MCG1100/1500

Free-Body Diagram Examples / Exemples des schémas de corps isolés

Solutions given at the end / Les solutions sont données à la fin

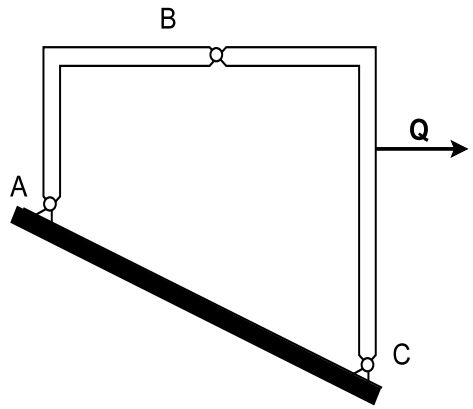
The following free-body diagram problems are taken from old GNG1105 tests or exams. They are given roughly in order of difficulty. For each problem
1. Identify all two-force members
2. Take the whole structure as the FB and draw as many reactions as you can.
3. Complete the FBD's of the parts.

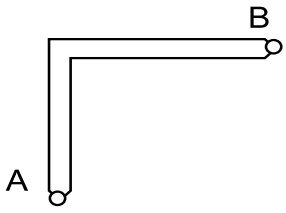
All pins and contacts are frictionless, and the weights of the parts are negligible. Find the directions of forces by mentally taking ΣF and ΣM about different points. Where it is not possible to get all force directions correctly without doing calculations, this is noted.

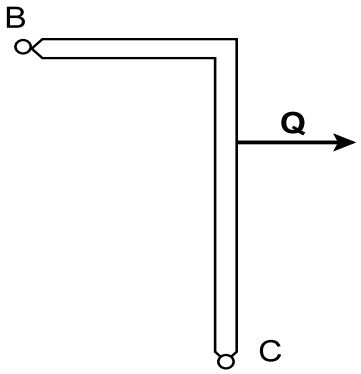
Les problèmes suivants sur les schémas de corps isolés sont tirés des vieux examens de GNG1505. Ils sont donnés en ordre de difficulté. Pour chaque problème:
1. Identifiez toutes les pièces à deux forces.
2. Prenez le mécanisme complet comme CI, et dessinez les réactions, si possible.
3. Complétez les SCI`s des pièces.

Toutes les rotules et surfaces en contact sont sans frottement, et les poids des pièces sont négligibles. Trouver les directions des forces par faire ΣF et ΣM à des différentes pointes. Si il n'y a pas possible à trouver toutes les directions des forces sans faire des calculs, ce fait est noté.

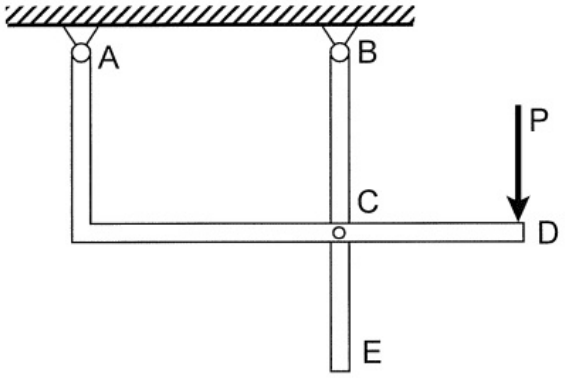
1. A, B and C are frictionless pins. /
A, B et C sont des rotules sans frottement.

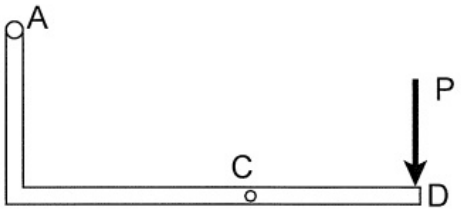




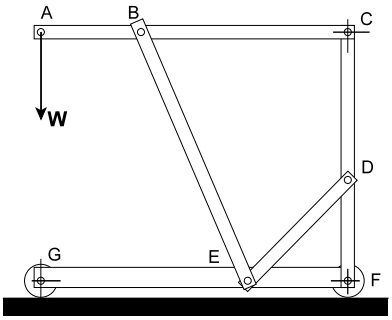


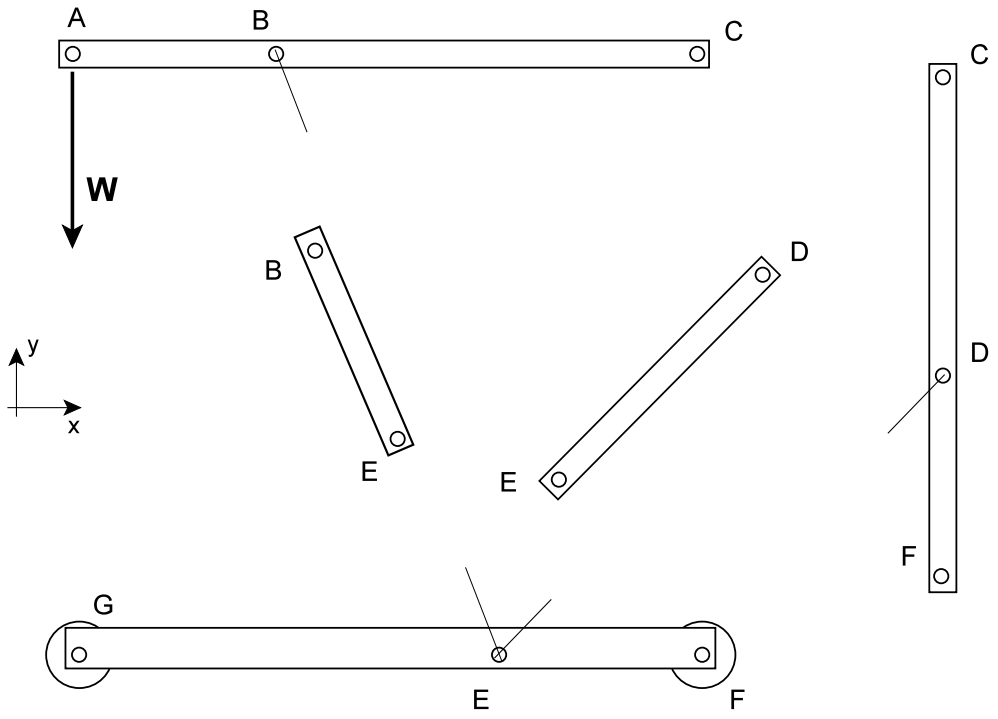
2. A, B and C are frictionless pins. / A, B et C sont des rotules sans frottement.



