Engineering Mechanics
AGE 2330

Lect 6: Review

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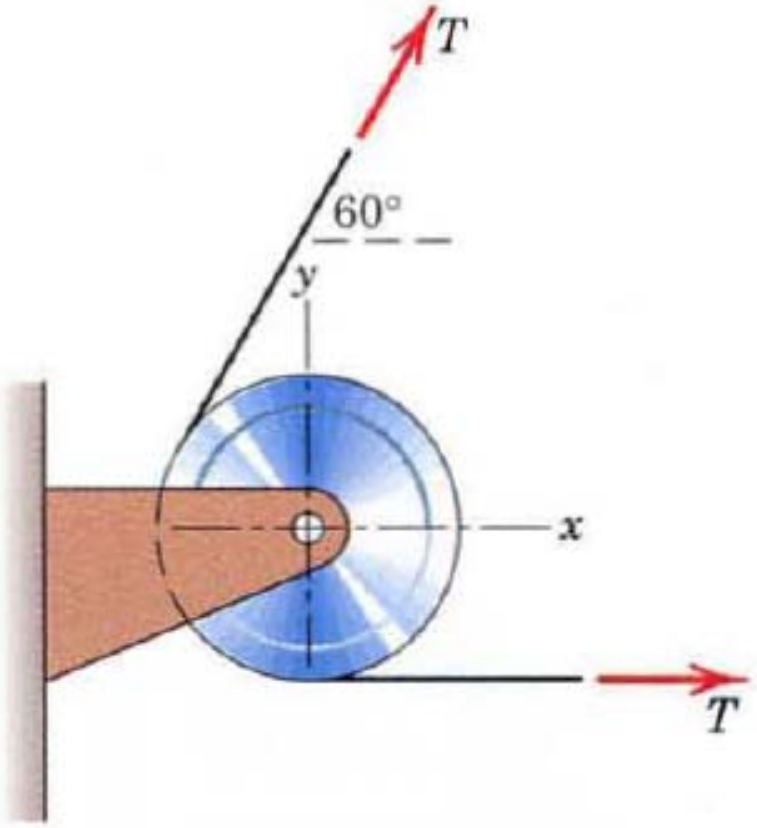
2/13 If the equal tensions T in the pulley cable are 400 N, express in vector notation the force $\mathbf{R}$ exerted on the pulley by the two tensions. Determine the magnitude of $\mathbf{R}$.

Ans. $\mathbf{R} = 600\mathbf{i} + 346\mathbf{j}$ N, $R = 693$ N



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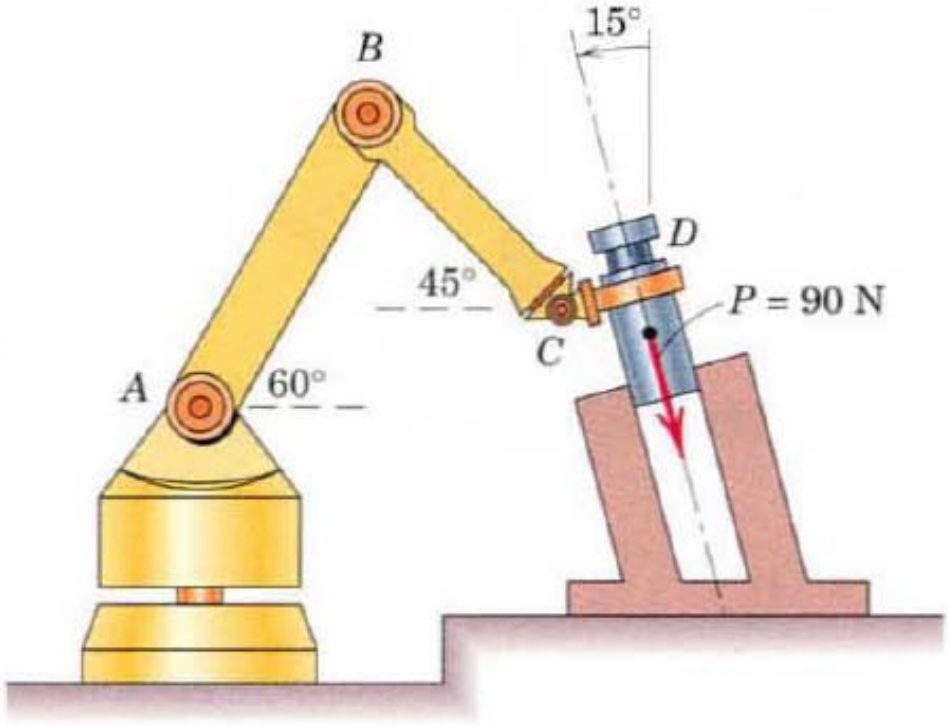
$$R_x = \Sigma F_x = 400 + 400 \cos 60^\circ = 600 \text{ N}$$

