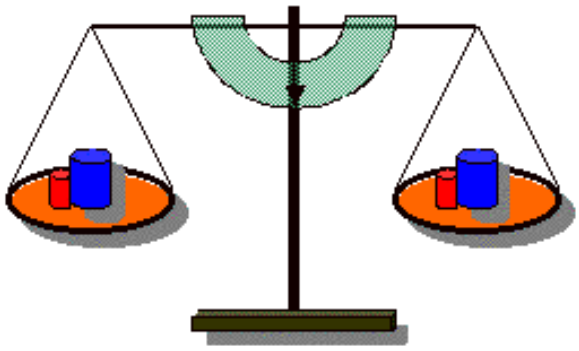
The Simple Balance

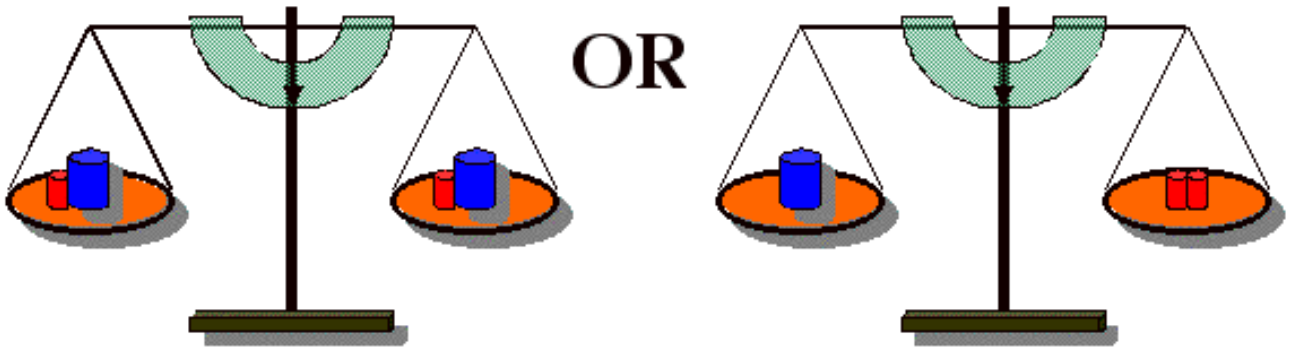
Part II

The Fundamental Equation of Equilibrium



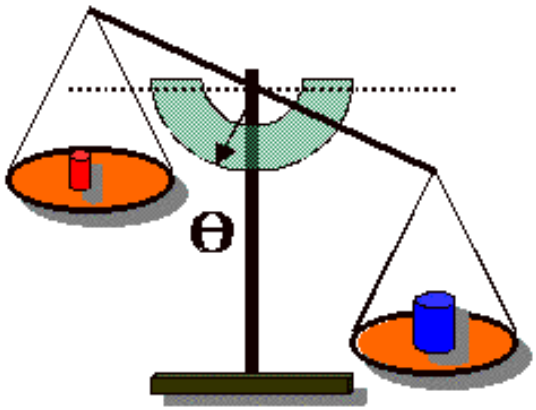
$$w_1 = w_2$$

A principle law of the balance is that when the total weights from each side are equal, then the horizontal equilibrium is restored



