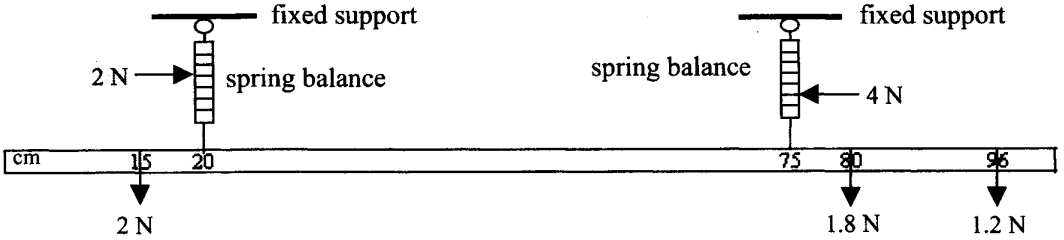
Dept. of Education and Science – Physics – Higher Level, 2002

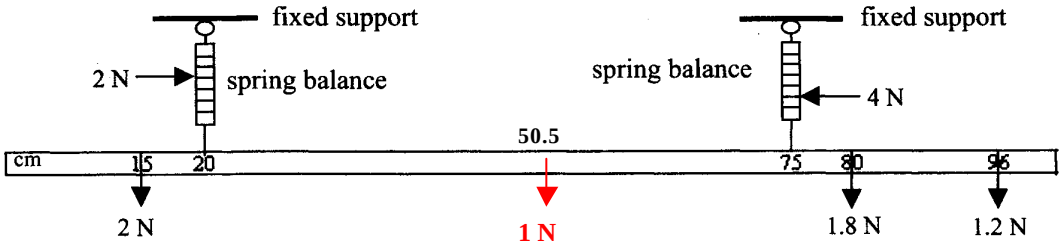
Question 1.

A student investigated the laws of equilibrium for a set of co-planar forces acting on a metre stick. The weight of the metre stick was 1 N and its centre of gravity was found to be at the 50.5 cm mark. two spring balances and a number of weights were attached to the metre stick. Their positions were adjusted until the metre stick was in horizontal equilibrium, as indicated in the diagram. The reading on the spring balance attached at the 20 cm mark was 2 N and the reading on the spring balance was 4 N. The other end of each spring was attached to a fixed support



Calculate the sum of the upward forces and the sum of the downward forces acting on the metre stick. Explain how these values verify one of the laws of equilibrium for co-planar forces.
Calculate the sum of the clockwise moments and the sum of the anti-clockwise moments about an axis through the 10 cm mark on the metre stick. Explain how these experimental values verify the second law of equilibrium for a set of co-planar forces.
Describe how the centre of gravity of the metre stick was found.
Why was it important to have the spring balances hanging vertically?

Calculate the sum of the upward forces and the sum of the downward forces acting on the metre stick.



Sum of upward forces = 2 N + 4 N = 6 N
Sum of downward forces = 2 N + 1 N (gravity) + 1.8 N + 1.2 N = 6 N

Explain how these values verify one of the laws of equilibrium for co-planar forces.

One of the laws states that the resultant of the co-planar forces acting on a body must be zero if the body is in equilibrium. This is clearly the case here. (6 – 6 = 0)

Calculate the sum of the clockwise moments and the sum of the anti-clockwise moments about an axis through the 10 cm mark on the metre stick. . Explain how these experimental values verify the second law of equilibrium for a set of co-planar forces.

Sum of clockwise moments = (2 x 5) + (1 x 40.5) + (1.8 x 70) + (1.2 x 86) = 279.7 N cm
Sum of anti clockwise moments = (2 x 10) + (4 x 65) = 280 N cm

Now, 280 N cm ≈ 279.7 N cm

⇒ Sum of moments is zero for the body in equilibrium. This is the second law that has been verified.

Describe how the centre of gravity of the metre stick was found.

A piece of thread was tied around the metre stick and positioned so that the metre stick hung horizontally when suspended by the thread. The position of the thread was then noted (50.5 cm mark).

Why was it important to have the spring balances hanging vertically?

If a spring balance were not hanging vertically the reading on the spring balance would not be the upward force exerted by the spring on the metre stick. The upward force on the metre stick would instead be the vertical component of the reading on the spring balance.