Nguyen Xuan Binh 887799

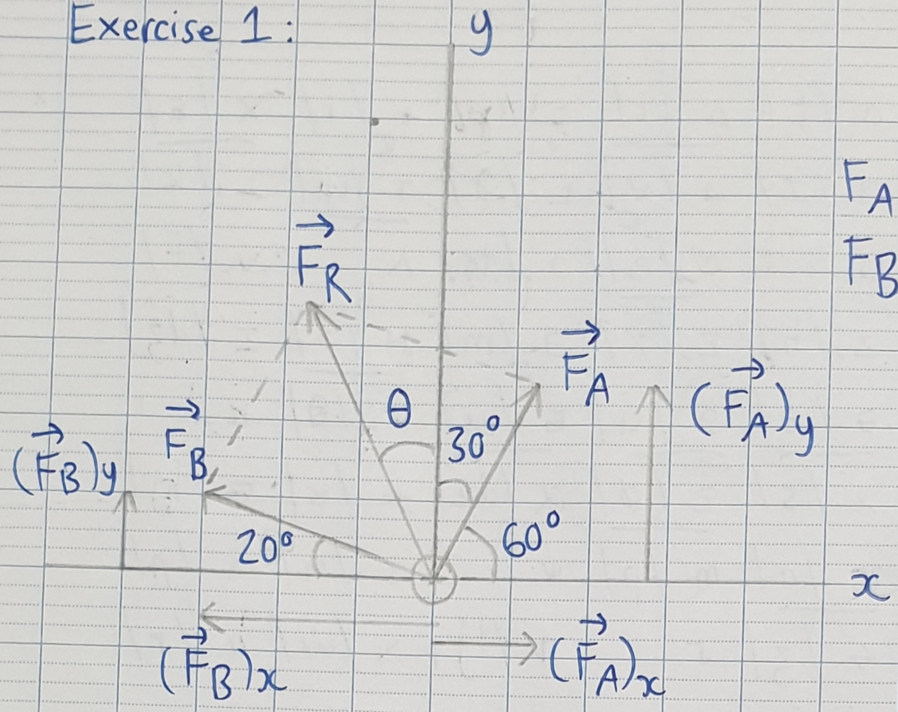
Thứ

Ngày

No.

Statics & Dynamics (Assignment 1)

Exercise 1:



$F_A = 700N$

$F_B = 600N$

* The components of the resultant force are

▫ $(F_R)_x = (F_B)_x - (F_A)_x$

$\Rightarrow (F_R)_x = 600 \cos 20^\circ - 700 \cos 60^\circ \approx 213,82 \text{ N}$

▫ $(F_R)_y = (F_B)_y + (F_A)_y$

$= 600 \sin 20^\circ + 700 \sin 60^\circ \approx 811,43 \text{ N}$

* The magnitude of $\vec{F}_R$

$F_R = \sqrt{(F_R)_x^2 + (F_R)_y^2} = \sqrt{213,82^2 + 811,43^2}$

$\Rightarrow F_R \approx 839,13 \text{ N}$

* Orientation θ of $\vec{F}_R$

$\theta = \tan^{-1}\left(\frac{(F_R)_x}{(F_R)_y}\right) = \tan^{-1}\left(\frac{213,82}{811,43}\right) \approx 14,762^\circ$

The resultance force $\vec{F}_R$ has the magnitude of 839,13N and orientation of $\theta = 14,762^\circ$ measured counter-clockwise from the positive y-axis

