

Teknologi A

Mekanik

Lösningar

I detta dokument finns lösningsförslag till samtliga uppgifter i boken ”Teknologi A – Mekanik”.

På YouTube kanalen, ”Lösningar Teknologi A Mekanik”, finns inspelade lösningsförslag till många av uppgifterna. Det finns även en spellista med föreläsningar som är anpassad till boken (dock ej kombinerade lastfall och knäckning).

Jag använder mig att Karl Björks ”Formler och Tabeller för Mekanisk konstruktion” när jag löser uppgifterna.

Om du inte har en formelsamling i maskinkonstruktion så rekommenderar jag starkt Karl Björks formelsamling. Denna finns att beställa på bjorksfordlag.se

En komplett översikt av kanalen och materialet finns på edume.ru

/Madeleine



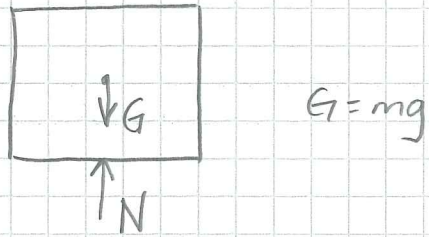
<https://www.youtube.com/channel/UCZWty6uAUlkab9XyHQAu9Q>



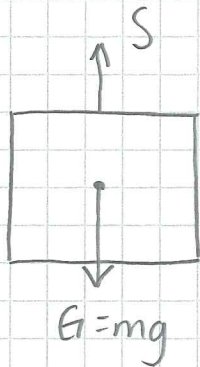
Madeleine Hermann

EduME – Education and Mechanical Engineering

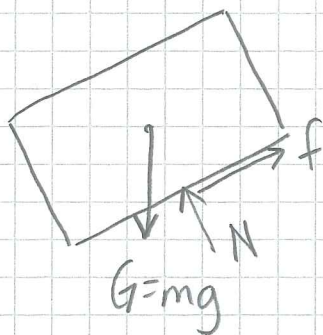
5.1



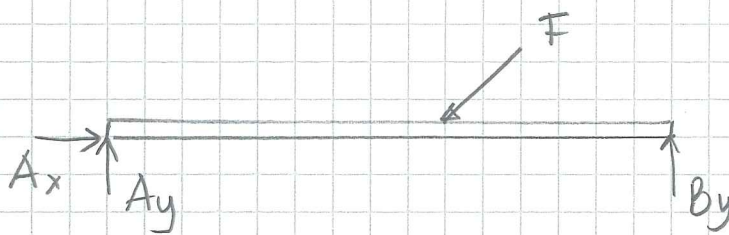
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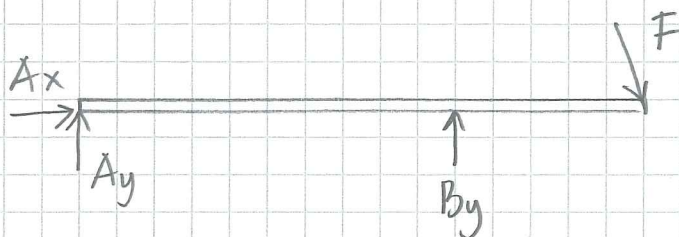
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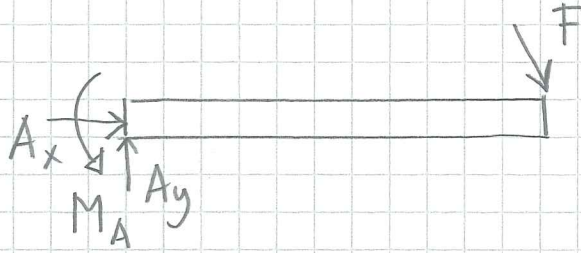
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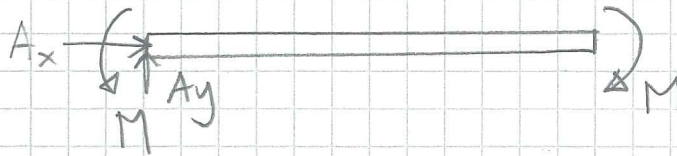
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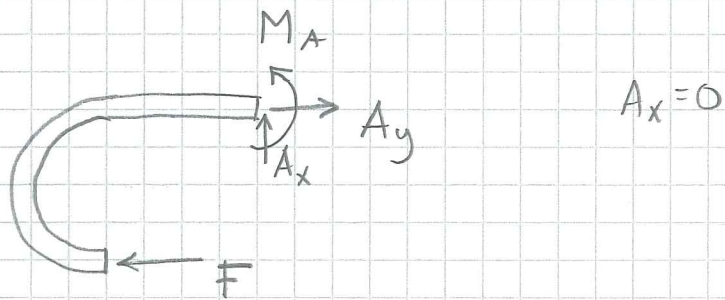
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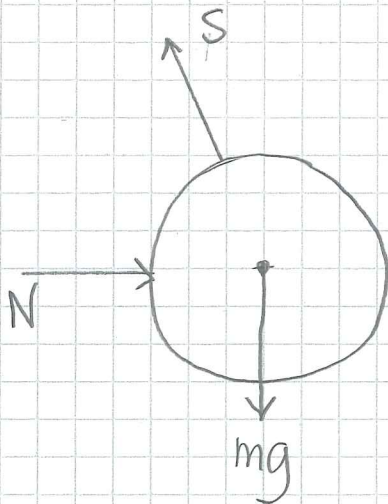
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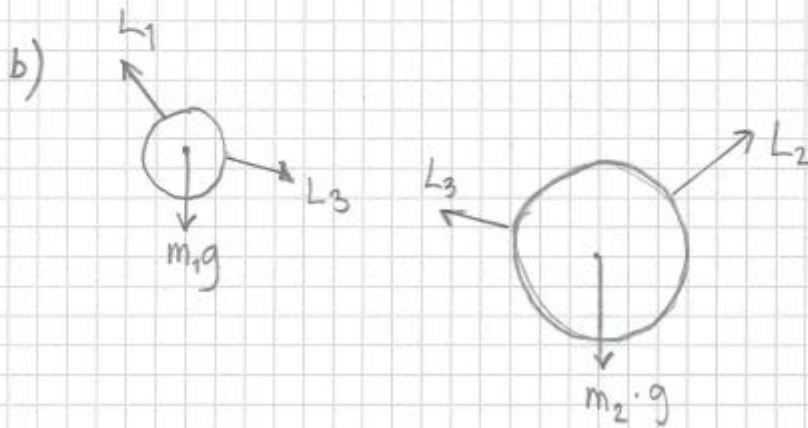
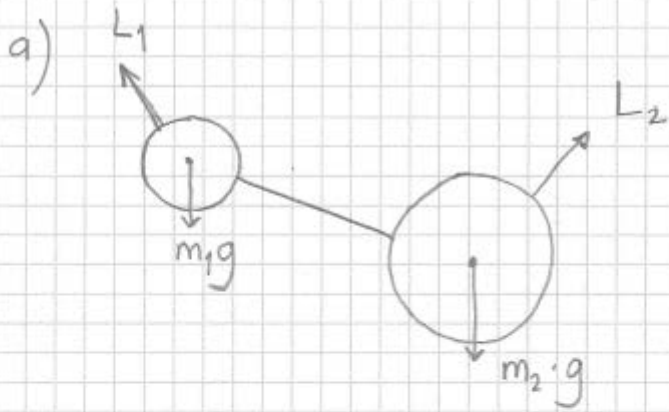
5.8



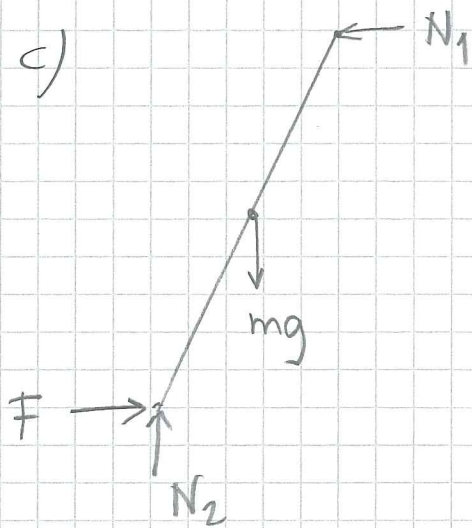
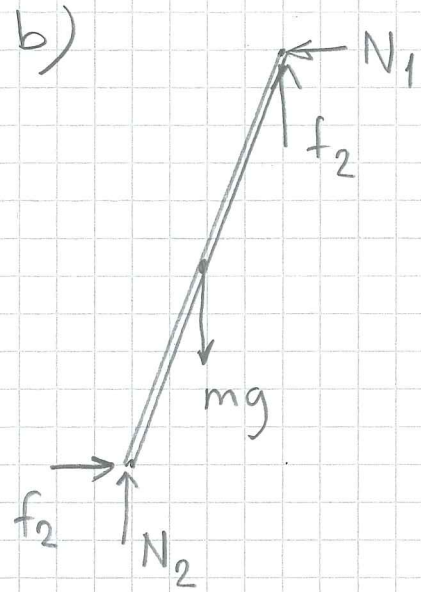
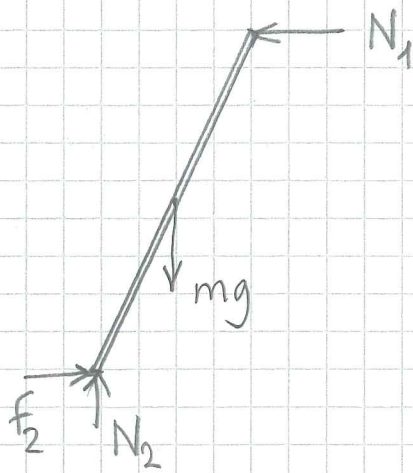
5.9



5.10

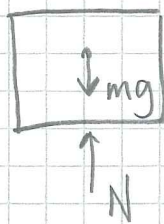


5.11 a



5.12

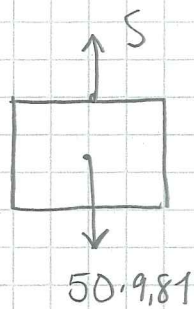
$m = 75 \text{ kg}$



$$\uparrow N - 75 \cdot 9,81 = 0$$

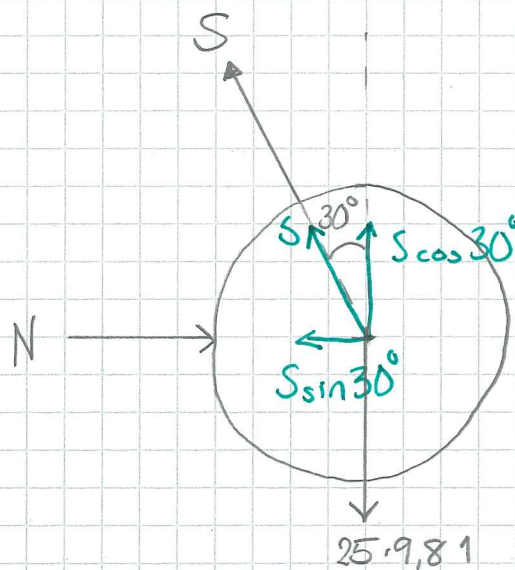
$$N = 736 \text{ N}$$

5.13



$$\uparrow S - 50 \cdot 9,81 = 490 \text{ N}$$

5.14



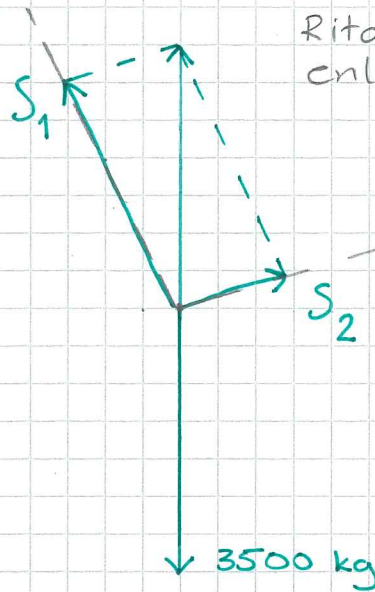
$$\uparrow S \cos 30^\circ - 25 \cdot 9,81 = 0$$

$$S = \frac{25 \cdot 9,81}{\cos 30^\circ} = \underline{\underline{283 \text{ N}}}$$

$$\rightarrow N - S \sin 30^\circ = 0$$

$$N = 283 \sin 30^\circ = \underline{\underline{142 \text{ N}}}$$

5.15a



Rita med rätt proportioner enl. mått i bild.

$$1 \text{ cm} = 1000 \text{ kg}$$

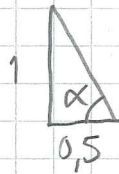
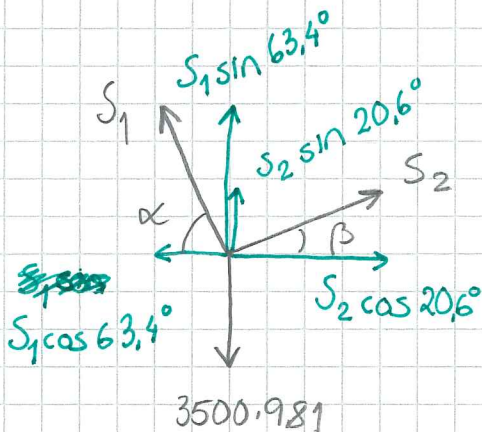
$$S_2 = 1,5 \text{ cm} = 1500 \text{ kg}$$

$$S_2 = 9,81 \cdot 1500 = 14,7 \text{ kN}$$

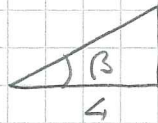
$$S_1 = 3,3 \text{ cm} = 3300 \text{ kg}$$

$$S_1 = 9,81 \cdot 3300 = 32,4 \text{ kN}$$

b)



$$\alpha = \arctan\left(\frac{1}{0,5}\right) = 63,4^\circ$$



$$\beta = \arctan\left(\frac{1,5}{4}\right) = 20,6^\circ$$

$$\rightarrow S_2 \cos 20,6^\circ - S_1 \cos 63,4^\circ = 0$$

$$S_2 = S_1 \frac{\cos 63,4^\circ}{\cos 20,6^\circ} = S_1 \cdot 0,478$$

$$\uparrow S_1 \sin 63,4^\circ + S_2 \sin 20,6^\circ - 3500 \cdot 9,81 = 0$$

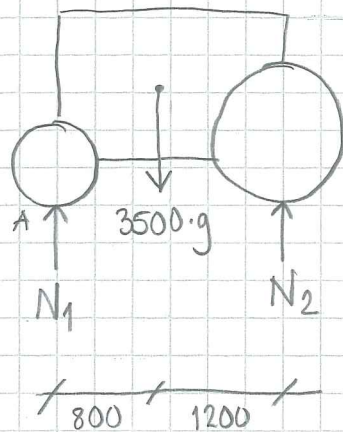
$$S_1 \sin 63,4^\circ + S_1 \cdot 0,478 \sin 20,6^\circ = 3500 \cdot 9,81$$

$$S_1 (\sin 63,4^\circ + 0,478 \cdot \sin 20,6^\circ) = 3500 \cdot 9,81$$

$$S_1 \cdot 1,062 = 3500 \cdot 9,81 \Rightarrow S_1 = \underline{\underline{32,3 \text{ kN}}}$$

$$S_2 = 32,3 \cdot 0,478 = \underline{\underline{15,4 \text{ kN}}}$$

5.16



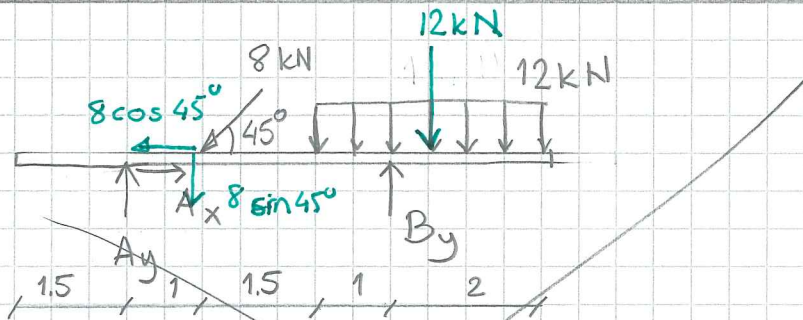
$$\overset{\curvearrowright}{A} \quad 3500 \cdot 9,81 \cdot 0,8 - N_2 \cdot (0,8 + 1,2) = 0$$

$$N_2 = \frac{3500 \cdot 9,81 \cdot 0,8}{0,8 + 1,2} = 13734 \text{ N} = \underline{\underline{13,7 \text{ kN}}}$$

$$\uparrow \quad N_1 + N_2 - 3500 \cdot 9,81 = 0$$

$$N_1 = 3500 \cdot 9,81 - 13734 = 20601 \text{ N} = \underline{\underline{20,6 \text{ kN}}}$$

