Exam Questions
Chapter 1·5 - Torque & Equilibrium
Question 1 2010:1:7

(4 marks)

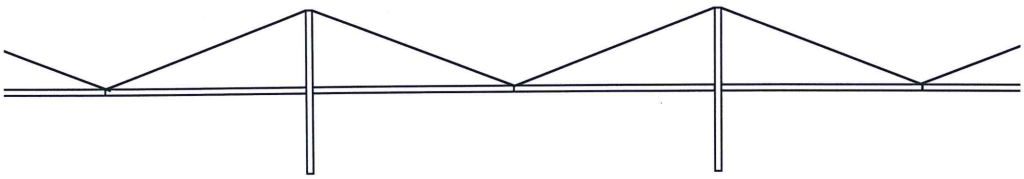
The photograph shows the yacht *BMW Oracle*, which has both a length and width of 28 m.

Estimate the torque, exerted by the wind blowing on the sails, that would just begin to tip the *BMW Oracle* as shown. The sail has a mass of 3.5×10^3 kg, the central hull 1.0×10^3 kg and each outrigger 0.5×10^3 kg.

Question 2 2010:2:19

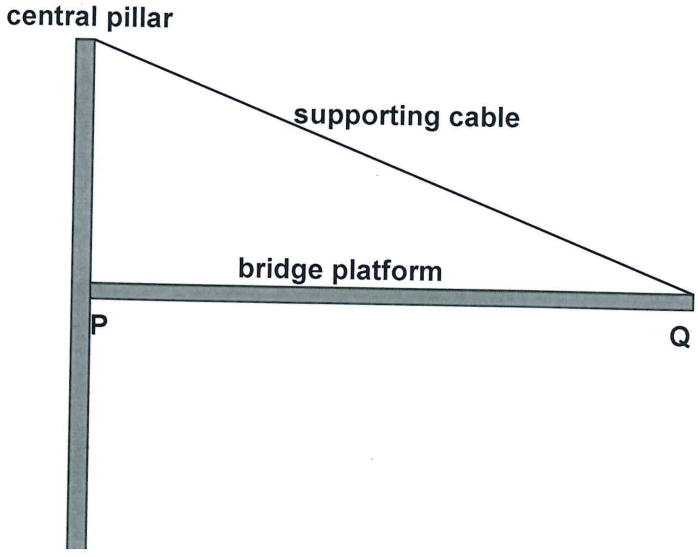
(9 marks)

A concrete bridge structure is being built. It consists of vertical pillars that support horizontal platforms, as shown below.



(a) The section of bridge platform labelled PQ on the diagram below is in equilibrium even though three forces act on it. Draw and label these three forces on the diagram.

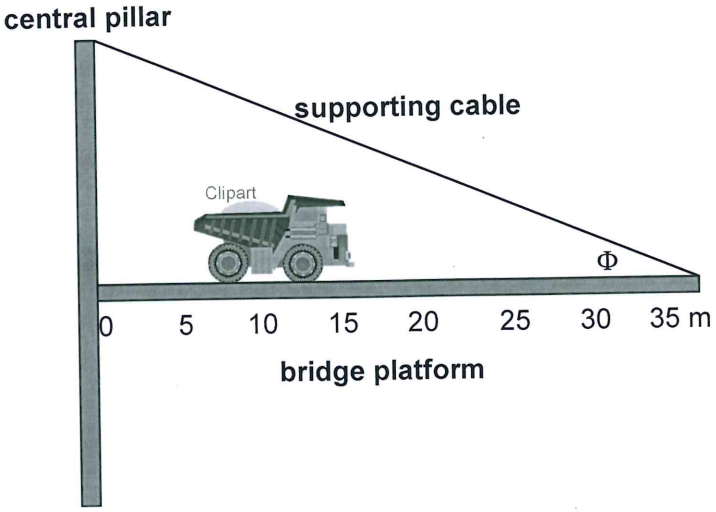
(3 marks)



Exam Questions
Chapter 1.5 - Torque & Equilibrium
Question 2: continued

The diagram below shows a heavy truck moving along the bridge during construction. The distances in metres from the central pillar are shown on the diagram. The centre of mass of the truck is at the 10.0 m mark and the bridge platform extends to 35.0 m from the pillar, the top of which is 17.5 m above the platform.

The section of bridge platform shown has a mass of 420 tonnes and the truck has a mass of 50.0 tonnes.



