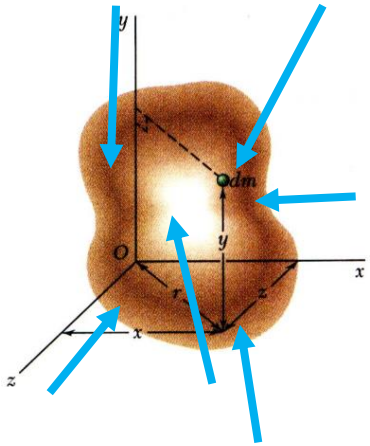




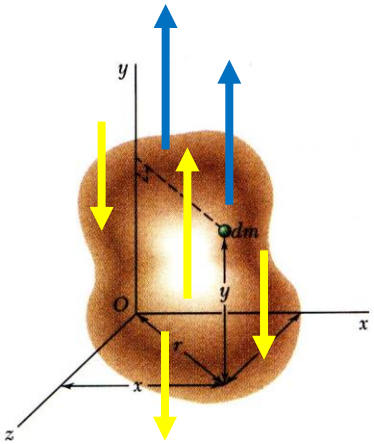
(A)



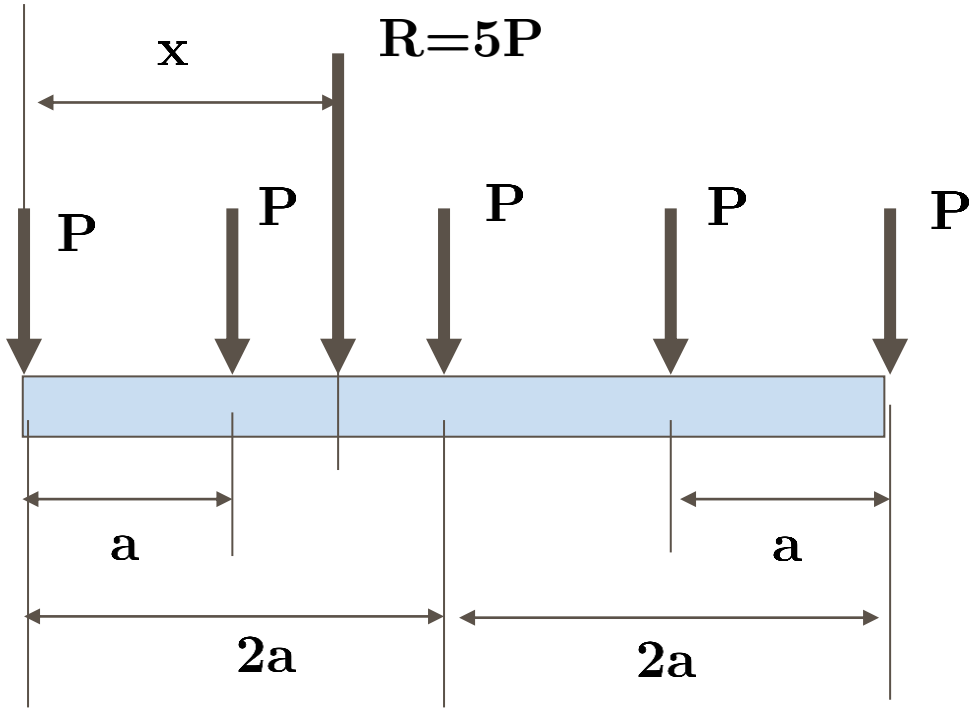
(B)



(C)



(D)



(9) At which point **x**, we have a resultant force **R** and the resultant moment **M=0**?

(A) x= a;

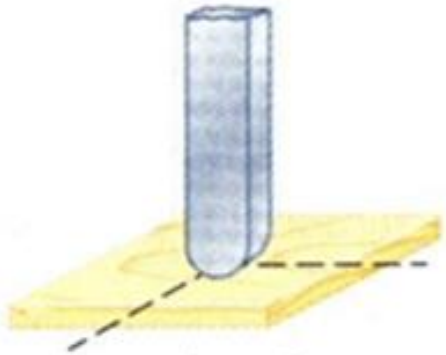
(C) x= 2a;

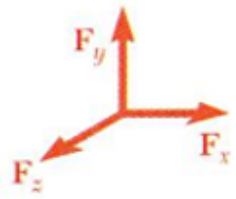
Ans: (C)

(B) x= 1.5a;

(D) x= 3a;

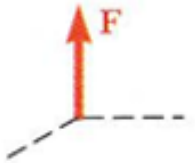
Q10. Which is the correct reaction diagram?





