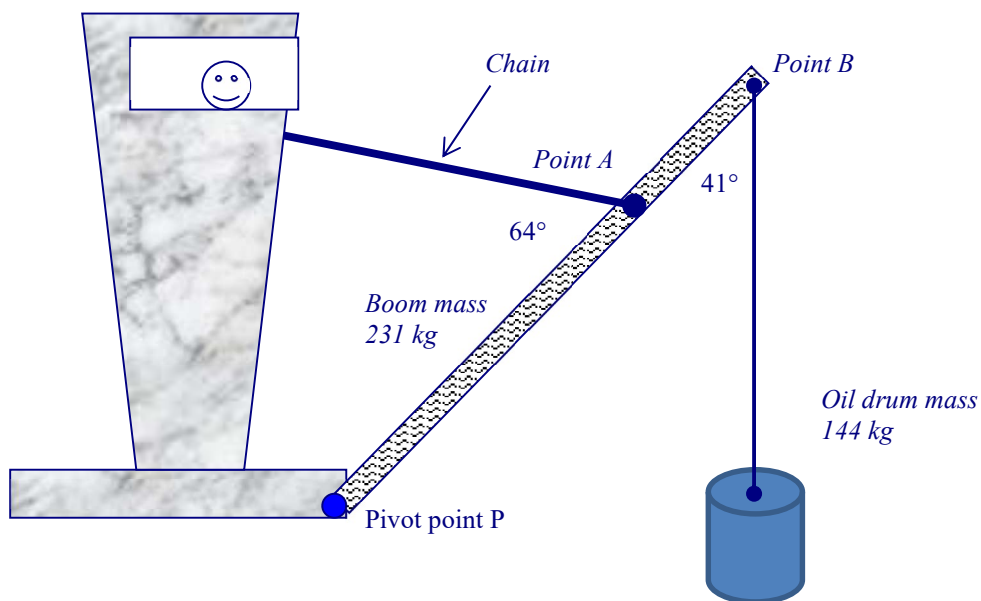


Question 16 (9 marks)

A crane at Fremantle port is unloading an oil drum from a ship.

- The boom of the crane has a mass of 231 kg and is pivoted at point P.
- The oil drum of mass 144 kg is suspended from point B. Its rope makes an angle of 41° with the boom.
- A chain attached at point A is holding the boom in position. The distance from P to A is 3.80 m.
- The chain makes an angle of 64° with the boom.
- The boom has a length of 4.50 m from P to B with uniform mass distribution.



- a. Demonstrate by calculation that the tension in the chain = 2.20×10^3 N.

(4)

Consider boom in static equilibrium, $\Sigma M = 0$

Select pivot at P and take moments

$$\Sigma \text{acwm} = \Sigma \text{cwm}$$

Concept ✓

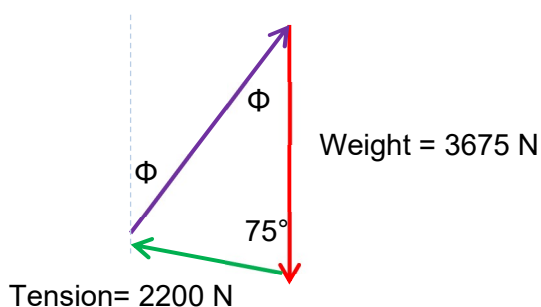
$$3.80 \times F_T \times \sin 64^\circ \checkmark = (4.50 \times 144 \times 9.8 \times \sin 41^\circ) + (2.25 \times 231 \times 9.8 \times \sin 41^\circ) \checkmark$$

$$F_T = 7507.9 / (3.80 \times \sin 64^\circ)$$

$$F_T = 2198.23 = 2.20 \times 10^3 \text{ N} \checkmark$$

- b. Calculate the magnitude of the **reaction force** acting on the boom from the pivot.

(3)



Consider boom in static equilibrium, $\Sigma F = 0$

Construct vector diagram / solve by components (Concept)

$$\theta = 180 - (41 + 64) = 75^\circ$$

$$\text{Combined weight} = (231 + 144) \times 9.8 = 3675 \text{ N down} \quad \checkmark$$

By Cosine Rule $R^2 = W^2 + T^2 - 2.W.T.\cos 75^\circ$

$$R^2 = 3675^2 + 2200^2 - 2 \times 3675 \times 2200 \times \cos 75^\circ \quad \checkmark$$

$$R = 3763 = 3.76 \times 10^3 \text{ N} \quad \checkmark$$

- c. Calculate the direction of the **reaction force** acting on the boom from the pivot.

(2)

By Sine rule $\frac{T}{\sin \Phi} = \frac{R}{\sin 75}$

$$\sin \Phi = \frac{T \times \sin 75}{R} = \frac{2200 \times \sin 75}{3763} \quad \checkmark$$

$$\sin \Phi = 0.56471879$$

$$\Phi = 34.4^\circ \text{ from vertical (or } 55.6^\circ \text{ above horizontal)}$$

Must correspond to angle shown on diagram. \checkmark

A solution using components in vertical and horizontal is also possible.