CE 201 STATICS (Sections A & 6)
First Semester (081)
H. W. # 6 Solutions.

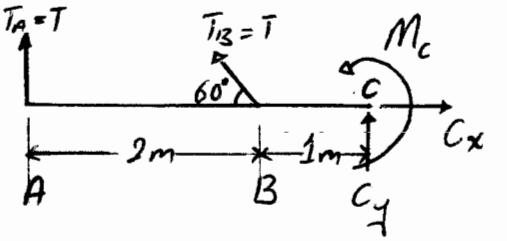
Problem 1

Given:
The figure P1 shown in the question sheet with a cable AB having a tension of 2kN.

Required:
Reactions at C in the two cases (a) and (b)

Solution.

a) First, the FBD is drawn as shown



Note that

$T_A = T_B = T = 2\,kN$

((Why ?!))

$\pm \rightarrow \sum F_x = 0 \Rightarrow C_x - 2\cos 60^\circ = 0$

$$\boxed{C_x = 1\,kN \rightarrow \text{(as shown)}}$$

$+\uparrow \sum F_y = 0 \Rightarrow C_y + 2 + 2\sin 60 = 0$

$$\boxed{C_y = -3.732 = 3.732\,kN \downarrow \text{(opposite of what is shown)}}$$

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

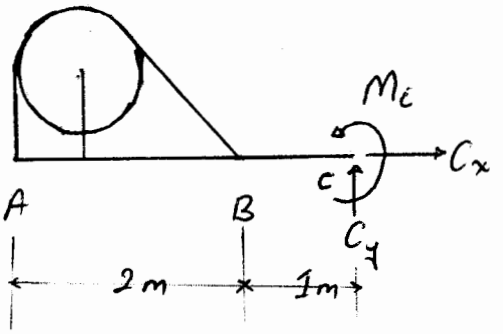
$$M_c - 2(3) - 2\sin 60\,(1) = 0$$

$$\Rightarrow \boxed{M_c = 7.732\,kN.m \circlearrowleft \text{ as shown.}}$$

(b)

The FBD is drawn.

Note that no external forces exist (?!)



Then,

$$\boxed{C_x = C_y = M_c = 0}$$

Problem 2

Given:

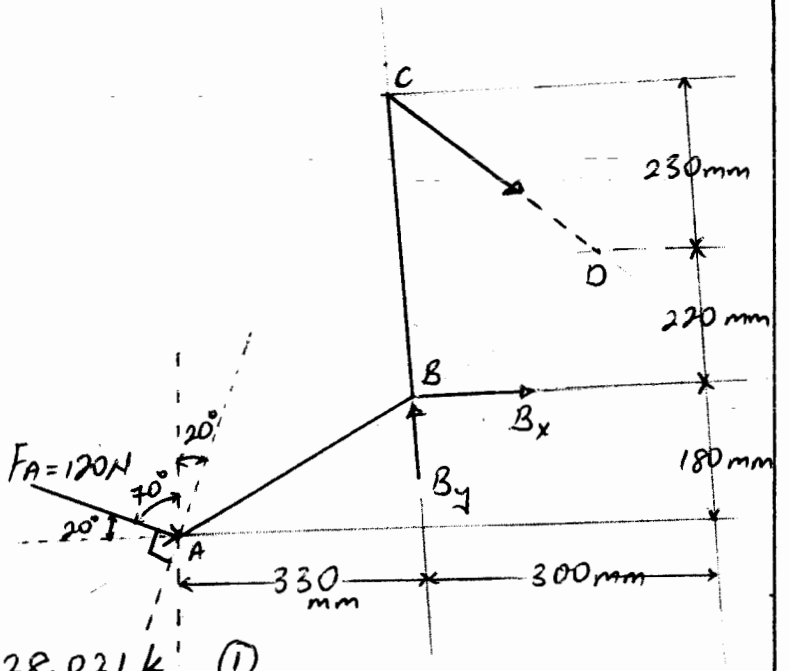
The figure P2 shown in the question sheet

Required:

The necessary value of the spring constant, k and the resulting reactions at B.

Solution.

First, the FBD is drawn



Note the direction of F_A (?!)

$l_{o_{sp}} = 350\,mm$

$l_{sp} = \sqrt{300^2 + (230)^2}$

$= 378.021\,mm$

$F_{sp} = ks$

$= k(l - l_o)$

$= k(378.021 - 350) = 28.021k$ ①

$+) \sum M_B = 0$ (Why M_B ?!)