$$R_y = \Sigma F_y = 400 \sin 60^\circ = 346 \text{ N}$$

$$\Rightarrow \underline{R} = 600\underline{i} + 346\underline{j} \text{ N}$$

$$R = \sqrt{600^2 + 346^2} = \underline{693 \text{ N}}$$

2/24 In the design of the robot to insert the small cylindrical part into a close-fitting circular hole, the robot arm must exert a 90-N force P on the part parallel to the axis of the hole as shown. Determine the components of the force which the part exerts *on* the robot along axes (*a*) parallel and perpendicular to the arm AB, and (*b*) parallel and perpendicular to the arm BC.



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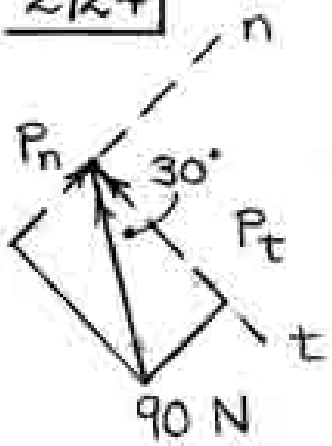
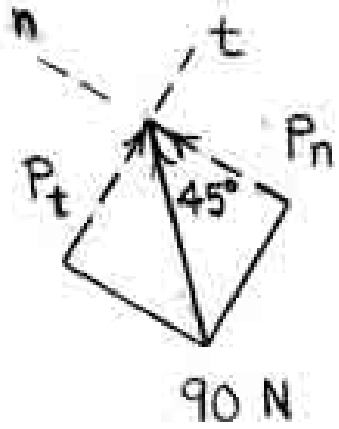