5.17



$$\overset{\curvearrowright}{A} \quad 12 \cdot 3 + 1,8 \sin 45^\circ - B_y \cdot 3,5 = 0$$

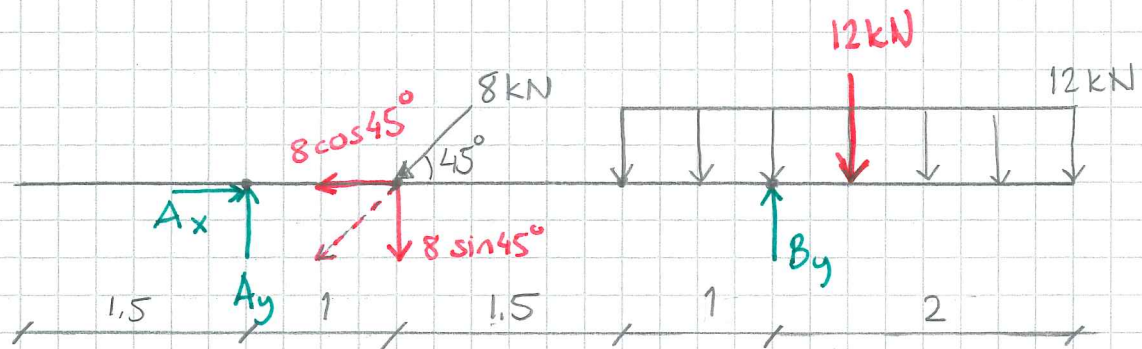
$$B_y = \frac{12 \cdot 3 + 1,8 \sin 45^\circ}{3,5} \Rightarrow B_y = 11,9 \text{ kN}$$

$$\uparrow \quad A_y + B_y - 12 - 8 \sin 45^\circ = 0$$

$$A_y = 12 + 8 \sin 45^\circ - 11,9 = 5,76 \text{ kN}$$

$$\rightarrow \quad A_x - 8 \cos 45^\circ = 5,66 \text{ kN}$$

5,17



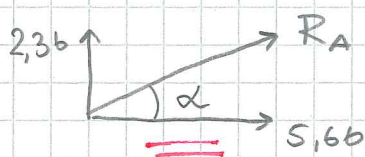
$$\overset{\curvearrowright}{A} \quad 1 \cdot 8 \sin 45^\circ + 4 \cdot 12 - 3,5 \cdot B_y = 0$$

$$B_y = \frac{8 \sin 45^\circ + 4 \cdot 12}{3,5} = \underline{\underline{15,3 \text{ kN}}}$$

$$\uparrow \quad A_y + B_y - 8 \sin 45^\circ - 12 = 0$$

$$A_y = 8 \sin 45^\circ + 12 - 15,3 = 2,36 \text{ kN.}$$

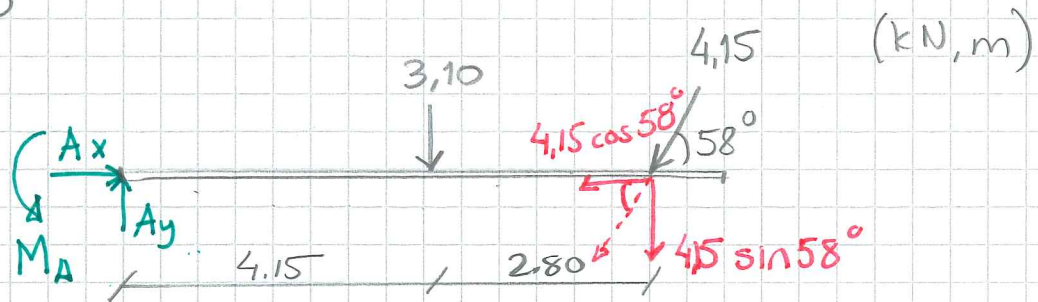
$$\rightarrow \quad A_x - 8 \cos 45^\circ = 5,66 \text{ kN}$$



$$R_A = \sqrt{5,66^2 + 2,36^2} = \underline{\underline{6,1 \text{ kN}}}$$

$$\alpha = \arctan \frac{2,36}{5,66} = \underline{\underline{22,6^\circ}}$$

5,18

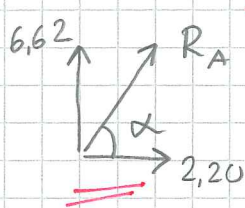


$$\uparrow A_y - 3,10 - 4,15 \sin 58^\circ = 0 \Rightarrow A_y = 6,62 \text{ kN}$$

$$\rightarrow A_x - 4,15 \cos 58^\circ = 0 \Rightarrow A_x = 2,20 \text{ kN}$$

$$\curvearrow A) M_A - 3,10 \cdot 4,15 - 4,15 \sin 58^\circ \cdot (4,15 + 2,80) = 0$$

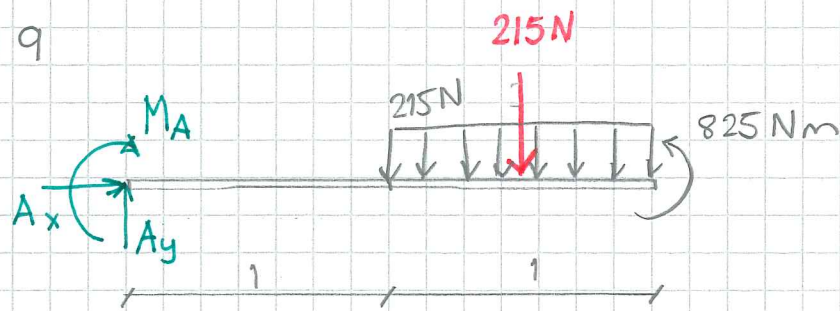
$$M_A = \underline{\underline{37,3 \text{ kNm}}}$$



$$R_A = \sqrt{6,62^2 + 2,20^2} = \underline{\underline{7,0 \text{ kN}}}$$

$$\alpha = \arctan\left(\frac{6,62}{2,20}\right) = \underline{\underline{71,6^\circ}}$$

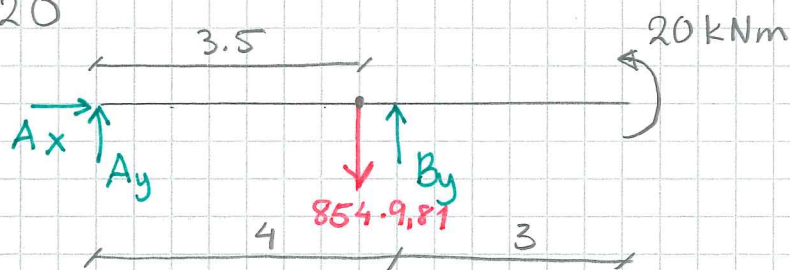
5,19



$$\rightarrow \underline{A_x = 0} \quad \uparrow Ay - 215 = 0 \quad Ay = \underline{215 \text{ N}}$$

$$\curvearrowleft A \quad M_A + 215 \cdot 1,5 - 825 = 0 \Rightarrow M_A = \underline{503 \text{ Nm}}$$

5,20



$$m = 122.7 = 854 \text{ kg}$$

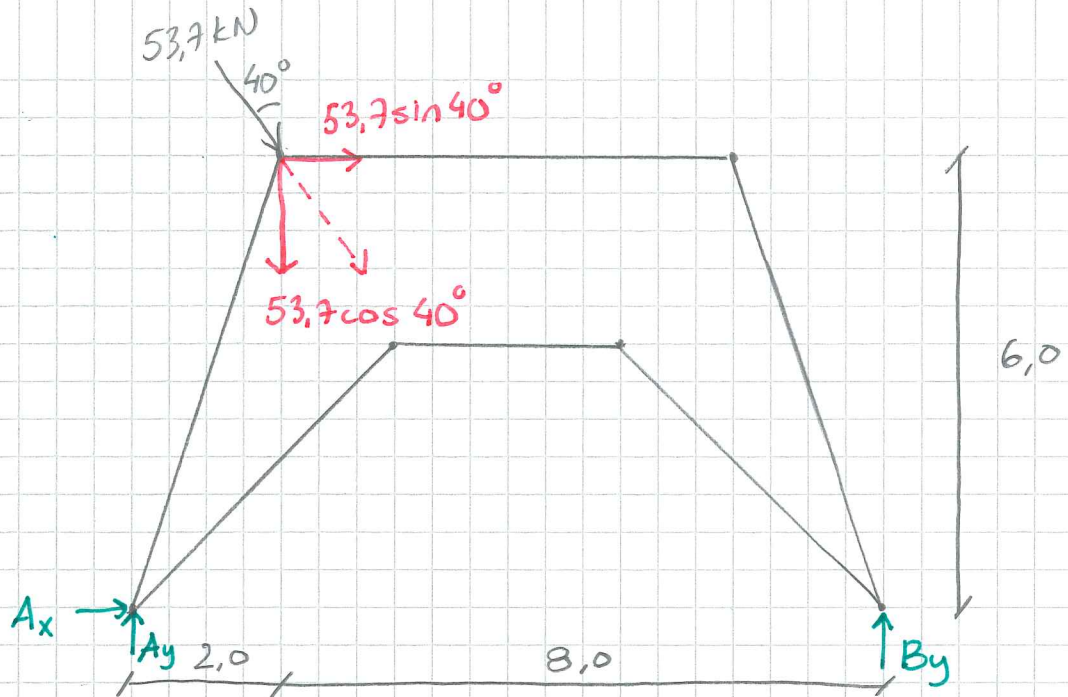
$$\curvearrowleft A \quad 854 \cdot 9,81 \cdot 3,5 - 20 \cdot 10^3 - B_y \cdot 4 = 0$$

$$B_y = \frac{854 \cdot 9,81 \cdot 3,5 - 20 \cdot 10^3}{4} = \underline{2331 \text{ N}}$$

$$\rightarrow \underline{A_x = 0} \quad \uparrow B_y + A_y - 854 \cdot 9,81 = 0$$

$$A_y = 854 \cdot 9,81 - 2331 = \underline{6047 \text{ N}}$$

5.2.1



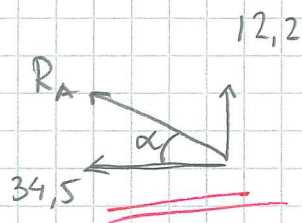
$$\overset{A}{\curvearrowleft} 6 \cdot 53,7 \sin 40^\circ + 2 \cdot 53,7 \cos 40^\circ - 10,0 \cdot B_y = 0$$

$$B_y = \frac{6 \cdot 53,7 \sin 40^\circ + 2 \cdot 53,7 \cos 40^\circ}{10} = \underline{\underline{28,9 \text{ kN}}}$$

$$\uparrow A_y + B_y - 53,7 \cos 40^\circ = 0$$

$$A_y = 12,2 \text{ kN}$$

$$\rightarrow A_x + 53,7 \sin 40^\circ = 0 \Rightarrow A_x = -34,5 \text{ kN.}$$



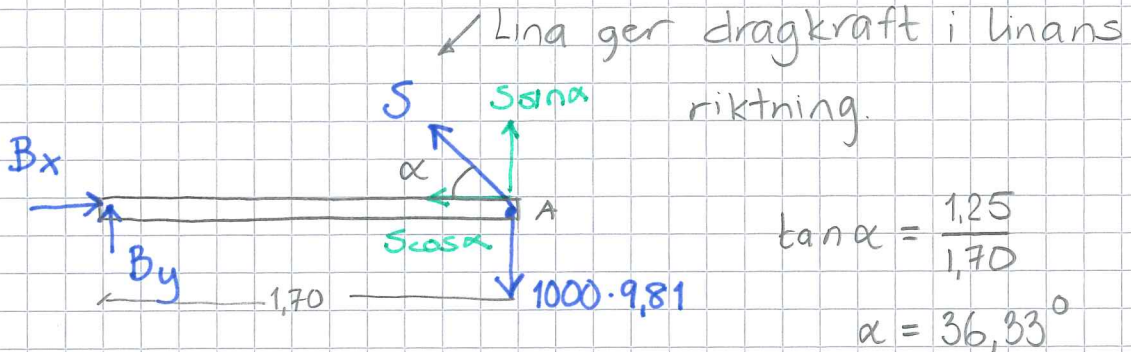
$$R_A = \sqrt{34,5^2 + 12,2^2} = \underline{\underline{36,6 \text{ kN}}}$$

$$\alpha = \arctan\left(\frac{12,2}{34,5}\right) = \underline{\underline{19,5^\circ}}$$

5,22

Sökt: Lin = stångkrafter

Alt 1



$$\curvearrowright A \quad B_y \cdot 1,70 = 0 \Rightarrow B_y = 0$$

$$\uparrow \quad S \sin 36,33^\circ - 1000 \cdot 9,81 + B_y = 0$$

$$S = \underline{16559 \text{ N}}$$

$$\rightarrow B_x - S \cos 36,33^\circ = 0$$

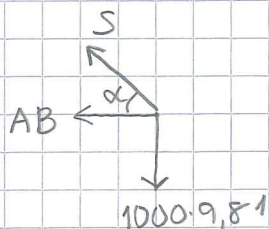
$$B_x = 16559 \cdot \cos 36,33^\circ = \underline{13340 \text{ N}}$$