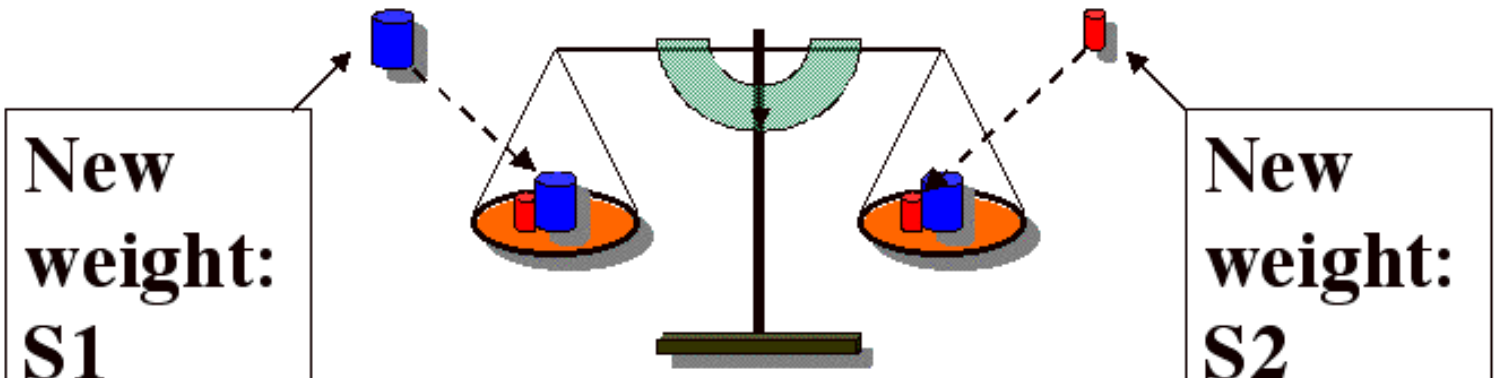
$$w_1 = w_2$$

the horizontal equilibrium can be restored by more than one way



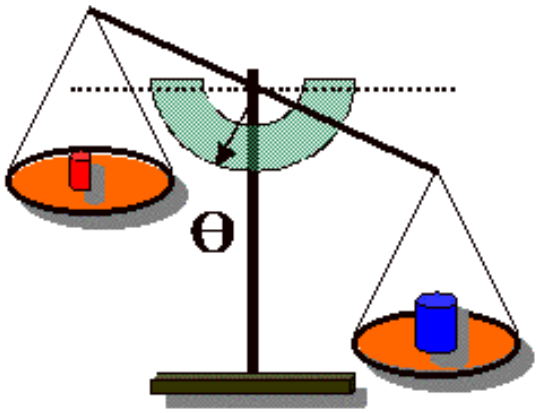
$$w_1 < w_2$$

If the total weight on the right is larger than the total weight on the left, then the balance is shifted by the angle - θ



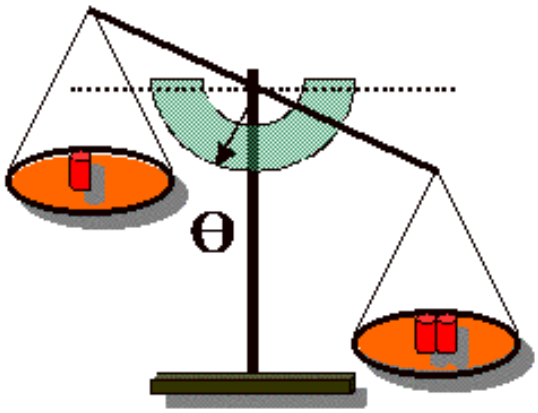
= $w_1 + S_1 = w_2 + S_2$

The addition of new, unequal weights, S1 and S2, to the weights, w1 and w2, restores the horizontal equilibrium