BC

$P_t = -90 \cos 30° = -77.9$ N

$P_n = 90 \sin 30° = 45.0$ N



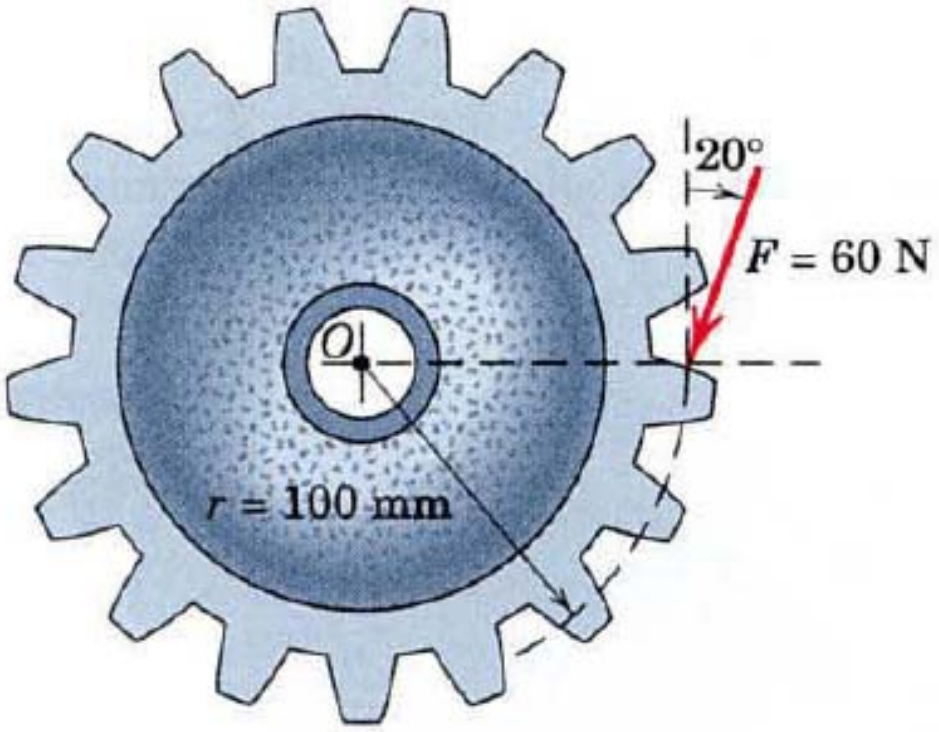
AB

$P_t = 90 \sin 45° = 63.6$ N

$P_n = 90 \cos 45° = 63.6$ N

2/31 A force **F** of magnitude 40 N is applied to the gear. Determine the moment of **F** about point *O*.

Ans. $M_O = 5.64$ N·m CW



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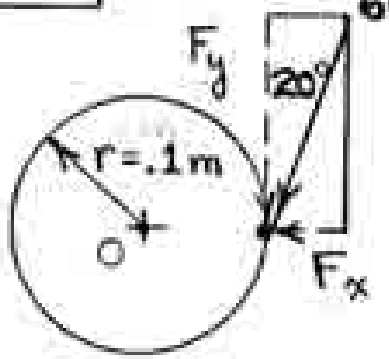
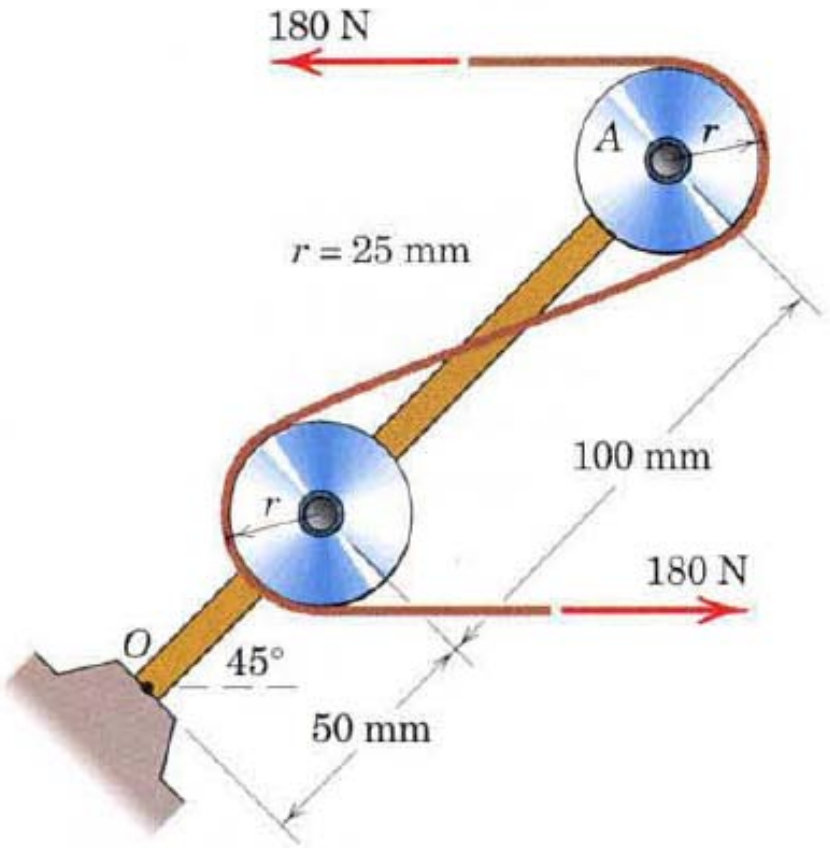


$$+\circlearrowleft M_o = r F_y$$

$$= (0.1)(60 \cos 20^\circ)$$

$$= 5.64 \text{ N·m}$$

2/62 The system consisting of the bar OA, two identical pulleys, and a section of thin tape is subjected to the two 180-N tensile forces shown in the figure. Determine the equivalent force–couple system at point O.