Bx ger tryck enligt friläggning

Alt 2: Inse att systemet består av tvåkraftskroppar

- leder: - Momentfritt samman kopplade
- Kraft angriper i knutpunkt

Frilägg punkt A



$$\uparrow \quad S \sin 36,33^\circ - 1000 \cdot 9,81 = 0$$

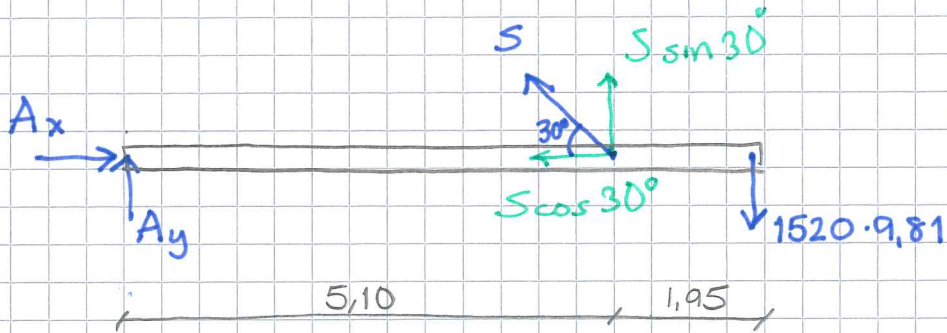
$$S = \underline{16559 \text{ N}}$$

$$\leftarrow AB - S \cos 36,33^\circ = 0$$

$$AB = \underline{-13340 \text{ N}} \quad (\text{tryck})$$

5.23 Sökt: krafter på balken AB

Frläggning

S har riktning 30° ty ledad

$$\overset{\curvearrowright}{A} \quad 5,10 \cdot S \cdot \sin 30^\circ - 1520 \cdot 9,81 (5,10 + 1,95) = 0$$

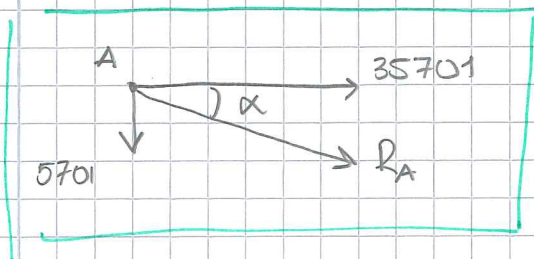
$$S = \underline{\underline{41225 \text{ N}}}$$

$$\uparrow \quad A_y + S \sin 30^\circ - 1520 \cdot 9,81 = 0$$

$$A_y = 1520 \cdot 9,81 - 41225 \cdot \sin 30^\circ = -5701 \text{ N}$$

$$\rightarrow \quad A_x - S \cos 30^\circ = 0$$

$$A_x = 41225 \cos 30^\circ = 35701 \text{ N}$$

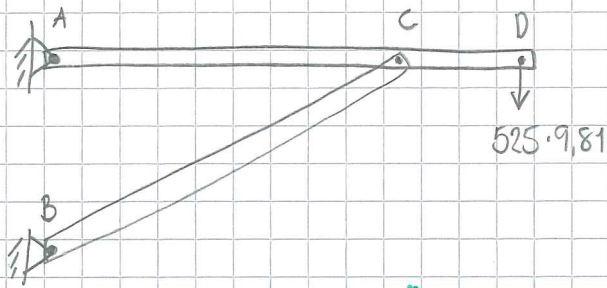


$$R_A = \sqrt{35701^2 + 5701^2} = \underline{\underline{36,1 \text{ kN}}}$$

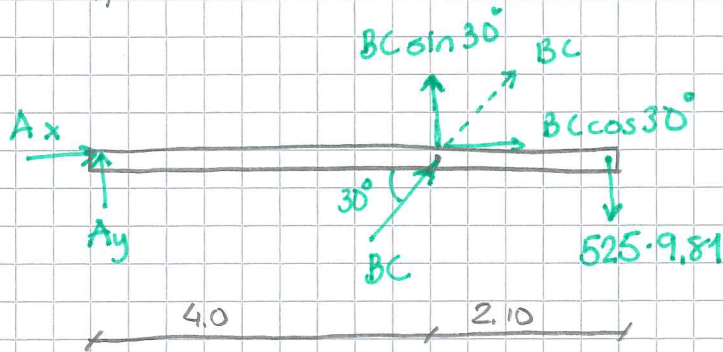
$$\alpha = \arctan\left(\frac{5701}{35701}\right) = \underline{\underline{9,1^\circ}}$$

5,24

Sökt: Krafterna på ACD = BC



BC => led => endast axiella krafter



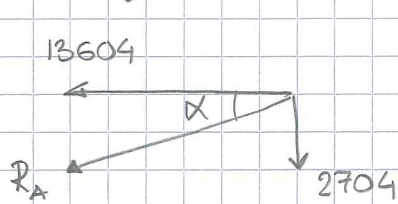
$$\sum \overset{\curvearrowright}{M}_A = 525 \cdot 9,81 (4 + 2,1) - BC \sin 30^\circ \cdot 4 = 0$$

$$BC = 15708 \text{ N}$$

$$\rightarrow A_x + BC \cos 30^\circ = 0 \Rightarrow A_x = -15708 \cos 30^\circ = -13604 \text{ N}$$

$$\uparrow A_y + BC \sin 30^\circ - 525 \cdot 9,81 = 0$$

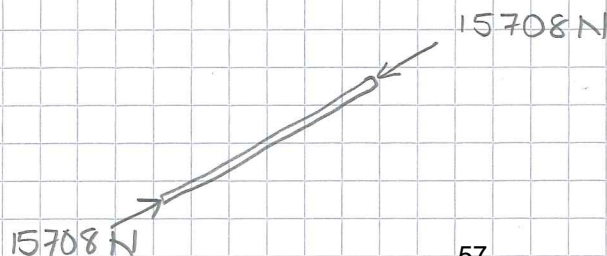
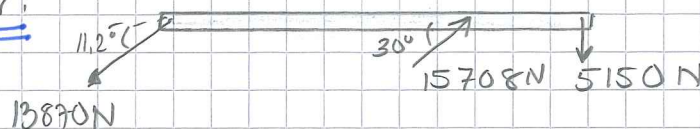
$$A_y = 525 \cdot 9,81 - 15708 \sin 30^\circ = -2704 \text{ N}$$



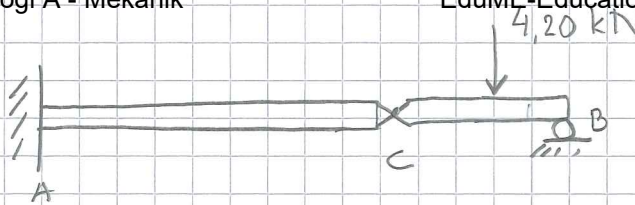
$$R_A = \sqrt{2704^2 + 13604^2} = 13870 \text{ N}$$

$$\alpha = \arctan\left(\frac{2704}{13604}\right) = 11,2^\circ$$

Svar:



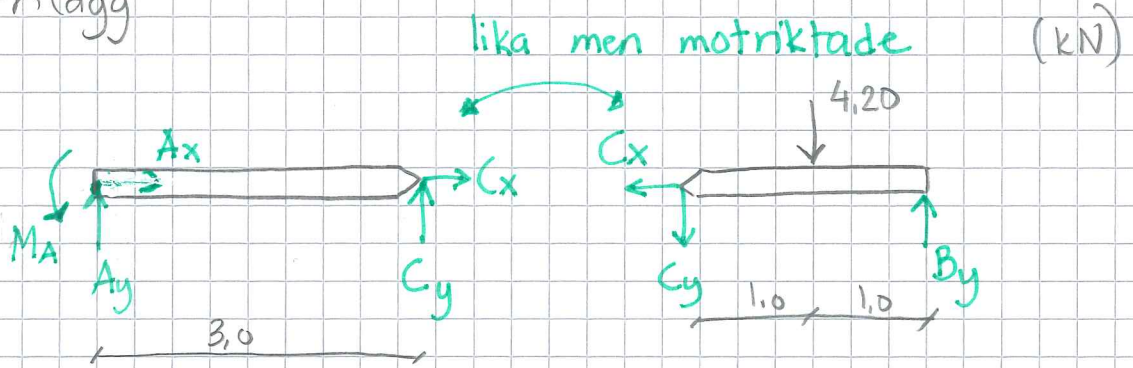
5.25



Sökt: Stödreaktioner
 R_A, R_B, M_A

Börja med jämvikt
 här 3 obekanta = 3 ekv
 lösbart.

Frilägg



$$C_x = 0$$

$$C_y = -2,1 \text{ kN}$$

$$\rightarrow A_x = 0$$

$$\curvearrowleft A \quad M_A + C_y \cdot 3 = 0$$

$$M_A = -(-2,1) \cdot 3 = 6,3 \text{ kNm}$$

$$\uparrow A_y + C_y = 0$$

$$A_y = -C_y = -(-2,1) = 2,1 \text{ kN}$$

Svar: $R_A = A_y = 2,1 \text{ kN} \uparrow$

$$R_B = B_y = 2,1 \text{ kN} \uparrow$$

$$M_A = 6,3 \text{ kNm} \curvearrowleft$$

$$\leftarrow C_x = 0$$

$$\curvearrowleft C \quad B_y \cdot 2 - 4,2 \cdot 1 = 0$$

$$B_y = 2,1 \text{ kN}$$

$$\uparrow B_y - 4,20 - C_y = 0$$

$$C_y = 2,1 - 4,2 = -2,1 \text{ kN}$$

Antagit fel riktning på

C_y i friläggningen därav negativ.

Då lasten är mitt på BC

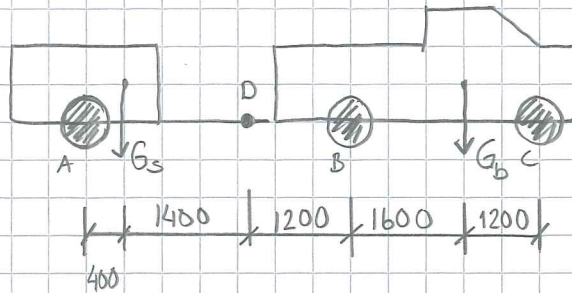
kan man inse att 4,20 kN

fördelas lika på C och B

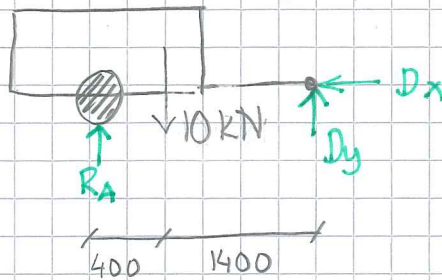
samt är riktade uppåt,

vilket jämvikten visar.

5.26 Sökt: R_A, R_B, R_C



(kN) alla x-komponenter är noll ty endast vertikala krafter.

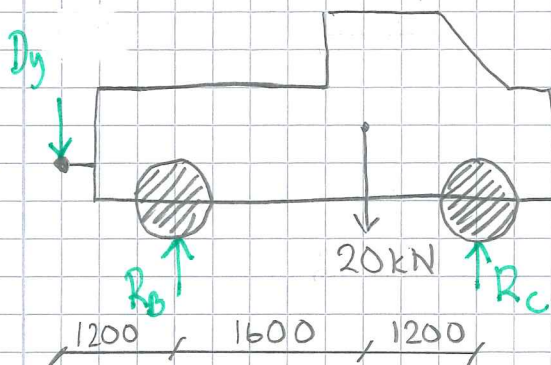


$\leftarrow D_x = 0$ (förstås)
 $\curvearrowright D \quad R_A \cdot 1800 - 10 \cdot 400 = 0$

$R_A = 7,78 \text{ kN}$

$\uparrow R_A + D_y - 10 = 0$

$D_y = 2,22 \text{ kN}$



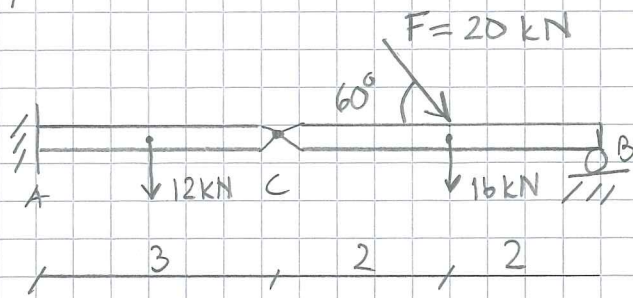
$\curvearrowright B \quad 1200 \cdot 2,22 - 20 \cdot 1600 + R_C (1600 + 1200) = 0$

$R_C = 10,48 \text{ kN}$

$\uparrow R_B + R_C - 2,22 - 20 = 0$

$R_B = 20 + 2,22 - 10,48 = 11,74 \text{ kN}$

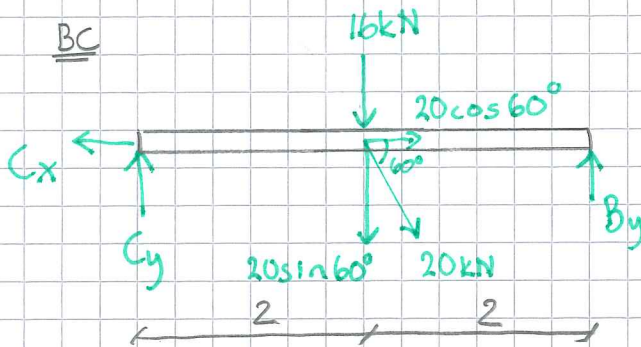
5,27



Egentyngd: 4 kN/m

$$M_{Ac} = 3 \cdot 4 = 12 \text{ kNm}$$

$$M_{cB} = 4 \cdot 4 = 16 \text{ kNm}$$

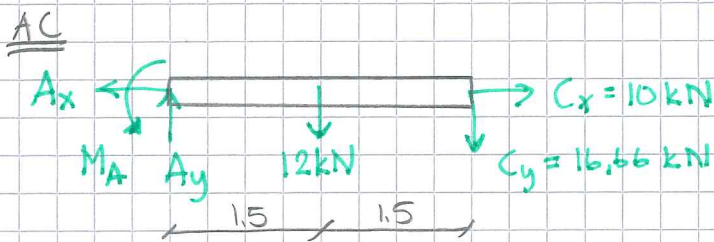


$$\leftarrow C_x - 20 \cos 60^\circ = 0 \Rightarrow C_x = 10 \text{ kN}$$

$$\curvearrow C \quad B_y \cdot 4 - (16 + 20 \sin 60^\circ) \cdot 2 = 0 \quad \underline{B_y = 16,66 \text{ kN}}$$

$$\uparrow C_y + B_y - 16 - 20 \sin 60^\circ = 0$$

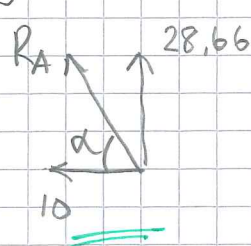
$$C_y = 16 + 20 \sin 60^\circ - 16,66 = 0 \Rightarrow C_y = 16,66 \text{ kN (förstås)}$$



$$\leftarrow A_x - C_x = 0 \Rightarrow A_x = C_x = 10 \text{ kN}$$

$$\curvearrow A \quad M_A - 12 \cdot 1,5 - C_y \cdot 3 = 0 \Rightarrow \underline{M_A = 12 \cdot 1,5 + 16,66 \cdot 3 = 68 \text{ kNm}}$$

$$\uparrow A_y - 12 - C_y = 0 \quad A_y = 12 + 16,66 = 28,66 \text{ kN}$$



$$\underline{R_A} = \sqrt{28,66^2 + 10^2} = \underline{30,35 \text{ kN}}$$

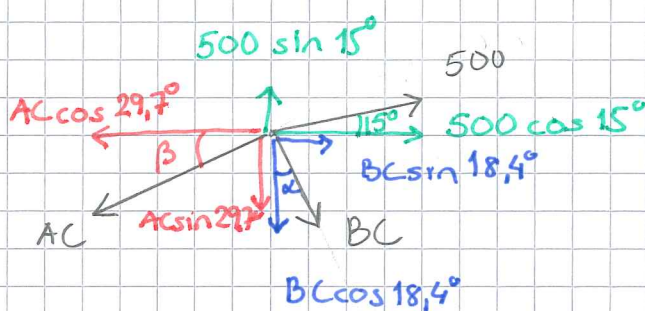
$$\underline{\alpha} = \arctan\left(\frac{28,66}{10}\right) = \underline{70,7^\circ}$$

5.28 Sökt: Krafter på AC & BC

AC & BC är ledat ifästa, lasten (500N) påverkar en ledpunkt (C).