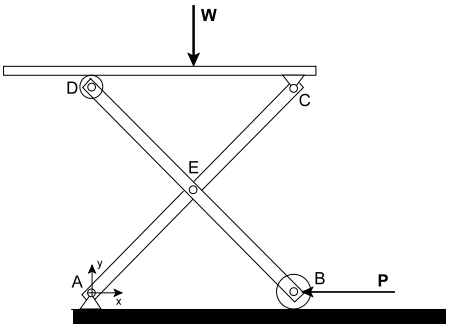


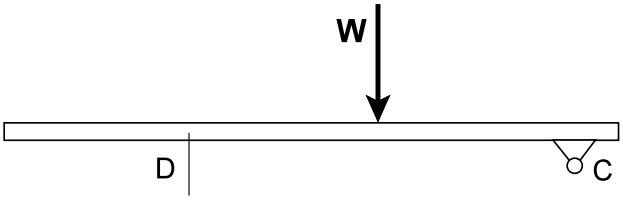
3. B, C, D and E are frictionless pins, while F and G are frictionless rollers.
B, C, D et E sont des rotules sans frottement, et F et G sont des roues sans frottement.

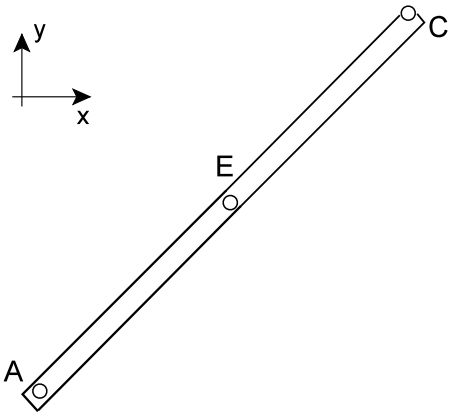


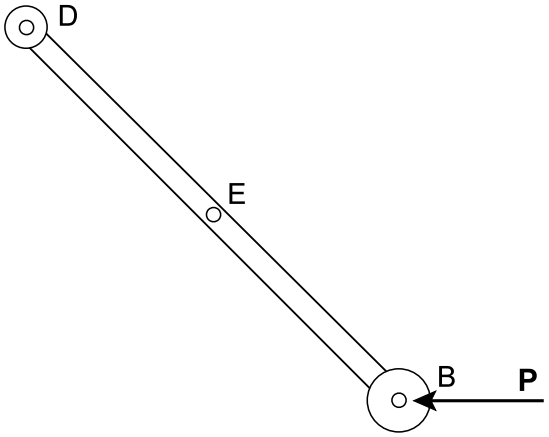


4. A, C and E are frictionless pins, and B and D are frictionless rollers. The direction of E_Y cannot be found without calculations. /
A, C et E sont des rotules sans frottement, et B, D sont des roues sans frottement. On ne peut pas trouver la direction de E_Y sans faire des calculs.

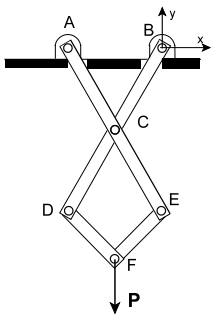


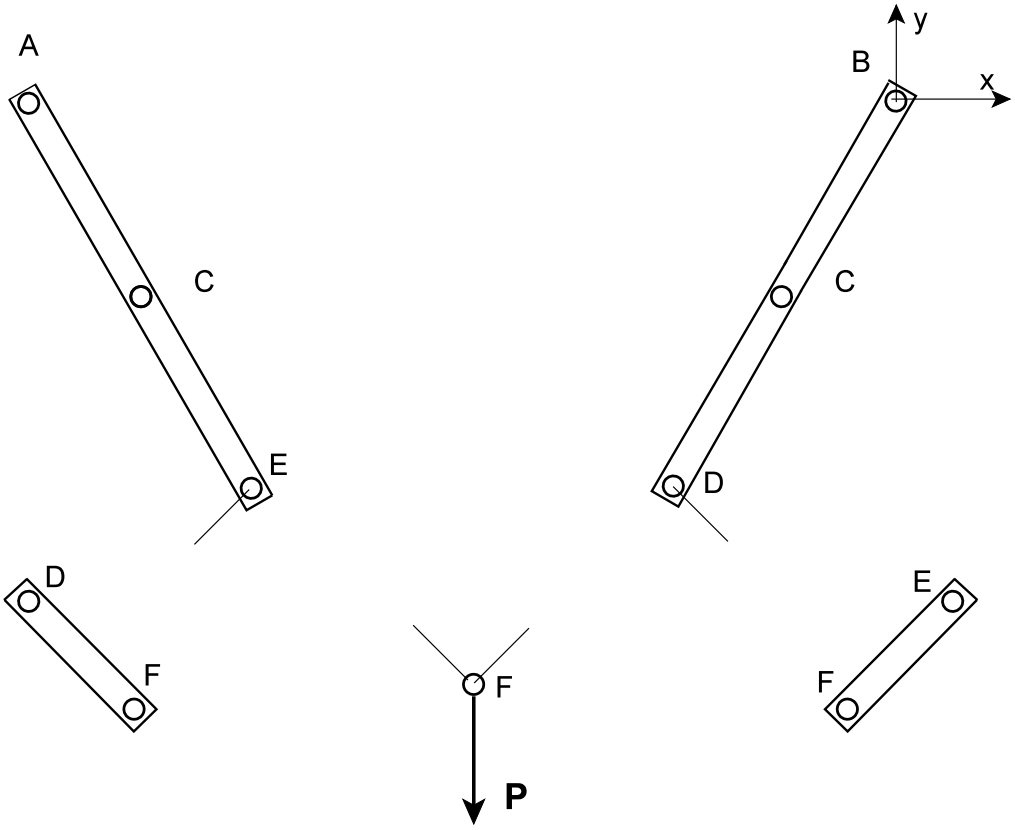




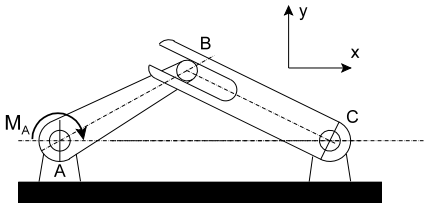


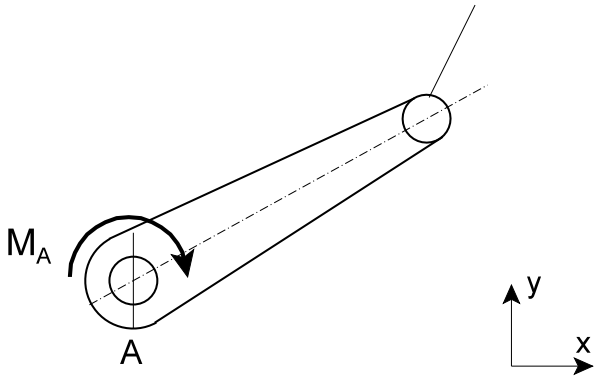
5. All joints are frictionless pins. The direction of C_Y cannot be found without calculations. /
Toutes les jointes sont des rotules sans frottement. On ne peut pas trouver la direction de C_Y sans faire des calculs.