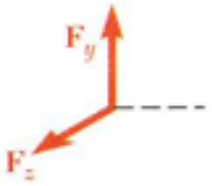
Three force components

(A)



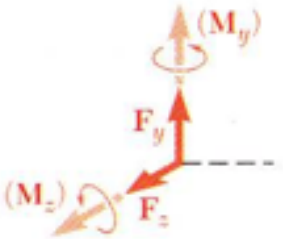
Force with known line of action (one unknown)

(B)



Two force components

(C)

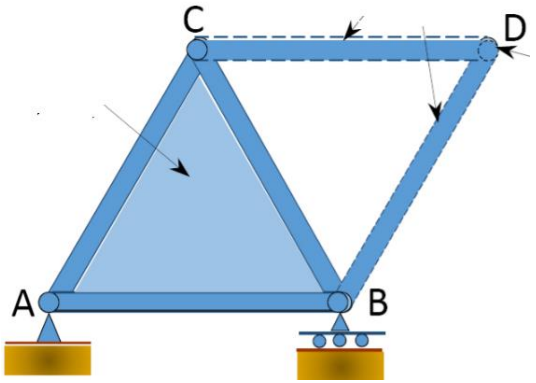


Two force components (and two couples)

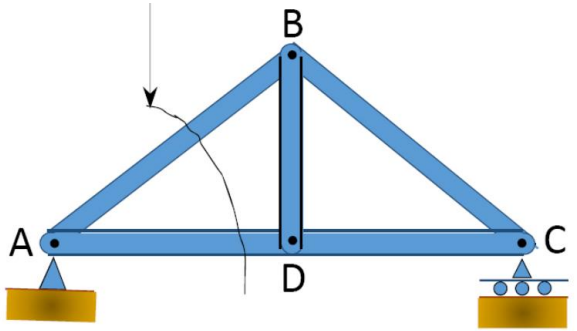
(D)

Ans. (A)

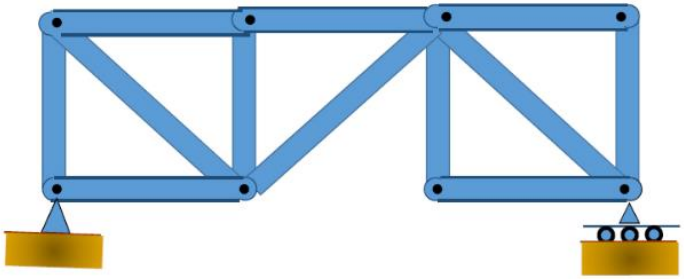
Q11. Which of the following are not simple structur**es**?



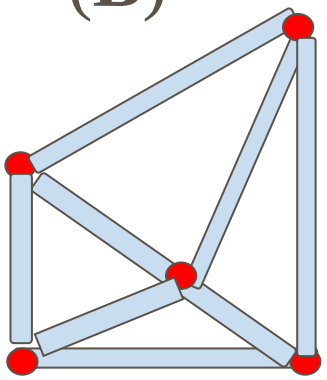
(A)



(B)



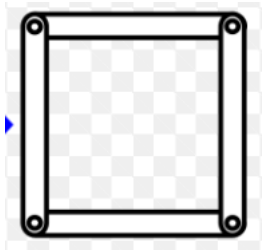
(C)



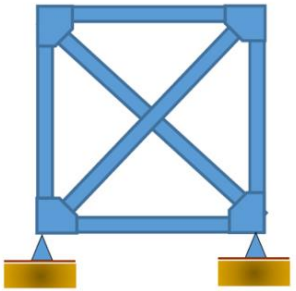
(D)

Ans: (C) &(D)

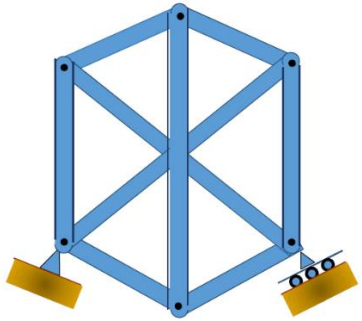
Q12. Which of the following are rigid structures?



