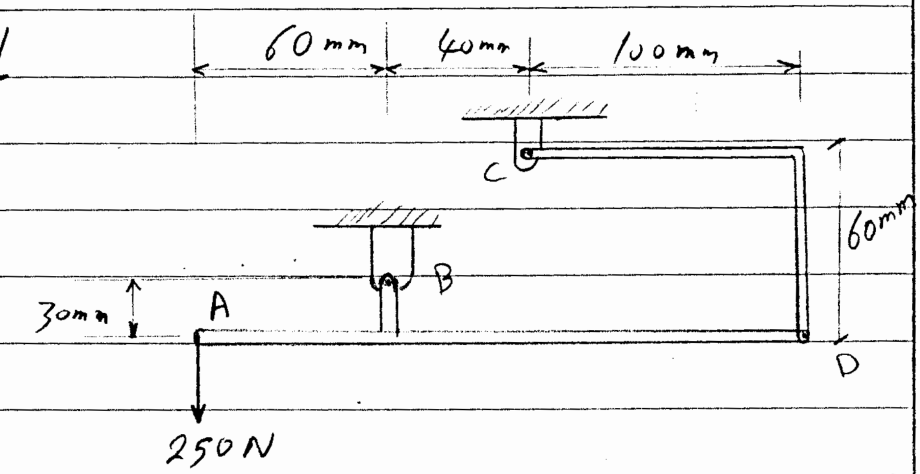
Solution of HW # 7

Problem # 1

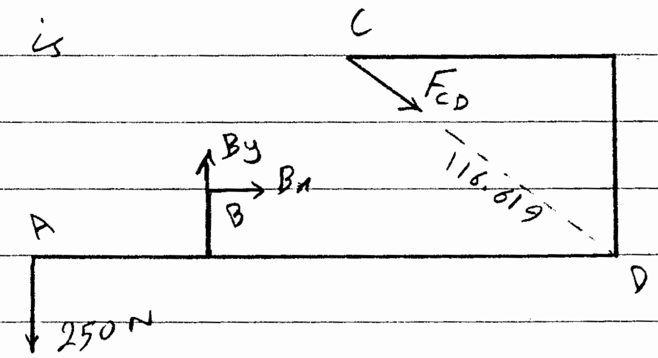


Given: The system shown in the figure

Required: The reactions at B & C

Solution: From the FBD

Note that CD is a two-force member.



$\circlearrowleft + \sum M_B = 0 \Rightarrow$

$$-F_{CD}\frac{100}{116.619}(0.06-0.03)-\frac{60}{116.619}F_{CD}(0.04)+250(0.06)=0$$

$\Rightarrow F_{CD} = 323.94 \text{ N} \Rightarrow$ $\boxed{C_x = 277.78 \text{ N}}$ $\boxed{C_y = -166.67 \text{ N}}$

$\sum F_x = 0 \Rightarrow B_x + C_x = 0 \Rightarrow \boxed{B_x = -277.78 \text{ N}}$

$\sum F_y = 0 \Rightarrow B_y - 166.67 - 250 = 0$

$\Rightarrow \boxed{B_y = 416.67 \text{ N}}$

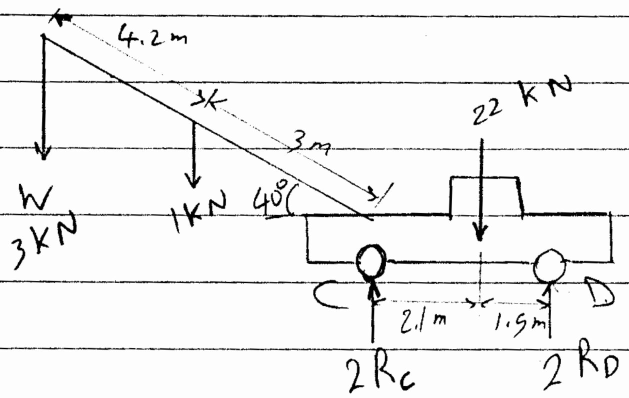
Problem # 2

Given: The system as shown in Fig P2 in the HW sheet.

