InkPhysics

QUESTION WORKBOOK

Moments and equilibrium

Mechanics · Year 12

AQA 3.4.1.2 · CIE 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2
OCR A 3.2.3(a), 3.2.3(b), 3.2.3(c), 3.2.3(d), 3.2.3(e)

19 questions · 58 marks

NAVY SCREEN EDITION

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SECTION A · Warm-up

A1 Define the moment of a force about a point, and state its SI unit. [2]

A2 A force of 15 N acts at a perpendicular distance of 0.40 m from a pivot. Calculate the moment of the force. [2]

A3 State the principle of moments for a body in equilibrium. [2]

SECTION B · Standard

B1 A uniform metre rule is pivoted at its centre. A 2.0 N weight hangs 0.20 m to the left of the pivot. Calculate the distance from the pivot at which a 4.0 N weight must hang on the right-hand side to balance the rule. [3]

B2 Two children sit on a see-saw pivoted at its centre. One of weight 300 N sits 1.2 m from the pivot. Calculate the distance from the pivot at which a child of weight 450 N must sit on the other side to balance the see-saw. [3]

B3 A uniform beam of weight 120 N and length 4.0 m rests horizontally on two supports, one at each end (A on the left, B on the right). A load of 200 N is placed 1.0 m from A. Calculate the upward force provided by each support. [4]

B4 Two antiparallel forces of 8.0 N act on a bar, separated by a perpendicular distance of 0.25 m. State what this pair of forces is called and calculate its turning effect. [3]

SECTION C · Stretch

C1 A uniform rod of weight 40 N and length 2.0 m is hinged at one end and held horizontal by a vertical cable attached at the other end. Calculate the tension in the cable and the vertical force exerted by the hinge on the rod. [4]

C2 A non-uniform beam balances on a pivot placed 0.40 m from its left-hand end when a 2.0 N weight hangs from that end. The centre of mass of the beam is 0.65 m from the left-hand end. Calculate the weight of the beam. [4]

C3 A door handle is fitted on the edge of the door furthest from the hinge. Explain, in terms of moments, why this makes the door easier to open. [3]

SECTION A · Warm-up

A4 A cyclist presses vertically downwards on a pedal with a force of 300 N at the moment when the crank is horizontal. The crank is 0.17 m long. Calculate the moment of the force about the crank axle. [2]

A5 State the two conditions that must both be satisfied for a rigid body to be in equilibrium. [2]

A6 Explain why a force has no turning effect about a pivot when its line of action passes through the pivot. [1]

SECTION B · Standard

B5 A mechanic pulls on the end of a spanner of length 240 mm with a force of 90 N. The force acts at 55° to the line of the spanner. Calculate the moment of the force about the nut. [3]

B6 A uniform metre rule has a mass of 120 g. It balances horizontally on a knife-edge pivot at its 35.0 cm mark when an object is hung from the 5.0 cm mark. Taking g = 9.81 N kg^{-1}, calculate the mass of the object. [4]

B7 The blades of a pair of bolt cutters are 45 mm from the pivot and the handles are gripped 0.55 m from the pivot. A student squeezes the handles with a force of 120 N. Calculate the force the blades exert on a bolt. [3]

SECTION C · Stretch

C4 A uniform scaffold plank of weight 150 N and length 3.0 m rests horizontally on two supports, one at each end, A and B. Support B is damaged and must not carry a force greater than 600 N. A decorator of weight 720 N steps on at A and walks towards B. Deduce whether the decorator can walk all the way to B and, if not, determine the greatest distance from A they can safely reach. [4]

C5 A uniform horizontal bar of weight 35 N and length 1.2 m is hinged to a wall at one end. A shop sign of weight 90 N hangs from the bar 1.0 m from the hinge. The bar is held by a chain joining its outer end to the wall above the hinge; the chain makes an angle of 30° with the bar. Calculate the tension in the chain. [4]

C6 You are given a metre rule, a knife-edge pivot and a single 50 g mass. Describe how you would use them to determine the mass of the rule, using the principle of moments. State the measurements you would take and show how the mass of the rule is calculated from them. [5]