$\Rightarrow 120\cos 20°(180) + 120\underbrace{\cos 70}_{\text{or } \sin 20}(330) - F_{sp}\left(\frac{300}{378.021}\right)(450) = 0$

$\Rightarrow F_{sp} = 94.761$ ②

From equations ① and ②

$F_{sp} = 28.021k = 94.761$

$\Rightarrow \boxed{k = 3.382\,N/mm}$

or $3.382\,kN/m$ or $3382\,N/m$

$\xrightarrow{+} \sum F_x = 0 \Rightarrow$

$$B_x + 120\cos 20 + 94.761\left(\frac{300}{378.021}\right) = 0$$

$$\Rightarrow \boxed{B_x = -188.0\,N = 188.0\,N \leftarrow}$$

$+\uparrow \sum F_y = 0 \Rightarrow$

$$B_y - 120\sin 20 - 94.761\left(\frac{230}{378.021}\right) = 0$$

$$\Rightarrow \boxed{B_y = 98.70\,N(\uparrow) \text{ as shown.}}$$

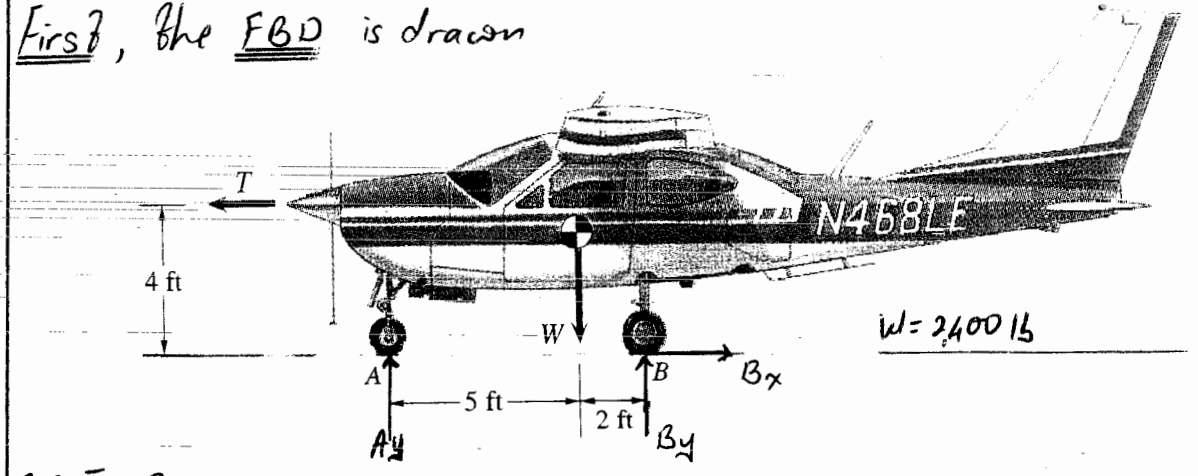
Problem 3

Given:
The figure P.3 shown in the question sheet.

Required:
Reaction exerted on the nose wheel and the total normal reaction exerted on the rear wheel when,
a) $T = 0$, (b) $T = 250$ lb.

Solution

First, the FBD is drawn



(a) $T = 0$

$\pm \rightarrow \sum F_x = 0 \rightarrow$

$$\boxed{B_x = 0}$$

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

$2400(2) - A_y(7) = 0 \Rightarrow \boxed{A_y = 685.7 \text{ lb} (\uparrow) \text{ as shown}}$

$+\uparrow \sum F_y = 0 \Rightarrow$

$685.7 - 2400 + B_y = 0 \Rightarrow B_y = 1714 \text{ lb} (\uparrow)$ as shown

(b) $T = 250$ lb

$\pm \rightarrow \sum F_x = 0 \Rightarrow B_x - 250 = 0$

$$\boxed{B_x = 250 \text{ lb} (\rightarrow) \text{ as shown}}$$

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

$2400(2) + 250(4) - A_y(7) = 0 \Rightarrow$

$\boxed{A_y = 828.6 \text{ lb} \uparrow \text{ as shown}}$

$+\uparrow \sum F_y = 0 \Rightarrow$

$2400 - 828.6 + B_y = 0$

$\boxed{B_y = 1571 \text{ lb} \uparrow \text{ (as shown)}}$

Problem 4

Given:

The figure P.4 shown in the question sheet

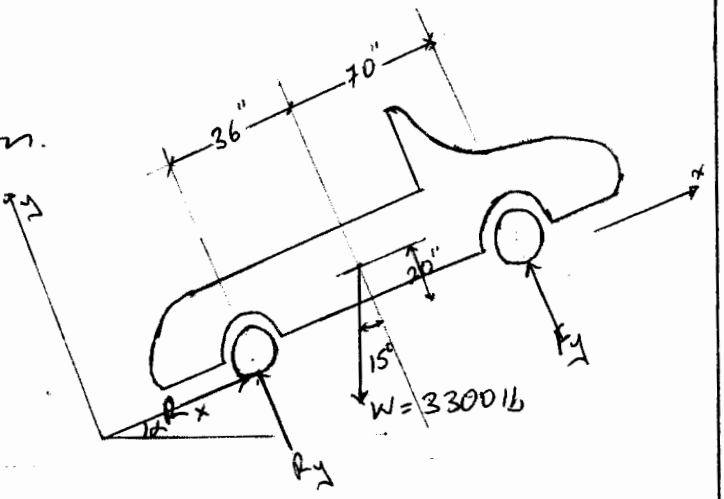
Required:

Forces exerted on the front and rear wheels by the road when the car is parked: (a) on an up slope with $\alpha = 15°$

(b) on a downslope with $\alpha = -15°$

Solution:

(a) First, the FBD is drawn.