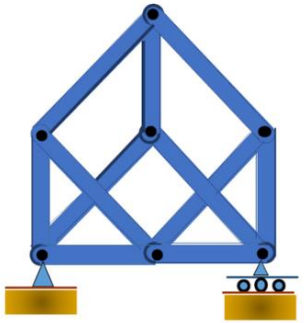
(A)



(B)



(C)



(D)

Ans: (B)

Q13 Given $\mathbf{A} : (1, 9, -3)$ and $\mathbf{B} : (0, 7, 2)$.
Which of the following is the correct relative positive vector?

(A) $\mathbf{r}_{AB} = -\mathbf{i} + 2\mathbf{j} + \mathbf{k}$.

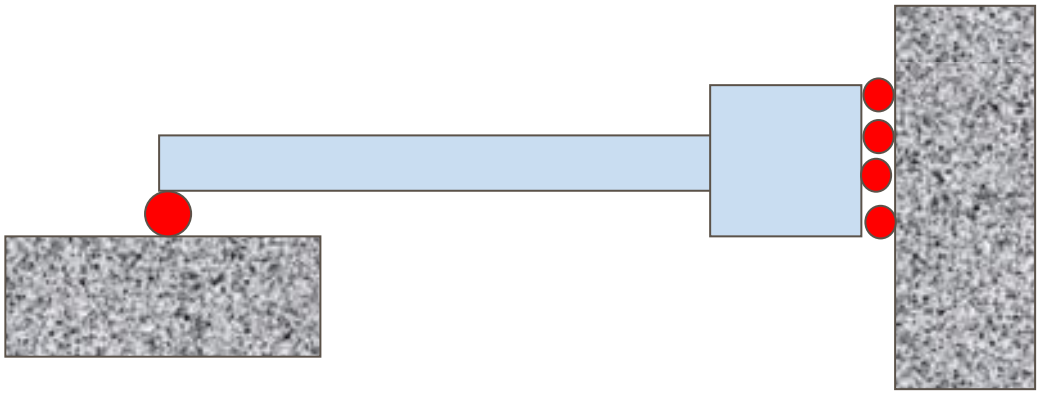
(B) $\mathbf{r}_{AB} = -\mathbf{i} - 2\mathbf{j} + 5\mathbf{k}$.

(C) $\mathbf{r}_{BA} = -\mathbf{i} - 2\mathbf{j} - \mathbf{k}$.

(D) $\mathbf{r}_{BA} = \mathbf{i} - 2\mathbf{j} - 5\mathbf{k}$.

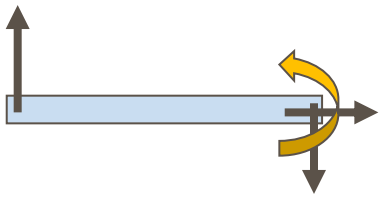
Ans: (B)

Q14. Which of the following is the correct free-body diagram?

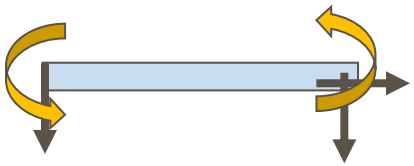


Ans (c)

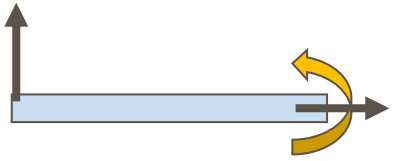
(a)



(b)