(b) Calculate the angle Φ. (1 mark)

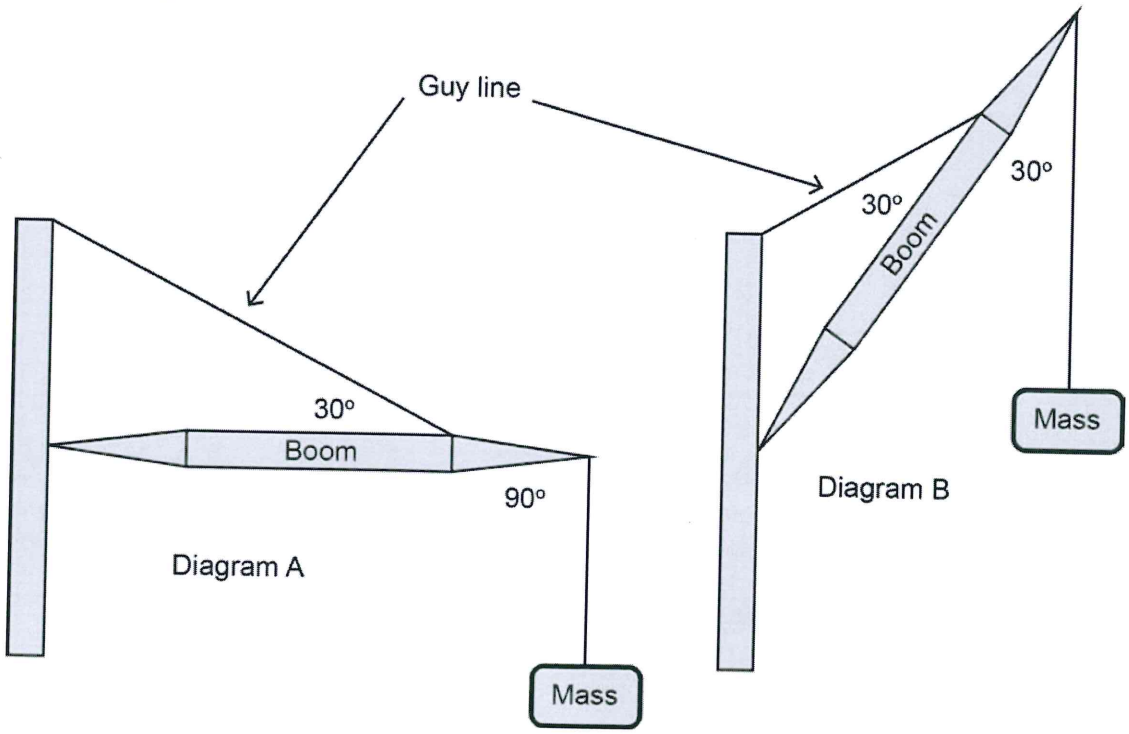
(c) By taking moments about a suitable point calculate the vertical component of the tension. (3 marks)

(d) Using the vertical component from (c), determine the tension in the cable. If you could not calculate the vertical component, use 4.20×10^6 N. (2 marks)

Question 3 2011:1:8

(4 marks)

A crane (Diagram A) lifts a mass by raising its boom (Diagram B). Explain how this affects the tension in the guy line as the crane shifts the mass from its initial position in Diagram A to its position in Diagram B.