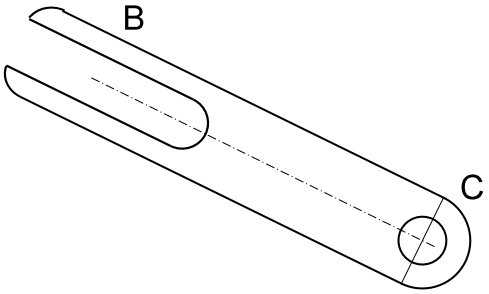




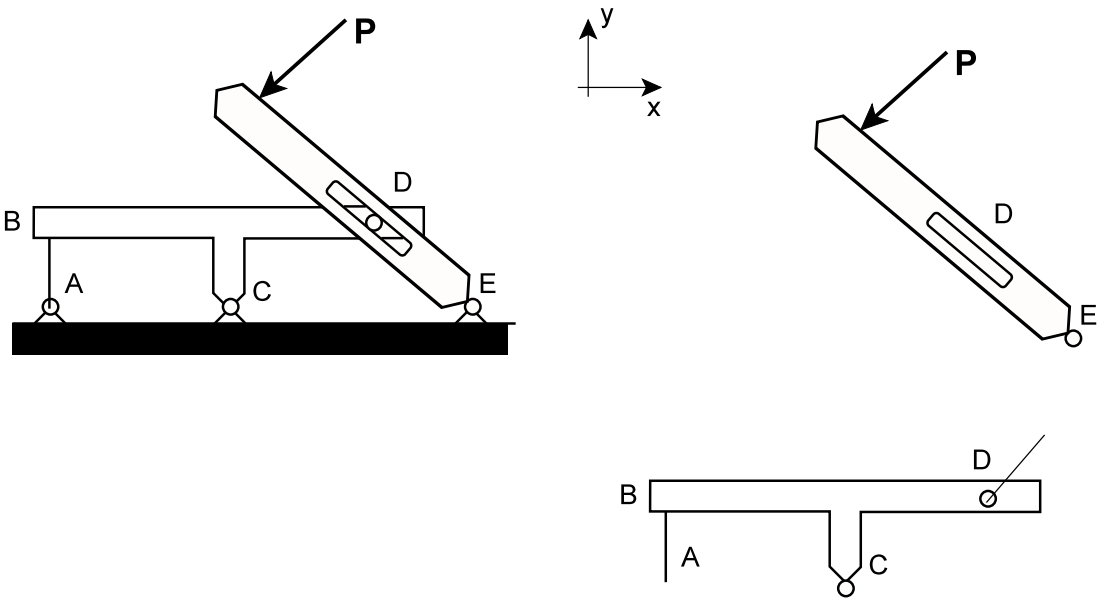
6. A and C are frictionless pins, B a frictionless contact. Note that a couple is required at C to maintain equilibrium. /
A et C sont des rotules sans frottement, B un contact sans frottement. Un couple est requis à C pour maintenir l'équilibre.



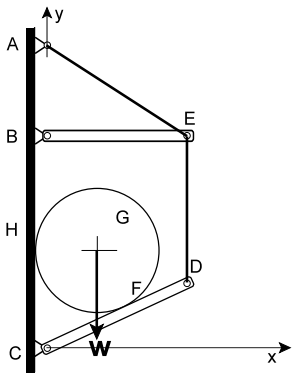


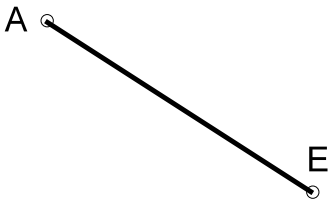


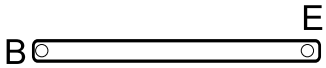
7. AB is a cord, C and D are frictionless pins, and D is a frictionless contact. /
AB est une corde, C et D sont des rotules sans frottement, et D est un contact sans frottement.

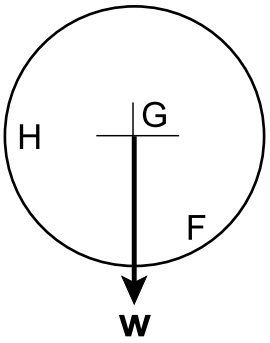


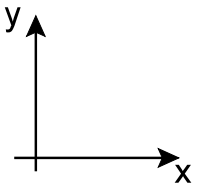
8. The structure is loaded by the weight **W** of the barrel G. Joints A, B, C, D and E are frictionless pins; F, H are frictionless contacts. The direction of C_Y cannot be found without calculations. /
La charge sur la structure est le poids de G. A, B, C, D et E sont des rotules sans frottement, F, H sont des contacts sans frottement. On ne peut pas trouver la direction de C_Y sans faire des calculs.

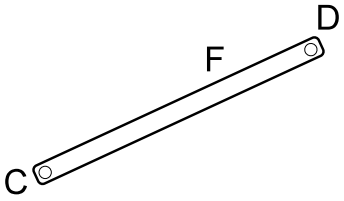




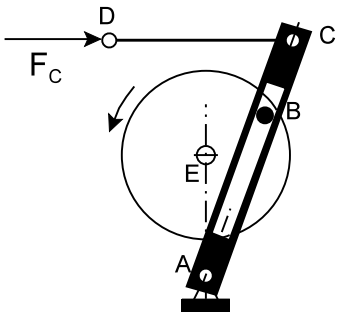


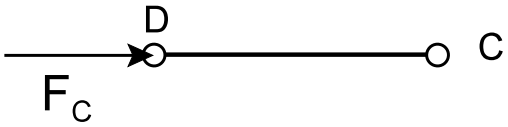


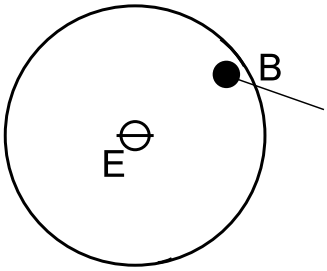


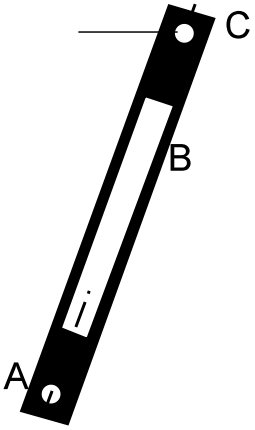


9. A, C and D are frictionless pins, E is a frictionless bearing, and B is a frictionless contact. /
A, C, et D sont des rotules sans frottement, E un palier sans frottement, et B un contact sans frottement.