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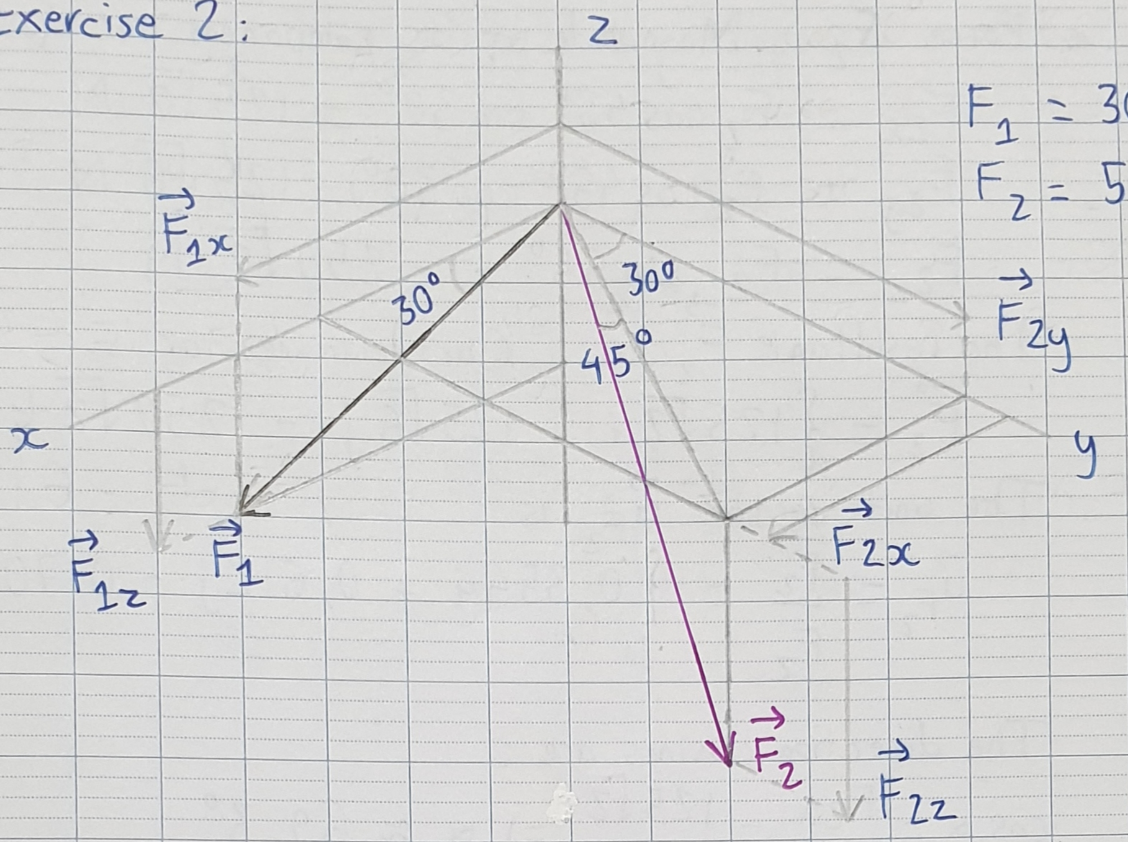
Exercise 2:

$F_1 = 300N$

$F_2 = 500N$



* Force $\vec{F}_1$: Magnitude of its component vectors are

$F_{1x} = F_1 . \cos 30° = 300 \cos 30° = 259,8 N$

$F_{1z} = -F_1 . \sin 30° = -300 . \sin 30° = -150 N$

$F_{1y} = 0$

The resultant $\vec{F}_1$ as a cartesian vector is

$\vec{F}_1 = \{259,8i - 150k\} N$

The unit vector $\vec{u}_{F_1}$ is

$$\vec{u}_{F_1} = \frac{\vec{F}_1}{F_1} = 0,866i - 0,5k$$

The direction cosines are

$$\cos\alpha = \frac{F_{1x}}{F_1} \Rightarrow \alpha = 30° \qquad \cos\beta = \frac{F_{1y}}{F_1} = 0 \Rightarrow \beta = 90°$$

$$\cos\gamma = \frac{F_{1z}}{F_1} \Rightarrow \gamma = 120°$$

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* Force $\vec{F}_2$: Magnitude of its component vectors are :

$$F_{2x} = F_2 \cos 45^\circ . \sin 30^\circ = 125\sqrt{2}\ N$$

$$F_{2y} = F_2 \cos 45^\circ . \cos 30^\circ = 125\sqrt{6}\ N$$

$$F_{2z} = -F_2 . \sin 45^\circ = -250\sqrt{2}\ N$$

The resultant $\vec{F}_2$ as a Cartesian vector is

$$\vec{F}_2 = \{125\sqrt{2}\, i + 125\sqrt{6}\, j - 250\sqrt{2}\, k\}\ N$$

The unit vector $\vec{u}_{F_2}$ is

$$\vec{u}_{F_2} = \frac{\vec{F}_2}{F_2} = 0,354 i + 0,612 j - 0,707 k$$

The direction cosines are :

$$\cos\alpha = \frac{F_{2x}}{F_2} = \frac{125\sqrt{2}}{500} \Rightarrow \alpha \approx 69,3^\circ$$

$$\cos\beta = \frac{F_{2y}}{F_2} = \frac{125\sqrt{6}}{500} \Rightarrow \beta \approx 52,2^\circ$$

$$\cos\gamma = \frac{F_{2z}}{F_2} = \frac{-250\sqrt{2}}{500} \Rightarrow \gamma = 135^\circ$$