Detta innebär att det blir krafter i stängernas riktning.

Krafterna bestäms enklast med en knutpunktsanalys av C



Antar drag i AC och BC.

$$\alpha = \arctan\left(\frac{16}{48}\right) = 18,4^\circ$$

$$\beta = \arctan\left(\frac{48}{84}\right) = 29,7^\circ$$

$$\uparrow 500 \sin 15^\circ - AC \sin 29,7^\circ - BC \cos 18,4^\circ = 0 \quad (1)$$

$$\rightarrow 500 \cos 15^\circ - AC \cos 29,7^\circ + BC \sin 18,4^\circ = 0 \quad (2)$$

$$(1) \Rightarrow AC = \frac{500 \sin 15^\circ}{\sin 29,7^\circ} - \frac{BC \cos 18,4^\circ}{\sin 29,7^\circ} = 261,19 - 1,915 BC \quad (3)$$

(3) i (2)

$$500 \cos 15^\circ - (261,19 - 1,915 BC) \cdot \cos 29,7^\circ + BC \sin 18,4^\circ = 0$$

$$500 \cos 15^\circ - 226,88 + 1,663 BC + 0,316 BC = 0$$

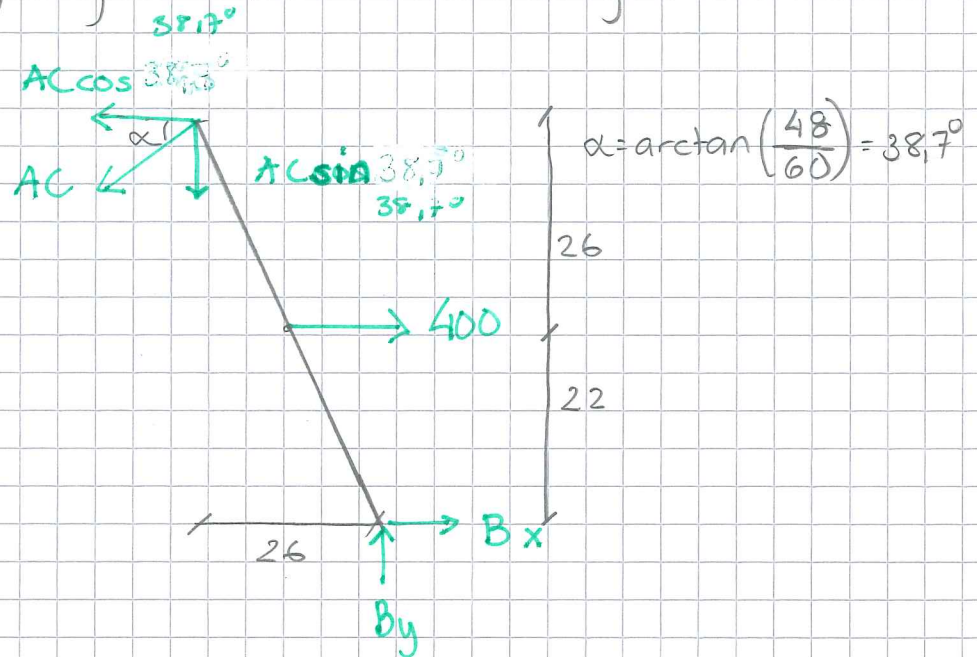
$$\underline{BC} = \underline{-129,4 N} \quad (\text{tryckkraft, rimligt})$$

$$(3) \underline{AC} = 261,19 - 1,915 \cdot (-129,4) = \underline{509 N} \quad (\text{drag, rimligt})$$

5,29 Sökt: krafterna på AC & BC

En yttre kraft påverkar mitt på BC-balken
 Detta innebär att man får kraft-riktningar
 som skiljer från balkens riktning i BC.
 AC får däremot en kraft i dess riktning.

Friläggning av BC \Rightarrow samtliga krafter



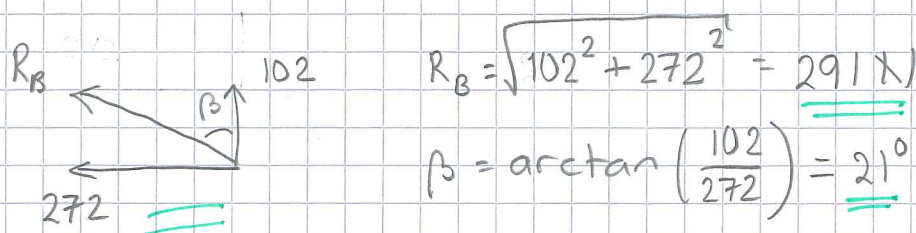
$$\overset{B}{\curvearrowright} 400 \cdot 22 - AC \sin 38,7^\circ \cdot 26 - AC \cos 38,7^\circ \cdot 48 = 0$$

$$AC = \frac{400 \cdot 22}{26 \sin 38,7^\circ + 48 \cos 38,7^\circ} = \underline{\underline{163,8 \text{ N}}}$$

$$\rightarrow B_x + 400 - AC \cos 38,7^\circ = 0$$

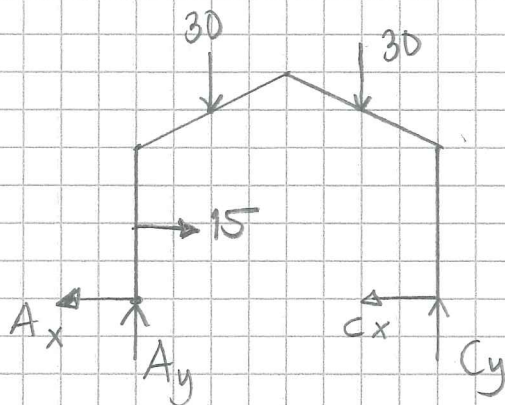
$$B_x = 163,8 \cos 38,7^\circ - 400 = -272 \text{ N}$$

$$\uparrow B_y - AC \sin 38,7^\circ = 0 \Rightarrow B_y = 163,8 \cdot \sin 38,7^\circ = 102 \text{ N}$$



5.30 Sökt: R_A, R_C

Global friläggning



(kN)
4 obekanta } ej lösbart
3 jämviktsekv }

=> gör vad du kan
därefter inre friläggning

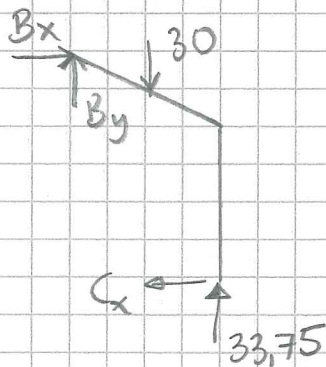
$$\curvearrowleft A: C_y \cdot 8 - 15 \cdot 2 - 30 \cdot 2 - 30 \cdot 6 = 0$$

$$C_y = 33,75 \text{ kN}$$

$$\uparrow A_y + C_y - 2 \cdot 30 = 0$$

$$A_y = 60 - 33,75 = 26,25 \text{ kN}$$

Inre Friläggning => C_x

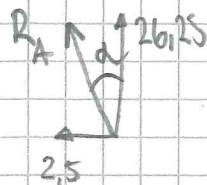


$$\curvearrowleft B: C_x \cdot 6 + 30 \cdot 2 - 33,75 \cdot 4 = 0$$

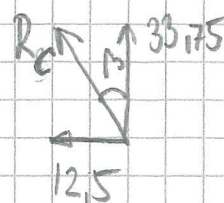
$$C_x = 12,5 \text{ kN}$$

Global friläggning

$$\leftarrow A_x - 15 + 12,5 = 0 \Rightarrow A_x = 2,5 \text{ kN}$$

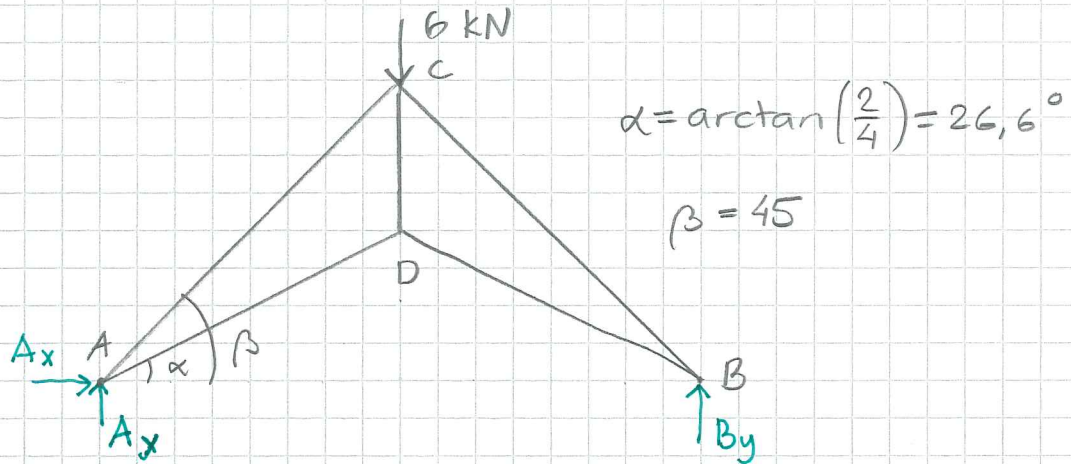


$R_A = 26,4 \text{ kN}$ $\alpha = 5,4^\circ$



$R_C = 36 \text{ kN}$ $\beta = 20,3^\circ$

5,31

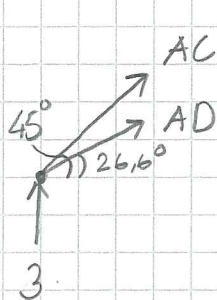


Symmetri $\Rightarrow A_x = 0 \quad A_y = B_y = 3 \text{ kN}$

Symmetri $\Rightarrow AC = CB$
 $AD = DB$

Svar: $AC = CB = -8,50 \text{ kN}$ $AD = DB = 6,72 \text{ kN}$ $CD = 6 \text{ kN}$
--

Knutpunkt A



$$\uparrow AC \sin 45^\circ + AD \sin 26,6^\circ + 3 = 0 \quad (1)$$

$$\rightarrow AC \cos 45^\circ + AD \cos 26,6^\circ = 0$$

$$AC = -AD \cdot \frac{\cos 26,6^\circ}{\cos 45^\circ} = -AD \cdot 1,265$$

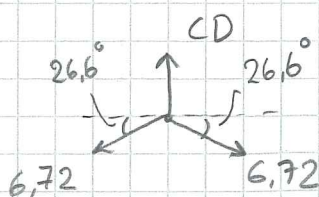
$$-AD \cdot 1,265 \sin 45^\circ + AD \sin 26,6^\circ + 3 = 0$$

$$AD (1,265 \sin 45^\circ - \sin 26,6^\circ) = 3$$

$$AD = 6,72 \text{ kN}$$

$$AC = -6,72 \cdot 1,265 = -8,50 \text{ kN}$$

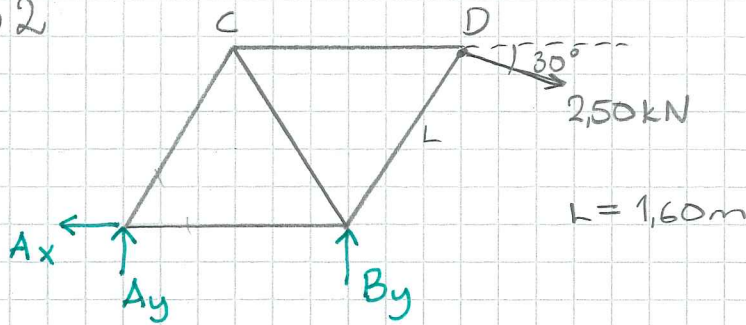
Knutpunkt D



$$\uparrow CD - 2 \cdot 6,72 \cdot \sin 26,6^\circ = 0$$

$$CD = 6 \text{ kN}$$

5.32



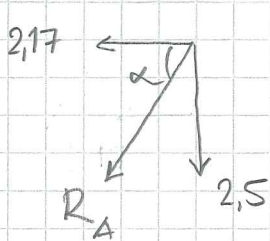
Svar:
 AC = 2,89 kN
 AB = 0,725 kN
 CB = -2,89 kN
 BD = -1,44 kN
 CD = 2,89 kN

a) $\curvearrowright A \quad 250 \cdot \cos 30^\circ \cdot 1,60 \cdot \sin 60^\circ + 250 \sin 30^\circ \cdot (1,60 + 0,8) \dots$
 $- B_y \cdot 1,60 = 0 \Rightarrow B_y = \underline{\underline{3,75 \text{ kN}}}$

$\uparrow A_y + B_y - 250 \sin 30^\circ = 0$

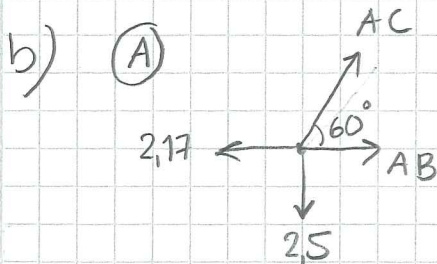
$A_y = 250 \sin 30^\circ - 3,75 = -2,5 \text{ kN}$

$\leftarrow A_x - 250 \cos 30^\circ = 0 \Rightarrow A_x = 2,17 \text{ kN}$



$R_A = \sqrt{2,17^2 + 2,5^2} = \underline{\underline{3,31 \text{ kN}}}$

$\alpha = \arctan\left(\frac{2,5}{2,17}\right) = \underline{\underline{49^\circ}}$