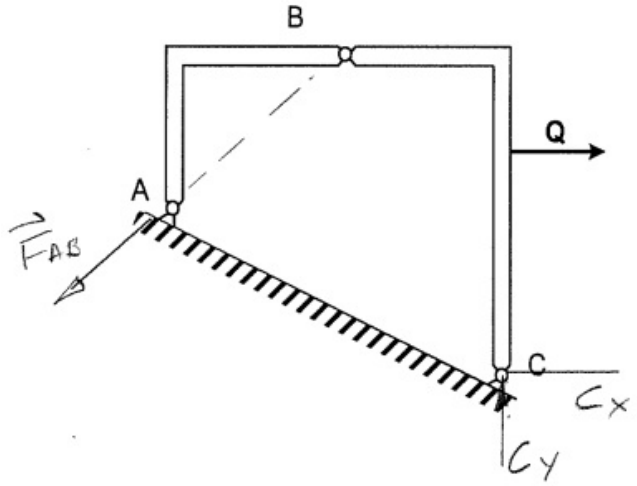


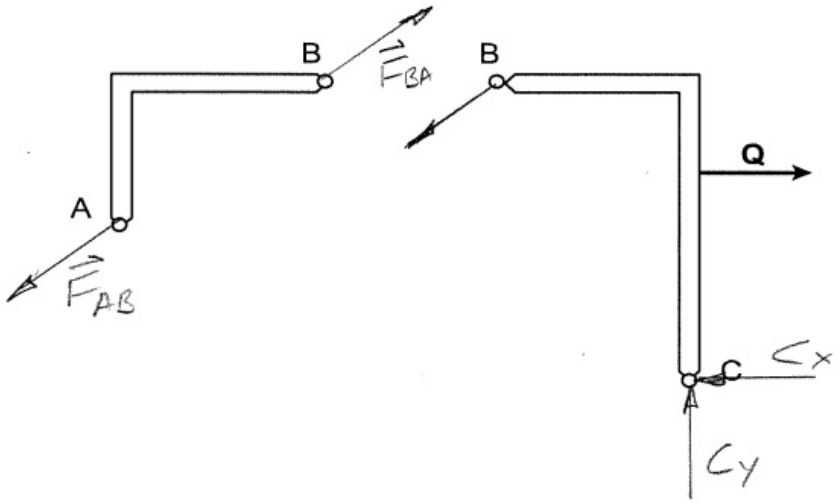
- W. Hallett February 2016

MCG1100 Free-body Diagram Practice Problems - Solutions
MCG1500 - Exemples - Schémas de corps isolées - solutions

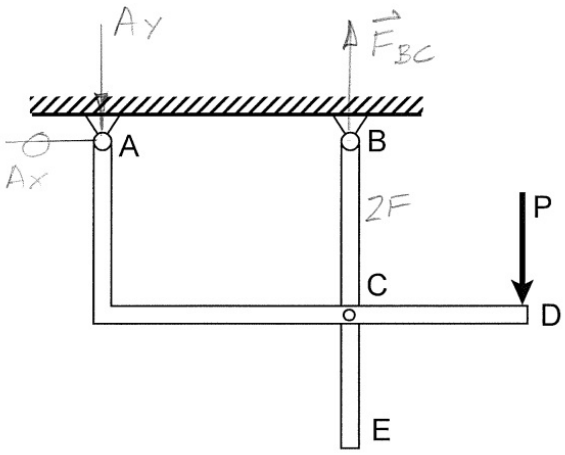
1. AB is two-force.
FB = whole structure: ΣM_C gives F_{AB}, ΣF_Y gives C_Y.
FB = BC: ΣM_B gives C_X.

1. AB est une pièce à deux forces.
CI = mécanisme complet: ΣM_C donne F_{AB}, ΣF_Y donne C_Y.
CI = BC: ΣM_B donne C_X.

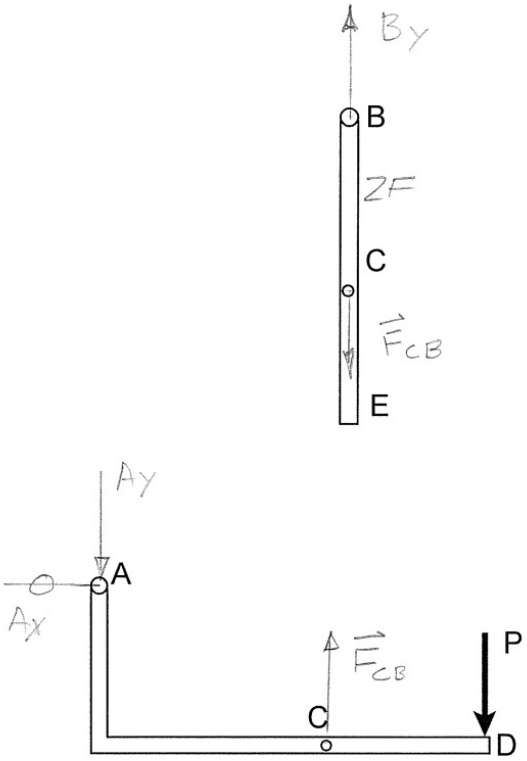




2. BCE is two-force (CE doesn`t do anything).
FB = whole structure: ΣM_B gives A_Y ; ΣM_A gives F_{BC}; ΣF_X shows that $A_X = 0$.
FB = BC: ΣF_Y gives F_{CB}; there is no x component at C.

