



## General Physics I (PHYS 101) Lab. Exercise No..... **Ballistic Pendulum**

**Name :** \_\_\_\_\_ **ID No.** \_\_\_\_\_

### PERFORMANCE OBJECTIVES

Upon completion of this laboratory exercise the student will be able to:

- Predict the initial velocity of a projectile using the principles of conservation of linear momentum and conservation of total mechanical energy.
- Plot a graph between velocities and the maximum deflection of the pendulum

### MATERIALS AND EQUIPMENT

Ballistic unit, steel ball (d = 19 mm), speed measuring attachment, power supply (5V DC/2.5A)

### THEORETICAL CONCEPTS

A ballistic pendulum is a device used to measure the speed of a projectile mass (m) when it is fired at a resting mass (mass M) hanging from a string as a pendulum. The projectile mass embeds itself in the pendulum mass, and causes the whole system to swing up a height as shown in Figure 1.

If we assume the potential energy of the system at its resting position to be zero then the potential energy at the highest point of the oscillation can be written as

$$E_{pot} = (m + M) g \Delta h$$

With the help of the diagram shown in Figure 1 we can rewrite the above equation as

$$E_{pot} = (m + M) g r (1 - \cos \phi)$$

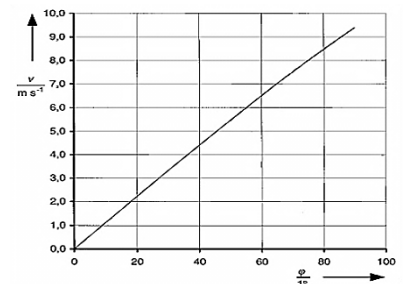
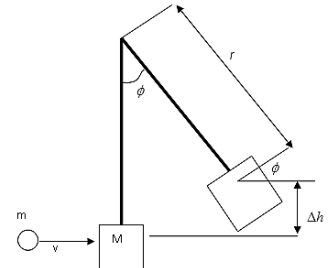
Since the potential energy must be equal to kinetic energy  $E_{kin}$  immediately after the collision, therefore

$$E_{kin} = \frac{1}{2} (m + M) v_p^2$$

Was  $v_p$  being the velocity of the pendulum's mass immediately after the collision. By using the principle of conservation of momentum one can obtain the following relation.

$$v = \frac{m + M}{m} \sqrt{2 g r (1 - \cos \phi)}$$

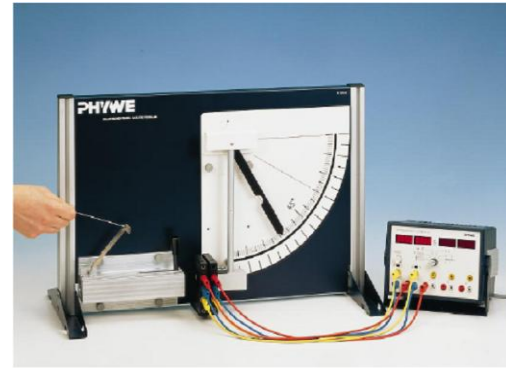
Figure 2 shows a plot between the velocity of projectile mass (v) and the deflection angle ( $\phi$ )



**EXPERIMENTAL SETUP AND PROCEDURE**

**[04 Marks]**

1. Measure mass of steel ball ( $m$ ) = .....
2. Measure mass of pendulum ( $M$ ) = .....
3. Measure the diameter of the steel ball ( $d$ ) = .....
4. Radius of the steel ball ( $r$ ) = .....
5. Set up the ballistic unit as shown in Figure 3.
6. Place the steel ball to the holding magnet of the bolt.
7. Pull the bolt until the desired lock-in position is achieved.
8. Trigger the shot by pulling the release lever.
9. Read the amplitudes of the pendulum's oscillation from the trailing pointer.
10. Measure the angle of deflection  $\phi$  and record this value in Table 1.
11. Determine velocity by using the speed measuring unit and record in the Table 1.