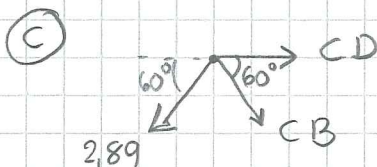


$\uparrow AC \sin 60^\circ - 2,5 = 0$

$AC = 2,89 \text{ kN}$

$\rightarrow AB + AC \cos 60^\circ - 2,17 = 0$

$AB = 2,17 - 2,89 \cos 60^\circ = 0,725 \text{ kN}$

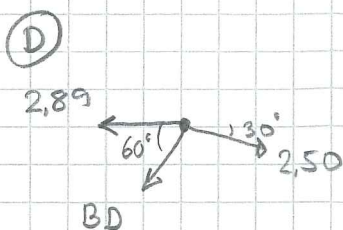


$\downarrow CB \sin 60^\circ + 2,89 \sin 60^\circ = 0$

$CB = -2,89 \text{ kN}$

$\rightarrow CD + CB \cos 60^\circ - 2,89 \cos 60^\circ = 0$

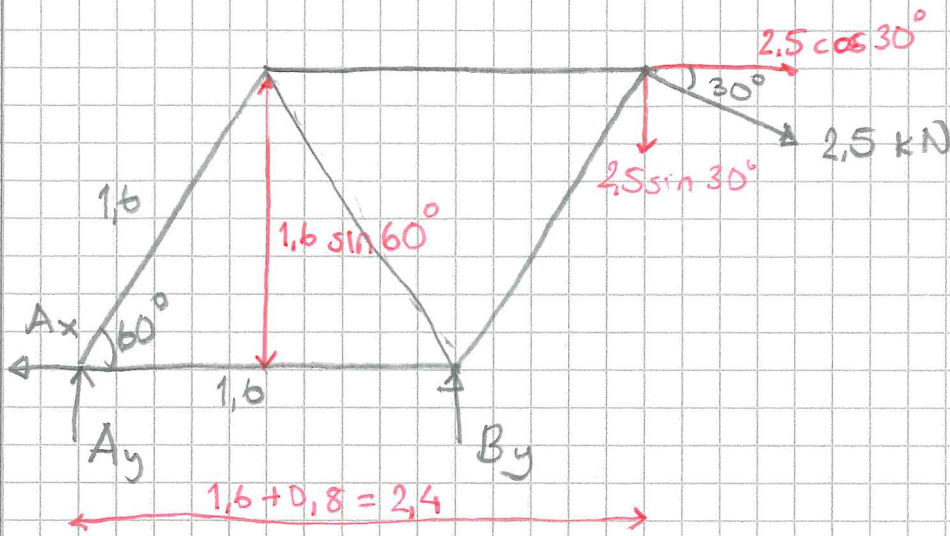
$CD = \cos 60^\circ (2,89 - (-2,89)) = 2,89 \text{ kN}$



$\downarrow BD \sin 60^\circ + 250 \sin 30^\circ = 0$

$BD = -1,44 \text{ kN}$

5.32a Skikt: R_A, R_B



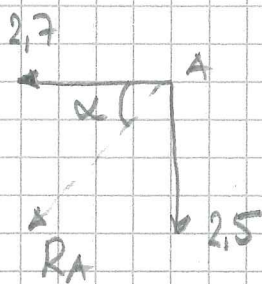
$$\curvearrowright B_y \cdot 1,6 - 2,4 \cdot 2,5 \sin 30^\circ - 1,6 \sin 60^\circ \cdot 2,5 \cos 30^\circ = 0$$

$$B_y = 3,75 \text{ kN}$$

$$\rightarrow 2,5 \cos 30^\circ - A_x = 0 \quad A_x = 2,17 \text{ kN}$$

$$\uparrow A_y + B_y - 2,5 \sin 30^\circ = 0$$

$$A_y = 1,25 - 3,75 = -2,5 \text{ kN}$$



$$R_A = \sqrt{2,17^2 + 2,5^2} = \underline{\underline{3,68 \text{ kN}}}$$

$$\alpha = \arctan \frac{2,5}{2,17} = \underline{\underline{49^\circ}}$$

eller $180 + 49 = 229$ från x-axeln

$$R_B = 3,75 \text{ kN} \uparrow$$

5.32 b Knutpunktsanalys

Börja med punkt A eller D då det finns två okända stängkrafter.

(A)

$\uparrow AC \sin 60^\circ - 2,5 = 0$
 $AC = \frac{2,5}{\sin 60^\circ} = 2,89 \text{ kN (drag)}$
 $\rightarrow AC \cos 60^\circ + AB - 2,17 = 0$
 $AB = 2,17 - 2,89 \cos 60^\circ = 0,73 \text{ kN (drag)}$

(C)

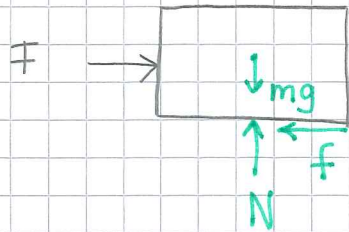
$AC = 2,89 \text{ kN}$ Sökta: $CD \neq CB$
 $\downarrow CB \sin 60^\circ + AC \sin 60^\circ = 0$
 $CB = -AC = -2,89 \text{ kN}$
 $\rightarrow CD + CB \cos 60^\circ - AC \cos 60^\circ = 0$
 $CD = \cos 60^\circ (AC - CB) = \cos 60^\circ (2,89 - (-2,89))$
 $CD = 2,89 \text{ kN}$

(D)

$\downarrow BD \sin 60^\circ + 2,5 \sin 30^\circ = 0$
 $BD = -2,5 \frac{\sin 30^\circ}{\sin 60^\circ} = -1,44 \text{ kN}$

- Svar:
- $AC = 2,89 \text{ kN (drag)}$
 - $AB = 0,73 \text{ kN (drag)}$
 - $CB = -2,89 \text{ kN (tryck)}$
 - $CD = 2,89 \text{ kN (drag)}$
 - $BD = -1,44 \text{ kN (tryck)}$

5.33



$$\uparrow N - mg = 0 \quad N = 35 \cdot 9,81 = 343 \text{ N}$$

$$\rightarrow F - f = 0 \quad F = f \quad (1)$$

a) vid glidning $f = f_{\max} = N \cdot \mu$

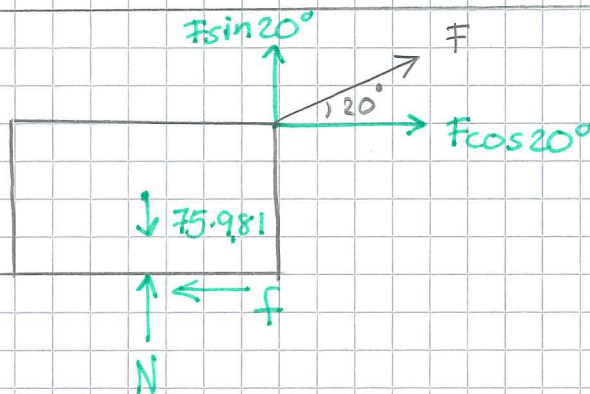
$$\mu = 0,350 \Rightarrow f = 343 \cdot 0,35 = 120 \text{ N}$$

$$(1) \Rightarrow \underline{\underline{F = 120 \text{ N}}}$$

b) Om $F = 100 \text{ N}$ utnyttjat friktionstal blir

$$(1) \Rightarrow F = f = \mu_b N \Rightarrow \mu_b = \frac{100}{343} = \underline{\underline{0,292}}$$

5.34



$$\mu = 0,220$$

Sökt: F vid glidning

Vid glidning $f = f_{\max} = N \cdot \mu$

$$\uparrow N - 75 \cdot 9,81 + F \sin 20^\circ = 0 \quad N = 735,75 - F \sin 20^\circ \quad (1)$$

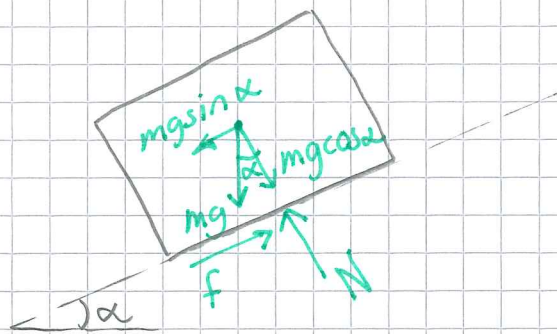
$$\rightarrow F \cos 20^\circ - N \mu = 0$$

$$(1) \Rightarrow F \cos 20^\circ - \mu (735,75 - F \sin 20^\circ) = 0$$

$$F \cos 20^\circ + \mu F \sin 20^\circ = \mu \cdot 735,75$$

$$F = \frac{0,220 \cdot 735,75}{\cos 20^\circ + 0,22 \sin 20^\circ} = \underline{\underline{160 \text{ N}}}$$

5,35

Sökt: α vid glidning.

$$m = 30 \text{ kg}$$

$$\mu = 0,3$$

Vid glidning $f = f_{\max} = \mu N$

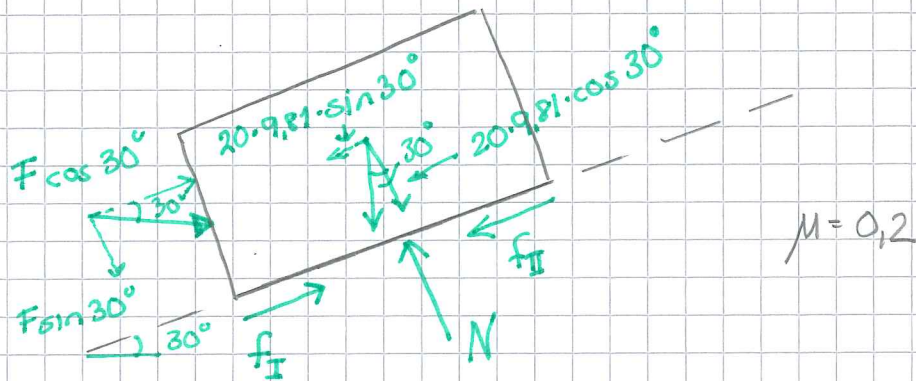
$$\leftarrow \mu N - mg \sin \alpha = 0 \quad N = \frac{mg}{\mu} \sin \alpha \quad (1)$$

$$\uparrow N - mg \cos \alpha = 0 \quad N = mg \cos \alpha \quad (2)$$

$$(1) = (2) \quad \frac{mg}{\mu} \sin \alpha = mg \cos \alpha \quad \Rightarrow \quad \mu = \frac{\sin \alpha}{\cos \alpha} = \tan \alpha$$

$$\alpha = \arctan \mu = \arctan 0,3 = \underline{\underline{16,7^\circ}}$$

5.36 Sökt: F för jämvikt dvs (ödan glider ej - varken uppför eller utför planet.



(I) Anta glidning nedför $\Rightarrow F_{\min}$

f_I hjälper att förhindra glidning $f_I^{\max} = N \cdot \mu$

$$\uparrow N - 20 \cdot 9,81 \cdot \cos 30^\circ - F \sin 30^\circ = 0 \quad (1)$$

$$\rightarrow -N \cdot \mu + F \cos 30^\circ - 20 \cdot 9,81 \cdot \sin 30^\circ = 0 \quad (2)$$

$$(1) \quad N = 169,9 + 0,5 F$$

$$(2) \quad - (169,9 + 0,5 F) \cdot 0,2 + F \cos 30^\circ = 98,1$$

$$- 33,98 + 0,1 F + F \cos 30^\circ = 98,1$$

$$F_{\min} = 66,4 \text{ N}$$

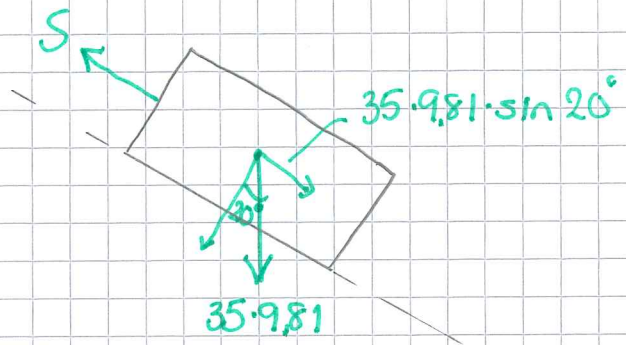
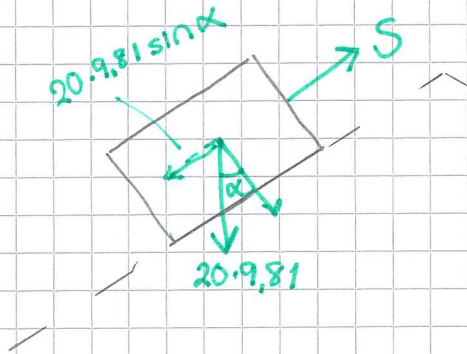
(II) Anta glidning uppför $\Rightarrow F_{\max}$

f_{II} förhindrar glidning uppför $f_{II}^{\max} = N \cdot \mu$

Titta på ekvationerna ovan $N\mu$ byter tecken då f byter riktning

$$F_{\max} = 172,4 \text{ N}$$

$$\underline{\underline{66,4 \text{ N} \leq F \leq 172,4 \text{ N}}}$$

5.37 Sökt: α vid jämvikt (ingen glidning)Glat \Rightarrow ingen friktion

$$S - 20 \cdot 9,81 \cdot \sin \alpha = 0$$

$$S = 20 \cdot 9,81 \sin \alpha \quad (1)$$

$$(1) = (2)$$

$$20 \cdot 9,81 \sin \alpha = 35 \cdot 9,81 \sin 20^\circ$$

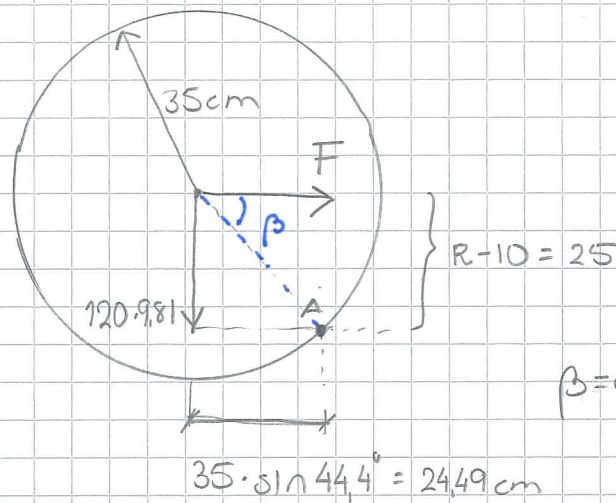
$$\sin \alpha = \frac{35}{20} \sin 20^\circ \Rightarrow \alpha = \arcsin 0,599 = \underline{\underline{36,7^\circ}}$$

5.38

Sökt: F om a) $\alpha = 0$

b) $\alpha = 35^\circ$

a)