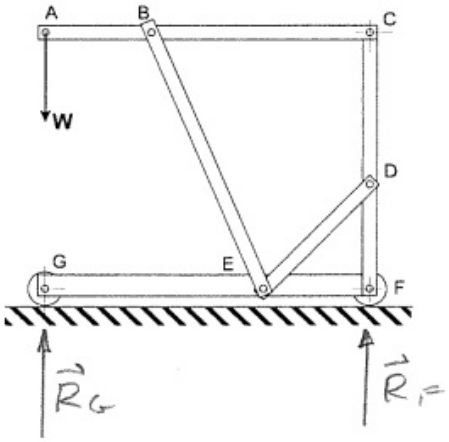


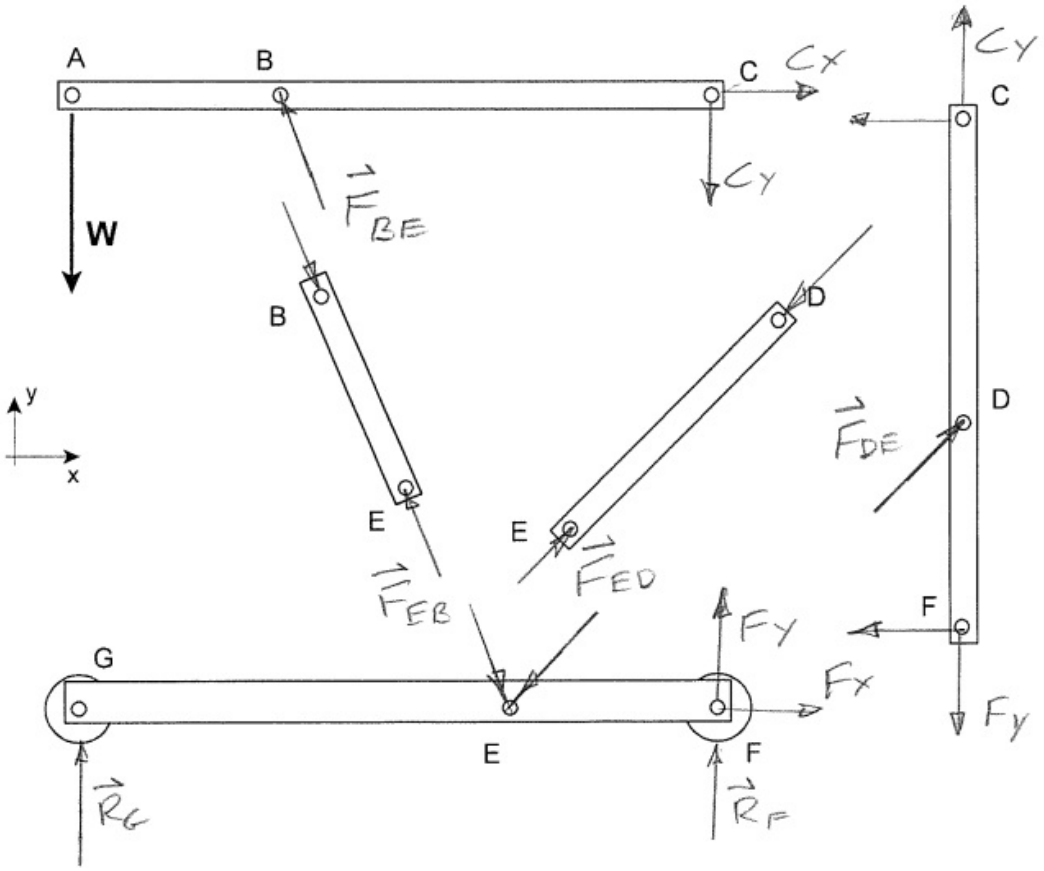
2. BCE est une pièce à deux forces (CE ne fait rien)
CI = mécanisme complet: ΣM_B donne A_Y ; ΣM_A donne F_{BC}; ΣF_X donne $A_X = 0$.
CI = BC: ΣF_Y donne F_{CB}; il n`y a pas de composante x à C.



3. Two-force: BE, DE
Whole structure as FB gives R_F and R_G.
Parts: FB = ABC: ΣM_C gives F_{BE}, ΣF_X gives C_X, ΣM_B gives C_Y.
FB = CDF: ΣM_F gives F_{DE}, ΣM_C gives F_X, ΣF_Y gives F_Y.

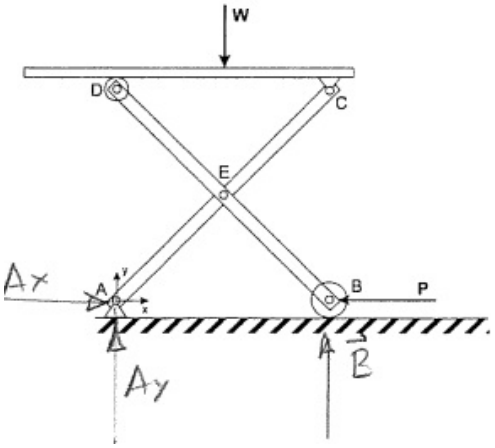
3. Membres à deux forces: BE, DE
CI = mécanisme complet donne R_F and R_G.
Pièces: CI = ABC: ΣM_C donne F_{BE}, ΣF_X donne C_X, ΣM_B donne C_Y.
CI = CDF: ΣM_F donne F_{DE}, ΣM_C donne F_X, ΣF_Y donne F_Y.

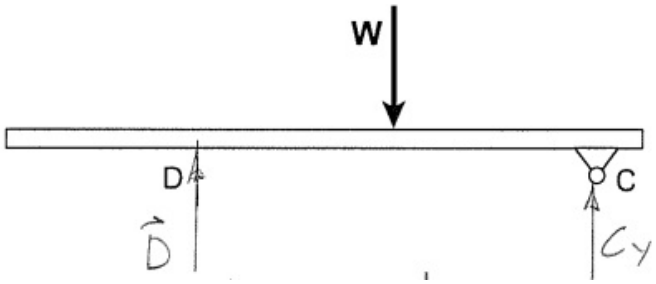


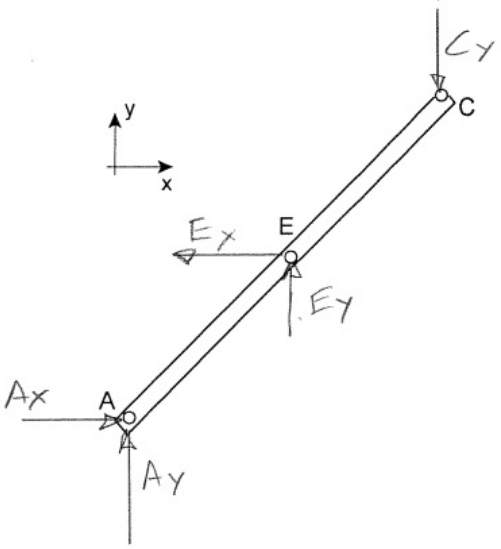


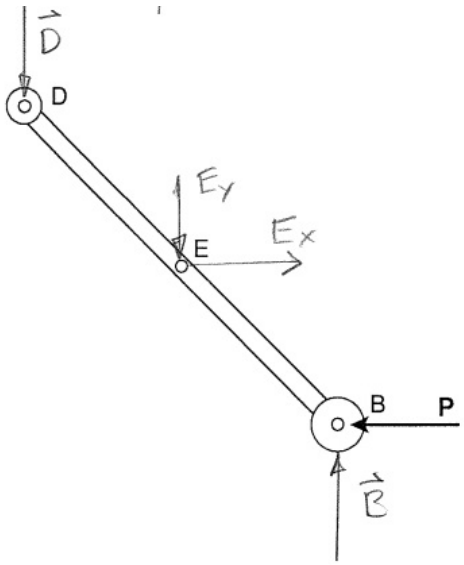
4. Two-force: none.
Whole structure as FB: ΣM_A and ΣM_B gives A_Y and B, ΣF_X gives A_X (= P).
Parts: FB = platform DC: gives D and C_Y. There is no C_X, because there are no other x forces.
FB = AEC: ΣF_X gives E_X. Direction of E_Y cannot be found, enter as +. (Calculations show that $E_Y = 0$ if load is centred between A and C.)