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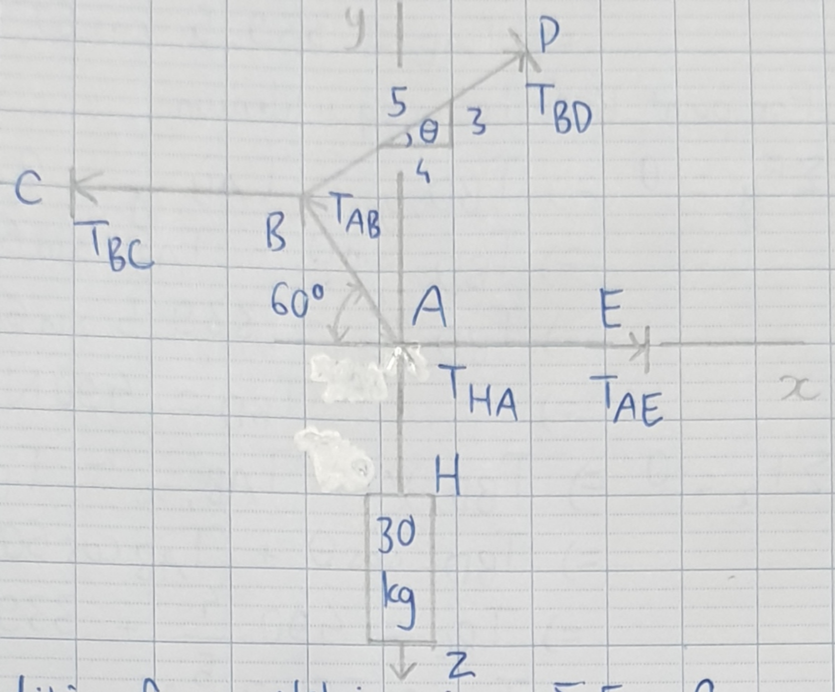
Exercise 3: The 30 kg pipe is supported at A by a system of five cords. Determine the force in each cord for equilibrium



The condition for equilibrium is: $\Sigma F = 0$

$\Rightarrow \Sigma F_x i + \Sigma F_y j = 0 \Rightarrow \Sigma F_x = 0, \ \Sigma F_y = 0$

- $\Sigma F_x = 0$

$\Rightarrow T_{BD,x} + T_{AE,x} \cancel{- T_{AB,x}} - T_{BC,x} = 0$

- $\Sigma F_y = 0$

$\Rightarrow \cancel{T_{AB,y}} - T_{AH,y} + T_{BD,y} = 0$

We have: 30 kg creates force of $30 \times$ gravity $= 30.9.81$
$= 294 N = T_{HZ}$

* For point H to be in equilibrium

$\Rightarrow \Sigma F_y = 0 \Rightarrow T_{HA} = T_{HZ} = 294 N$

* For point A to be in equilibrium

$\Sigma F_y = 0 \Rightarrow T_{AB,y} - T_{HZ} = 0$

$\Rightarrow T_{AB} \sin 60° - T_{HZ} = 0$

$\Rightarrow T_{AB} = \frac{T_{HZ}}{\sin 60°} = \frac{294}{\sin 60°} \approx 339,5 N$

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$\Sigma F_x = 0 \Rightarrow T_{AE} - T_{AB,x} = 0$

$\Rightarrow T_{AE} - T_{AB} \cos 60^\circ = 0$

$\Rightarrow T_{AE} = 339,5 \cdot \cos 60^\circ \approx 169,7\ N$

* For point B to be in equilibrium

$\Sigma F_y = 0 \Rightarrow T_{BD,y} - T_{AB,y} = 0$

$\Rightarrow T_{BD} \cdot \sin\theta - T_{AB} \cdot \sin 60^\circ = 0$

$\Rightarrow T_{BD} \frac{3}{5} - 339,5 \sin 60^\circ = 0$

$\Rightarrow T_{BD} = 490N$

$\Sigma F_x = 0 \Rightarrow T_{BD,x} + T_{AB,x} - T_{BC} = 0$

$\Rightarrow T_{BD} \cdot \cos\theta + T_{AB} \cos 60^\circ - T_{BC} = 0$

$\Rightarrow T_{BC} = 490 \cdot \frac{4}{5} + 339,5 \cdot \cos 60^\circ$

$\Rightarrow T_{BC} \approx 561,7\ N$

The force in each cord are

$T_{HA} = 294N \quad T_{AB} = 339,5N \approx 340N$

$T_{AE} = 169,7N \approx 170N \quad T_{BD} = 490N$

$T_{BC} \approx 561,7N \approx 562N$

Verify:

- $\Sigma F_x = 0$

$\Rightarrow T_{BD,x} + T_{AE} - T_{BC} = 0$

$\Rightarrow 450 \frac{4}{5} + 169,7 - 561,7 \approx 0$

- $\Sigma F_y = 0$

$\Rightarrow T_{BD,y} - T_{HZ} = 0$

$\Rightarrow 490 \cdot \frac{3}{5} - 294 = 0$

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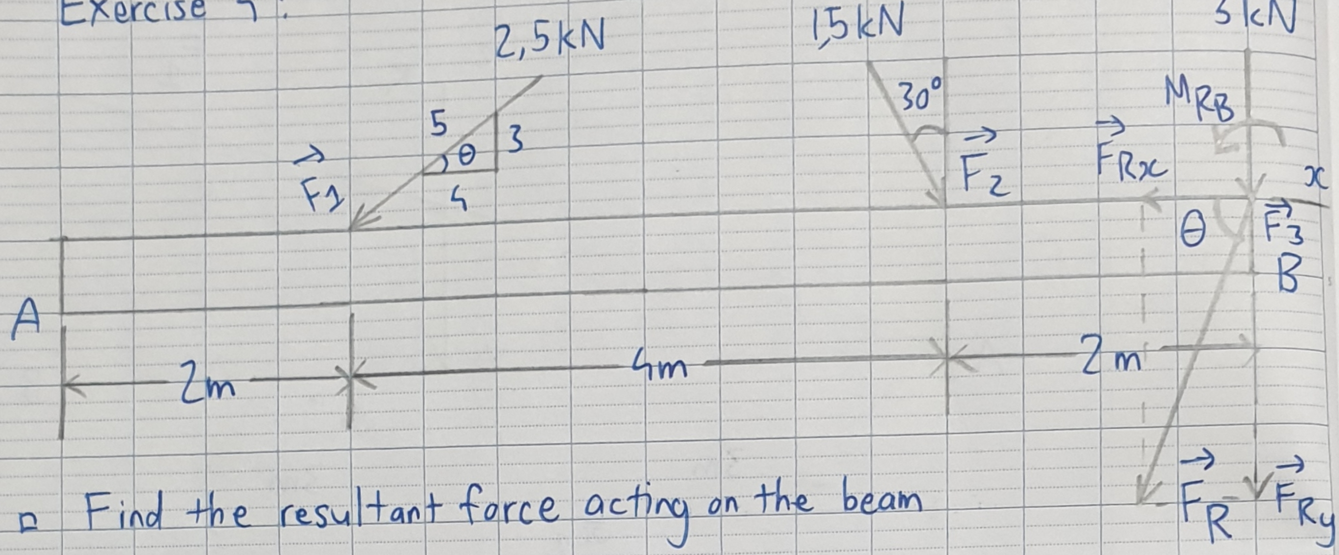
Exercise 4:



- Find the resultant force acting on the beam

- Its components

$$F_{Rx} = \Sigma F_x = -2,5\,kN \cos\theta + 1,5\,kN.\sin 30^\circ$$
$$= -2,5\,kN.\frac{4}{5} + 1,5\,kN.\sin 30^\circ$$
$$= -1,25\,kN$$

$$F_{Ry} = \Sigma F_y = -2,5\,kN \sin\theta - 1,5\,kN \cos 30^\circ - 3\,kN$$
$$= -2,5\,kN\,\frac{3}{5} - 1,5\,kN \cos 30^\circ - 3\,kN$$
$$\approx -5,8\,kN$$

- Its magnitude

$$F_R = \sqrt{F_{Rx}^2 + F_{Ry}^2} = \sqrt{(-1,25)^2 + (-5,8)^2} = 5,93\,kN$$

- Its direction from x negative axis

$$F_{R\theta} = \tan^{-1}\left(\frac{F_{Ry}}{F_{Rx}}\right) = \tan^{-1}\left(\frac{-5,8}{-1,25}\right) \approx 77,83^\circ$$

- Let rotation as counter-clockwise positive

Couple moment at point B is

$$\circlearrowleft + M_{R_B} = \Sigma M_{R_B} = \vec{F}_{1y}.d_1 + \vec{F}_{2y}.d_2 + \vec{F}_{3y}.d_3$$
$$= 2,5\,kN \times \frac{3}{5}.(6m) + 1,5\,kN \times \cos 30^\circ.(2m) + 3kN.0m$$
$$= 9 + 2,598 = 11,598\,kN.m$$