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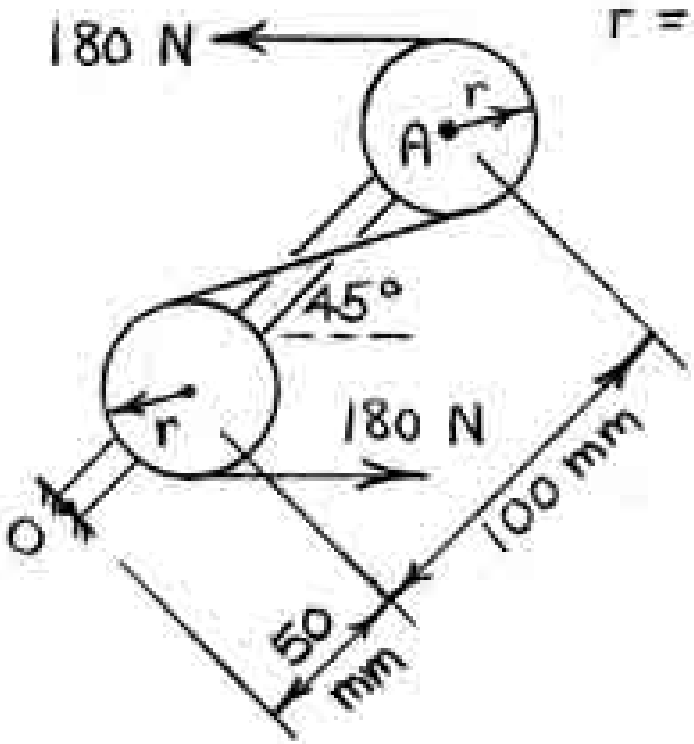


The system at O is a couple.

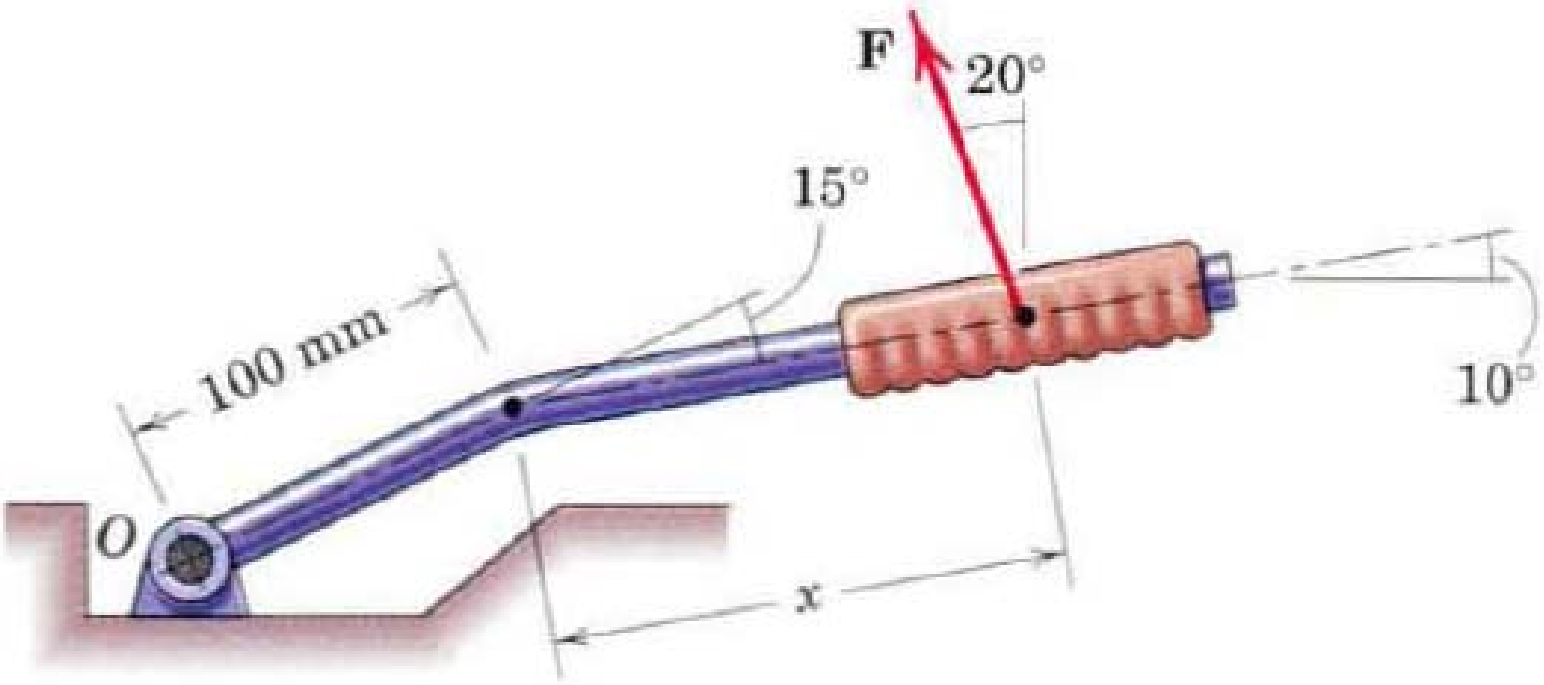
$\curvearrowleft M = Fd = 180(100 \sin 45° + 25 + 25)$