4. Membres à deux forces: aucun.
CI = mécanisme complet : ΣM_A, ΣM_B donnent A_Y et B, ΣF_X donne A_X (= P).
Pièces: CI = DC: donne D et C_Y. $C_X = 0$, car il n'y a pas des autres forces en x.
CI = AEC: ΣF_X donne E_X. On ne peut pas trouver la direction de E_Y , montrer comme +. (Les calculs montrent que $E_Y = 0$ si la charge est située au centre de A et C.)



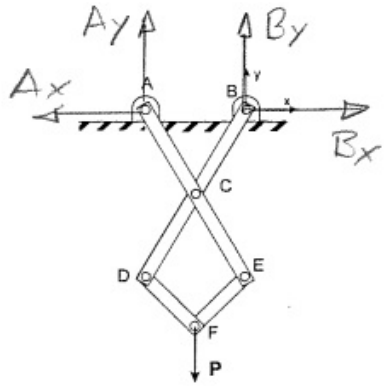


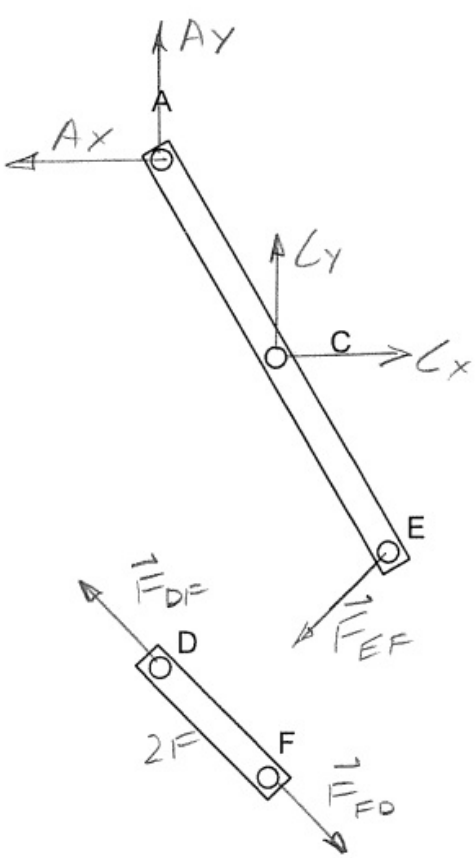


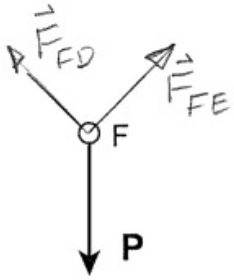


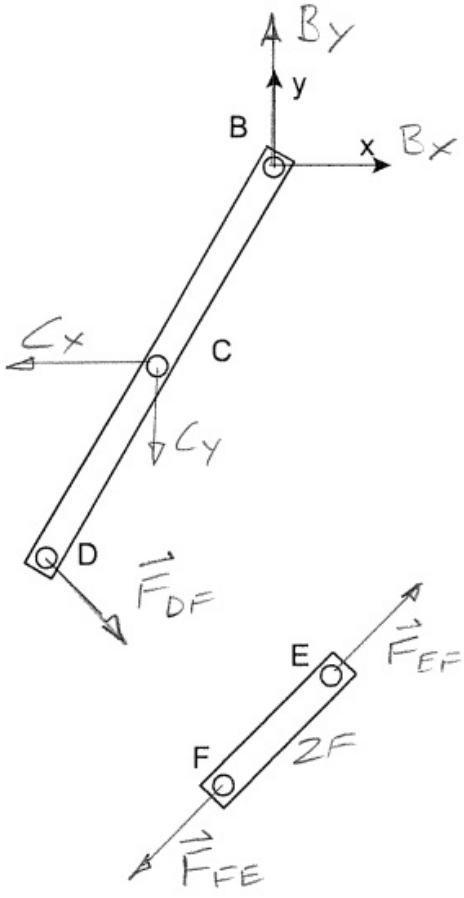
5. Two-force: FD and FE.
Whole structure as FB: ΣM_A and ΣM_B gives A_Y, B_Y
Parts: FB = pin F: ΣF_Y and ΣF_X give F_{FE} and F_{FD}
FB = ACE: ΣM_C gives A_X (= B_X, from whole structure), ΣF_X gives C_X. Direction of C_Y cannot be found without calculation - draw as + on ACE. (Symmetry shows that $C_Y = 0$.)

5. Membres à deux forces: FD, FE.
CI = structure complète: ΣM_A, ΣM_B donnent A_Y, B_Y
Pièces: CI = rotule F: ΣF_Y et ΣF_X donnentF_{FE} et F_{FD}
CI = ACE: ΣM_C donne A_X (= B_X - voir structure complète), ΣF_X donne C_X. On ne peut pas trouver la direction de C_Y sans faire des calculs - montrer comme + sur ACE. (La symmetrie montre que $C_Y = 0$.)









6. Two-force: none

FB = whole structure: does not give any information.

Parts: FB = AB: ΣM_A gives B (which is normal to the slot), ΣF_X, ΣF_Y give A_X, A_Y (or one can simply draw a force vector A which is equal and opposite to B).

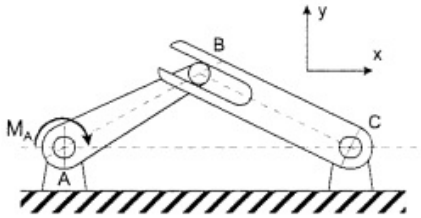
FB = BC: similar process gives C_X, C_Y and couple M_C. Note that on the whole structure, A_Y and C_Y constitute a couple which balances (M_A + M_C).