$\rightarrow \Sigma F_x = 0 \Rightarrow$

$R_x - 3300 \sin 15° = 0$

$\Rightarrow \boxed{R_x = 854.1 \text{ lb}, \nearrow \text{ as shown.}}$

$+\circlearrowleft \Sigma M_a = 0 \Rightarrow$

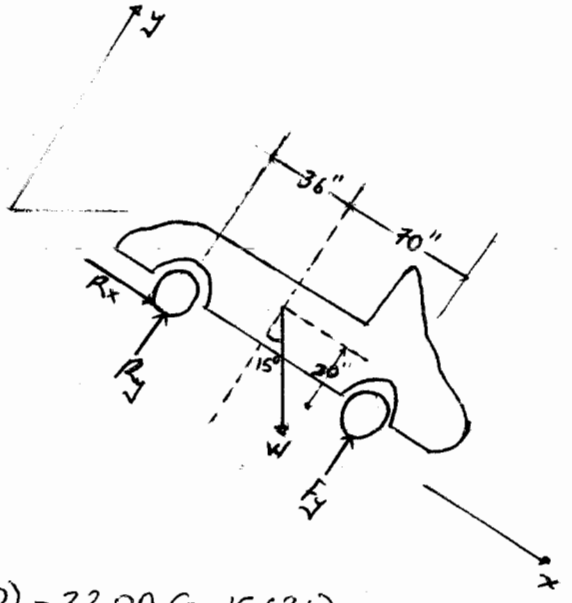
$F_y(36+70) + 3300 \sin 15°(20) - 33 \cos 15(36) = 0$

$\Rightarrow \boxed{F_y = 921.4 \text{ lb}, \nwarrow \text{ as shown.}}$

$+\uparrow \Sigma F_y = 0 \Rightarrow 921.4 - 3300 \cos 15 + R_b = 0 \Rightarrow$

$\boxed{R_y = 2266 \text{ lb}, \nwarrow \text{ as shown}}$

(b) First, the FBD is drawn



$\nearrow^{+} \Sigma F_x = 0 \Rightarrow$

$R_x + 3300 \sin 15^\circ = 0$

$\Rightarrow$ $R_x = -854.1$

$= 854.1$ lb, $\leftarrow$ (opposite of which is shown)

$+\circlearrowleft \Sigma M_z = 0 \Rightarrow$

$F_y(36+20) - 3300 \sin 15 (20) - 3300 \cos 15 (36) = 0$

$\Rightarrow$ $F_y = 1244$ lb, $\nearrow$ as shown

$+\nearrow \Sigma F_y = 0 \Rightarrow$

$R_y + 1244 - 3300 \cos 15 = 0 \Rightarrow$

$\Rightarrow$ $R_y = 1944$ lb, $\nearrow$ as shown

Compare the solutions of parts (a) and (b). What conclusion can you make?!

Problem 5

Given:

The figure P.5 in the question sheet

Required:

Reactions on the wing at the root, R.

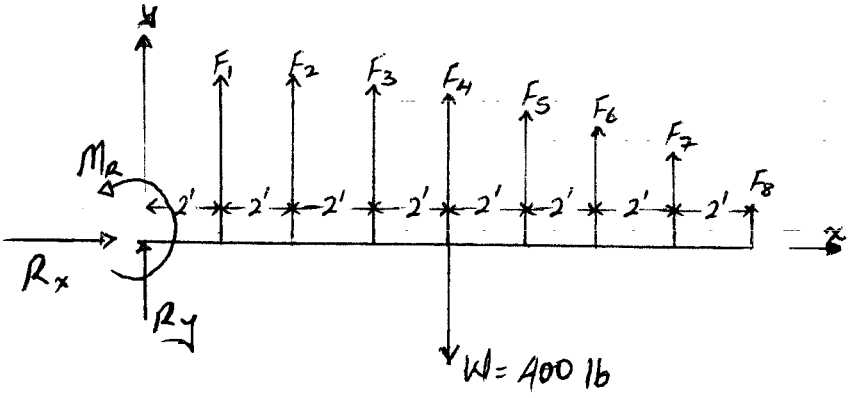
Solution:

First, the FBD is drawn.

From the equation,

$$F_i = 200\sqrt{1-\left(\frac{x_i}{17}\right)^2},$$

the forces F_1 to F_8 are calculated.



F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8
198.611	194.385	187.129	176.471	161.738	141.666	113.485	67.5831

$$\pm\rightarrow \sum F_x = 0 \Rightarrow \boxed{R_x = 0}$$

$$+\uparrow \sum F_y = 0 \Rightarrow \sum_{i=1}^{8} F_i - 400 + R_y = 0$$

$$\Rightarrow \boxed{R_y = -841.0 = 841.0 \text{ lb}, \downarrow \text{ opposite of FBD}}$$

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

$$F_1(2) + F_2(4) + F_3(6) + F_4(8) + F_5(10) + F_6(12) + F_7(14) + F_8(16) - 8(W) + M_R = 0$$

$$\Rightarrow \boxed{M_R = 6496 = 6496 \text{ ft. lb}, \circlearrowleft \text{ opposite of FBD}}$$