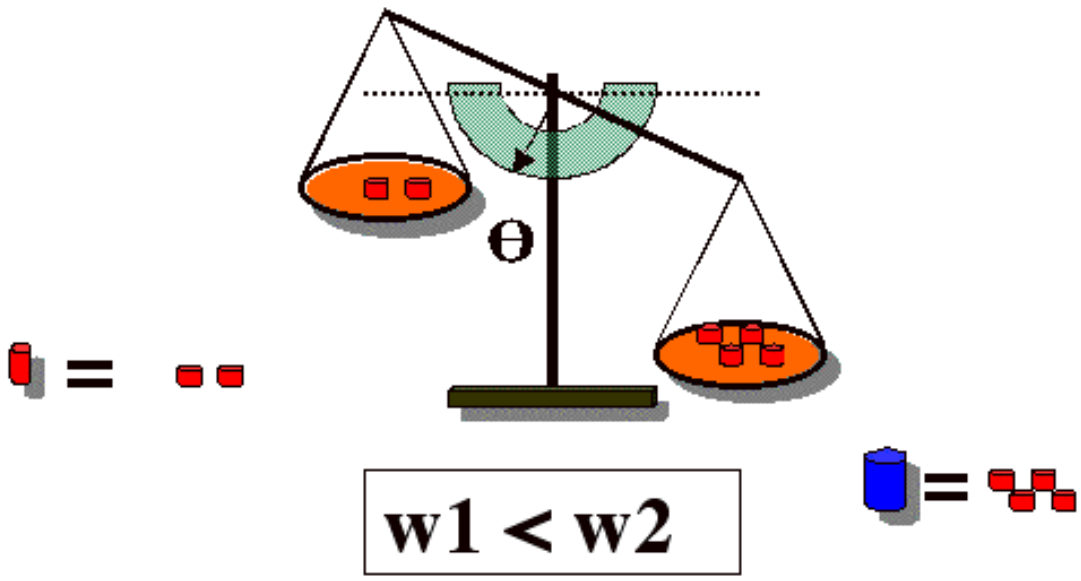
$$w_1 < w_2$$

Removing the weights, S1 and S2, returns the balance to its previous unequal state shifted by the angle - θ

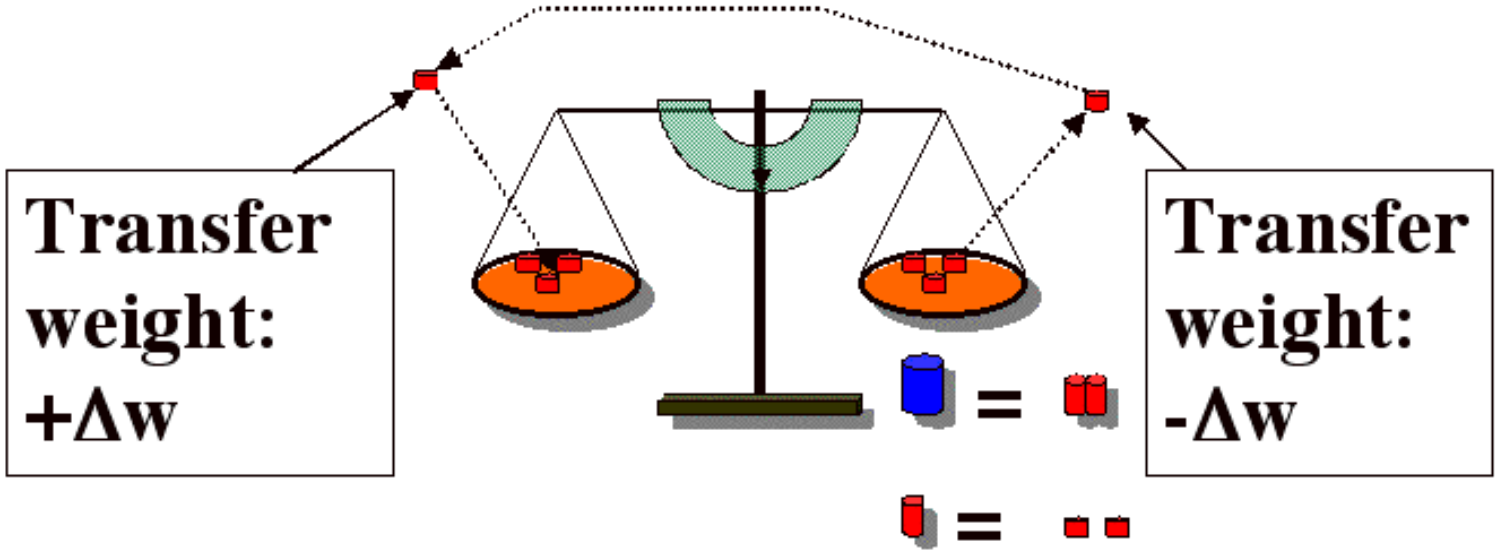


$w_1 < w_2$

The larger, blue weight can be replaced by two of the smaller red weights to give the same angle - θ