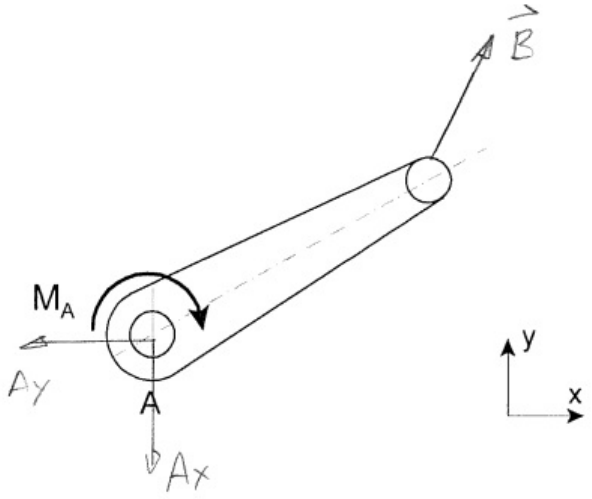
6. Membres à deux forces: aucun

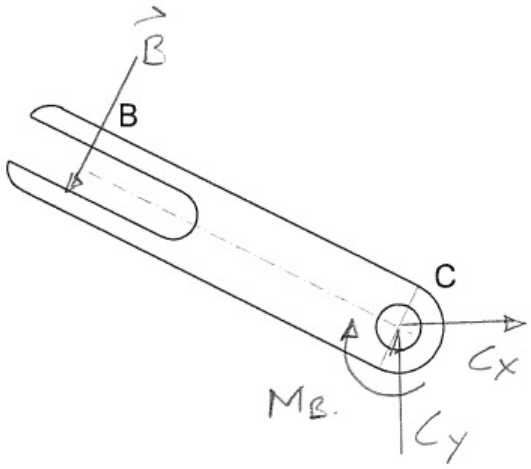
CI = mécanisme complet: ne donne aucune information

Pièces: CI = AB: ΣM_A donne B (force normale à la fente), ΣF_X, ΣF_Y donnent A_X, A_Y on peut aussi simplement montrer un vecteur de force A qui est égal et opposé à B).

CI = BC: un processus similaire donne C_X, C_Y et le couple M_C. Pour la structure complète, A_Y et C_Y forme un couple qui est en équilibre avec (M_A + M_C).

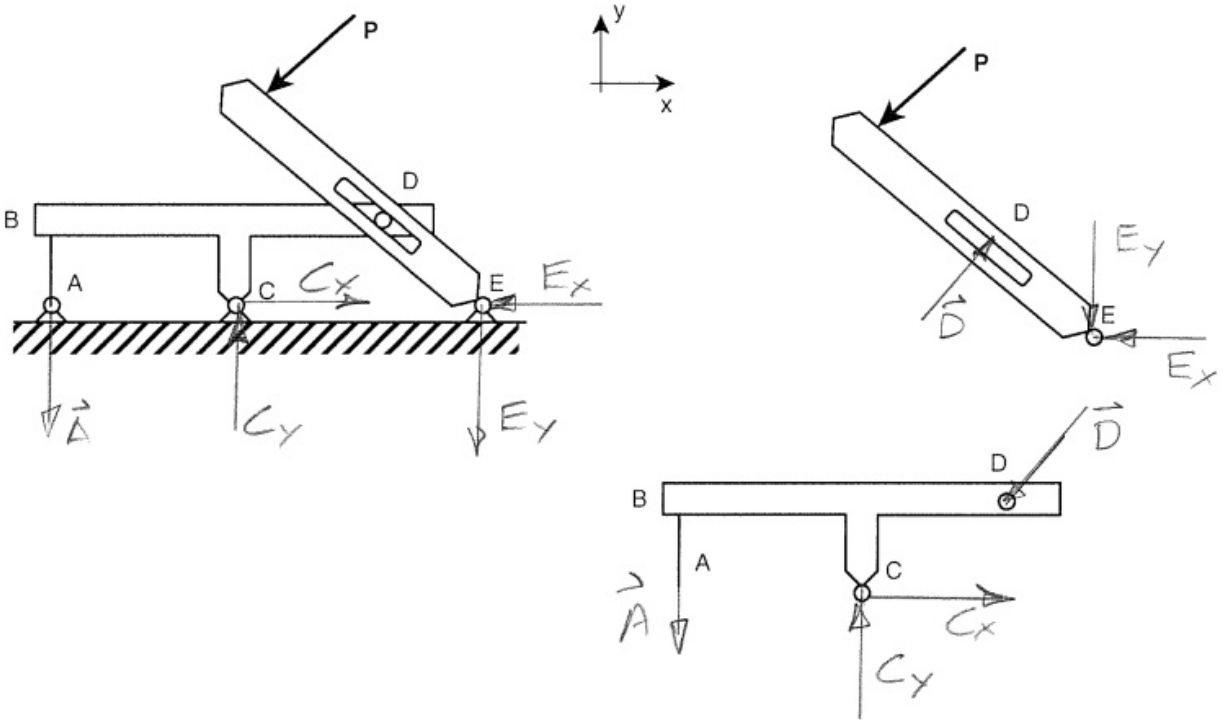






7. Two-force: AB
FB = whole structure: gives no information at this stage
Parts: FB = DE: ΣM_E gives D
FB = BD: ΣM_C gives A, ΣF_X, ΣF_Y give C_X, C_Y
FB = whole structure: ΣF_X gives E_X. For E_Y, note that force vector E must be parallel to P and D, therefore E_Y must be -.

7. Two-force: AB
CI = mécanisme complet: ne donne aucune information
Pièces: CI = DE: ΣM_E donne D.
CI = BD: ΣM_C gives A, ΣF_X, ΣF_Y give C_X, C_Y
CI = whole structure: ΣF_X gives E_X. For E_Y, note that force vector E must be parallel to P and D, therefore E_Y must be -.



8. Two-force: AE, BE, DE

FB = whole structure: directions of reactions at A and B line up with 2F's AE and BE. Frictionless contact at H gives H.

Parts: FB = CD: frictionless contact at F gives F, ΣM_C gives D, ΣF_X gives C_X. Direction of C_Y cannot be found without calculation, draw as +.

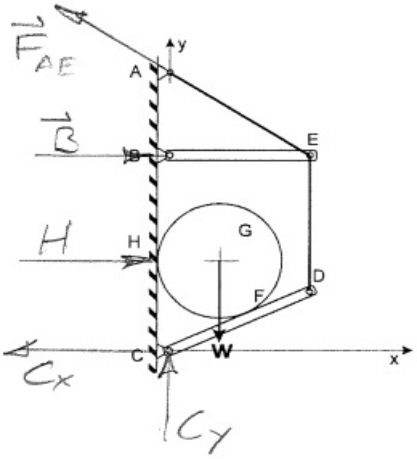
FB = BE: at E, assume pin E attached to BE, show forces DE and AE acting at E on BE. ΣF_X, ΣF_Y give B and F_{EA}. Note that F_{EA} and F_{ED} sum to a resultant in line with BE.

