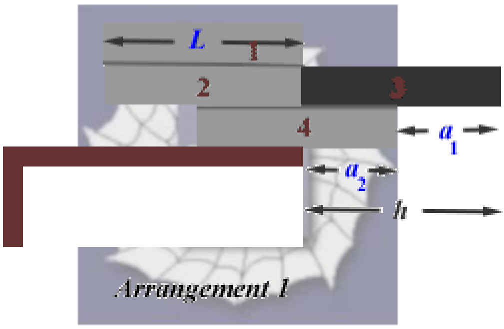
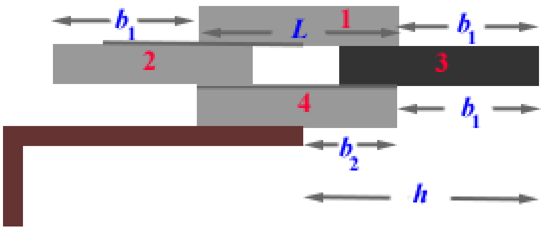
60.

<u>Problem 13.39P (HRW)</u>

Four identical bricks of length L are stacked on a table as shown in the figure. We seek to maximise the overhang distance h in both arrangements. We have to find the optimum distances a_1 , a_2 , b_1 *and* b_2, *and calculate h for the two arrangements.*





Arrangement 2

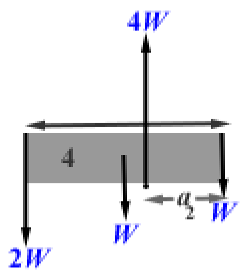
Solution:

***Arrangement* 1**

Key to maximising overhead distances is by ensuring that the normal force on the concerned brick lies at the edge of the brick/surface on which it is resting.

Brick 3 is resting on brick 4, therefore, maximum value of a_1 is *L/2* and the force that it exerts on brick 4 is *W*, the weight of the brick and it acts at the right-hand edge of brick 4.

Using a similar argument as above the force that bricks 1 and 2 exert on the brick 4 is 2*W* and it acts on its left-hand edge. Therefore, the free-body diagram of the brick 4 is as shown.



Free-body diagram of brick 4

We calculate the torque about the left-hand edge of brick 4 and require that for equilibrium the net torque on it has to be zero. This gives

$$4W \times (L - a_2) = W \times L/2 + W \times L$$

or

$$a_2 = \frac{5L}{8} \ .$$

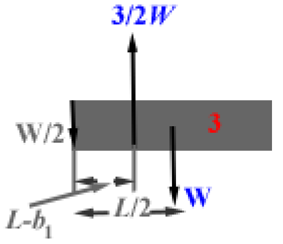
And,

$$h = \frac{9L}{8}.$$

Arrangement 2

In this configuration by symmetry, $b_2 = L/2$.

We will consider the free-body diagram of brick 3. Because of brick 1 there will be a force *W/2* on the left-hand edge of brick 3. From the symmetry we note that a normal force of $3W/2$ acts on brick 3 at the right-hand edge of brick 4, which is at a distance $L - b_1$ from the left-hand edge of brick 3. The free-body diagram of brick 3 is as shown.



Free-body diagram of brick 3

We calculate torque about the left-hand edge of brick 3 and as the brick is in equilibrium the net torque has to be zero. That is

$$\frac{3W\left(L-b_1\right)}{2}=\frac{WL}{2}$$

or

$$b_1=\frac{2W}{3}\ .$$

And,

$$h=b_1+b_2=\frac{7L}{6}\ .$$