$= 21\,700$ N·mm or <u>21.7 N·m CCW</u>

2/69 A force **F** of magnitude 50 N is exerted on the automobile parking-brake lever at the position $x = 250$ mm. Replace the force by an equivalent force–couple system at the pivot point O.

Ans. $R = 50$ N

$M_O = 17.29$ N·m CCW



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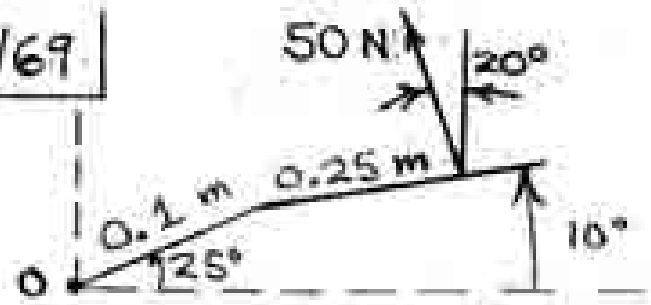


Use principle of moments.

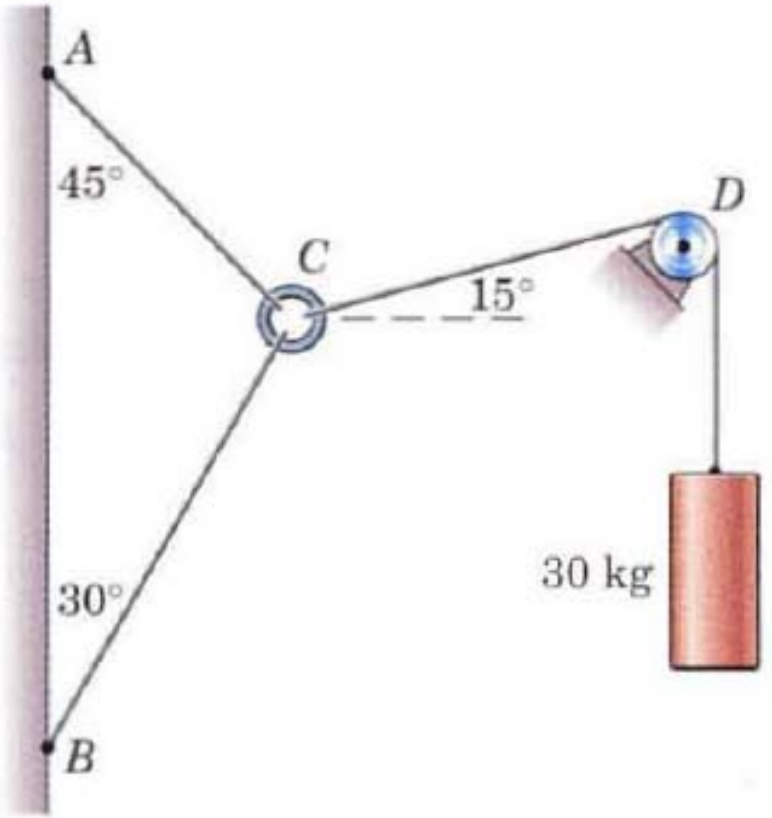
$$\circlearrowleft \Sigma M_O = 50 \cos 20^\circ [0.1 \cos 25^\circ + 0.25 \cos 10^\circ] + 50 \sin 20^\circ [0.1 \sin 25^\circ + 0.25 \sin 10^\circ]$$