This couple moment is counterclockwise

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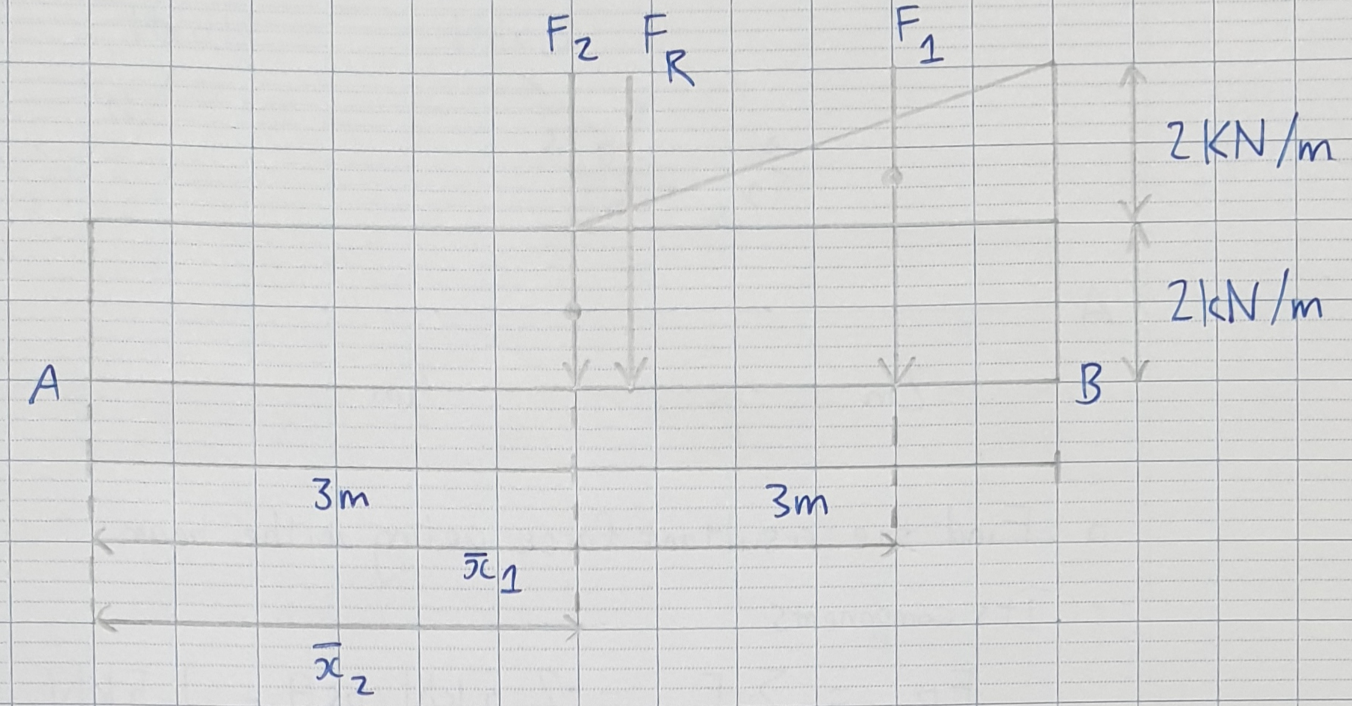
Exercise 5 :



- Divide the distribution in 2 areas

Triangle : $+\downarrow F_1 = \frac{1}{2}(2kN/m).3m = 3kN$

Rectangle : $+\downarrow F_2 = (2kN/m).6m = 12kN$

- The centroid for each distribution is located at

$$\bar{x}_1 = 3m + \frac{2}{3}3m = 5m$$

$$\bar{x}_2 = \frac{1}{2}(3m + 3m) = 3m$$

- The magnitude of the resultant force is

$$+\downarrow F_R = F_1 + F_2 = 3 + 12 = 15kN$$

- Location of the resultant force on the beam, measured from pin A

$$+\circlearrowleft (M_R)_A = \Sigma M_A$$

$\Rightarrow \quad -F_R \bar{x}_R = -F_1\bar{x}_1 - F_2\bar{x}_2$

$\Rightarrow \quad -15kN.\bar{x}_R = -3kN.5m - 12kN.3m$

$\Rightarrow \quad \bar{x}_R = \frac{51}{15}m = 3,4m$