$m = 120 \text{ kg}$

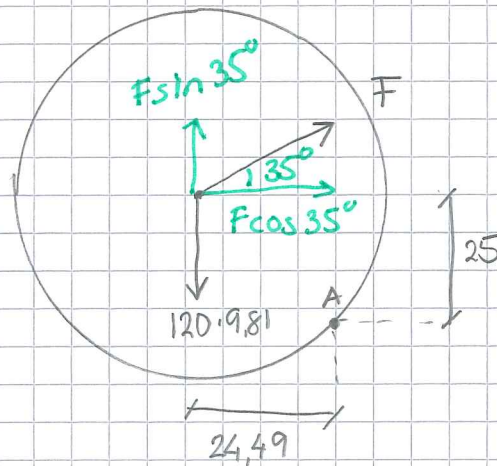
$\beta = \arccos \frac{25}{35} = 44,4^\circ$

$35 \cdot \sin 44,4^\circ = 24,49 \text{ cm}$

\curvearrowright
A

$F \cdot 25 - 120 \cdot 9,81 \cdot 24,49 = 0 \Rightarrow \underline{F = 1153 \text{ N}}$

b)

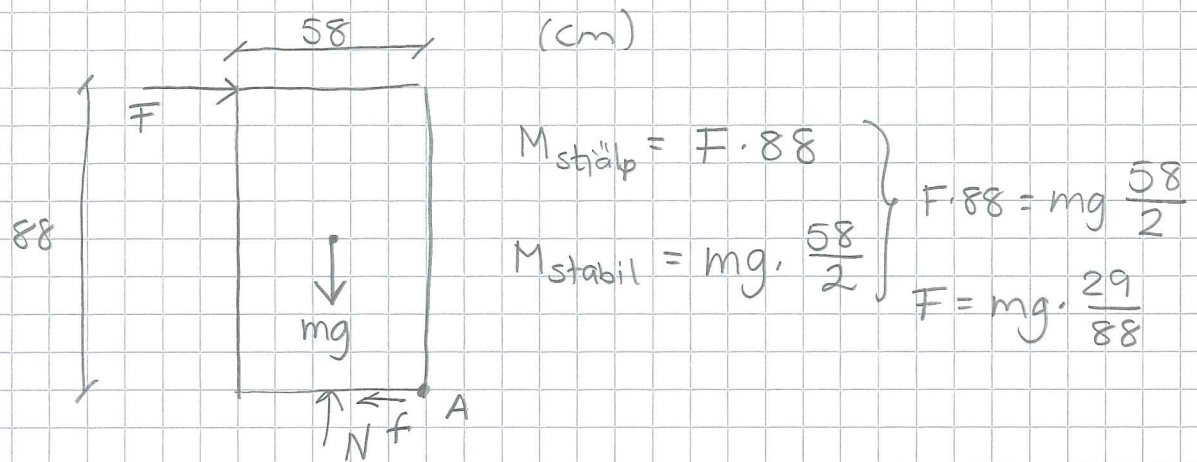


\curvearrowright
A

$F \cos 35^\circ \cdot 25 + F \sin 35^\circ \cdot 24,49 - 120 \cdot 9,81 \cdot 24,49 = 0$

$F = \frac{120 \cdot 9,81 \cdot 24,49}{25 \cos 35^\circ + 24,49 \sin 35^\circ} = \underline{835 \text{ N}}$

5.39 Sökt: μ för att stjälpning ska ske

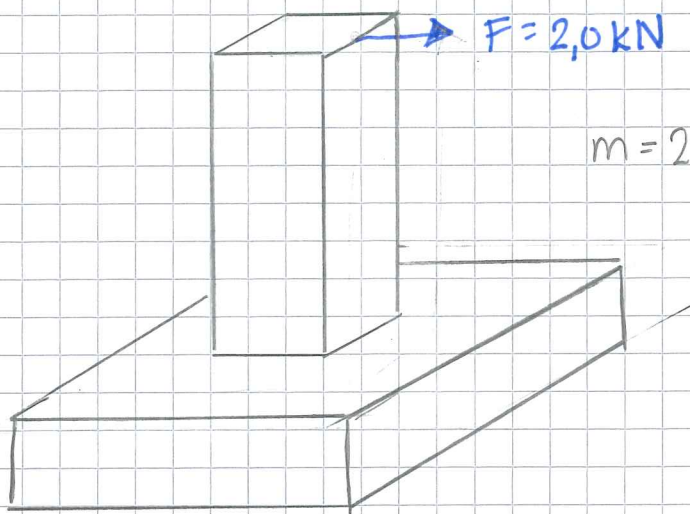


Om glidning inte ska ske måste

$$f_{\text{max}} = F$$

$$N\mu = mg \cdot \frac{29}{88}$$

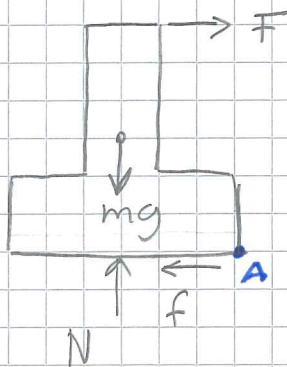
$$mg\mu = mg \cdot \frac{29}{88} \Rightarrow \mu_{\text{min}} = \underline{\underline{0,33}}$$

5,40 a) μ_{\min} b) Säkerhet mot stjälpning
 n_s 

$$\rho = 2400 \text{ kg/m}^3$$

$$m = 2400 (0,3^2 \cdot 0,6 + 0,9^2 \cdot 0,3)$$

$$m = 712,8 \text{ kg}$$

Vid glidning: $f = N\mu$

$$\uparrow N = mg$$

$$\rightarrow F = f = N\mu = mg\mu = 2000$$

$$\mu_{\min} = \frac{2000}{712,8 \cdot 9,81} = \underline{\underline{0,286}}$$

Bestäm tyngdpunkten

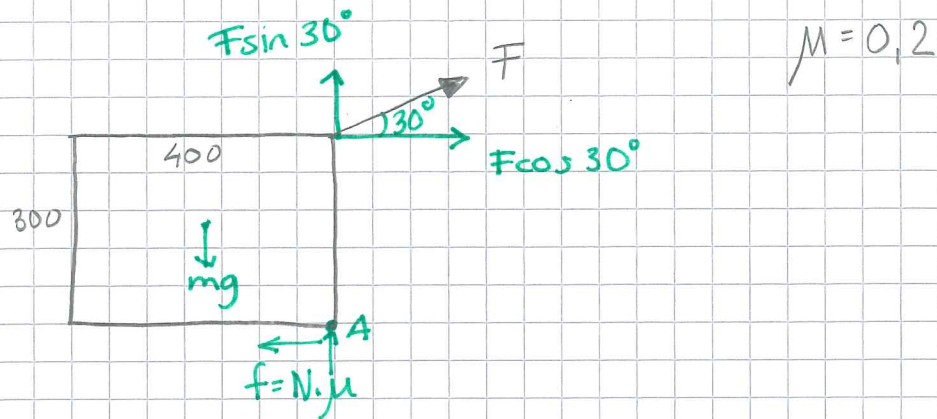
$$y_{tp} = \frac{V_1 y_1^{tp} + V_2 y_2^{tp}}{V_{tot}} = \frac{0,3^2 \cdot 0,6 \cdot 0,6 + 0,9^2 \cdot 0,3 \cdot 0,15}{0,3^2 \cdot 0,6 + 0,9^2 \cdot 0,3} = 0,232 \text{ m}$$

$$b) M_{stjälp} = F \cdot (300 + 600) = 2000 \cdot 900 = 1800000 \text{ Ncm}$$

$$M_{stabil} = mg \left(\frac{900}{2} \right) = 712,8 \cdot 9,81 \cdot 450 = 3146656 \text{ Ncm}$$

$$n_s = \frac{M_{stabil}}{M_{stjälp}} = \frac{3146656}{1800000} = \underline{\underline{1,75}}$$

5.41 Sökt: Sker glidning eller stjälpning
om F ökar.



$M_A = 0$ vid stjälpning

$$\sum \overset{\curvearrowright}{M}_A \quad mg \cdot 200 - F \cos 30^\circ \cdot 300 = 0 \quad F_{\text{stjälp}} = \frac{mg \cdot 200}{30 \cos 30^\circ} = mg \cdot 0,770$$

Glidning då $f = N \cdot \mu$

$$\uparrow \quad N - mg + F \sin 30^\circ = 0 \quad \Rightarrow \quad N = mg - F \sin 30^\circ$$

$$\leftarrow \quad N \cdot \mu - F \cos 30^\circ = 0$$

$$(mg - F \sin 30^\circ) \cdot \mu = F \cos 30^\circ$$

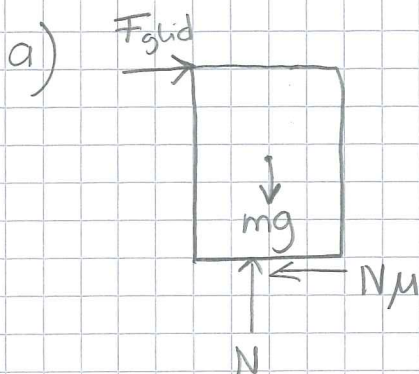
$$0,2mg = F(\cos 30^\circ + 0,2 \sin 30^\circ)$$

$$F = F_{\text{glid}} = mg \cdot 0,207$$

$F_{\text{stjälp}} > F_{\text{glid}} \Rightarrow$ Glider.

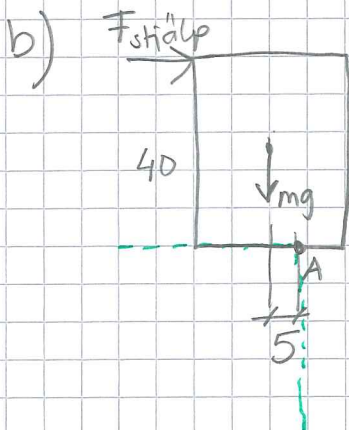
5,42 $m = 25 \text{ kg}$ $\mu = 0,25$

a) F_{glid} b) $F_{\text{stjälp}}$



$$\uparrow N = mg$$

$$\rightarrow F = N\mu = mg\mu = 25 \cdot 9,81 \cdot 0,25 = \underline{\underline{61,3 \text{ N}}}$$



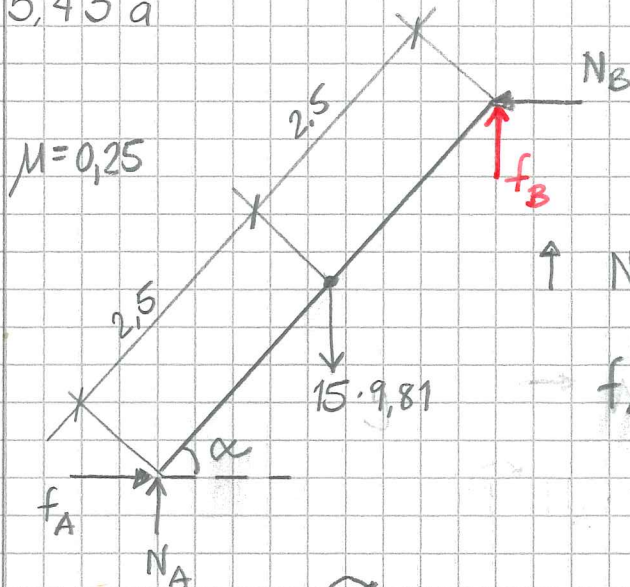
$$M_A = 0 \Rightarrow F_{\text{stjälp}}$$

$$\curvearrow A \quad mg \cdot 5 = F_{\text{stjälp}} \cdot 40$$

$$F_{\text{stjälp}} = 25 \cdot 9,81 \cdot \frac{5}{40} = \underline{\underline{30,7 \text{ N}}}$$

c) Stjälper

5,43 a

Sökt: α vid glidning

glidning $\Rightarrow f_A = \mu N_A$

$f_B = 0$ tygglatt vägg

$$\uparrow N_A - 15 \cdot 9,81 = 0 \Rightarrow N_A = 147,15 \text{ N}$$

$$f_A = 0,25 \cdot 147,15 = 36,79 \text{ N}$$

$$\curvearrowright N_A \cdot 5 \cos \alpha - 15 \cdot 9,81 \cdot 2,5 \cos \alpha - f_A \cdot 5 \sin \alpha = 0$$

$$(147,15 \cdot 5 - 15 \cdot 9,81 \cdot 2,5) \cos \alpha = 36,79 \cdot 5 \sin \alpha$$

$$\frac{\sin \alpha}{\cos \alpha} = \frac{367,9}{183,95} = \tan \alpha$$

$$\alpha = \arctan 2 = \underline{\underline{63,4^\circ}}$$

b) sträv vägg $\Rightarrow f_B = \mu N_B$ vid glidning

$$\uparrow N_A - 15 \cdot 9,81 + \mu N_B = 0 \quad (1)$$

$$\rightarrow \mu N_A - N_B = 0 \Rightarrow N_B = \mu N_A$$

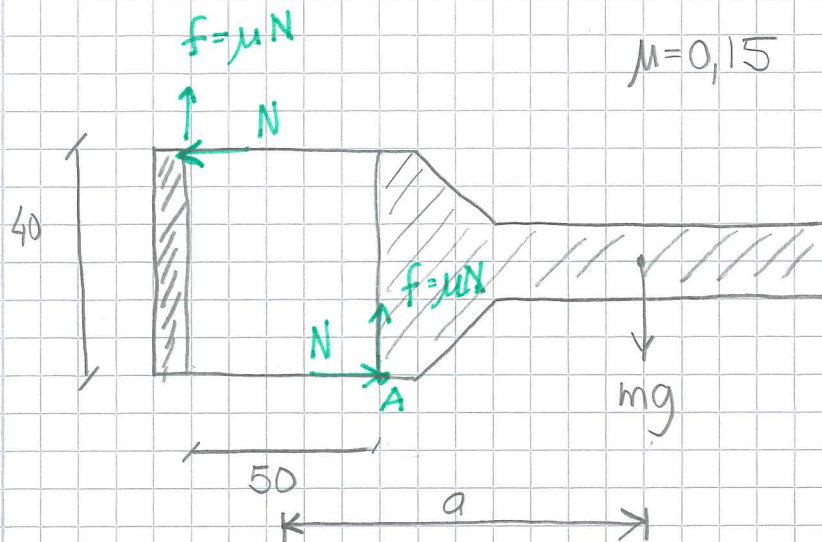
$$(1) \Rightarrow N_A + \mu^2 N_A = 15 \cdot 9,81 \quad N_A = \frac{15 \cdot 9,81}{1 + 0,25^2} = 138,49 \text{ N}$$

$$\curvearrowright N_A \cdot 5 \cos \alpha - 15 \cdot 9,81 \cdot 2,5 \cos \alpha - f_A \cdot 5 \sin \alpha = 0$$

$$f_A = 0,25 \cdot 138,49 = 34,62$$

$$(138,49 \cdot 5 - 15 \cdot 9,81 \cdot 2,5) \cos \alpha = 34,62 \cdot 5 \cdot \sin \alpha$$

$$\frac{\sin \alpha}{\cos \alpha} = \frac{324,57}{173,1} = \tan \alpha \quad \alpha = \underline{\underline{61,9^\circ}}$$