Required: The reaction at each of the two rear wheels C and the front wheels D

Solution:

From the FBD



$\Sigma M_C = 0$ (+ counterclockwise)

$3 \times 7.2 \cos 40 + 1 \times 3 \cos 40 + 2 R_D \times 3.6 - 22 \times 2.1 = 0$

$\Rightarrow$ $R_D = 3.799$ kN

$\Sigma F_y = 0 \Rightarrow -3 - 1 - 22 + 2 R_C + 2 \times 2.799 = 0$

$\Rightarrow$

$R_C = 9.2$ kN

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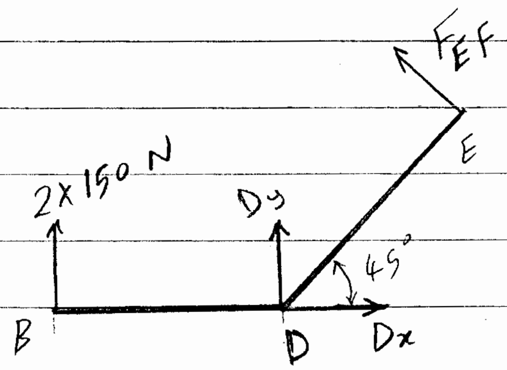
Problem # 3

Given: The system shown in Fig P_3 in the HW sheet.

Required: a) The force exerted at E
b) the reaction at D

Solution: From the FBD



Note: the force exerted at B is 2×150 N i.e. 300 N by neglecting the weight of the pulley at B

$\sum M_D = 0$ (+ counterclockwise)

$-300 \times 0.15 + F_{EF} \times 0.2 = 0$

$\Rightarrow \boxed{F_{EF} = 225 \text{ N}}$

$\sum F_x = 0 \Rightarrow D_x - F_{EF} \cos 45 = 0$

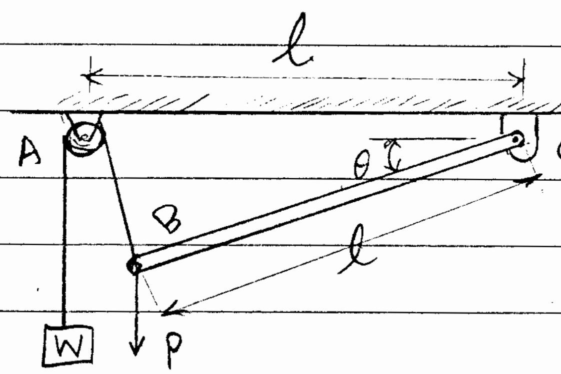
$\Rightarrow \boxed{D_x = 159.1 \text{ N}}$

$\sum F_y = 0 \Rightarrow 300 + F_{EF} \sin 45 + D_y = 0$

$\Rightarrow D_y = -459.1 \text{ N}$!

$\therefore \boxed{D_y = 459.1 \text{ N} \downarrow}$ #

Problem # 4

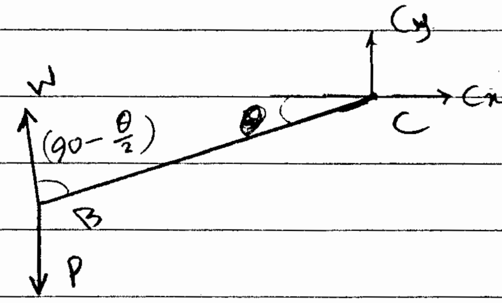


Given: The system shown in the figure

Required: a) express θ in terms of P, l & W

b) the value of θ when P = 2W

Solution: From the FBD



a)

$\overset{+}{\circlearrowleft} \sum M_C = 0 \Rightarrow$

$P l \cos\theta - W l \sin(90 - \frac{\theta}{2}) = 0$

$\Rightarrow P l \cos\theta - W l \cos\frac{\theta}{2} = 0$

divide on l

$\Rightarrow P\cos\theta - W\cos\theta/2 = 0$

$\Rightarrow P(\cos^2\frac{\theta}{2} - \sin^2\frac{\theta}{2}) - W\cos\frac{\theta}{2} = 0$

$P[\cos^2\frac{\theta}{2} - (1 - \cos^2\frac{\theta}{2})] - W\cos\frac{\theta}{2} = 0$

$P[2\cos^2(\frac{\theta}{2}) - 1] - W\cos\frac{\theta}{2} = 0$

divide on 2P

$\cos^2\frac{\theta}{2} - \frac{W}{2P}\cos\frac{\theta}{2} - \frac{1}{2} = 0$

$\Rightarrow \cos\frac{\theta}{2} = \dfrac{\frac{W}{2P} \pm \sqrt{(\frac{W}{2P})^2 + \frac{4}{2}}}{2}$

note:

$\{\{ Ax^2 + Bx + C = 0 \}\}$

$A = 1$

$B = -\frac{W}{2P}$

$C = -\frac{1}{2}$

Continue problem # 4

$$\cos\frac{\theta}{2} = \frac{w}{4p} \pm \frac{1}{2}\sqrt{\left(\frac{w}{2p}\right)^2 + 2} \quad \text{--- (1)}$$