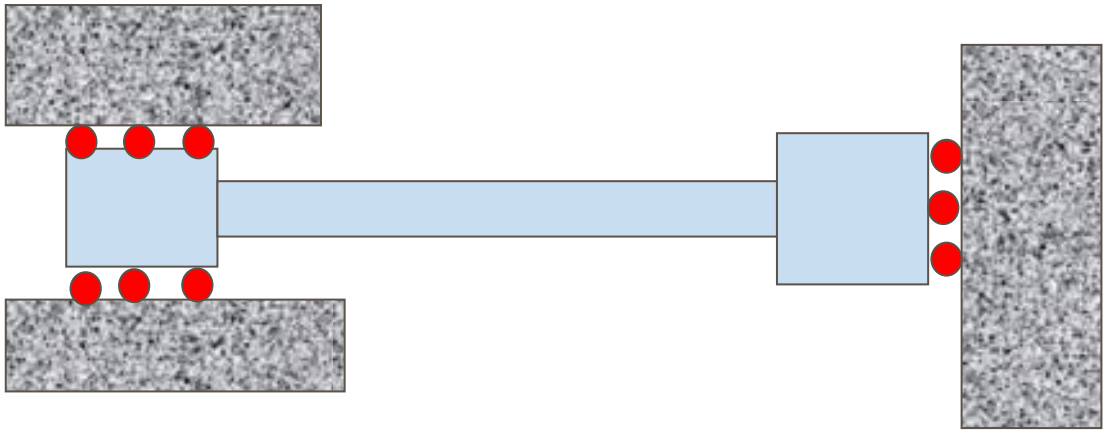


(c)



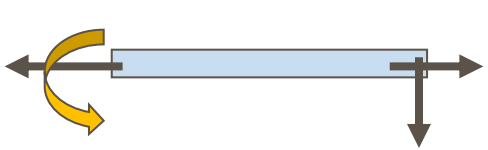
(d)

Q15. Which of the following is the correct free-body diagram?

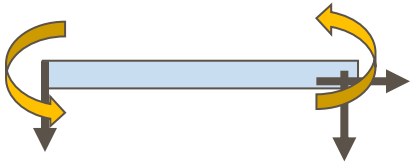


Ans (c)

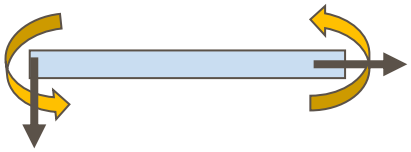
(a)



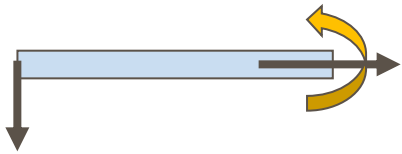
(b)



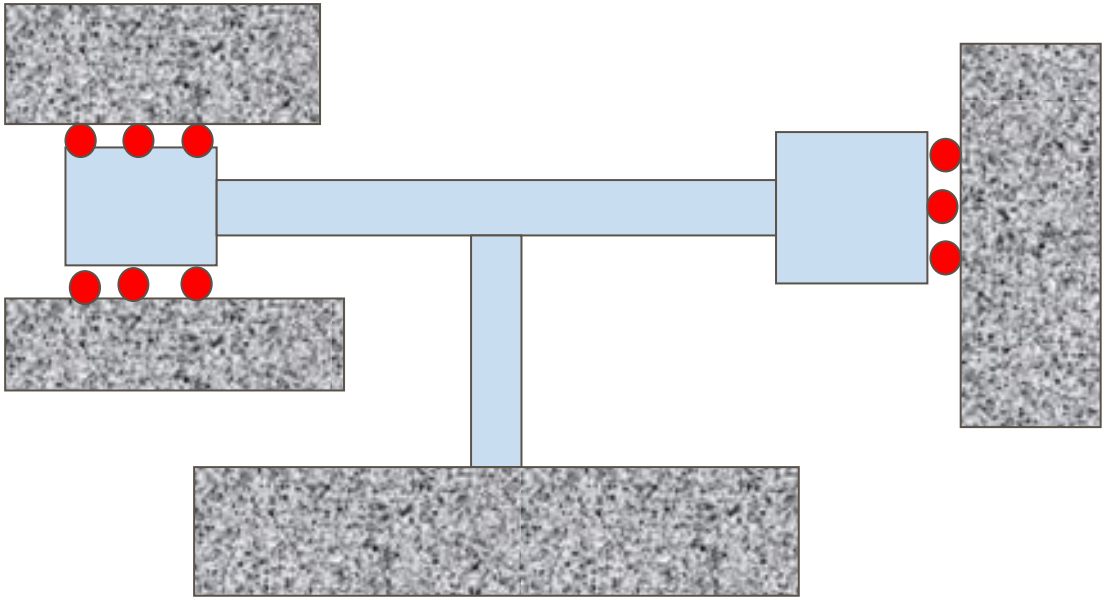
(c)



