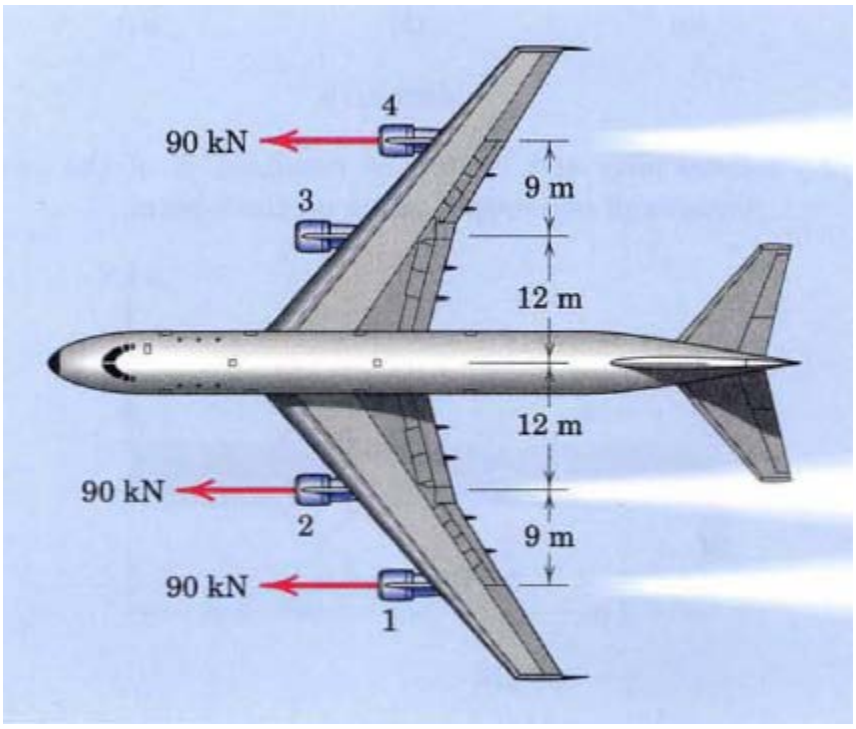
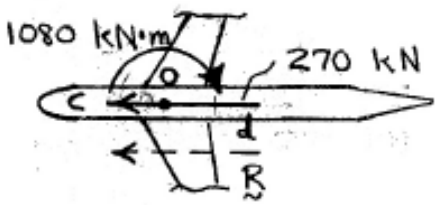
Problem 3

A commercial airliner with four jet engines, each producing 90 kN of forward thrust, is in a steady, level cruise when engine number 3 suddenly fails. Determine and locate the resultant of the three remaining engine thrust vectors. Treat this as a two dimensional problem.



Solution



$$R = 3(90) = 270 \text{ kN} \ (\leftarrow)$$

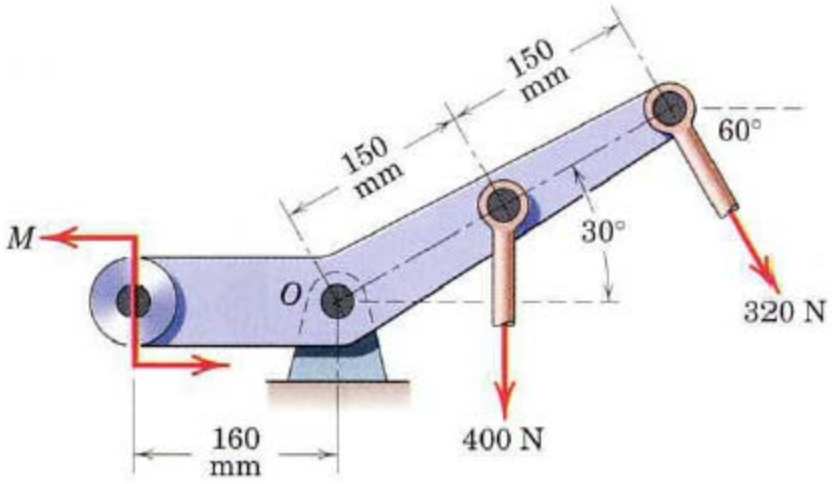
$$+\circlearrowleft M_O = 12(90) = 1080 \text{ kN·m}$$

$$d = \frac{M_O}{R} = \frac{1080}{270}$$

$$= 4 \text{ m}$$

Problem 4

If the resultant of the two forces and couple M passes through point O , determine M.



Solution

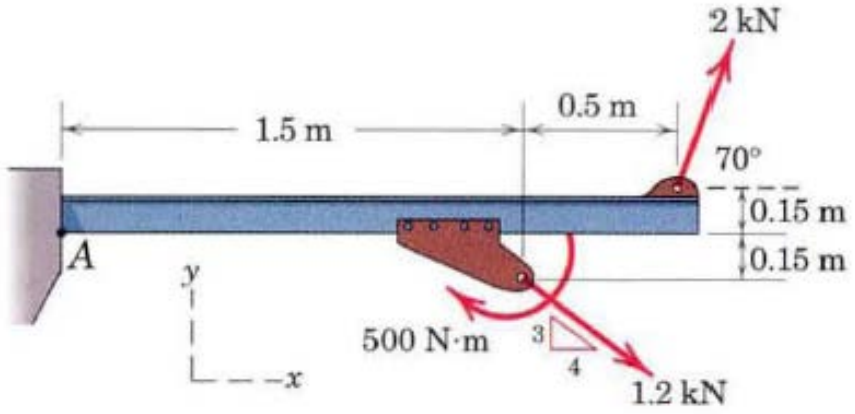
$M_o = 0$, so

$$\circlearrowleft_+ M - 400(0.150\cos 30°) - 320(0.300) = 0$$

$$M = 148.0 \text{ N·m}$$

Problem 5

The flanged steel cantilever beam with riveted bracket is subjected to the couple and two forces shown, and their effect on the design of the attachment at A must be determined. Replace the two forces and couple by an equivalent couple .M and resultant force R at A.



