STEM SMART Phase One, 2022

Physics Week 8 – Moments

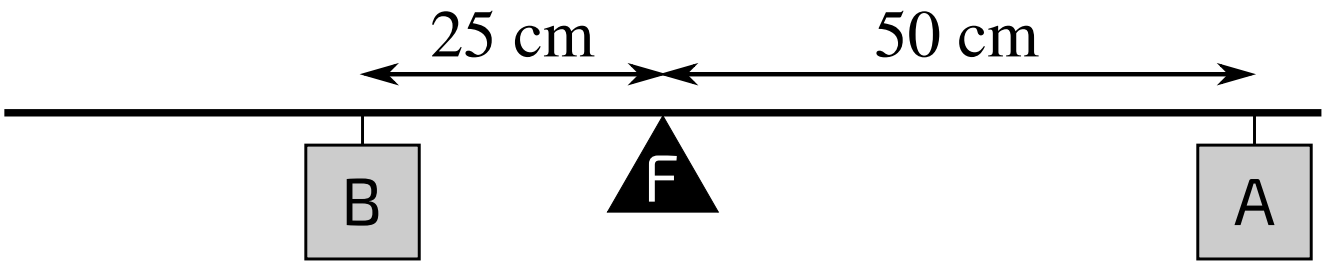
https://isaacphysics.org/gameboards#smart_p_1_8

Essential GCSE Physics 16.7

GCSE - Practice (P1)
A Level - Practice (P1)

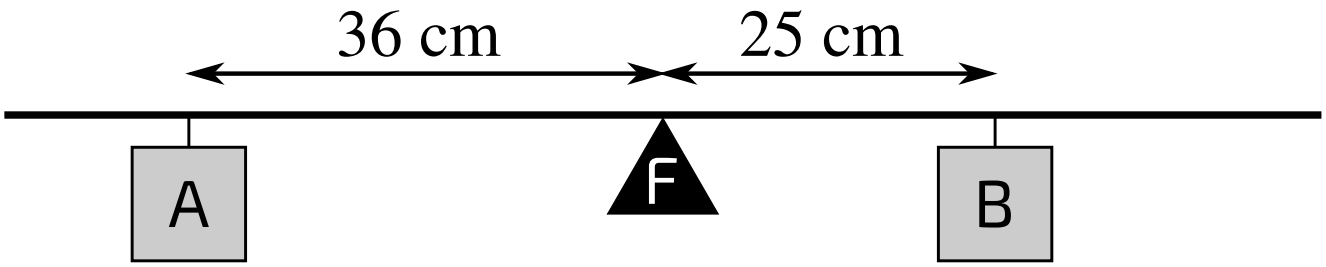
Calculate the weight of the block stated in each situation below where the uniform lever arm is balanced about the fulcrum 'F'.

Part A Weight of B



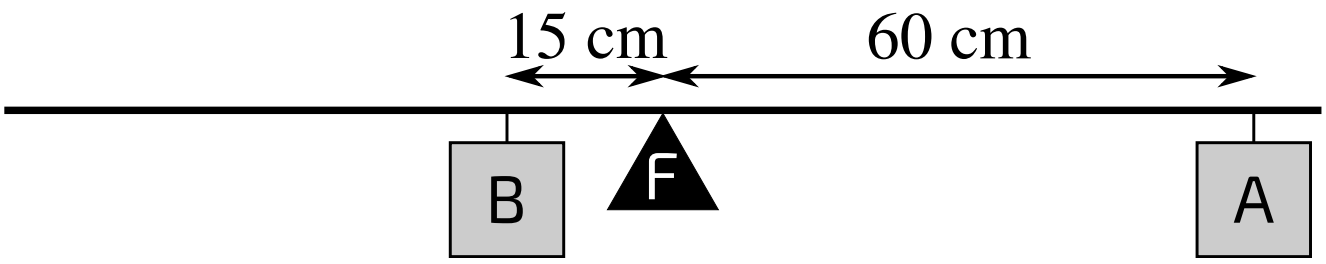
If A weighs $5.0\,\mathrm{N}$, what is the weight of B?

Part B Weight of B



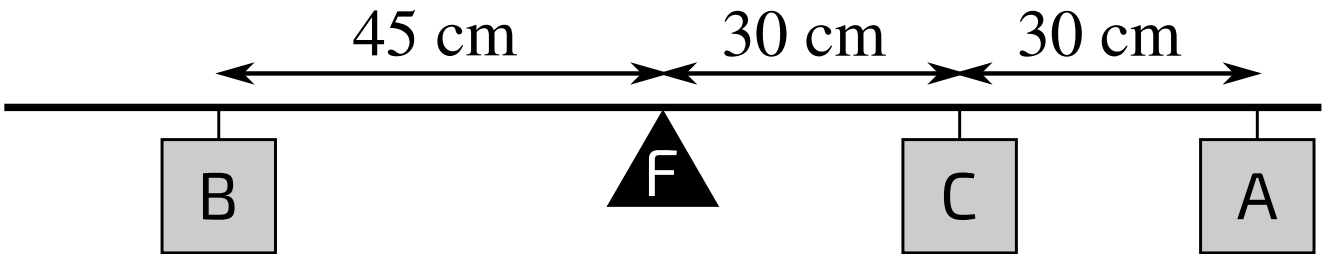
If A weighs $10\,\mathrm{N}$, what is the weight of B?

