1 Background

Air resistance, also called drag, is a force exerted on an object that is traveling through some fluid which resists the object's motion. (In physics, the term "fluid" is used to refer to both liquids and gases.) The magnitude of drag depends on many factors, including the material the object is made of, the size and shape of the object, and fluid the object is moving through.

Often, we say that air resistance is negligible. In this case, drag is small enough that it does not significantly alter a projectile's trajectory, and the object's motion can be described with kinematics:

$$\Delta x = v_{0,x} t \tag{1}$$

$$\Delta y = v_{0,y} t - \frac{1}{2} g t^2 \tag{2}$$

where $g = 9.81\,\mathrm{m/s^2}$, and the $+y$ direction is defined to be "up."

If air resistance truly is negligible for a given system, the equations above will accurately predict the actual motion of a projectile. That is, calculations for a given initial velocity will agree, within measurement uncertainty, with actual measurements of an object's change in position.

If the experiment does not agree, within measurement uncertainty, to the calculations assuming negligible air resistance, there are two possibilities:

1. Air resistance is not negligible
2. There is a flaw in your experiment

As scientists, we can carefully design and carry out experiments to increase our confidence that possibility two is not the case. We want to design experiments that are as simple as possible, and make measurements as accurately as we can.

2 Tools

In addition to "standard" equipment (scales, metersticks, tape measures, rods/clamps/ring stands, etc.), you will have a ball launcher, various balls, carbon paper, and two photogates.

The photogates are to be used in determining the speed of a ball as it leaves the launcher: mount them so that the ball triggers them both in rapid succession; use the time interval between when the first and second gate is triggered, and the distance between the two gates to determine the speed of the ball. Be sure to consider measurement uncertainty in your calculations.

3 Task

You are to determine if air resistance is negligible for this system (these ball launchers and their associated projectiles).