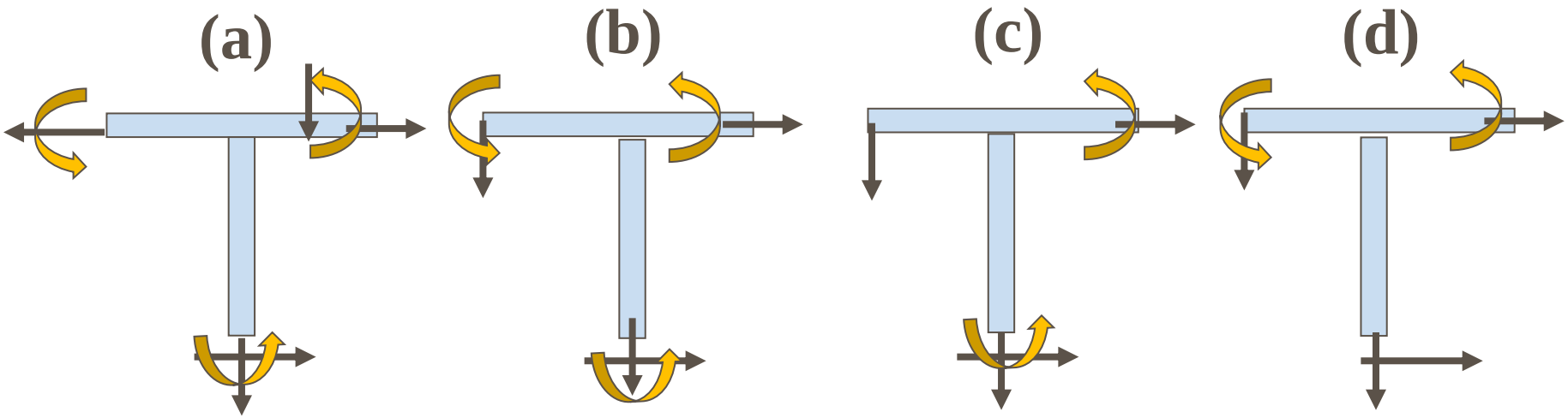
(d)



Q16. Which of the following is the correct free-body diagram?

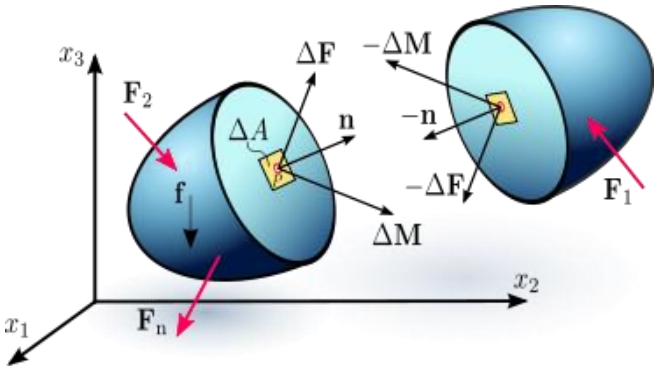


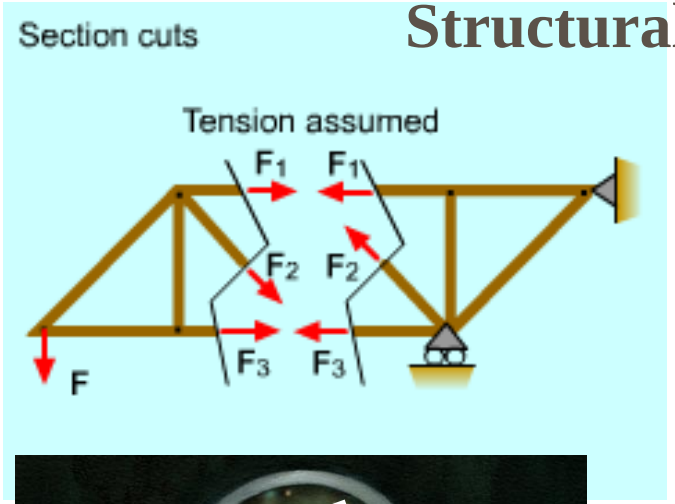
Ans (b)