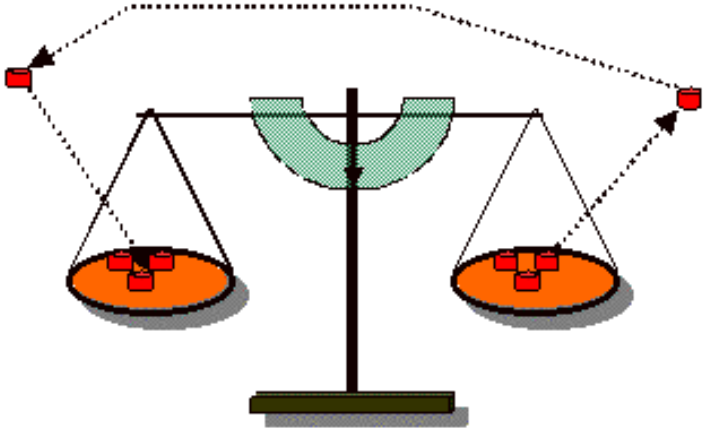


The total weights can also be replaced by the smallest red weights to give the same angle -θ

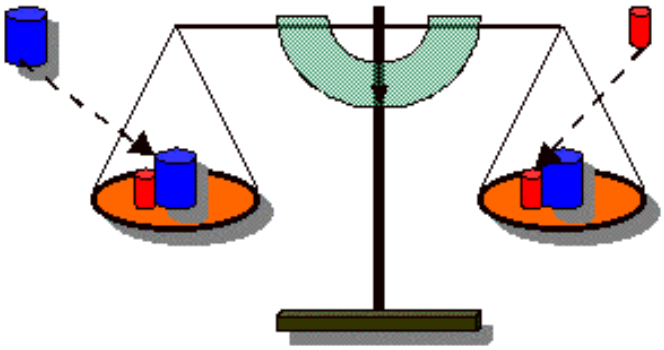


$$w_1 + \Delta w = w_2 - \Delta w$$

Transferring the weight, Δw, which is 1/2 of the red weight, restores the horizontal equilibrium



Transfer of weight



Adding unequal weights

Two ways to restore the horizontal equilibrium

$$w_1 + S_1 = w_2 + S_2$$

$$w_1 + \Delta w = w_2 - \Delta w$$

These two equations describe the two separate ways to restore the horizontal equilibrium of the balance.

