Answer on Question #70440, Physics / Other

A 22.00kg girl and her 95.00kg father sit on the opposite ends of 10.00m, 25.00kg uniform plank of wood. where must the fulcrum be placed to balance the plank wood?

SOLUTION

The law of the lever, which was proven by Archimedes, claims that static equilibrium is achieved if an algebraic sum of the force and distance products is equal to zero:

$\sum_i F_i D_i = 0$, (1)

where F_i is applied force, D_i is a distance to the fulcrum. Signs of the forces should be "+" if they turning lever to the same direction (e.g. clockwise), and "-" if in another direction (e.g. counterclockwise).

Let us place the fulcrum in the distance of l from the girl (look the figure 1). The masses are m_1=22 kg for the girl, m_2=95 kg for the father, and m_3=25 kg for the plank of wood, and the length of the plank is L=10 m. A barycenter of the plank wood is directly in the middle of it, so $l_b = L/2$. Using the equation (1) and assuming that the force is proportional to the mass of an object, we can simply write:

$$m_1 l + m_3(l - l_b) - m_2(L - l) = 0\ .$$

We chose the counterclockwise forces with sing '+' and clockwise force with sign '-'.

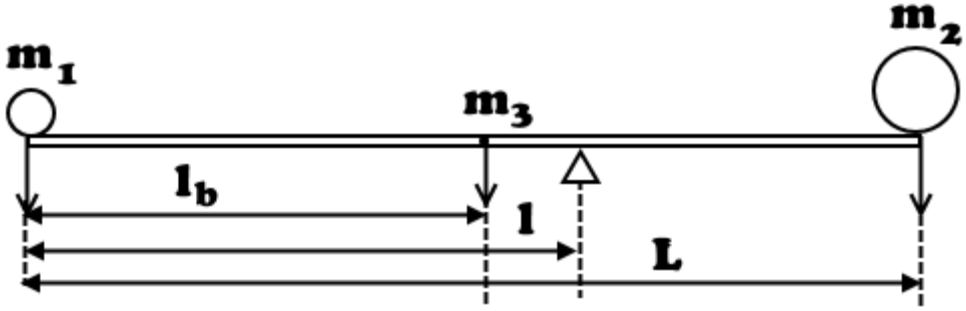

Fig. 1

From the obtained equation:

$$m_1 l + m_2 l + m_3 l - m_3 l_b - m_2 L = 0,$$

$$l = \frac{m_3 l_b + m_2 L}{m_1 + m_2 + m_3} = \frac{\frac{m_3 L}{2} + m_2 L}{m_1 + m_2 + m_3} = \frac{\frac{m_3}{2} + m_2}{m_1 + m_2 + m_3} L,$$

$$l = \frac{\frac{25}{2} + 95}{22 + 95 + 25} 10\ m = 7.57\ m$$

ANSWER: the fulcrum must be placed 7.57 m far away from the girl to balance the plank wood.