Lecture 11 Method of Section

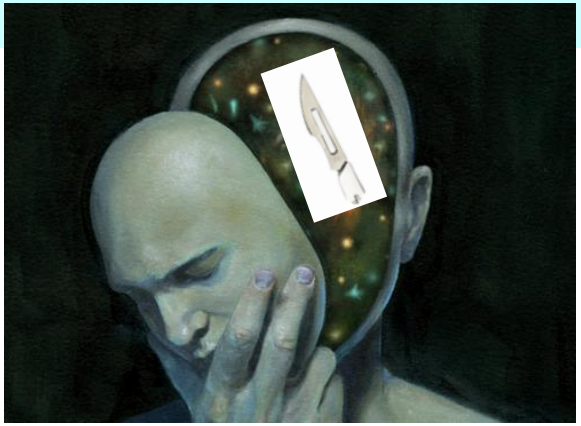
Insert an imaginery plane to cut structure member(s) into two parts at the specific location(s) where the desired internal forces are being sough. One can then draw free-body diagrams for "severed" member with the exposed internal force as the external forces acting on the cut (plane).





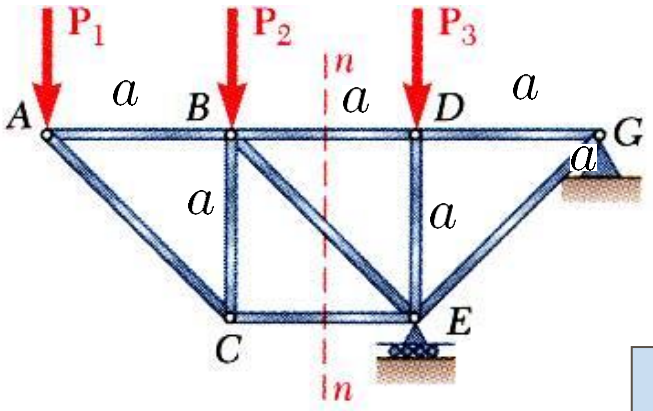
Structural analysis

Violence



Analytical

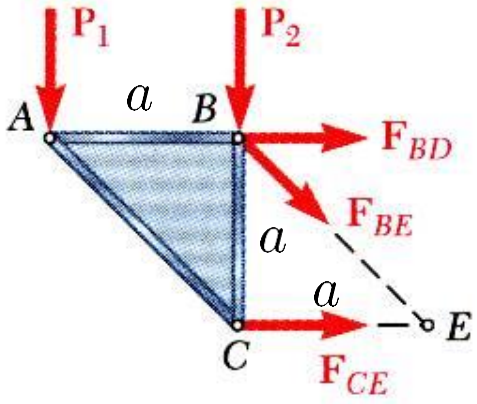
Today's Lecture Attendance Password: **Method of Section**



- When the force in only one member or the forces in a very few members are desired, the *method of sections* works well.
- Find internal force F_{CE} ?

Solution

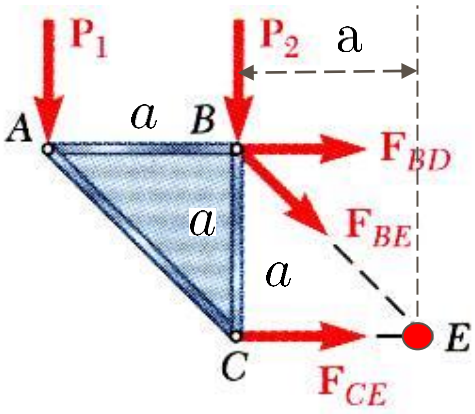
Insert an imaginary plane n-n to cut the structure into two parts, and analyze the left part:



$$\sum M_B = 0, \rightarrow P_1 a + F_{CE} a = 0$$

$$F_{CE} = -P_1$$

$$F_{CE} = -P_1$$



- Find internal force F_{BD} ?
- Using the left-side FBD, write one equilibrium equation that can be solved to find F_{BD}. Check your equation with a neighbor; resolve any differences between your answers if you can.