$$\frac{w_1 + S_1}{w_2 + S_2} = 1$$

$$\frac{w_1 + \Delta w}{w_2 - \Delta w} = 1$$

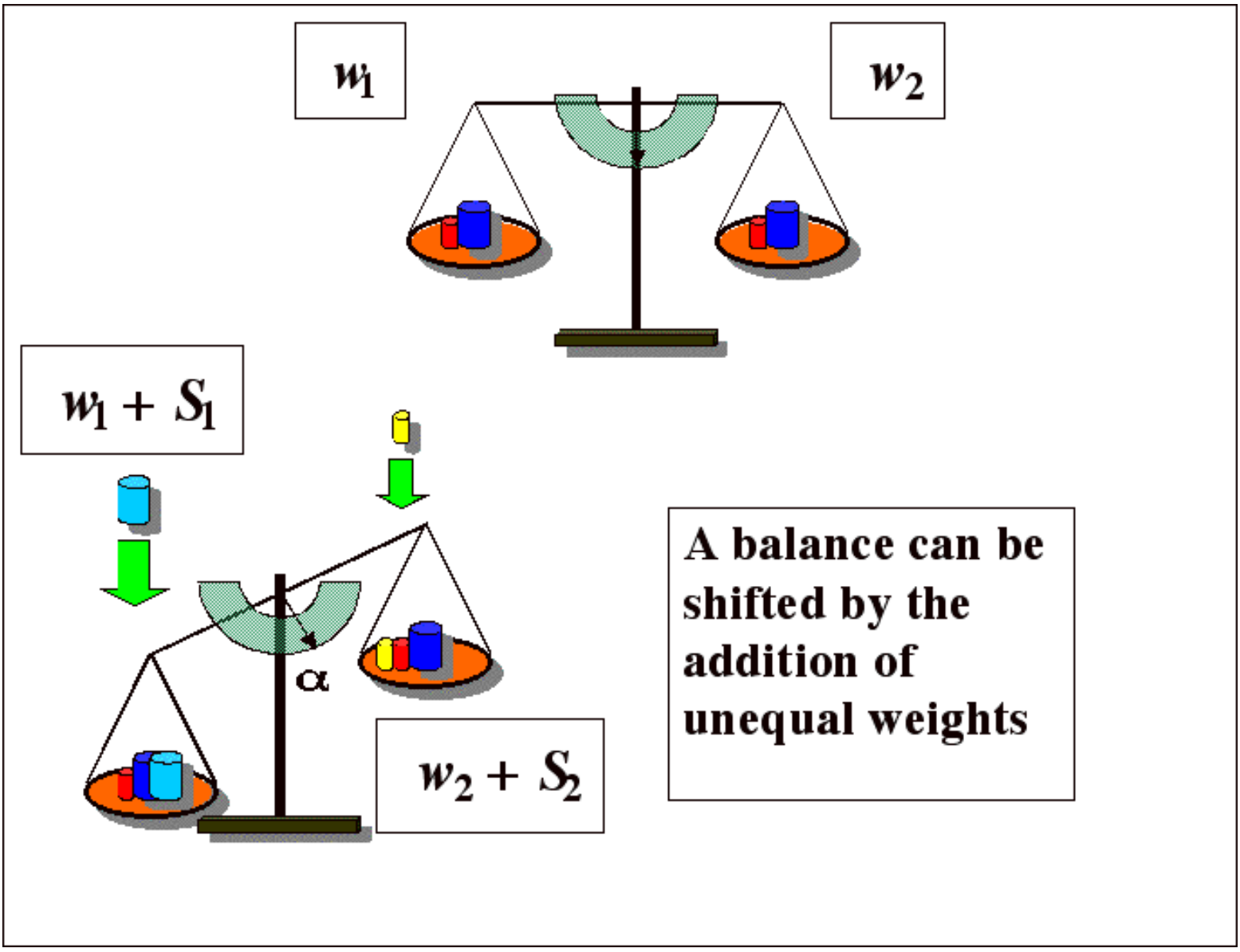
If we divide one side of each equation by the other side, then the ratios are equal to one in each case; therefore, their ratios are equal to each other.

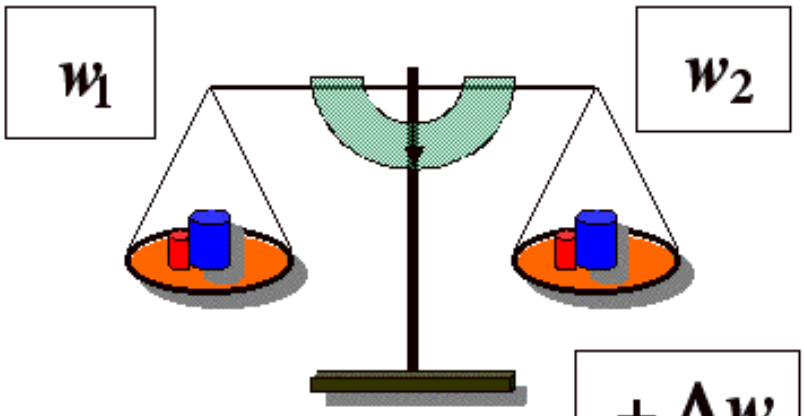
$$\frac{w_1 + S_1}{w_2 + S_2} = \frac{w_1 + \Delta w}{w_2 - \Delta w}$$

