B5 Moments

Strength of Earth's gravity at ground level = 9.8 N kg^{-1}. 1 tonne = 1000 kg.

As throughout this book, 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.

B5.1 A metre rule is pivoted about the '50 cm' mark (which is the position of its centre of mass). In each case, find the direction and magnitude of force F needed to balance the rule.

   a) There is a 3.0 N upwards force at the 20 cm mark. Force F acts at the 70 cm mark.

   b) There is a 5.0 N upwards force at the 10 cm mark. Force F acts at the 60 cm mark.

   c) There is a 2.0 N upwards force at the 5.0 cm mark, and a 12 N downwards force at the 40 cm mark. Force F acts at the 75 cm mark.

   d) There is a 100 g mass sitting on the 10 cm mark, and a 50 g mass sitting on the 60 cm mark. Force F acts at the 30 cm mark.

B5.2 A metre stick has its centre of mass at the 50 cm mark, and weighs 0.92 N. A 2.00 N weight is stuck to the 10 cm mark with massless glue. About which point will the ruler balance?

B5.3 A 200 m bridge span is supported at both ends. The span weighs 100 tonnes. A 30 tonne bus is 50 m from one end of the span. Calculate the supporting force holding the bridge up at the end nearer the bus.

B5.4 Two workers are moving a 20 kg, 10 m scaffolding pole. One stands at the end, the other stands 2.0 m from the other end. Calculate the force exerted by the worker standing at the end in holding the pole.

B5.5 Calculate the weight of the pole 'carried' by the other worker in question B5.4.

B5.6 Two pupils who don't like each other are made to carry a 1.0 m × 2.0 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, which end should they fight over?

B5.7   The pub sign shown in the diagram is supported by a hinge and by a
       metal rod. Calculate the tension in the rod if the pub sign is an 80 cm
       square of mass 30 kg. Ignore the mass of the rod, and assume that the
       hinge is well-oiled.