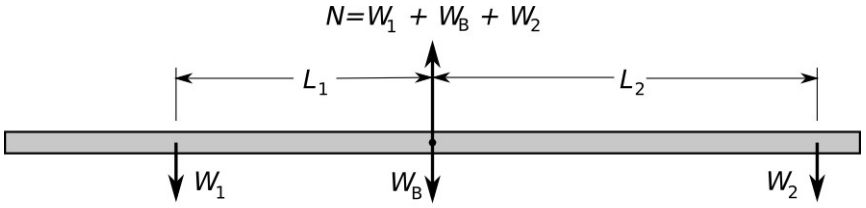
Teeter-Totter Physics Applied to a Mobile

Most elementary school classrooms will use mobiles as part of their decorations. From a physics point-of-view, a mobile is an elaborate teeter-totter.

The figure on the right shows a simple teeter-totter with its board supported in the center and weights at different distances on either side of the support point.



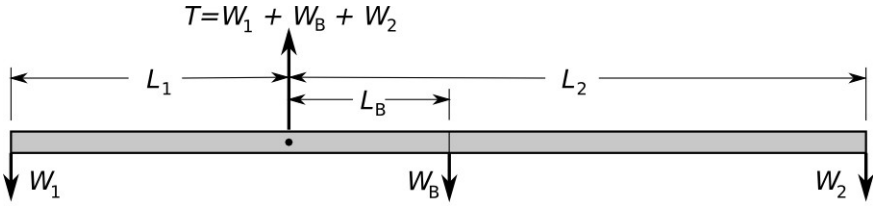
Pivot point at center

Since this teeter-totter is supported in the center, the weight of its board W_B does not tend to favor one side or the other. The twisting forces (torques) are entirely provided by the weights W_1 on the left at a distance L_1 from the pivot point and W_2 on the right at a distance L_2 . Balancing these torques gives the condition

$$W_1 L_1 = W_2 L_2 \quad \text{or} \quad \frac{W_1}{W_2} = \frac{L_2}{L_1}$$

The force $N=W_1+W_B+W_2$ is the upward support force needed to counter the three downward weights W_1, W_2 and W_B.

In an arm of a mobile, balance is achieved by adjusting the support (pivot) point as shown in this figure.



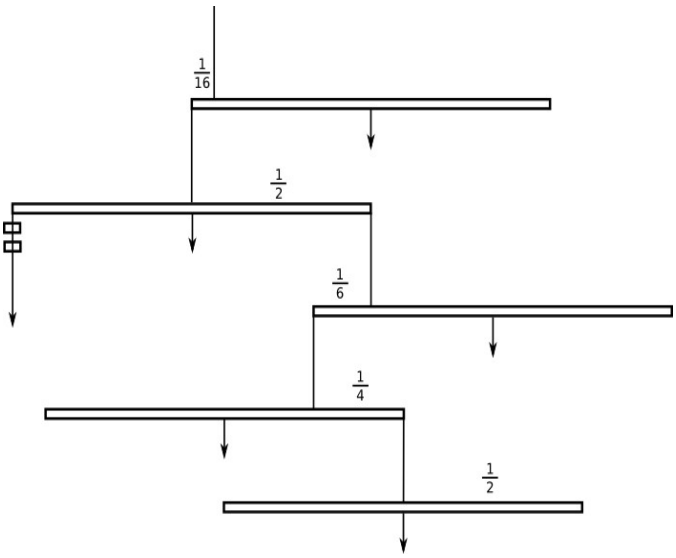
Pivot point at distance L_B to left of center-of-mass

Since the center-of-mass of the board is no longer at the same place as the center of support, the weight of the board will now contribute a twisting force (torque) equal to the product of W_B and L_B. As a result, the balance equation becomes

$$W_1 L_1 = W_B L_B + W_2 L_2$$

The force $T=W_1+W_B+W_2$ is the upward tension force in the string from which the beam is hanging. This tension force balances the three downward weights W_1, W_2 and W_B.

I used 5 dowels where W_1 and W_2 are 0.455 m apart and each dowel has a mass of about 9.8 g. I also have 2 metal nuts, each with a mass of 15.9 g. The two nuts total 31.8 g which nearly matches the total 29.4-g mass of three of the dowels. Using these, the mobile shown on the right was constructed. In the figure, the fractions shown indicate the portion of the dowel length between the support point and the end. Nylon fishing line was used to hang them together. The downward arrows represent the weights of the various components.



At first, it did not balance very well because the dowels were not identical or of a perfectly uniform diameter. To get it to balance nicely, the locations of the support holes for the fishing lines were readjusted slightly based on balance tests.