3.44 Sökt: a så att armen inte glider

$$\overset{\curvearrowright}{A} \quad mg(a-25) + \mu N \cdot 50 - N \cdot 40 = 0$$

$$\uparrow \quad 2\mu N = mg \Rightarrow N = \frac{mg}{2\mu}$$

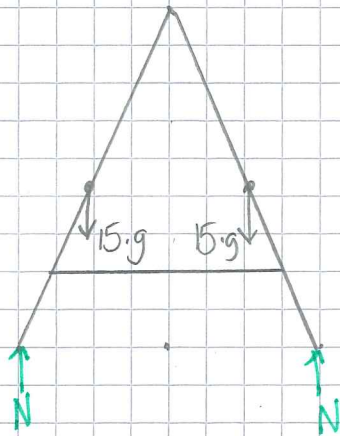
$$mg(a-25) + \mu \frac{mg}{2\mu} \cdot 50 + \frac{mg}{2\mu} \cdot 40 = 0$$

$$a - 25 + 25 + \frac{20}{0,15} = 0 \Rightarrow \underline{a = 134 \text{ mm}}$$

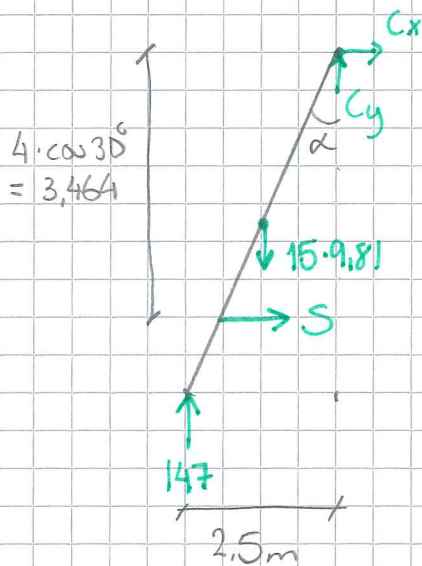
5.45 a) S då $F=0$

b) S då $F=75 \cdot 9,81 \text{ N}$

a)



$$\uparrow 2N - 2 \cdot 15 \cdot 9,81 = 0 \Rightarrow N = 147 \text{ N}$$

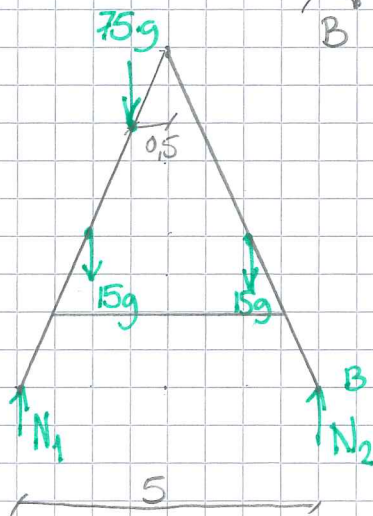


$$\alpha = \arcsin\left(\frac{2,5}{5}\right) = 30^\circ$$

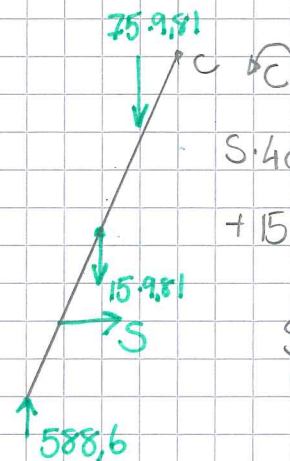
$$\curvearrow 147 \cdot 2,5 - 15 \cdot 9,81 \cdot 1,25 - S \cdot 4 \cos 30^\circ = 0$$

$$\underline{S = 53 \text{ N}}$$

b)



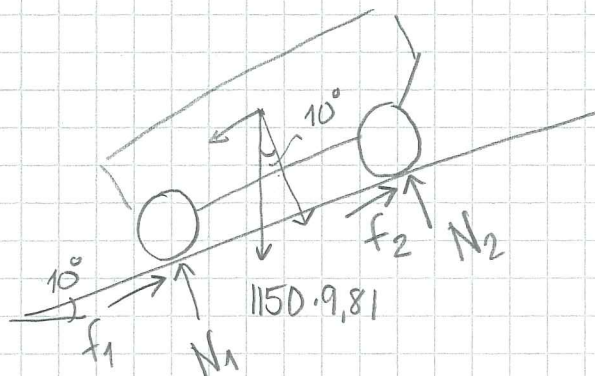
$$\curvearrow N_1 \cdot 5 - 15 \cdot 9,81 \cdot 3,75 - 15 \cdot 9,81 \cdot 1,25 - 75 \cdot 9,81 \cdot 3 = 0 \Rightarrow N_1 = 588,6 \text{ N}$$



$$\curvearrow S \cdot 4 \cos 30^\circ + 75 \cdot 9,81 \cdot 0,5 + \dots + 15 \cdot 9,81 \cdot 1,25 - 588,6 \cdot 2,5 = 0$$

$$\underline{S = 265,5 \text{ N}}$$

5,46



$$f_1 = \mu N_1$$

$$f_2 = \mu N_2$$

$$\uparrow N_1 + N_2 - 1150 \cdot 9,81 \cdot \cos 10^\circ = 0 \Rightarrow N_1 + N_2 = 1150 \cdot 9,81 \cos 10^\circ$$

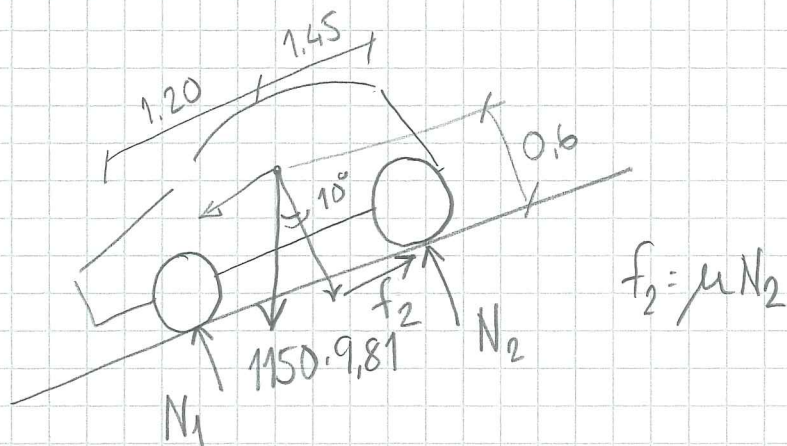
$$\rightarrow \mu N_1 + \mu N_2 - 1150 \cdot 9,81 \sin 10^\circ = 0$$

$$\mu (N_1 + N_2) = 1150 \cdot 9,81 \sin 10^\circ$$

$$\mu \cdot 1150 \cdot 9,81 \cos 10^\circ = 1150 \cdot 9,81 \sin 10^\circ$$

$$\mu = \frac{\sin 10^\circ}{\cos 10^\circ} = \tan 10^\circ = 0,176$$

b)



$N_1, N_2 \text{ \& } \mu$ okända \Rightarrow 3 ekv. krävs

$$\curvearrow 1 \quad N_2 (1,20 + 1,45) + 0,16 \cdot 1150 \cdot 9,81 \cdot \sin 10^\circ - 1,2 \cdot 1150 \cdot 9,81 \cdot \cos 10^\circ = 0$$

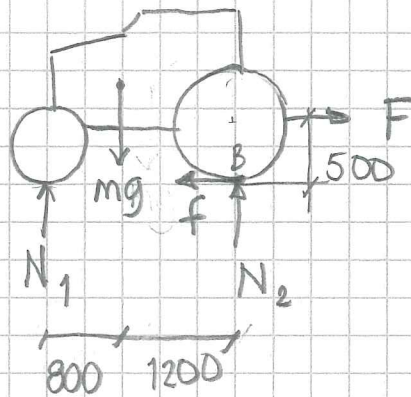
$$N_2 = \frac{1150 \cdot 9,81 (1,2 \cos 10^\circ - 0,16 \sin 10^\circ)}{(1,2 + 1,45)} = 4587 \text{ N}$$

$$\rightarrow \mu N_2 - 1150 \cdot 9,81 \sin 10^\circ = 0$$

$$\mu = \frac{1150 \cdot 9,81 \sin 10^\circ}{4587} = \underline{\underline{0,427}}$$

- 5.47 a) F om slirning då $\mu = 0,5$
 b) F om traktorn ska stegra vilket μ krävs.

Friläggning



$$M = 3500 \text{ kg}$$

a) slirning $\Rightarrow f = \mu N_2 = 0,5 N_2$

$$\uparrow N_1 + N_2 - mg = 0 \Rightarrow N_1 = mg - N_2$$

$$\leftarrow f - F = 0 \quad F = 0,5 N_2 \Rightarrow N_2 = 2F$$

$$\curvearrow B \quad mg \cdot 1200 - N_1 \cdot 2000 - F \cdot 500 = 0$$

$$mg \cdot 12 - (mg - 2F) \cdot 20 - F \cdot 5 = 0$$

$$mg \cdot 12 - 20mg + 40F - 5F = 0$$

$$35F = 8mg \Rightarrow \underline{\underline{F = 7848 \text{ N}}}$$

b) Stegrar då $N_1 = 0$

$$\overset{\curvearrowright}{B} \quad F \cdot 500 - mg \cdot 1200 = 0$$

$$F = \underline{\underline{82404 \text{ N}}}$$

$$f = F = \mu N_2 \quad \text{och} \quad N_2 = mg$$

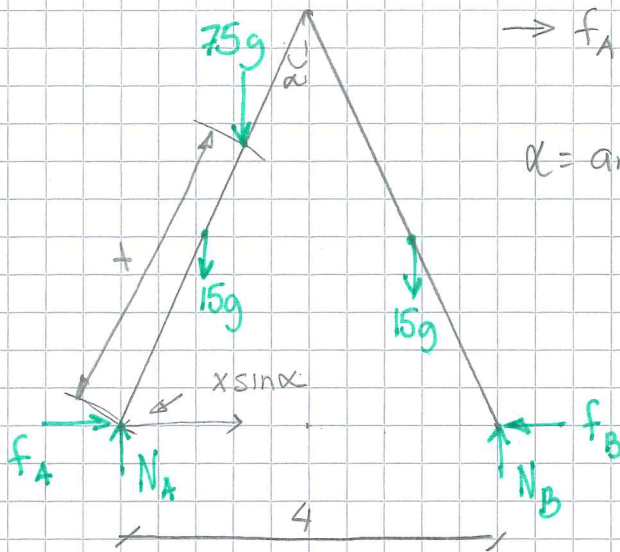
$$\mu = \frac{82404}{mg} = \underline{\underline{2,4}}$$

3,48 Sökt: x_{max}

$$\mu = 0,25$$

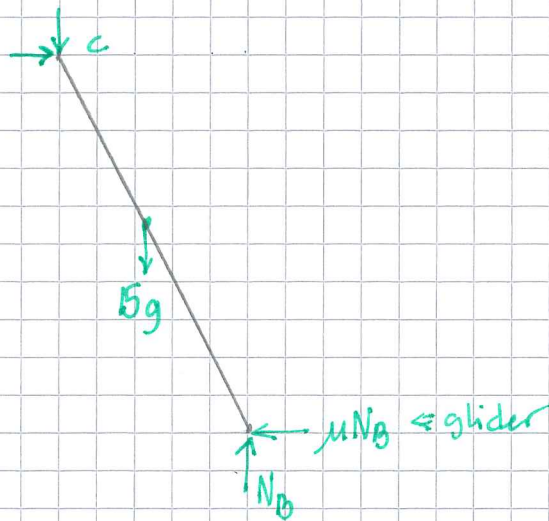
$$\rightarrow f_A = f_B$$

$$\alpha = \arcsin\left(\frac{2}{5}\right) = 23,6^\circ$$



$$\curvearrow A \quad N_B \cdot 4 - 15 \cdot 9,81 \cdot 3 - 15 \cdot 9,81 \cdot 1 - 75 \cdot 9,81 \cdot x \sin 23,6^\circ = 0$$

$$N_B = \frac{1}{4} (588,6 + 75 \cdot 9,81 x \sin 23,6^\circ) \quad (1)$$



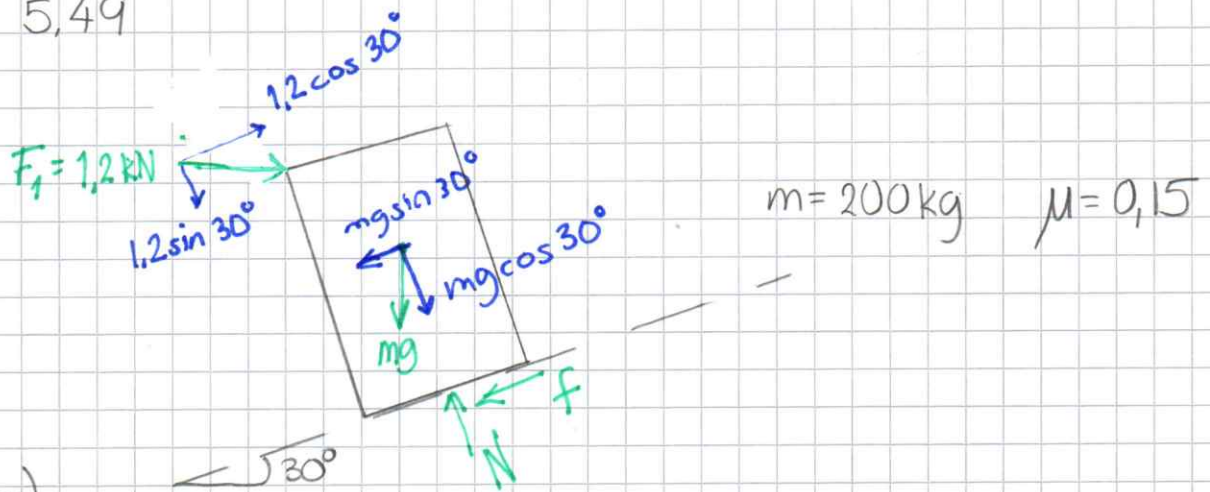
$$\curvearrow C \quad N_B \cdot 2 - \mu N_B \cdot 5 \cos 23,6^\circ - 15 \cdot 9,81 \cdot 1 = 0$$

$$N_B = \frac{147,15}{2 - 0,25 \cdot 5 \cos 23,6^\circ} = 172,20 \quad (2)$$

$$(1) \Rightarrow \frac{1}{4} (588,6 + 75 \cdot 9,81 x \sin 23,6^\circ) = 172,20$$

$$\underline{\underline{x = 0,34 \text{ m}}}$$

5,49

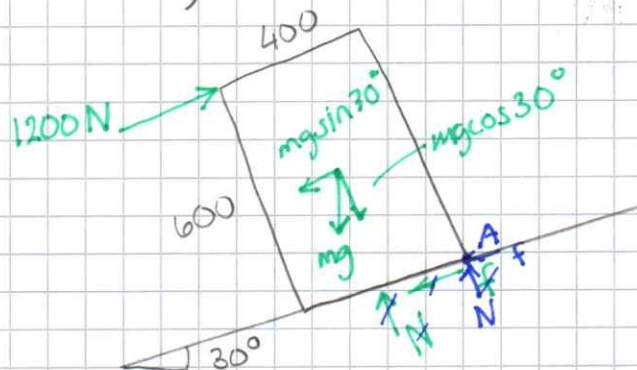


a)

$$\uparrow N - mg \cos 30^\circ - 1200 \sin 30^\circ = 0 \Rightarrow N = 2299 \text{ N}$$

$$\leftarrow f - 1200 \cos 30^\circ + mg \sin 30^\circ = 0 \quad \underline{f = 58 \text{ N}}$$