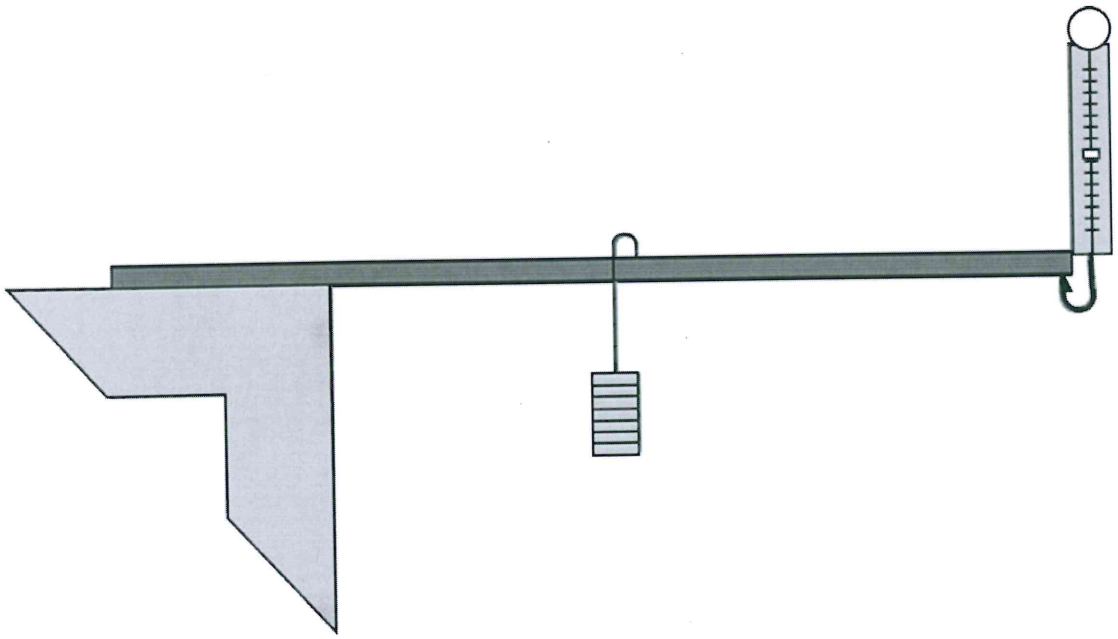
Exam Questions

Chapter 1.5 - Torque & Equilibrium

Question 4 2011:1:10

(4 marks)

A uniform 100 gram, metre-long ruler is placed on a table, with most of its length overhanging the edge. A 350 gram slotted mass is placed at the ruler's 500 mm mark, and a spring balance holds it up at one end, as shown in the diagram below.



The ruler is just lifted using the spring balance so that it touches the table in only one place. At this point the spring balance reads 2.20 N. Indicate on the diagram the fulcrum, or pivot point, for this action and label it 'A'.

The ruler is then lowered slightly, changing the position of the fulcrum.

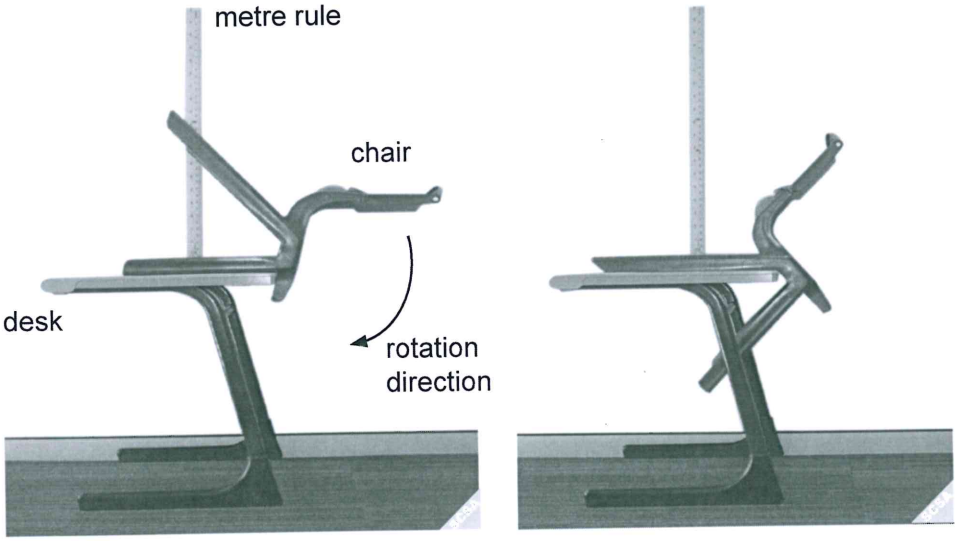
Label this new fulcrum, or pivot point, 'B'.

When the ruler is in this position, the spring balance reads 1.65 N. Determine the distance between the points 'A' and 'B'. Note that the angle that the ruler makes with the horizontal has not changed significantly and should not be considered in your calculations.

Question 5

Exam Questions
Chapter 1·5 - Torque & Equilibrium
Question 5 2013:1:5

(8 marks)

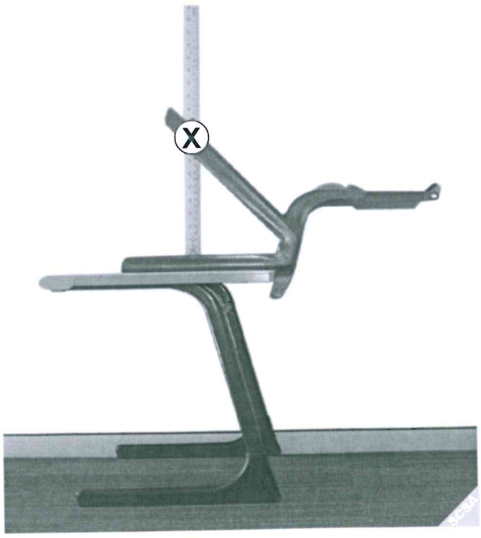


Photograph A **Photograph B**

(a) The photographs above show the same chair in two different positions. A metre rule is included to provide scale. Photograph A shows the chair in the instant after the person holding it in place let go.

