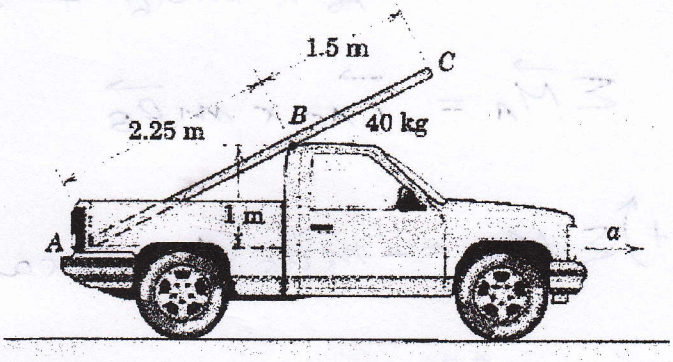
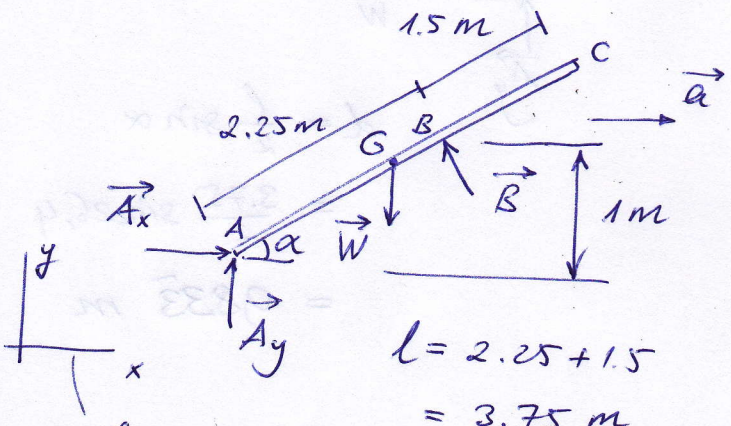
Name-Surname:
Student ID:

ITU Faculty of Aeronautics and Astronautics **14.12.2015**
Department of Aeronautical Engineering
2015-2016 Fall Term
11230 DNK201E Dynamics QUIZ – 3

Problem: The uniform 40-*kg* plank is supported in the pickup truck at its end *A* and at *B* where it rests on the smooth top of the cab. Calculate the contact force at *B* if the truck starts forward with an acceleration of $a = 4\ m/s^2$. $\left(I_G = \frac{1}{12}ml^2\right)$



Solution: FBD:



$l = 2.25 + 1.5$

$= 3.75\ m$

$\alpha = \sin^{-1}(1/2.25)$

$\cong 26{,}4°$

Equations of motion:

$\Sigma F_x = ma_x$:

$$A_x - B\sin\alpha = ma_x \qquad (1)$$

$\Sigma F_y = ma_y$:

$$A_y - W + B\cos\alpha = 0 \qquad (2)$$

$+\circlearrowleft \Sigma M_G = I_G\alpha$:

$$A_x\cdot(l/2)\sin\alpha + B(l/2 - 1.5) - A_y(l/2)\cos\alpha = 0 \qquad (3)$$

$(1) \rightarrow A_x = ma_x + B\sin\alpha \qquad (4)$

$(2) \rightarrow A_y = W - B\cos\alpha \qquad (5)$

$(4),(5) \rightarrow (3)$: $-ma_x(l/2)\sin\alpha + W(l/2)\cos\alpha$

$= B\{(l/2 + 1{,}5) + (l/2)\sin^2\alpha + (l/2)\cos^2\alpha\}$

$= B\{l - 1{,}5\}$

$$\Rightarrow B = \frac{(40\cdot 9.81\cdot\cos 26{,}4°/2 - 40\cdot 4\cdot\sin 26{,}4°/2)\cdot 3.75}{(3.75 - 1{,}5)} = 233{,}6\ N$$

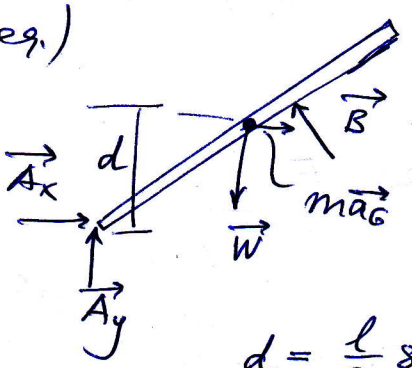
Alternatively :

$$\Sigma \vec{M}_A = \vec{r}_{AG} \times m\vec{a}_G + \Sigma \vec{M}_G$$

$$= \vec{r}_{AG} \times m\vec{a}_G + \cancel{I_G \vec{\alpha}}^{\,0}$$

$$\Sigma \vec{M}_A = \vec{r}_{AG} \times m\vec{a}_G$$

$$\overset{+}{\circlearrowleft} \Sigma M_A = -m a_G d \quad \text{(scalar eq.)}$$



$$B \cdot 2.25 - W \frac{3.75}{2} \cos\alpha = -40 \cdot 4 \cdot 0{,}833$$

$$B = 233{,}7 \text{ N}$$

$$d = \frac{l}{2} \sin\alpha$$

$$= \frac{3.75}{2} \sin 26{,}4$$

$$= 0{,}833 \text{ m}$$