3.15 Pressure, Moments and Levers: Test Pack

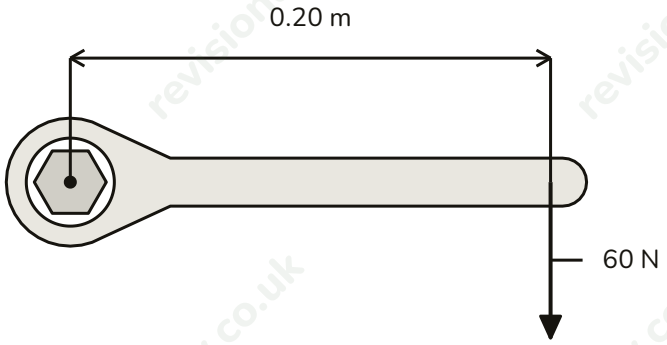
AQA 8464 · Calculator allowed · about 35 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Figure 1 shows a spanner being used to tighten a nut. A force of 60 N is applied at right angles (perpendicular) to the spanner handle, at a distance of 0.20 m from the nut, which acts as the pivot.



(a) Define what is meant by the moment of a force. **(1)**

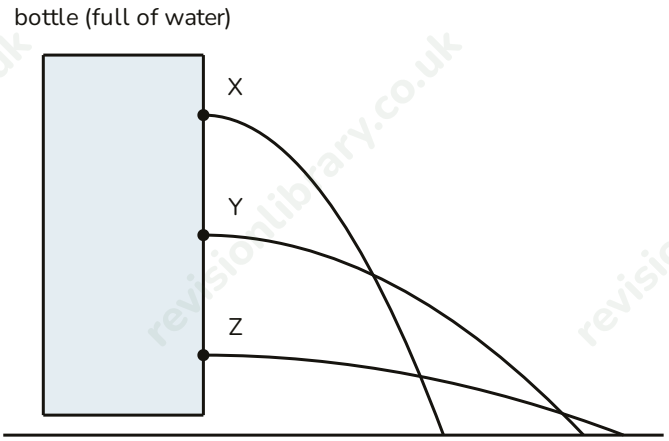
(b) State the equation linking the moment of a force, the force, and the perpendicular distance from the pivot to the line of action of the force, and state the unit of moment. **(2)**

(c) Calculate the moment of the 60 N force about the nut. **(2)**

(Total for Question 1 is 5 marks)

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2 A student, Ayesha, investigates how pressure in a liquid varies with depth. She takes a plastic bottle and makes three small holes in its side, at different heights above the base: hole X near the top, hole Y in the middle, and hole Z near the bottom. She fills the bottle completely with water and removes her finger from each hole in turn, measuring the horizontal distance each water jet travels before landing. Figure 7 shows the bottle and the jets of water. Her results are given in the table: Hole: X (near top), Y (middle), Z (near bottom); Depth below the water surface (cm): 5.0, 15.0, 25.0; Horizontal distance travelled by jet (cm): 12.0, 19.0, 21.0.



(a) State the hole (X, Y or Z) that produces the jet with the greatest horizontal distance, and use this observation to state how pressure varies with depth in a liquid. **(2)**

(b) Explain, in terms of the column of liquid above each hole, why the water at hole Z is pushed out with a greater force than the water at hole X. **(2)**

(c) Identify one variable, other than the depth of each hole, that should be controlled to make this a fair test between the three jets. **(1)**

(d) Suggest one improvement to Ayesha's method that would make her conclusion more reliable. **(2)**

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(e) State one other application where understanding that pressure increases with depth in a liquid is important. **(1)**

(Total for Question 2 is 8 marks)

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3 A hydraulic excavator (digger) has wide caterpillar tracks instead of narrow wheels, and a long hydraulic arm, pivoted at a joint, to lift and move soil.

(a) Explain why the excavator is fitted with wide tracks rather than narrow wheels. **(2)**

(b) The hydraulic arm applies a force of 2000 N at a perpendicular distance of 0.15 m from a pivot joint, to lift a load. Calculate the moment produced about the pivot. **(2)**

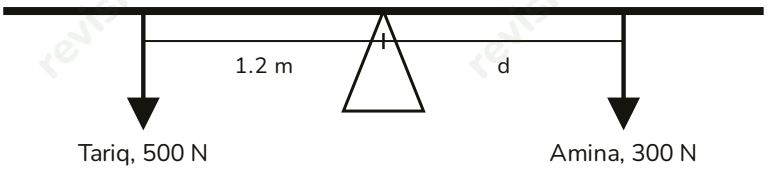
(c) To lift a heavier load, an engineer suggests redesigning the arm so the same force acts further from the pivot, rather than increasing the force itself. State one advantage of increasing the distance from the pivot, rather than the force, to increase the moment. **(1)**