In Photograph A the chair will begin to rotate and fall to the floor as soon as the hand is removed, while in Photograph B the chair will stay in the position as shown. Explain why the chair will rotate in Photograph A but not in Photograph B. (3 marks)

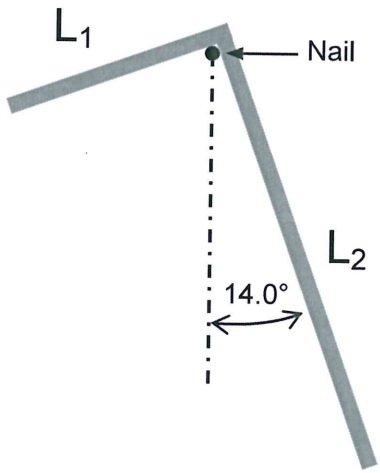
(b) On the photograph below, indicate the direction of the force that you could apply at Point X in order to prevent the chair from rotating. Estimate the magnitude of this force, stating clearly any assumptions that you make. (5 marks)



Exam Questions
Chapter 1.5 – Torque & Equilibrium
Question 6 2014:1:13

(6 marks)

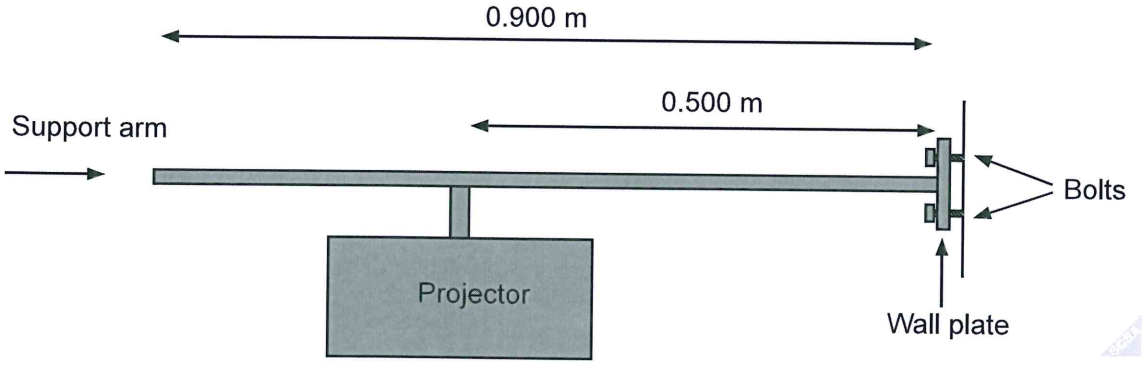
A thin metal rod is bent into a right angle and hung on a nail from a wall, as shown in the diagram. Assume that there is no contact between the rod and wall. The longer side (L_2) is 0.800 m long and makes an angle of 14.0° to the vertical. The rod has uniform density and constant thickness. Calculate the length of the shorter side, L_1. Show **all** workings.



Question 7 2014:2:16

(10 marks)

The diagram below shows a data projector with a mass of 7.00 kg. The projector is mounted on its uniform horizontal support arm at a distance of 0.500 m from the wall plate. The support arm itself is 0.900 m long and has a total mass of 1.00 kg.



The assembly is held in place by bolts as shown in the diagram above. The upper bolt is 4.00 cm above the support arm and the lower bolt is 4.00 cm below the support arm. The wall plate does not touch the wall and is supported only by the bolts.

(a) Calculate the **horizontal force** in newtons exerted by the **upper bolt** used to attach this projector to the wall. Show **all** workings.
Hint: Take the bottom bolt of the wall plate as a pivot point. (4 marks)

(b) Explain quantitatively the effect on the centre of mass of the projector/support arm system as the projector is moved further away from the wall. (3 marks)

(c) Explain quantitatively the effect on the horizontal force exerted by the upper bolt as the projector is moved further away from the wall, assuming the system maintains its stability. (3 marks)