The equal ratios allows us to solve for the change or transfer of weight, Δw

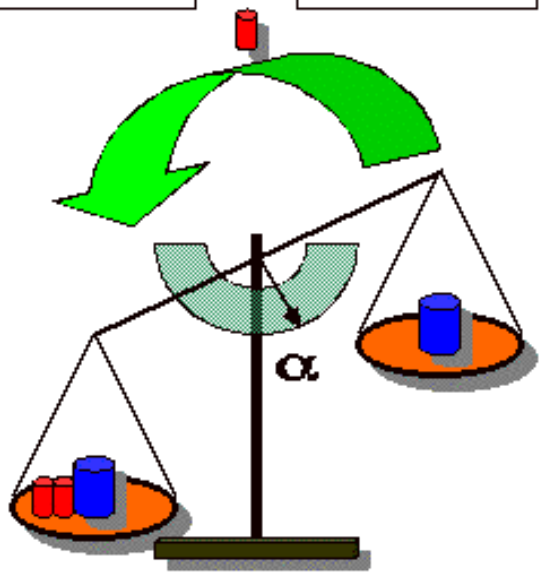
$$\Delta w = \frac{S_1 w_2 - S_2 w_1}{w_1 + S_1 + w_2 + S_2}$$

We can solve for the change or transfer of weight, Δw


w_1
w_2
$w_1 + S_1$
α
$w_2 + S_2$
A balance can be shifted by the addition of unequal weights

