EXPERIMENT 2

MOMENT

1. Objectives

- To learn the fundamentals of moment.
- To learn the relations between the distance from the origin of the coordinates and the point of action of the force.
- To learn the moment as a function of the angle between the force and the position vector to the point of action of the force.
- To learn the moment as a function of both the distance from origin and the applied force.

2. Equipment

Moment disk
Spring Balance 1 N
Tripod base -PASS-
Barrel base -PASS-
Support rod -PASS-, square, l = 400 mm
Right angle clamp -PASS-
Swivel clamp -PASS-
Bolt with pin
Weight holder f. slotted weights
Slotted weight, 10 g, black
Slotted weight, 50 g, black
Fish line, l = 100 m
Rule, plastic, l = 200 mm

Figure 1 Experimental set-up for investigating moments in equilibrium

3. Theory

There are two types of moment calculations which are also investigated by this experiment system. **First** is related with the forces that are directly perpendicular to the point of action. This means that there is no need to **take into account(care)** the angles of forces. **Second** is related with the forces having the angles between the point of action. This means that there is a need to **take into consideration(care)** the angles of forces. This can be seen in Fig. 2.

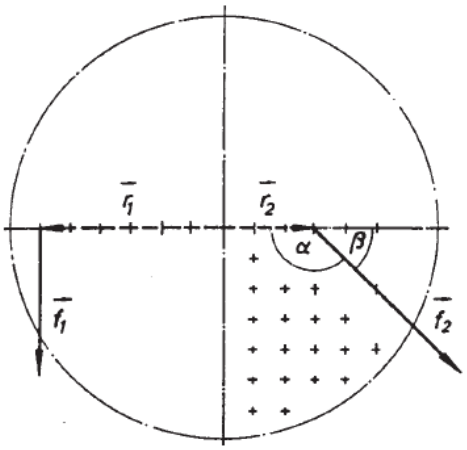

Figure 2 Moment for the forces with angles

For the first situation, all the force or forces on the right and the force or forces on the lefts are perpendicular to the point of action. In Fig. 2, the relation between α and β can be written for the first situation as

$$\alpha = \beta = 90^{\circ}. \tag{1}$$

After that if the point of action is at balance (no any rotation in any direction), using Fig. 2, the moment equality in terms of f_1 and f_2 can be written as

$$\vec{f}_1\vec{r}_1 \sin 90^{\circ} = \vec{f}_2\vec{r}_2 \sin\left(\alpha = \beta = 90^{\circ}\right) \tag{2}$$

where $\sin 90^{\circ} = 1$, then the equality can be rewritten as

$$\vec{f}_1\vec{r}_1 = \vec{f}_2\vec{r}_2. \tag{3}$$

For the second situation, the angle β should be taken into account. This consideration divides the force into two parts as the vertical and horizontal forces, respectively. Since the horizontal forces pass from the point of action, these forces have no any effect for the rotation. As a result, the vertical forces affect the system rotation. Then, if the point of action is at balance (no any rotation in any direction), using again Fig. 2, the moment equality for any angle β can be written as

$$\vec{f}_1\vec{r}_1 = \vec{f}_2\vec{r}_2 \sin\beta. \tag{4}$$

4. Procedure

- The moment equality will be investigated for both the **first situation** and **second situation**.

a) For the first situation, there is no angle difference with the vertical position.

- Use the given related black weights below for the right side of the point of action and use the free weight holder with slotted scale for the right side of the point of action. Then, measure and calculate the moment equality of both sides. After that, fill in the Table 1 below. Please also show your calculations clearly in the part calculations.

$r_1 = 2$ units	$r_2 = 1$ unit		
Calculated 10g black weight force	**Measured slotted weight force**	**Left Moment Calculated**	**Right Moment Calculated**

Table 1

Calculations:

- Fill in the Table 2 below. Please also show your calculations clearly in the part calculations.

$r_1 = 4$ units	$r_2 = 2$ units		
Calculated 10g black weight force	**Measured slotted weight force**	**Left Moment Calculated**	**Right Moment Calculated**

Table 2

Calculations:

- Fill in the Table 3 below. Please also show your calculations clearly in the part calculations.

$r_1 = 2$ units	$r_2 = 2$ units		
Calculated 20g black weight force	**Measured slotted weight force**	**Left Moment Calculated**	**Right Moment Calculated**

Table 3

Calculations:

- Fill in the Table 4 below. Please also show your calculations clearly in the part calculations.

$r_1 = 3$ units	$r_2 = 4$ units		
Calculated 30g black weight force	**Measured slotted weight force**	**Left Moment Calculated**	**Right Moment Calculated**

Table 4

Calculations:

b) For the second situation, there will be the angle difference with the vertical position.

- Use the given black weights below for the right side of the point of action and use the angled weight holder with slotted scale for the right side of the point of action. Then, measure and calculate the moment equality of both sides. After that, fill in the Table 5 below. Please also show your calculations clearly in the part calculations.

$r_1 = 2$ units	$r_2 = 1$ unit			
Calculated 10g black weight force	**Measured slotted weight force**	β **in degrees**	**Left Moment Calculated**	**Right Moment Calculated**

Table 5

Calculations:

- Fill in the Table 6 below. Please also show your calculations clearly in the part calculations.

$r_1 = 1$ unit	$r_2 = 1$ unit			
Calculated 20g black weight force	**Measured slotted weight force**	β **in degrees**	**Left Moment Calculated**	**Right Moment Calculated**

Table 6

Calculations:

• Fill in the Table 7 below. Please also show your calculations clearly in the part calculations.

$r_1 = 1$ unit	$r_2 = 3$ units			
Calculated 60g black weight force	**Measured slotted weight force**	β **in degrees**	**Left Moment Calculated**	**Right Moment Calculated**

Table 7

Calculations:

• Fill in the Table 8 below. Please also show your calculations clearly in the part calculations.

$r_1 = 1$ unit	$r_2 = 4$ unit			
Calculated 60g black weight force	**Measured slotted weight force**	β **in degrees**	**Left Moment Calculated**	**Right Moment Calculated**

Table 8

Calculations:

5. Results and Discussions

Discuss the results