N5 Structures

Moments

$$\Sigma CWM = \Sigma ACWM$$

$$F_1 \times d_1 = F_2 \times d_2$$

A moment is a Force (N) x a distance (m).

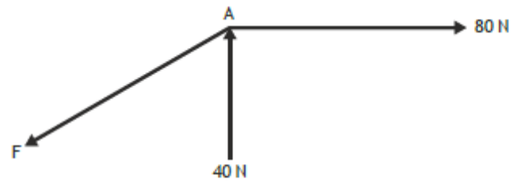
Vertical Forces

$$\Sigma F\uparrow = \Sigma F\downarrow$$

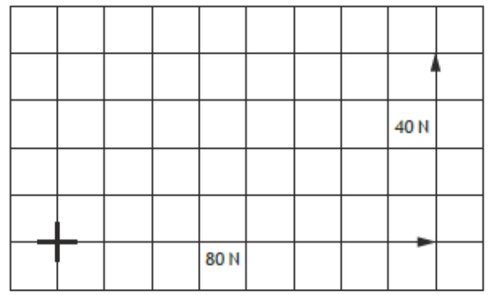
All of the forces going up added together equal all of the forces going down added together.

Vectors

During the design of the guitar, the designer needs to calculate the force F required to keep point A in equilibrium.



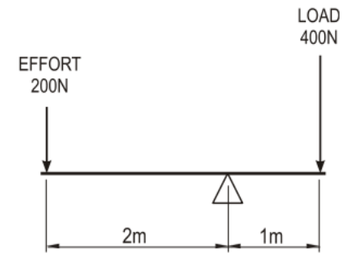
Determine the size of force F using the scale drawing of the triangle of forces shown in the diagram below.



F = _____ N

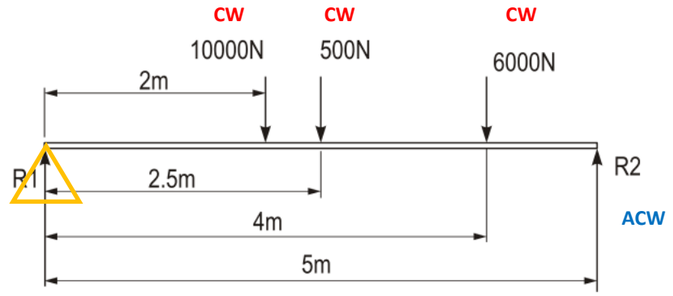
Start with the horizontal force and join them nose to tail to complete the triangle. Then measure the length of force F and compare against the size of the boxes to work out the size of the force.

Equilibrium - When a system is balanced.



Moments Calculations

Take moments about R1 to find R2.



free-body diagram

$$\Sigma CWM = \Sigma ACWM$$

$$(10000 \times 2) + (500 \times 2.5) + (6000 \times 4) = R_2 \times 5$$

$$20000 + 1250 + 24000 = R_2 \times 5$$

$$45250 = R_2 \times 5$$

$$\frac{45250}{5} = R_2$$

$$R_2 = 9050N$$

To find R1:

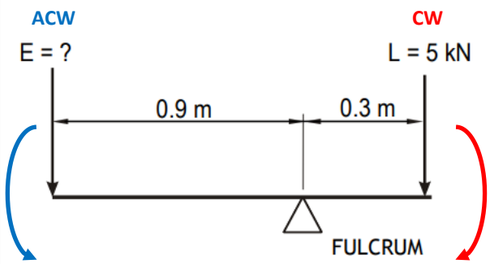
$$\Sigma F\uparrow = \Sigma F\downarrow$$

$$R_1 + 9050 = 10000 + 500 + 6000$$

$$R_1 = 16500 - 9050$$

$$R_1 = 7450N$$

Moments Calculations



$$\Sigma CWM = \Sigma ACWM$$

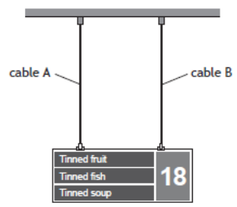
$$5000 \times 0.3 = E \times 0.9$$

$$1500 = E \times 0.9$$

$$\frac{1500}{0.9} = E$$

$$E = 1667N$$

4. A sign hanging from a supermarket ceiling is shown.



A free body diagram of the sign is to be drawn.

(a) Describe one piece of information that should be included on a free body diagram. 1

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(a)	Size/direction/position of force(s). Do not accept: size/direction/ forces/position on its own. Accept distance between cables.	1	Descriptive response.

N5 Properties of Materials

Strut

Members that are in compression, due to external forces trying to compress them, are known as Struts.

Tie

Members that are in tension, due to external forces trying to pull them apart, are known as Ties.

Most common properties to be considered include:

1. **STRENGTH** - the ability of a material to resist force, the bigger the force it can resist the stronger the material.

2. **ELASTICITY** - the ability of a material to return to its original shape or length once an applied load or force has been

removed.

3. **PLASTICITY** - the ability of a material to change its shape or length under a load and stay deformed even when the

load is removed.

4. **DUCTILITY** - the ability of a material to be stretched without fracturing and be formed into shapes such as very thin

sheets or very thin wire.

5. **BRITTLENESS** - the property of being easily cracked, snapped or broken.

6. **MALLEABILITY** - the ability of a material to be shaped, worked or formed without fracturing.

The properties of the four metals considered for the support structure are shown in the table below.

Metal	Corrosion resistant	Durability
A	no	low
B	yes	high
C	yes	low
D	no	high

(d) Select the most suitable metal (A–D) from the table above to be used for the support structure and justify your choice. 2

Choice of metal _____

Justification _____

(d)	B Metal B is corrosion resistant and is (more) durable. Metal B because the structure will be used outside and it is corrosion resistant. Metal B because it is durable and so parts will not need to be replaced often.	2	1 mark for metal B. 1 mark for corrosion resistant **and** durable. **OR** 1 mark for a property with valid rationale based on selection. Apply FTE from metal selection.

The sign hangs from the ceiling by two cables.
Cable A has an original length of 4.5 m and is stretched by 0.0013 m.

(b) Calculate the strain in cable A. 2

(c) State the nature of the force in cable A. 1

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(b)	$\varepsilon = \frac{\Delta l}{l}$ $\varepsilon = \frac{0.0013}{4.5}$ $\varepsilon = 0.00028889$ $\varepsilon = 0.00029$ (2 sf)	2	1 mark for substitution. 1 mark for correct answer from given working. Ignore any units.
(c)	Tensile	1	Accept tension/tie. Do not accept pulling force/gravity.

A force applied to the seatbelt strap results in a stress of 15 N mm^{-2}. The seatbelt strap has a cross-sectional area of 48 mm^2.

(b) Calculate the force applied. 3

(b)	$\sigma = \frac{F}{A}$ $15 = \frac{F}{48}$ $F = 15 \times 48$ $F = 720$ N (2 sf)	3	1 mark for substitution. 1 mark for transposition. 1 mark for correct answer from given working with unit.

Stress

$$Stress = \frac{Force}{Area}$$

$$\sigma = \frac{F}{A}$$

Stress is measured in Nmm^{-2}.

Force is measured in N.

Area is measured in mm^2.

Area - radius is r, diameter is d.

Area of a circle

$$A = \pi r^2$$

$$A = \frac{\pi d^2}{4}$$

Strain

$$Strain = \frac{Change\ in\ Length}{Original\ Length}$$

$$\varepsilon = \frac{\Delta L}{L}$$

Strain has no units.

Change in length and original length need to be in the same units before they are substituted into the equation. So if one is in metres but the other is in mm, they both need to be in mm before putting into the equation.