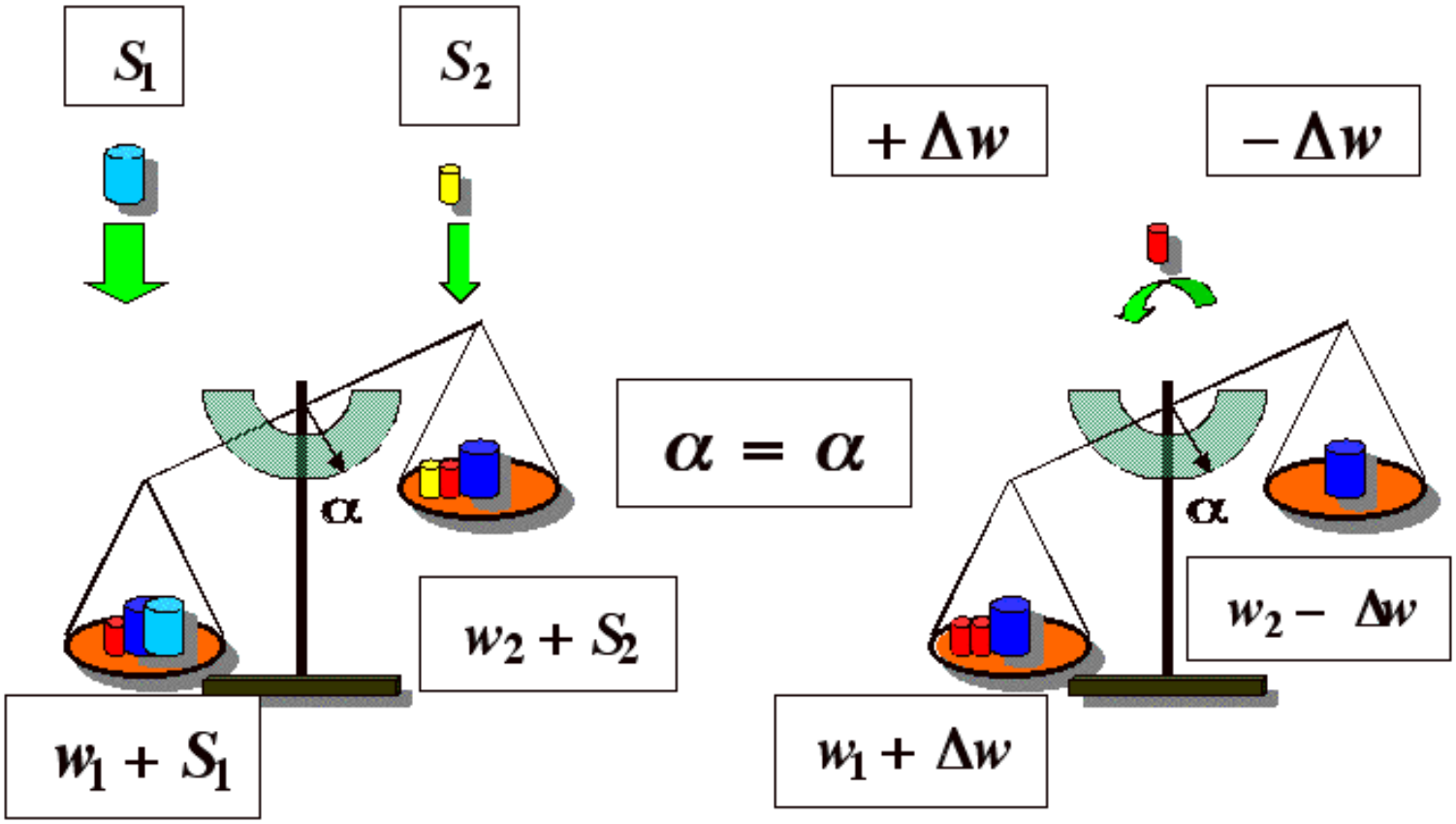


$+\Delta w$ $-\Delta w$



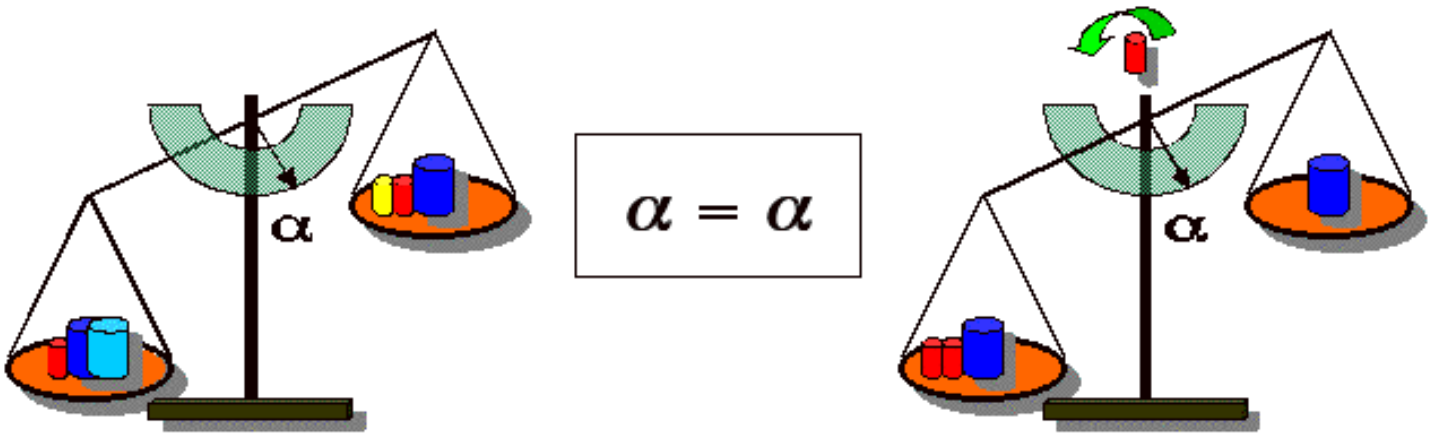
A balance can also be shifted by a redistribution of weight, Δw