$$= 17.29 \text{ N·m}$$

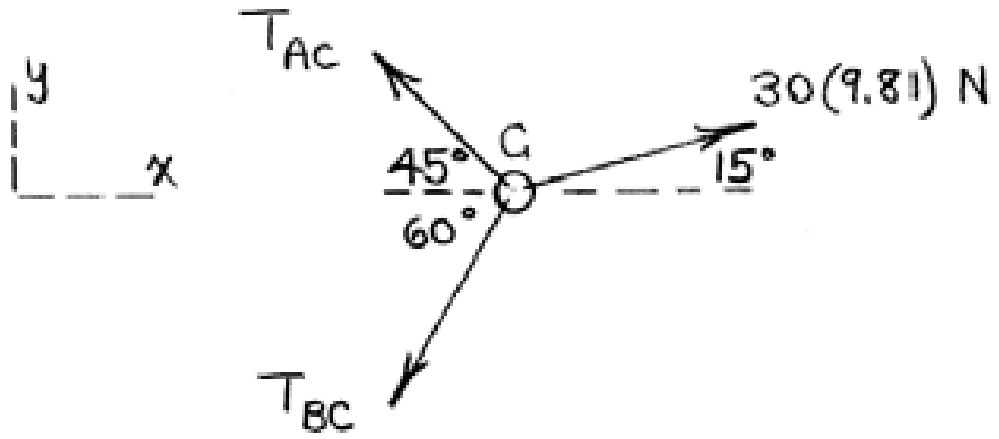
Force-Couple System at O:

$$\begin{cases} R = 50 \text{ N} \quad \nwarrow 110^\circ \\ M_O = 17.29 \text{ N·m} \quad \curvearrowleft \end{cases}$$

3/14 Three cables are joined at the junction ring C. Determine the tensions in cables AC and BC caused by the weight of the 30-kg cylinder.



3/14 FBD of junction ring C:

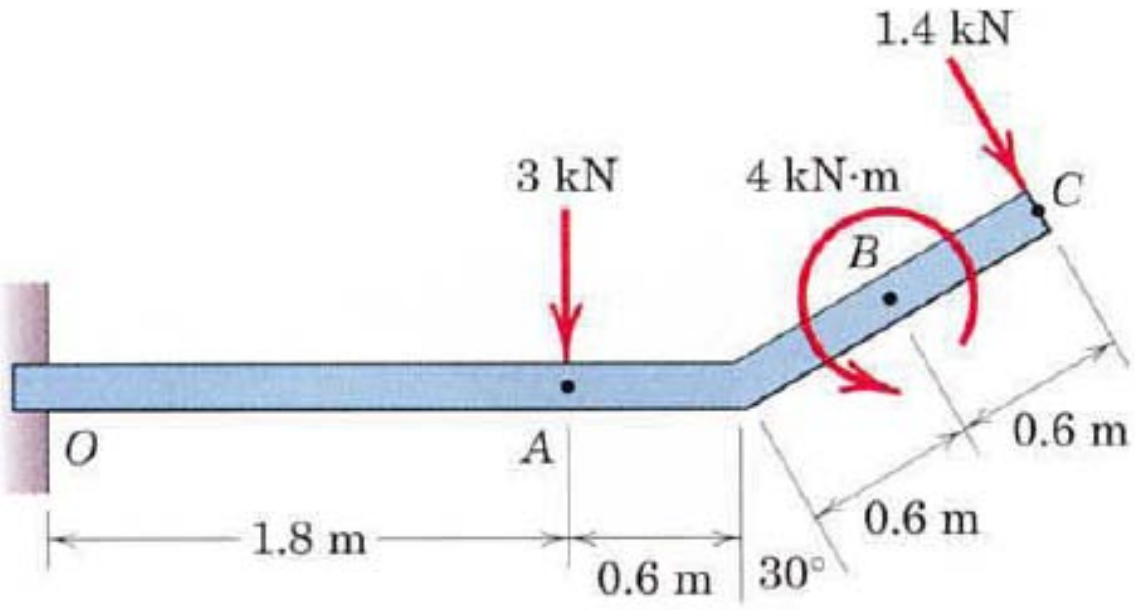


$$\begin{cases} \Sigma F_x = 0 : -T_{AC}\cos 45^\circ - T_{BC}\cos 60^\circ + 30(9.81)\cos 15^\circ = 0 \\ \Sigma F_y = 0 : T_{AC}\sin 45^\circ - T_{BC}\sin 60^\circ + 30(9.81)\sin 15^\circ = 0 \end{cases}$$

Solve simultaneously to obtain

$$\begin{cases} T_{AC} = 215 \text{ N} \\ T_{BC} = 264 \text{ N} \end{cases}$$

3/16 The uniform beam has a mass of 50 kg per meter of length. Compute the reactions at the support O. The force loads shown lie in a vertical plane.



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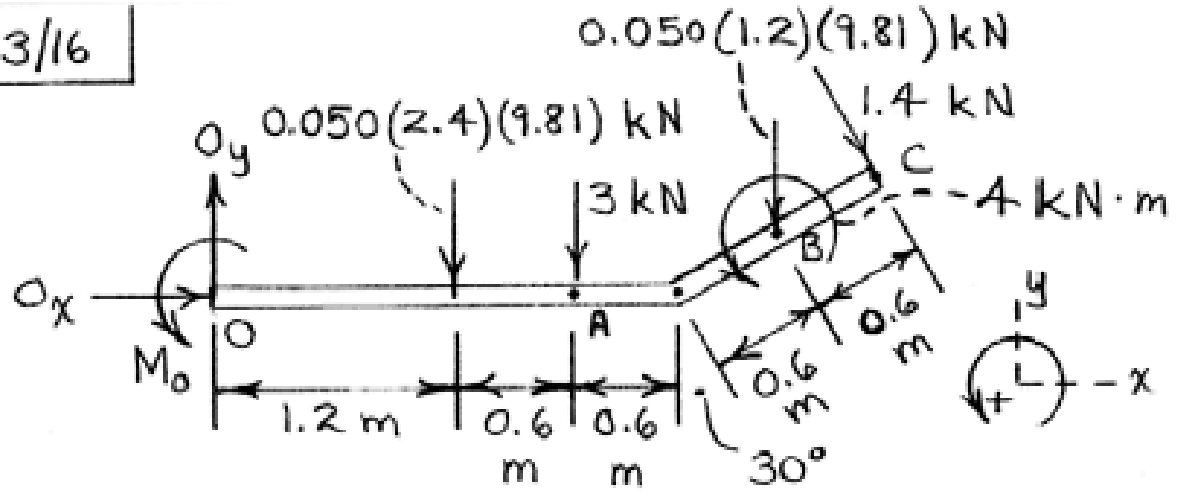

$\Sigma F_x = 0$: $O_x + 1.4 \sin 30° = 0$

$O_x = -0.7$ kN

$\Sigma F_y = 0$: $O_y - 0.050(2.4)(9.81) - 3 - 1.4 \cos 30°$

$- 0.050(1.2)(9.81) = 0$, $O_y = 5.98$ kN

$\Sigma M_O = 0$: $M_O - 0.050(2.4)(9.81)(1.2) - 3(1.8)$

$- 0.050(1.2)(9.81)(2.4 + 0.6 \cos 30°) + 4$

$- 1.4(2.4 \cos 30° + 1.2) = 0$, $M_O = 9.12$ kN·m