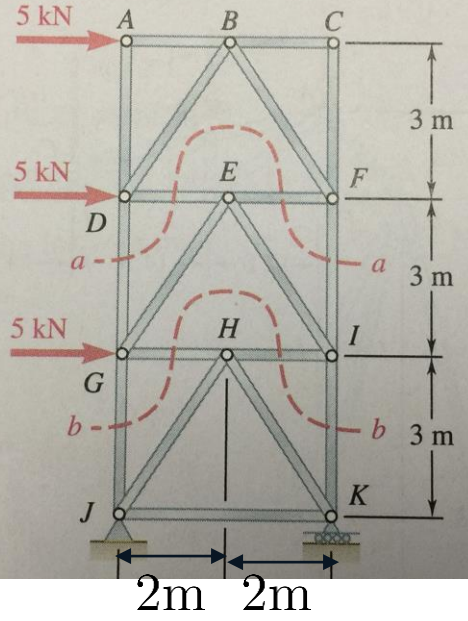
$$\sum \mathrm{M}_E = 0 \quad \rightarrow \quad 2aP_1 + aP_2 - aF_{BD} = 0$$

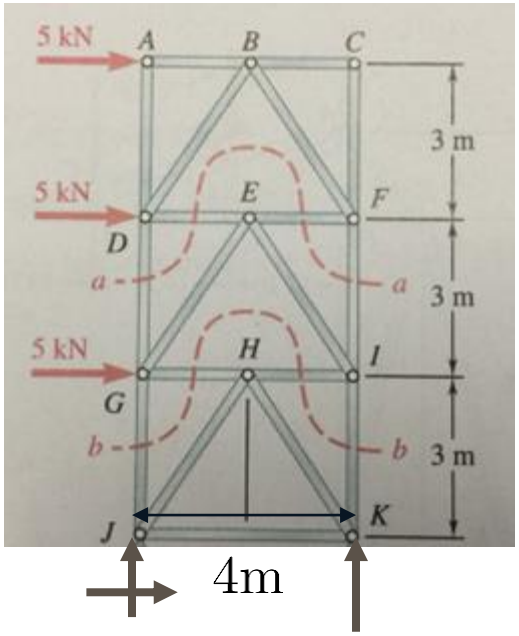
$$F_{BD} = 2P_1 + P_2 \ .$$

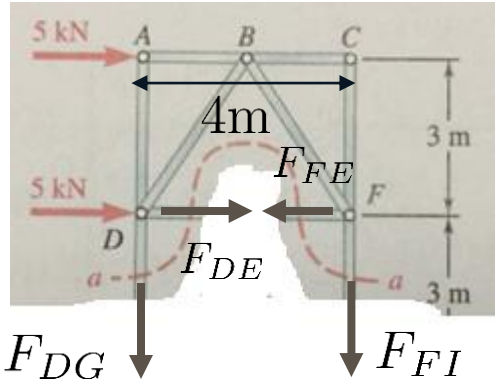
$$\sum F_y = 0 \quad \rightarrow \quad -P_1 - P_2 - \frac{\sqrt{2}}{2} F_{BE} = 0 \quad \rightarrow \quad F_{BE} = -\sqrt{2}(P_1 + P_2)$$

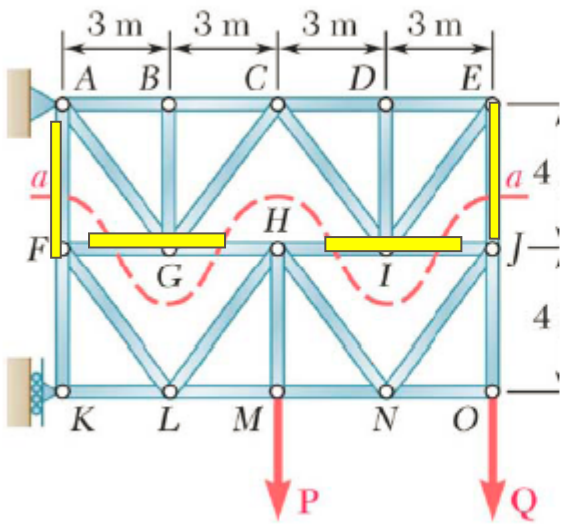
$$\sum F_x = 0 \quad \rightarrow \quad F_{BD} + \frac{\sqrt{2}}{2} F_{BE} + F_{CE} = 0 \quad \rightarrow \quad F_{CE} = -P_1$$