Two equal ways to shift the balance by the same angle



$$\frac{w_1 + S_1}{w_2 + S_2} = \frac{w_1 + \Delta w}{w_2 - \Delta w}$$

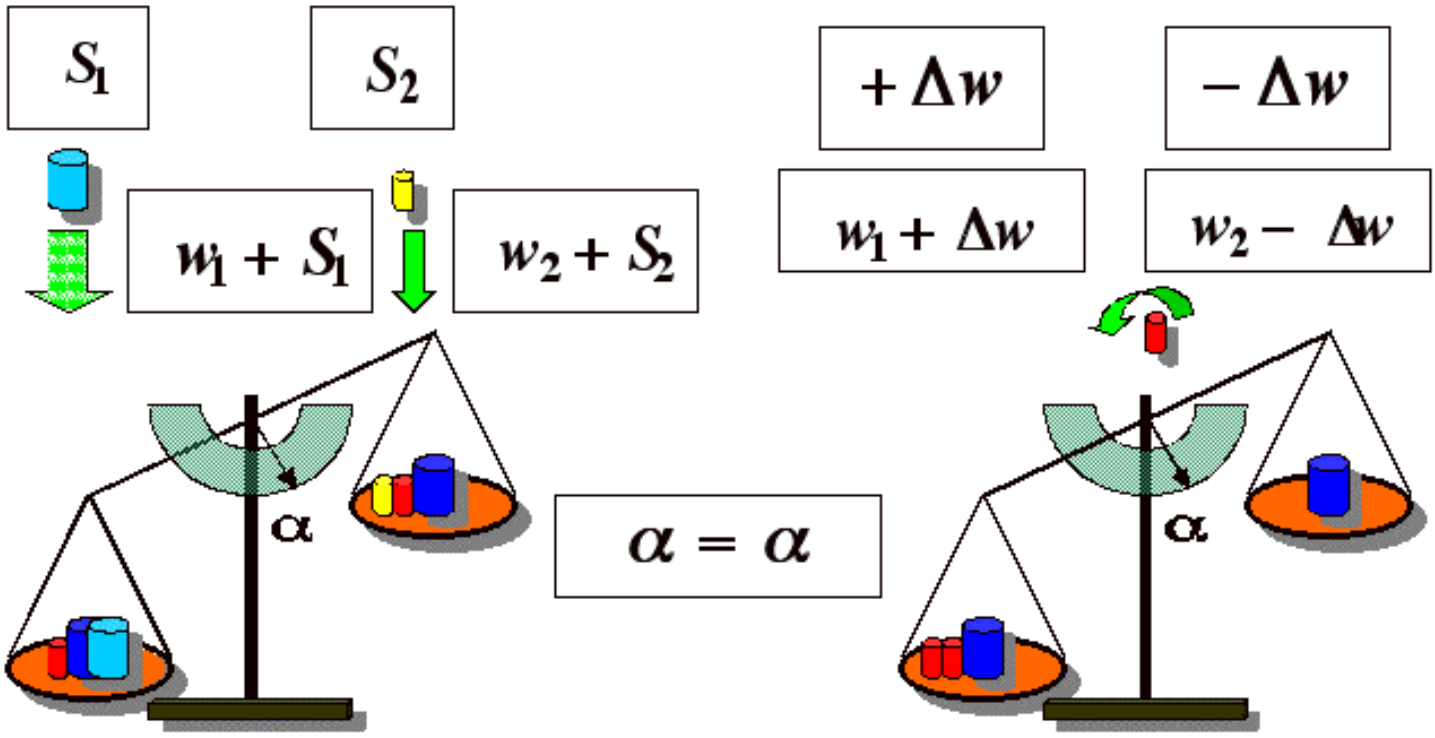
$w_1 + S_1$ $w_2 + S_2$ $w_1 + \Delta w$ $w_2 - \Delta w$



$$\Delta w = \frac{S_1 w_2 - S_2 w_1}{w_1 + S_1 + w_2 + S_2}$$

This equation solves for the amount of the transferred weight that will produce the same change in the balance as adding unequal weights.

$$\Delta w = \frac{S_1 w_2 - S_2 w_1}{w_1 + S_1 + w_2 + S_2}$$



The Fundamental Equation of Equilibrium

$$\Delta w = \frac{S_1 w_2 - S_2 w_1}{w_1 + S_1 + w_2 + S_2}$$

This fundamental equation of equilibrium tells us the amount of weight to transfer from one side to the other in order to produce the same change in the balance as when we add unequal weights to each side.

The Fundamental Equation of Equilibrium

$$\Delta w = \frac{S_1 w_2 - S_2 w_1}{w_1 + S_1 + w_2 + S_2}$$

This is an important equation of equilibrium. The reasons for this will be seen in further presentations.