(d) State why the excavator's hydraulic arm can be described as a lever. **(1)**

(Total for Question 3 is 6 marks)

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4 Figure 2 shows a playground see-saw, pivoted at its centre. Tariq, weight 500 N, sits on the left side, at a distance of 1.2 m from the pivot. His younger sister Amina, weight 300 N, sits on the right side. The see-saw is perfectly balanced (horizontal).



(a) State the principle of moments. **(1)**

(b) Calculate the moment of Tariq's weight about the pivot. **(2)**

.....

(c) Use the principle of moments to calculate the distance, d, from the pivot at which Amina must sit for the see-saw to balance. **(2)**

.....

(Total for Question 4 is 5 marks)

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Mark scheme · 3.15 Pressure, Moments and Levers: Test Pack

Question 1

(a) the turning effect of a force (about a pivot), oe **B1**

(a) Answer: The turning effect of a force about a pivot.

(b) moment = force x perpendicular distance (from the pivot) oe, accept M = F x d **B1**

(b) unit: newton-metre (Nm) **B1**

(b) Answer: Moment = force x perpendicular distance. Unit: newton-metre (Nm).

(c) substitutes: moment = 60 x 0.20 **M1**

(c) 12 Nm cao **A1**

(c) Answer: 12 Nm

Question 2

(a) hole Z (near the base) produces the jet that travels furthest **B1**

(a) this shows that pressure in a liquid increases with depth, oe **B1**

(a) Answer: Hole Z; this shows that pressure in a liquid increases with depth.

(b) there is a greater height (depth) of water above hole Z than above hole X, oe **B1**

(b) a greater height of liquid produces a greater pressure ($p = h \times \rho \times g$), so a greater force pushes the water out of hole Z, oe **B1**

(b) Answer: There is a greater height of water above hole Z, producing a greater pressure and a greater force pushing the water out.

(c) e.g. the size (diameter) of each hole must be the same, or the bottle must be completely full at the start each time **B1**

(c) Answer: E.g. the size (diameter) of each hole should be the same.

(d) e.g. repeat each measurement, refilling the bottle to the same level each time, and calculate a mean distance for each hole **B1**

(d) linked reason: reduces the effect of random error (e.g. from timing when the finger is removed, or how the landing distance is measured), giving more reliable results, oe **B1**

(d) Answer: E.g. repeat each measurement and take a mean, reducing random error and giving a more reliable result.

(e) any sensible example, e.g. submarine and diving suit design must withstand higher pressure at greater depth; dam walls are built thicker at the bottom **B1**

(e) Answer: E.g. submarine hulls and diving suits must withstand greater pressure at greater depth.

Question 3

(a) wide tracks give a much larger contact area with the ground than narrow wheels, for the same weight of machine, oe **B1**

(a) since pressure = force / area, a larger area produces a smaller pressure on the ground, reducing the chance of the excavator sinking into soft ground, oe **B1**

(a) Answer: Wide tracks give a larger contact area, which produces a smaller pressure on the ground for the same weight, reducing the chance of sinking.

(b) substitutes: moment = 2000 x 0.15 **M1**

(b) 300 Nm cao **A1**

(b) Answer: 300 Nm

(c) a smaller force is needed to produce the same (or a greater) moment, reducing the strain on the hydraulic system, oe **B1**

(c) Answer: A smaller force can produce the same moment, reducing the strain on the hydraulic system.

(d) it is a rigid bar that turns about a pivot, using the principle of moments to make lifting a load easier, oe **B1**

(d) Answer: It is a rigid bar that turns about a pivot, using the principle of moments to make lifting easier.

Question 4

(a) for a system in equilibrium (balanced), the sum of the clockwise moments about a pivot equals the sum of the anticlockwise moments about the same pivot, oe **B1**

(a) Answer: For a balanced system, the sum of the clockwise moments equals the sum of the anticlockwise moments about the pivot.

(b) substitutes: moment = 500 x 1.2 **M1**

(b) 600 Nm cao **A1**

(b) Answer: 600 Nm

(c) ft rearranges: d = their (b) / 300 **M1**

(c) 2.0 m cao ft **A1**

(c) Answer: 2.0 m

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