6.41 Determine the force in members *DG* and *FI* of the truss shown. (*Hint:* Use section *aa*.)









PROBLEM 6.99

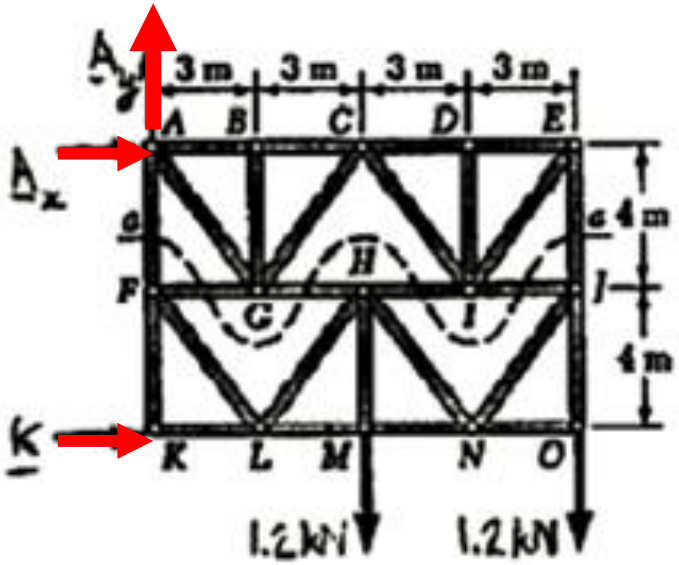
Determine the force in members *AF* and *EJ* of the truss shown when $P = Q = 1.2$ kN. (*Hint:* Use section *aa*.)

$$\sum F_y = 0, \ \rightarrow \ A_y - 1.2kN - 1.2kN = 0 \ \rightarrow$$

$$A_y = 2.4kN$$

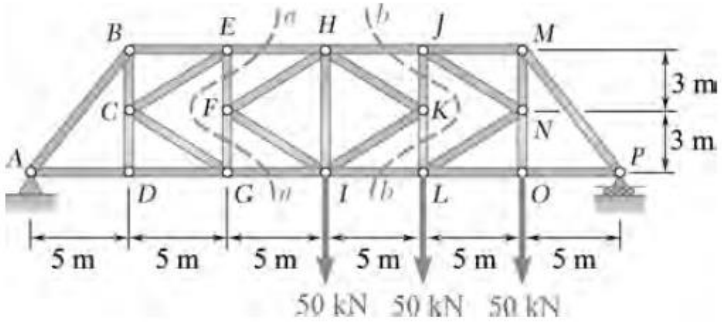
$$\sum M_A = 0 \ \rightarrow \ 8K - 6 \times 1.2kN - 12 \times 1.2kN = 0$$

$$K = 2.7kN.$$

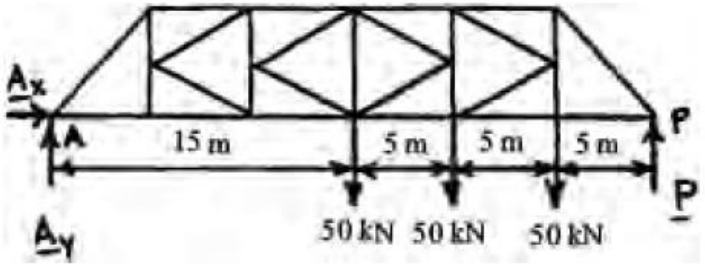


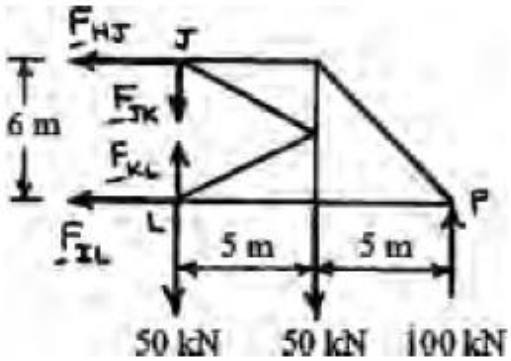
$$\sum F_x = 0 \ \rightarrow \ A_x + K = 0 \ \rightarrow \ A_x = -K = -2.7kN$$

Free-body diagram



Determine the force in members HJ and IL of the truss shown. (*Hint:* Use section *bb*.)



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Happy
Weekend!