**Table 1**

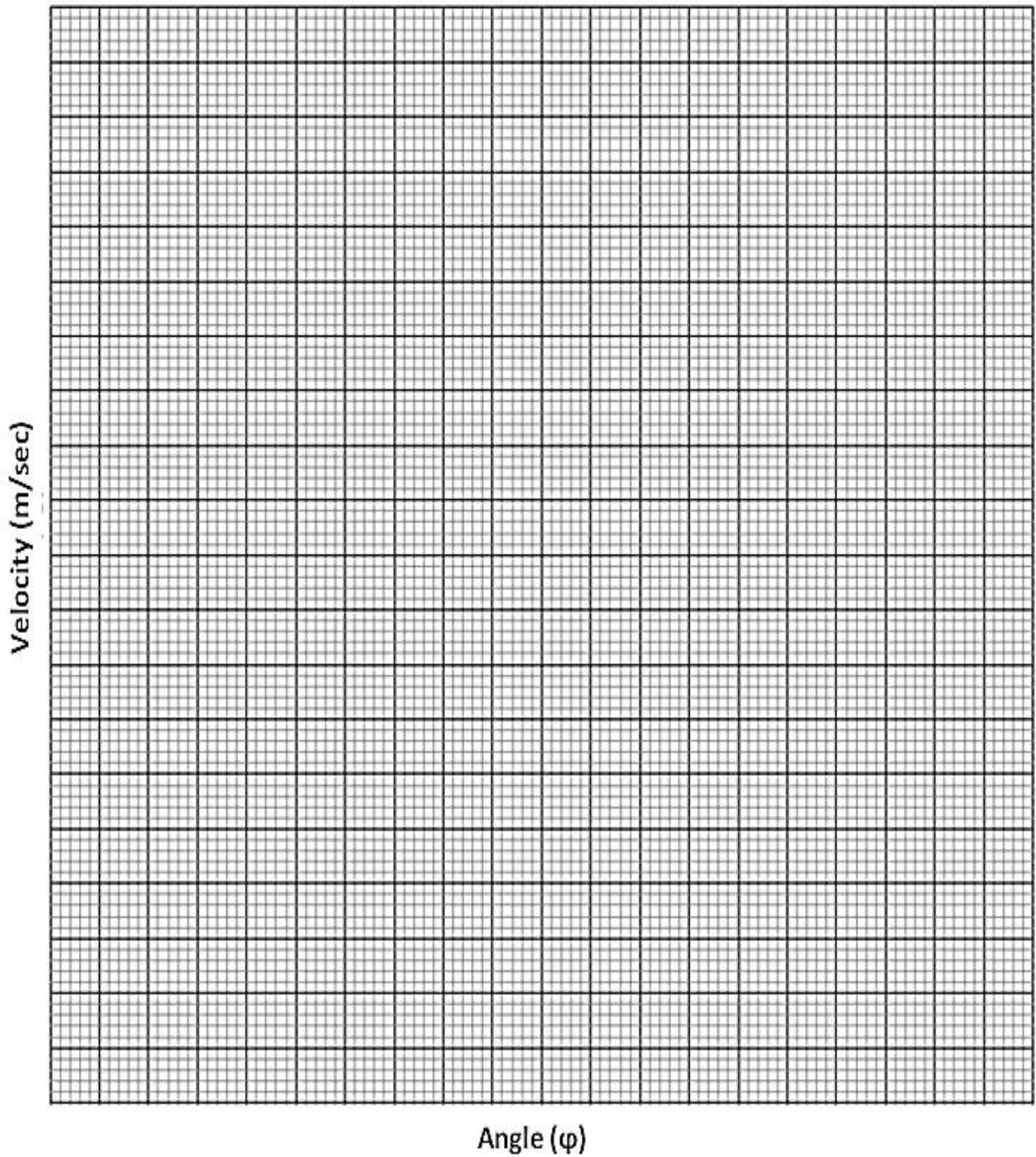
**[04 Marks]**

Sr. No.	Angle $\Phi$ (degrees)	Velocity (measured) m/s	Velocity (calculated) $v = \frac{m + M}{m} \sqrt{2 g r (1 - \cos \phi)}$ m/s
1			
2			
3			

**Graph between velocity ( $v$ ) and the deflection angle ( $\Phi$ )**

**[01 Mark]**

Use the values obtained in Table 1 to plot a graph between velocity ( $v$ ) and the deflection angle ( $\Phi$ ). The graph is given in Figure 4.



**Plot a graph between the velocity ( $v$ ) and the deflection angle ( $\Phi$ )**