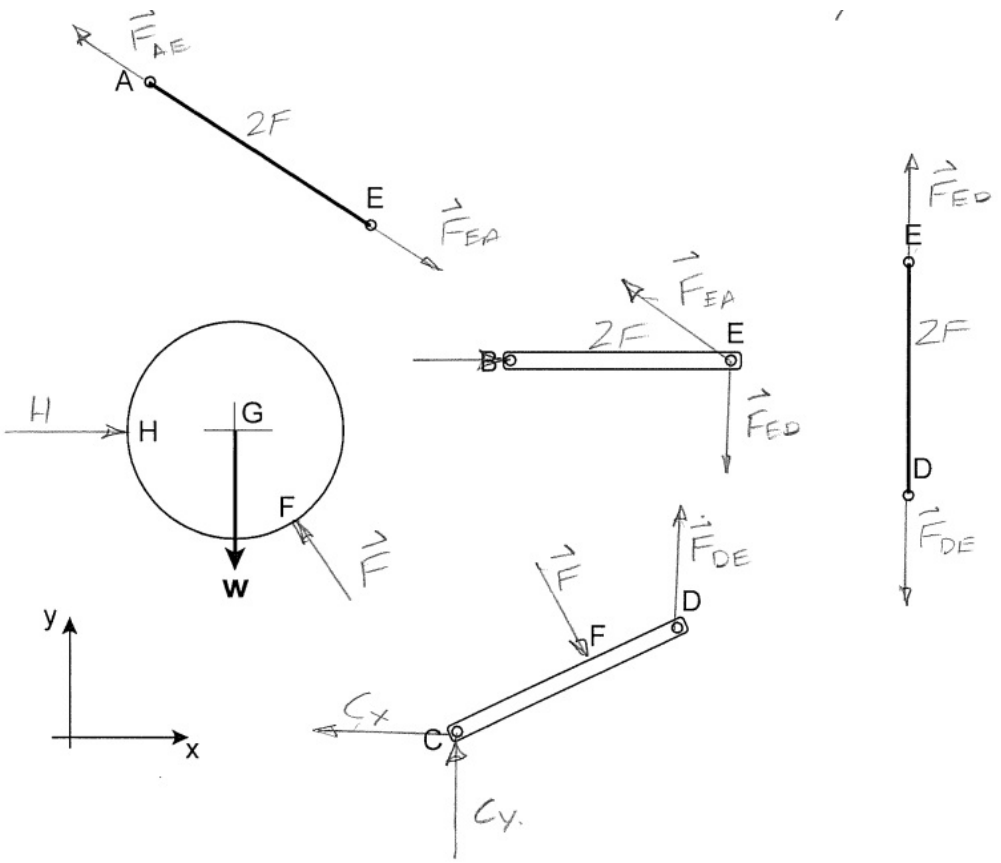
8. Membres à deux forces: AE, BE, DE

CI = structure complète: réactions à A, B s'alignent avec AE, BE. Contact sans frottement à H donne H.

Pièces: CI = CD: contact sans frottement à F donne F, ΣM_C donne D, ΣF_X donne C_X. On ne peut pas trouver la direction de C_Y sans faire des calculs, montrer comme +.

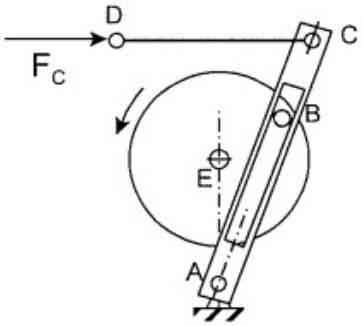
CI = BE: À E, assumer que la rotule E est attachée à BE, donc montrer forces de DE et AE à E sur BE. ΣF_X, ΣF_Y donnent B et F_{EA}. Notez que ($F_{EA} + F_{ED}$) donne une force résultant égale et opposée à BE.

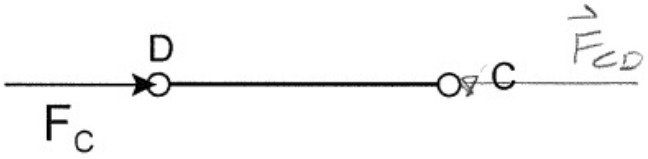


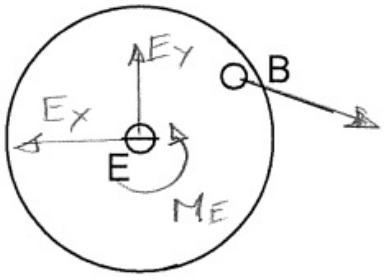


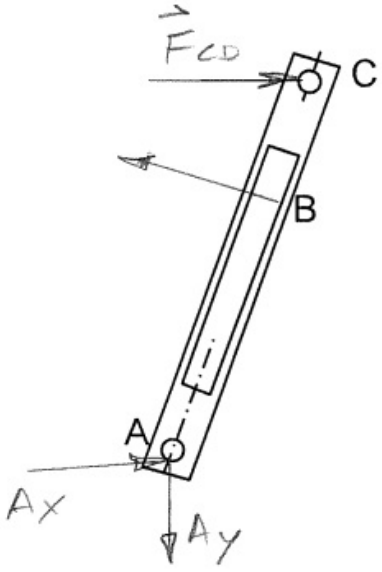
9. Two-force: CD
FB = structure: gives no information
Parts: FB = ABC: ΣM_A gives B (note that B is normal to slot), ΣF_Y gives A_Y. A_X cannot be found without calculation, draw as + . (A_X can be found if one recognizes that ABC is a three-force member, so that the lines of action of F_{CD}, B, and A intersect at a single point.)
FB = wheel: ΣM_E gives driving couple M_E, ΣF_X , ΣF_Y give E_X, E_Y.

9. Membres à deux forces: CD
CI = structure complète: ne donne aucune information
Pièces: CI = ABC: ΣM_A donne B (B est normale à la fente) ΣF_Y donne A_Y. On ne peut pas trouver A_X sans faire des calculs, montrer comme + . (On peut trouver A_X si on reconnait que ABC est un membre à trois forces, donc les lignes de F_{CD}, B, and A se coupe à une pointe unique.)
CI = rou: ΣM_E donne le couple M_E, ΣF_X , ΣF_Y donnent E_X, E_Y.









W. Hallett, February 2016