$f < N \cdot \mu = 2299 \cdot 0,15 = 345 \text{ N}$ glidning sker
ej \Rightarrow info stämmer



Kontrollera glidning

$$\uparrow N = mg \cos 30^\circ = 1699 \text{ N} \Rightarrow f_{\text{tug}} = 1699 \cdot 0,15 = 255 \text{ N}$$

$$\rightarrow 1200 - mg \sin 30^\circ - f = 0 \Rightarrow f = 219 \text{ N}$$

$f < f_{\text{tug}} \Rightarrow$ glider ej

Stjälpning runt A

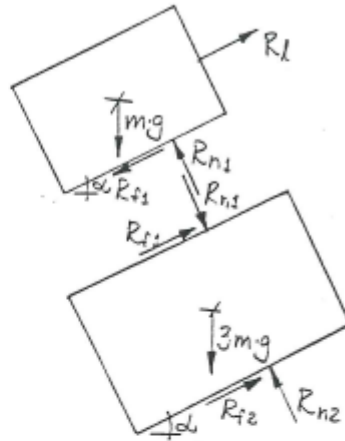
$$M_{\text{stjälp}} = 1200 \cdot 600 = 720000 \text{ Ncm}$$

$$M_{\text{stabil}} = mg \sin 30^\circ \cdot 300 + mg \cos 30^\circ \cdot 200 = 634128 \text{ Ncm}$$

$M_{\text{stjälp}} < M_{\text{stabil}}$ välter

5:50

JÄMVIKT



$$R_{f1} = \frac{1}{3} \cdot R_{n2}$$

$$R_{f2} = \frac{1}{3} \cdot R_{n2}$$

LILLA LÄZAN:

$$\uparrow: R_{n2} - m \cdot g \cdot \cos \alpha = 0$$

$$R_{n2} = m \cdot g \cdot \cos \alpha$$

STORA LÄZAN:

$$\uparrow: R_{n2} - 3 \cdot m \cdot g \cdot \cos \alpha - m \cdot g \cdot \cos \alpha = 0$$

$$R_{n2} = 4 \cdot m \cdot g \cdot \cos \alpha$$

$$\rightarrow: \frac{1}{3} \cdot 4 \cdot m \cdot g \cdot \cos \alpha + \frac{1}{3} \cdot m \cdot g \cdot \cos \alpha - 3 \cdot m \cdot g \cdot \sin \alpha = 0$$

$$\frac{5}{3} \cdot m \cdot g \cdot \cos \alpha = 3 \cdot m \cdot g \cdot \sin \alpha$$

$$\tan \alpha = \frac{\sin \alpha}{\cos \alpha} = \frac{\frac{5}{3} \cdot m \cdot g}{3 \cdot m \cdot g} \quad \alpha = 29,1^\circ$$

SVAR: $\alpha = 29,1^\circ$

5:5J	JÄMVIKT
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A:

$$\begin{cases} \rightarrow: 0,3 \cdot R_{n2} \cdot \cos 15^\circ - R_{n2} \cdot \sin 15^\circ - R_{n1} = 0 & (1) \\ \uparrow: -500 + 0,3 \cdot R_{n2} + 0,3 \cdot R_{n2} \cdot \sin 15^\circ + R_{n2} \cdot \cos 15^\circ & (2) \end{cases}$$

(1): $R_{n1} = 0,3 \cdot R_{n2} \cdot \cos 15^\circ - R_{n2} \cdot \sin 15^\circ$

(2): $-500 + 0,3 (0,3 \cdot R_{n2} \cdot \cos 15^\circ - R_{n2} \cdot \sin 15^\circ) + 0,3 \cdot R_{n2} \cdot \sin 15^\circ + R_{n2} \cdot \cos 15^\circ = 0$

$R_{n2} = 474,9 \text{ N}$

B:

$$\begin{cases} \rightarrow: F + 474,9 \cdot \sin 15^\circ - 0,3 \cdot 474,9 \cdot \cos 15^\circ - 0,3 \cdot R_{n3} = 0 & (3) \\ \uparrow: R_{n3} - 474,9 \cdot \cos 15^\circ - 0,3 \cdot 474,9 \cdot \sin 15^\circ = 0 & (4) \end{cases}$$

(4): $R_{n3} = 495,6 \text{ N}$

(3): $F = 163,4 \text{ N}$

SVAR: $F = 163 \text{ N}$

5:52	JÄMVIKT
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↑: $R_{n2} - G = 0$
 $R_{n2} = G$

↑: $R_{n3} - G - G = 0$
 $R_{n3} = 2 \cdot G$

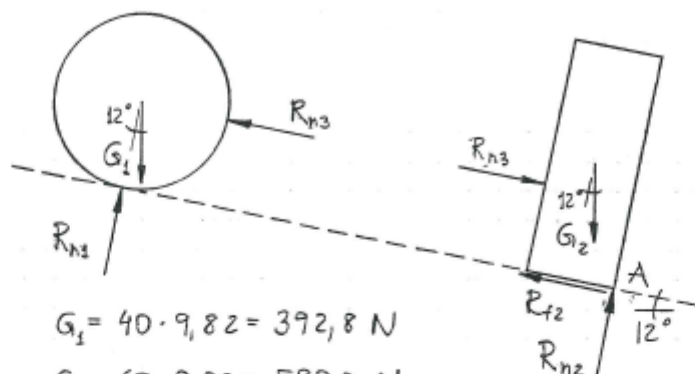
↑: $R_{n4} - 2 \cdot G - G = 0$
 $R_{n4} = 3 \cdot G$

→: $\mu_v \cdot 2G - 0,5 \cdot 3G = 0$
 $\mu_v < 0,75$

SVAR: $\mu_v < 0,75$

5:53

JÄMVIKT



$$G_1 = 40 \cdot 9,82 = 392,8 \text{ N}$$

$$G_2 = 60 \cdot 9,82 = 589,2 \text{ N}$$

CYLINDERN:

$$\rightarrow: 392,8 \cdot \sin 12^\circ - R_{n3} = 0$$

$$R_{n3} = 81,7 \text{ N}$$

KLOSSEN:

$$R_{n3} = 81,7 \text{ N}$$

$$\rightarrow: 589,2 \cdot \sin 12^\circ + 81,7 - R_{f2} = 0 \quad R_{f2} = 204 \text{ N}$$

$$\uparrow: R_{n2} - 589,2 \cdot \cos 12^\circ = 0 \quad R_{n2} = 576 \text{ N}$$

$$\text{GLIDNINGSVILLKOR: } R_f < \mu \cdot R_n$$

$$0,4 \cdot 576 = 231 > 204 \quad \text{INGEN GLIDNING!}$$

$$\text{STJÄLPNINGSVILLKOR: } \overline{M}_S > \overline{M}_M$$

$$\overline{M}_S = 81,7 \cdot 30 + 589,2 \cdot \sin 12^\circ \cdot 40 = 7351 \text{ Nmm}$$

$$\overline{M}_M = 589,2 \cdot \cos 12^\circ \cdot 15 = 8645 \text{ Nmm}$$

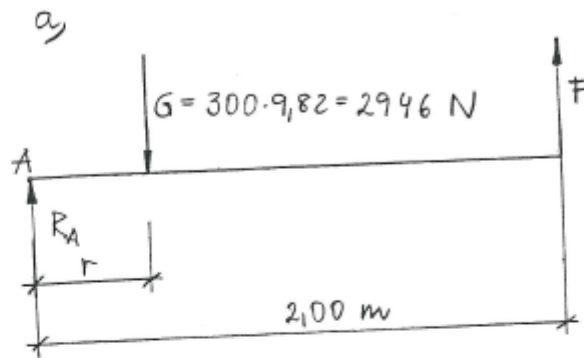
$$M_M > M_S \quad \text{INGEN STJÄLPNING!}$$

SVAR: a) INGEN GLIDNING

b) INGEN STJÄLPNING

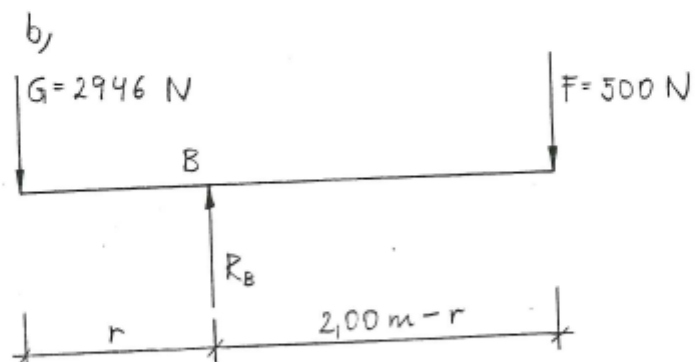
5:54

JÄMVIKT



$$\overset{\curvearrowright}{A}: 2946 \cdot r - 500 \cdot 2 = 0$$

$$r = 0,3394 \text{ m}$$



$$\overset{\curvearrowright}{B}: -2946 \cdot r + 500(2,00 - r) = 0$$

$$r = 0,2902 \text{ m}$$

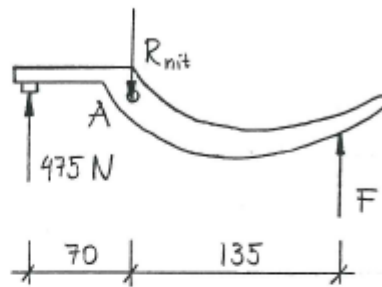
SVAR:

a) $r = 339 \text{ mm}$

b) $r = 290 \text{ mm}$

5:55

JÄMVIKT



$$\begin{cases} \uparrow: 475 - R_{nit} + F = 0 & (1) \\ \curvearrowright: 475 \cdot 70 - F \cdot 135 = 0 & (2) \end{cases}$$

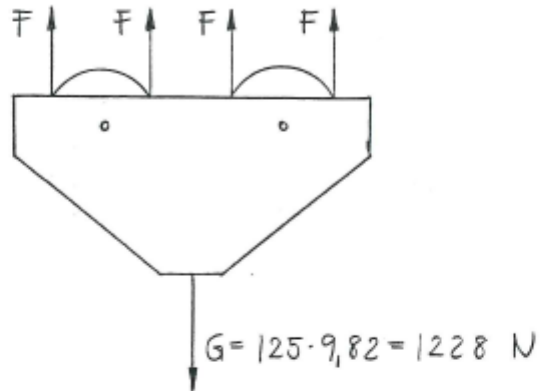
$$(2): F = 246,3 \text{ N}$$

$$(1): R_{nit} = 721,3 \text{ N}$$

SVAR: a) $F = 246 \text{ N}$
b) $R_{nit} = 721 \text{ N}$

5:56

JÄMVIKT



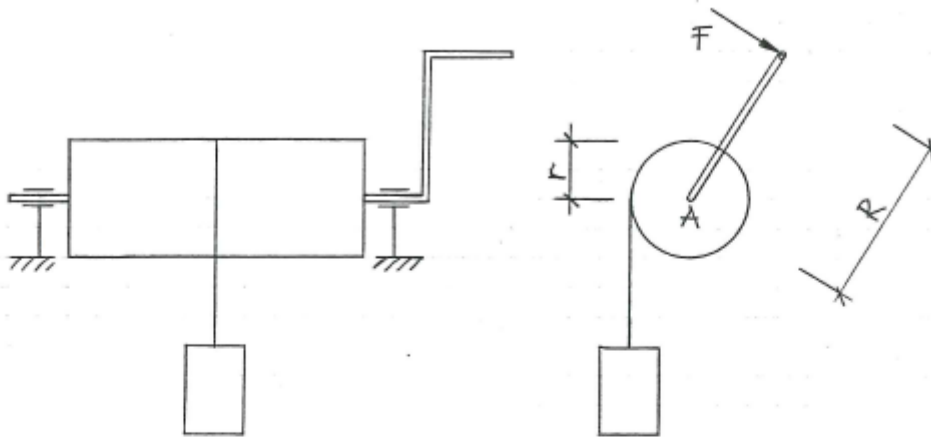
$$\uparrow: 4 \cdot F - 1228 = 0$$

$$F = 306,9 \text{ N}$$

SVAR: $F = 307 \text{ N}$.

5:57

JÄMVIKT



a)

$$\sum \vec{A}: F \cdot 310 - 50 \cdot 9,82 \cdot 107,5 = 0$$

$$F = 170,3 \text{ N}$$

b)

$$U = \frac{z_1}{z_2} = \frac{60}{12} = 5$$

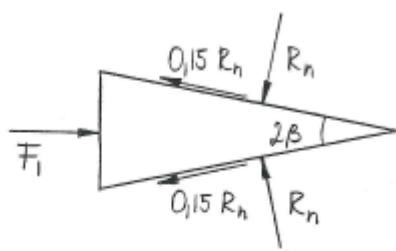
$$\eta = 0,80$$

$$F_1 = \frac{F}{U \cdot \eta} = \frac{170,3}{5 \cdot 0,80} = 42,58 \text{ N}$$

SVAR: a, $F = 170 \text{ N}$
 b, $F = 42,6 \text{ N}$

5:58

JÄMVIKT

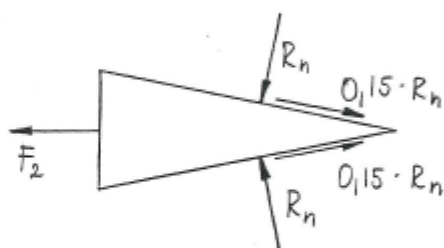


$$\tan \beta = \frac{20}{200}$$

$$2\beta = 11,42^\circ$$

$$\rightarrow: F_1 - 2 \cdot R_n \cdot \sin \frac{11,42^\circ}{2} - 2 \cdot 0,15 R_n \cdot \cos \frac{11,42^\circ}{2} = 0$$

$$F_1 = 0,4975 \cdot R_n$$



$$\rightarrow: -F_2 - 2 \cdot R_n \cdot \sin \frac{11,42^\circ}{2} + 2 \cdot 0,15 \cdot R_n \cdot \cos \frac{11,42^\circ}{2} = 0$$

$$F_2 = 0,09952 \cdot R_n$$

$$\frac{F_1}{F_2} = \frac{0,4975}{0,09952} = 5,000$$

SVAR: 5x