Solution

$$R_x = \Sigma F_x = 2\cos 70^\circ + 1.2\left(\frac{4}{5}\right) = 1.644 \text{ kN}$$

$$R_y = \Sigma F_y = 2\sin 70^\circ - 1.2\left(\frac{3}{5}\right) = 1.159 \text{ kN}$$

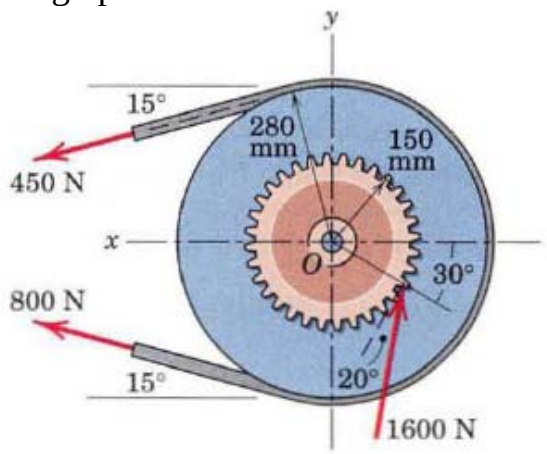
$$\curvearrowleft + M_A = -2\cos 70^\circ (0.15) + 2\sin 70^\circ (1.5 + 0.5)$$

$$+1.2\left(\frac{4}{5}\right)(0.15) - 1.2\left(\frac{3}{5}\right)(1.5) - 0.5$$

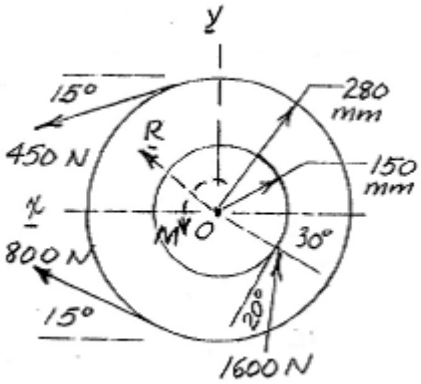
$$= 2.22 \text{ kN·m} \quad \text{CCW}$$

Problem 6

The gear and attached V-belt pulley are turning counterclockwise and are subjected to the tooth load of 1600 N and the 800-N and 450-N tens ions in the V-belt. Represent the action of these three forces by a resultant force R at O and a couple of magnitude *M*. Is the unit slowing down or speeding up?



Solution



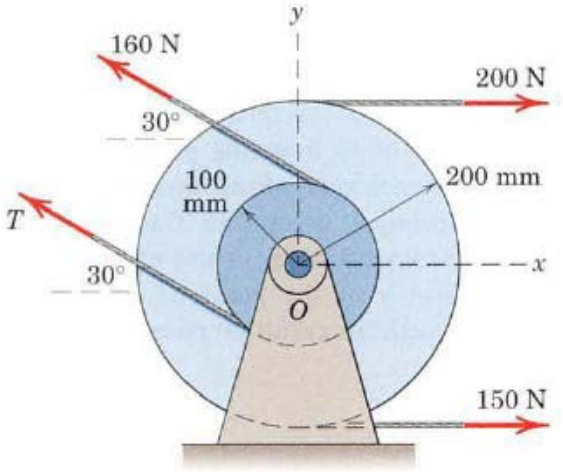
$$R_x = \Sigma F_x = (800 + 450)\cos 15° - 1600 \sin(30° - 20°)$$
$$= 1207 - 278 = 929.6 \text{ N}$$

$$R_y = \Sigma F_y = 1600 \cos 10° + (800 - 450)\sin 15°$$
$$= 1576 + 90.6 = 1666 \text{ N}$$

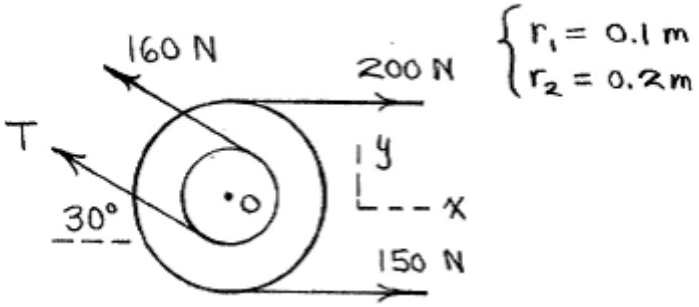
$$M = \Sigma M_O \; (+); \quad M = 1600 \cos 20°(0.150) + (450 - 800)0.280$$
$$= 225.5 - 98.0 = \underline{127.5 \text{ N·m CCW}}$$

Problem 7

Two integral pulleys are subjected to the belt tensions shown. If the resultant R of these forces passes through the center O, determine T and the magnitude of R and the counterclockwise angle θ it makes with the x-axis.



Solution



$+\circlearrowleft M_O = 0: \quad 200(0.2) - 150(0.2) - 160(0.1) + (0.1)T = 0$

$T = 60\ N$

$R_x = \Sigma F_x = 200 + 150 - (160 + 60)\cos 30^\circ = 159.5\ N$

$R_y = \Sigma F_y = (160 + 30)\sin 30^\circ = 110\ N$

$R = \sqrt{R_x^2 + R_y^2} = 193.7\ N$

$\theta = \tan^{-1}(R_y / R_x) = 34.6^\circ$