From equation (1) we choose the positive root.

$$\cos\frac{\theta}{2} = \frac{w}{4p} + \frac{1}{2}\sqrt{\left(\frac{w}{2p}\right)^2 + 2}$$

$$\Rightarrow \frac{\theta}{2} = \cos^{-1}\left[\frac{w}{4p} + \frac{1}{2}\sqrt{\left(\frac{w}{2p}\right)^2 + 2}\right]$$

$$\therefore \boxed{\theta = 2\cos^{-1}\left[\frac{w}{4p} + \frac{1}{2}\sqrt{\left(\frac{w}{2p}\right)^2 + 2}\right]}$$

b) $\theta = 2\cos^{-1}\left[\frac{1}{8} + \frac{1}{2}\sqrt{\left(\frac{1}{4}\right)^2 + 2}\right]$

$$\boxed{\theta = 65.068^\circ} \quad \#$$

Problem # 5

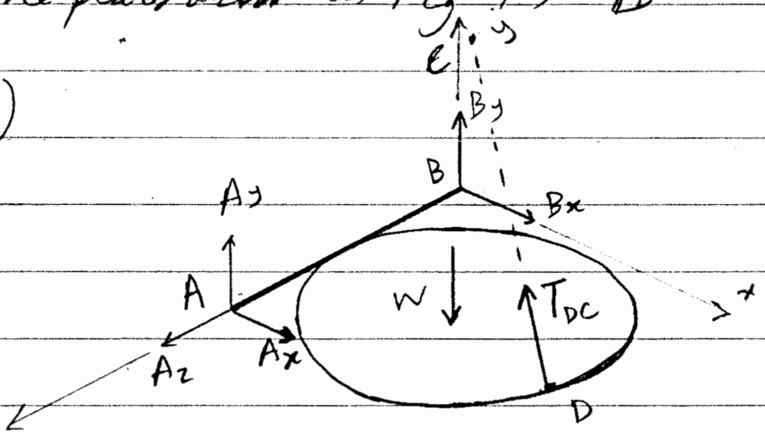
Given: The systems shown in Fig. P5A & Fig P5 B in the HW sheet.

Required: A) complete and clear free body diagram for the cover in Fig P5 A

b) complete and clear free body diagram for the platform in Fig P5 B

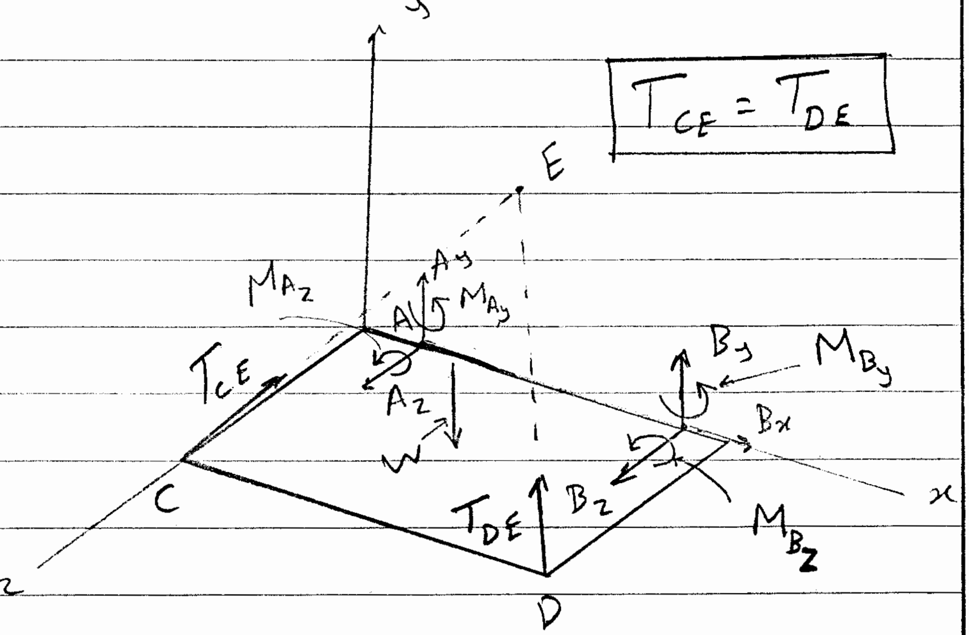
Solution:

A)



$W = 30g$ N

B)



$T_{CE} = T_{DE}$

$W = 250\,g$ N

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