Part C **Weight of B**



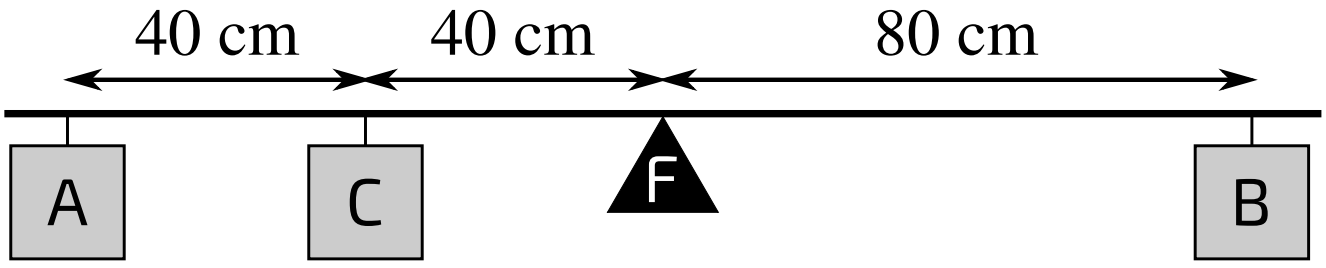
If A weighs $10\,\mathrm{N}$, what is the weight of B?

Part D **Weight of C**



If A weighs $10\,\mathrm{N}$ and B weighs $20\,\mathrm{N}$, what is the weight of C?

Part E **Weight of C**



If A weighs $2.0\,\mathrm{N}$ and B weighs $4.0\,\mathrm{N}$, what is the weight of C?

Essential Pre-Uni Physics B5.1

GCSE - Practice (P1)
A Level - Practice (P1)

The strength of Earth's gravity at ground level = $9.8\,\mathrm{N\,kg^{-1}}$. 1 tonne = $1000\,\mathrm{kg}$.

Numeric answers should contain units. Where forces are asked for, ensure that the direction is in the answer (e.g. up/down). Assume that the mass is evenly distributed in the rulers, poles, planks, bridge spans mentioned in the questions.

A metre rule is pivoted about the '$50\,\mathrm{cm}$' mark (which is the position of its centre of mass). In each part, find the direction and magnitude of force F needed to balance the rule. Assume the upwards direction is positive.

Part A The $70\,\mathrm{cm}$ mark

a) There is a $3.0\,\mathrm{N}$ upwards force at the $20\,\mathrm{cm}$ mark. Force F acts at the $70\,\mathrm{cm}$ mark.

Part B The $60\,\mathrm{cm}$ mark

There is a $5.0\,\mathrm{N}$ upwards force at the $10\,\mathrm{cm}$ mark. Force F acts at the $60\,\mathrm{cm}$ mark.

Part C The $75\,\mathrm{cm}$ mark

There is a $2.0\,\mathrm{N}$ upwards force at the $5.0\,\mathrm{cm}$ mark, and a $12\,\mathrm{N}$ downwards force at the $40\,\mathrm{cm}$ mark. Force F acts at the $75\,\mathrm{cm}$ mark.

Part D The $30\,\mathrm{cm}$ mark

There is a $100\,\mathrm{g}$ mass sitting on the $10\,\mathrm{cm}$ mark, and a $50\,\mathrm{g}$ mass sitting on the $60\,\mathrm{cm}$ mark. Force F acts at the $30\,\mathrm{cm}$ mark.

Essential Pre-Uni Physics B5.2

GCSE - Challenge (C2)
A Level - Practice (P2)

The strength of Earth's gravity at ground level = $9.8\,\mathrm{N\,kg^{-1}}$. 1 tonne = $1000\,\mathrm{kg}$.

Numeric answers should contain units. Where forces are asked for, ensure that the direction is in the answer (e.g. up/down). Assume that the mass is evenly distributed in the ruler.

A metre stick has its centre of mass at the $50\,\mathrm{cm}$ mark, and weighs $0.92\,\mathrm{N}$. A $2.00\,\mathrm{N}$ weight is stuck to the $10\,\mathrm{cm}$ mark with massless glue. About which point will the ruler balance?

Essential Pre-Uni Physics B5.3

A Level - Practice (P2)

The strength of Earth's gravity at ground level = $9.8\,\mathrm{N\,kg^{-1}}$. 1 tonne = $1000\,\mathrm{kg}$.

