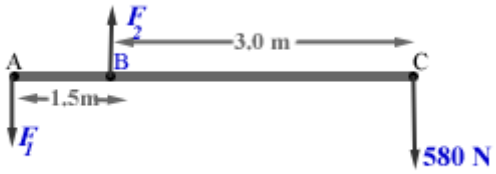
41.

Problem 13.15 E (HRW)

A diver of weight 580 N *stands at the end of a* 4.5 m *diving board of negligible weight. The board is attached to two pedestals* 1.5 m *apart. We have to find* (a) *the magnitude and direction of the force on the board from the left pedestal and* (b) *from the right pedestal,* (c) *and to answer which pedestal is being stretched, and which is being compressed.*

Solution:

We have sketched a line drawing indicating the positions where the forces are acting. The weight of the diver, 580 N, is a force due to the gravitational pull of the Earth and acts vertically downwards. As we will compute torques about axes perpendicular to the plane of the line drawing we have indicated that the weight instead of acting at the centre of mass of the driver can be represented as though it is acting on the diving board at the marker C.



The left and the right pedestals to which the diving board is clamped are indicated by markers A and B on the diving board. For the system to be in equilibrium vector sum of forces in the vertical direction on the system has to be zero and also torques computed about any axis perpendicular to the plane of the diagram have to be zero. If we compute torque about axis passing through the point A torque due to the weight of the diver will be in the clockwise direction. Therefore, direction of the force due to the right-pedestal, F_2, has to be vertically upward if it has contribute to torque in the anticlockwise direction for the vector sum of the torque to be zero.

$F_2 \times 1.5 \text{ m} = 580 \times 4.5 \text{ N m},$

or,

$$F_2 = \frac{580 \times 4.5 \text{ N}}{1.5}$$

$$= 1740 \text{ N}.$$

Using a similar argument we find that the force on the board due to the left-pedestal, F_1, will be acting

downwards. Magnitude of F_1 can be found by requiring that the net force acting on the system in the vertical direction has to be zero. That is

$F_1 + 580\ \text{N} = 1740\ \text{N},$

or,

$F_1 = 1160\ \text{N}.$

From Newton's third law of motion direction of forces acting on the left and right pedestals will be opposite to those shown in the diagrams. Therefore, the left-pedestal will be stretched and the right-pedestal will be compressed.