Experiment No: M1

Experiment Name: *"Newtons's Second Law of Motion"*

Objective:

- Observing Newton's second law of motion to find the acceleration caused by a force acting in one dimension.

- Compare the experimental weight $M_{system\ Exp}$ and theoretical weight $M_{system\ Theo}$ of the system M_{system}, where the system $M_{system} = m_{holder} + m_{glider}$.

Keywords:

Newtons's Second Law of Motion, mass, acceleration, force, time, velocity

Theoretical Information:

Newtons's Second Law of Motion :

$$F = m\,a$$

- **F**, the net force acting on an object.
- **m**, mass of the object.
- **a**, the acceleration (change in velocity) of the object.

The acceleration, which is the change in velocity of an object, is directly proportional to the total net force acting on it and inversely proportional to the mass of the object.This law describes the relationship between force, mass, and motion.
The experiment can be studied by the help of the simple model depicted in Figure 1.
m_1 corresponds to the mass of the holder m_{holder} , and m_2 corresponds to the mass of the glider m_{glider}.

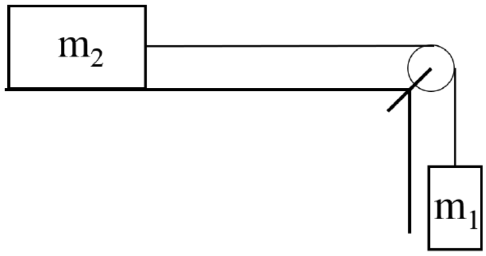

Figure 1: *A physical model for the experimental set-up*

We draw the "free body diagrams" of the two masses. These diagrams are shown in Figure 2.

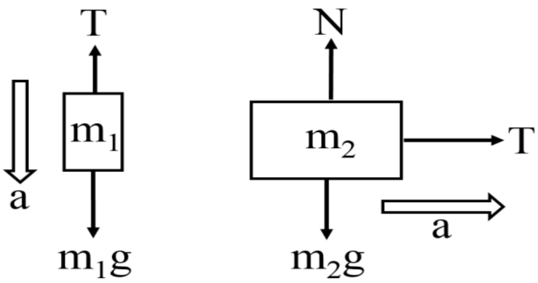

Figure 2: *Free body diagrams showing the forces acting on two bodies and their accelerations.*

Using **F =** m **a** we can write the following equations for the bodies.

$$m_1 g - T = m_1 a \qquad (1)$$
$$N - m_2 g = 0 \qquad (2)$$
$$T = m_2 a \qquad (3)$$

If we add equations [1] and [3] we get the following expression $m_1 g = (m_1 + m_2)a$. We can easily pull out as follows:

$$a = \frac{m_1 g}{m_1 + m_2}$$

$$\Rightarrow m_1 + m_2 = \frac{m_1 g}{\mathrm{a}}$$

$$M_{\text{system}} = \frac{F}{\mathrm{a}} \qquad (4)$$

where F = m_1g , M_{system} = $m_1 + m_2$ and g is gravitational acceleration (g = 9.81 m/s^2)

As one can see from equation [4] the acceleration of the system depends on m_1 and m_2. Given that the masses remain constant during one set of measurement the acceleration is also expected to stay constant. So in this system $m_1$is expected to make a motion with constant acceleration in the vertical direction while m_2 is expected to make the same in the horizontal.