Where forces are asked for, ensure that the direction is in the answer (e.g. up/down). Assume that the mass is evenly distributed in the rulers, poles, planks, bridge spans mentioned in the questions.

A $200\,\mathrm{m}$ bridge span is supported at both ends. The span has a mass of $100\,\mathrm{tonnes}$. A $30\,\mathrm{tonne}$ bus is $50\,\mathrm{m}$ from one end of the span. Calculate the supporting force holding the bridge up at the end nearer the bus. Please give your answer to 2 significant figures.

Essential Pre-Uni Physics B5.4 & B5.5

A Level - Practice (P2)

Two workers are moving a $20\,\mathrm{kg}$, $10\,\mathrm{m}$ scaffolding pole. One stands at the end, the other stands $2.0\,\mathrm{m}$ from the other end.

Note: The strength of Earth's gravity at ground level = $9.8\,\mathrm{N\,kg^{-1}}$. 1 tonne = $1000\,\mathrm{kg}$.

Numeric answers should contain units. Where forces are asked for, ensure that the direction is in the answer (e.g. up/down). Assume that the mass is evenly distributed in the rulers, poles, planks, bridge spans mentioned in the questions.

Part A B5.4 Scaffolding pole

Calculate the force exerted by the worker standing at the end in holding the pole.

Part B B5.5 Force exerted by the other worker

Calculate the weight of the pole 'carried' by the other worker.

Essential Pre-Uni Physics B5.6

A Level - Challenge (C2)

Two pupils who don't like each other are made to carry a $1.0\,\mathrm{m} \times 2.0\,\mathrm{m}$ whiteboard down some stairs. Each takes their share of the weight by holding the bottom corner at their end.

Assuming that they each want the easier job, and that the mass is evenly distributed in the whiteboard, which end should they fight over?

- Lower end
- Upper end

Symmetry and Centre of Mass

GCSE - Challenge (C1)
A Level - Practice (P1)

The following shapes are cut from a uniform sheet of metal. Draw the shapes and mark on their line(s) of symmetry:

- Square
- Rectangle
- Equilateral Triangle
- Isosceles Triangle

Part A Centre of Mass

Think about the centre of mass for each of these objects; how does it relate to their line(s) of symmetry?

Part B Square

If the square has side length a, what is the distance d from a corner to the centre of mass?

The following symbols may be useful: `a, b, d`

Part C Rectangle

If the rectangle has side lengths a and b, what is the distance d from the corners to the centre of mass?

The following symbols may be useful: `a, b, d`

Part D Equilateral Triangle

If the equilateral triangle has side length a, what is the distance d from the corners to the centre of mass?

The following symbols may be useful: `a, b, d`

Part E Isosceles Triangle

For an isosceles triangle, the centre of mass lies $\frac{2}{3}$ of the way from the corner to the base on the line of symmetry. The two equal length sides have length a and the base has length b. Find the distance d of the centre of mass from the corner of the triangle opposite the side of length b, in terms of the side lengths a and b .

The following symbols may be useful: `a, b, d`

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Essential Pre-Uni Physics B5.7

A Level - Challenge (C2)

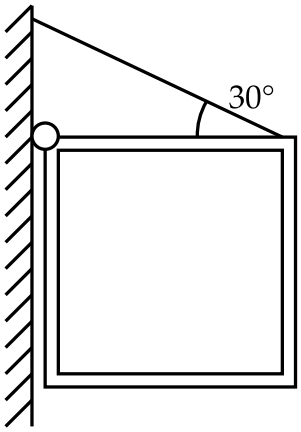

Figure 1: Diagram showing the pub sign.

The pub sign shown above is supported by a hinge and by a metal rod.

Note: The strength of Earth's gravity at ground level = $9.8\,\mathrm{N\,kg^{-1}}$.

Calculate the tension in the rod if the pub sign is an $80\,\mathrm{cm}$ square of mass $30\,\mathrm{kg}$. Ignore the mass of the rod, assume that the hinge is well-oiled, and assume that the mass is evenly distributed in the sign. Give your answer to 2 significant figures.

Weight of a Lorry

A Level - Practice (P2)

A haulage company wants to determine the weight of a lorry with four identical wheels, which is too large to stand with all four wheels on a single weighing platform.

The lorry is placed so that the two front wheels are on one weighing platform and the two back wheels on another; the masses recorded are $1350\,\mathrm{kg}$ and $1450\,\mathrm{kg}$ respectively. The axles are $3.00\,\mathrm{m}$ apart and at the same height.

Part A Mass of the lorry

Find the mass of the lorry.

Part B Position of centre of mass

Find the distance of the centre of mass from the front axle.

Part C Additional mass

What additional mass m would have to be placed $50.0\,\mathrm{cm}$ in front of the front axle to make the weights borne by the axles equal?

Adapted with permission from UCLES, Higher School Certificate Mathematics, June 1930, Paper 3, Question 5.