## Experimental No. (8)

## Conservation of Linear Momentum

**Objective:**

**Verification of the conservation of Linear Momentum.**

**Apparatus:**

**Flex-track, balls, ruler, and carbon paper.**

**Theory:**

**The law of consecration of linear momentum states that:**

**"bf the total linear momentum of an isolated system is constant"**

$$\sum_{i=1}^{N} \overrightarrow{P_i} = \sum_{i=1}^{N} \overrightarrow{P_f} = constant \tag{38}$$

**For a system consisting of two particles, the law of conservation of**

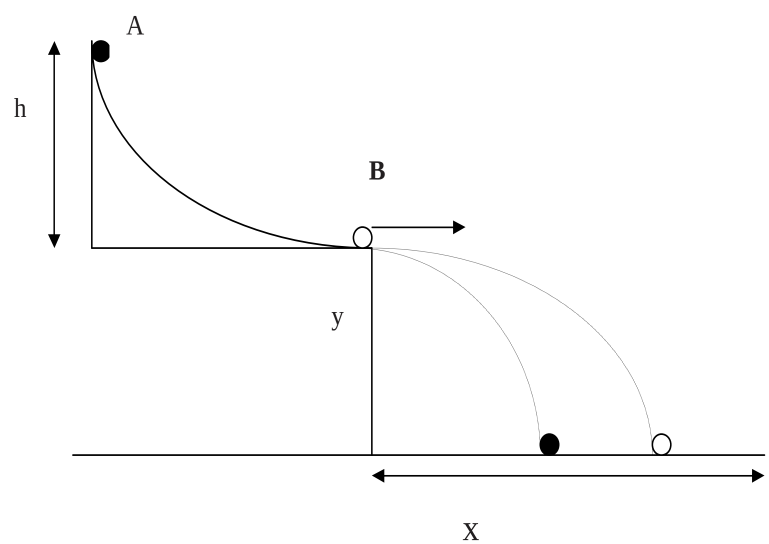


Figure 17:

**linear momentum in a collision reduces to:**

$$(\overrightarrow{P_1} + \overrightarrow{P_2})_{beforecollision} = (\overrightarrow{P_1} + \overrightarrow{P_2})_{aftercollision} \tag{39}$$

$$M\overrightarrow{V} + m\overrightarrow{v} = M\overrightarrow{V'} + m\overrightarrow{v'} \tag{40}$$

**if we choose m initially to be at rest, the equation will be given as:**

$$M\overrightarrow{V} = M\overrightarrow{V'} + m\overrightarrow{v'} \tag{41}$$

$$M\frac{\overrightarrow{r_1}}{t} = M\frac{\overrightarrow{r}_1}{t} + m\frac{\overrightarrow{r}_2}{t} \tag{42}$$

**Where,**

**V : is the velocity of the mass M before the collision in x direction,**$\overrightarrow{r_1}$ **is the position vector of the falling ball without collision,** $V'$, $\overrightarrow{r}_1$**: is the velocity and displacement of the falling mass after collision,** $v'$, $\overrightarrow{r}_2$**: is the velocity and displacement of the hitted mass after collision, since we choose the two masses are equaled, and the time of flight for all the masses is the same, the above equation become:**

$$\overrightarrow{r_1} = \overrightarrow{r}_1 + \overrightarrow{r}_2 \tag{43}$$

**Procedure:**

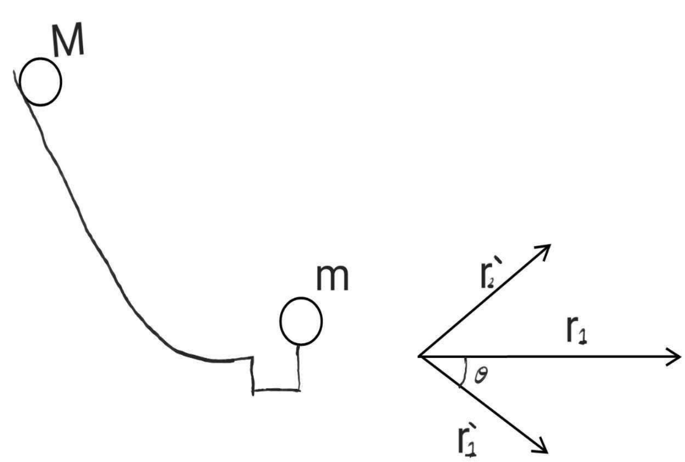


Figure 18:

1. **Place one ball near the end of the horizontal portion of the flex-track (see Fig. 1)**

2. **Release the ball from point A on the track and mark the position of the ball as $\vec{r_1}$.**

3. **Record the height h from which the ball is released. This should be measured . relative to the horizontal end of the track (see the figure).**

4. **Rerelease the ball again from the same height and put the other ball to make collision. Make sure that the collision is making small angle between the balls**

5. **Measure the distance of ball one and mark it as $\vec{r}_1$, and the other as $\vec{r}_2$ .**

6. **Repeat the outlined procedure for the same pair of balls and for the same h with a slight change in angle.**

7. **Repeat the above steps for the same pair of balls but for a different h.**

8. **Tabulate your results as in Table (1).**

**Name:** **Grade:**

**Students No.:** **Date:**

| | **h** | $\theta$ | $\overrightarrow{r_1}$ | $\overrightarrow{r_1'}$ | $\overrightarrow{r_2'}$ | $\overrightarrow{R_1'}=\overrightarrow{r_1'}+\overrightarrow{r_2'}$ | **error** |
|---|---|---|---|---|---|---|---|
| **Run1** | | | | | | | |
| **Run2** | | | | | | | |
| **Run3** | | | | | | | |
| **Run4** | | | | | | | |
| **Run5** | | | | | | | |
| **Run6** | | | | | | | |

**Questions:**

1. **What is the main sources of error in your experiment?**

**Discussion and Conclusion:**

**Experimental No. (9)**

**Pendulum**

**Objective:**

1. **To measure the dependence of period on length of the pendulum**

2. **To measure the acceleration of gravity.**

3. **To determine the spring's constant.**

**Apparatus:**

**Pendulum bob, spring, slotted weights, meter and stop watch.**

**Theory:**

**All vibrating systems have frequency (f) at which they vibrate. The frequency is how many vibrations the system makes per unit time. Sometimes it is more useful to work with the period ($\tau$) of the vibration or oscillation, and is the reciprocal of frequency. The size of the maximum displacement from the rest position is called the amplitude A. These quantities are related in such a way that they can describe the motion of an oscillating system mathematically. If we have a particle which is oscillating in the y-axes, the location in the y-axis at any given time (t) from the start of oscillation, can be found from the equation:**

$$y = A\sin(2\pi ft) = A\sin(\omega t) \tag{44}$$

**The velocity of the oscillating particle can be found from the displacement by taking the derivative of it with respect to time, the acceleration also can be found by taking the second derivative of displacement with respect to time as shown:**

$$v = \frac{dy}{dt} = 2\pi fA\cos(2\pi ft) = \omega A\cos(\omega t) \tag{45}$$