

## Newton's Second Law of Motion: Force and Acceleration

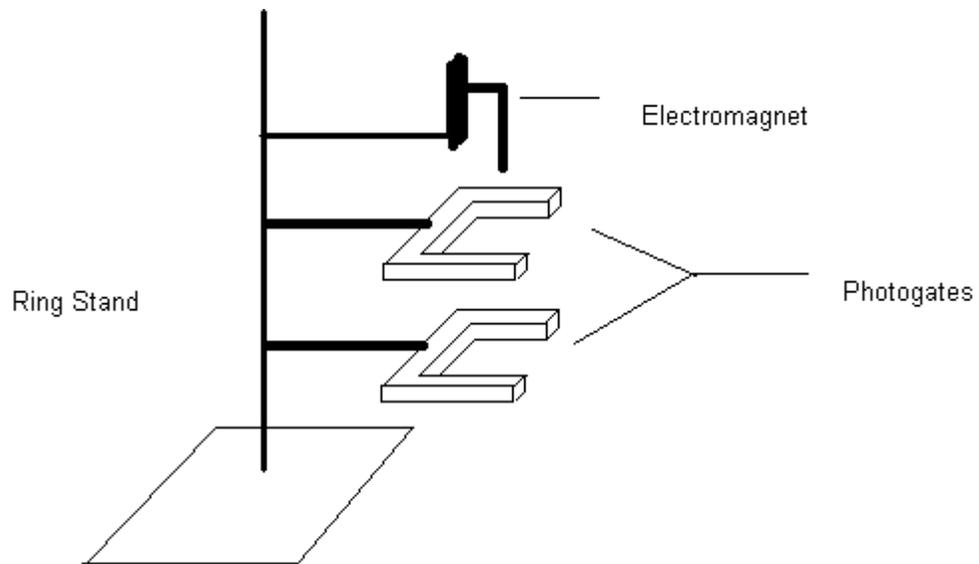
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### Introduction

As stated, Newton's first law of motion governs the properties of inertia that an object at rest stays at rest and an object in motion remain in motion in the absence of an external force. However, it is observed that an object that tends to move comes to rest at a certain point as well as objects that are pushed tend to speed up until a certain point.

Newton's second law of motion, governs this property in it that it states the relationship between the force applied and the acceleration or the change in velocity experienced by the object. Therefore, it can be assumed that when an object experiences a force the resulting mass would have an effective acceleration.

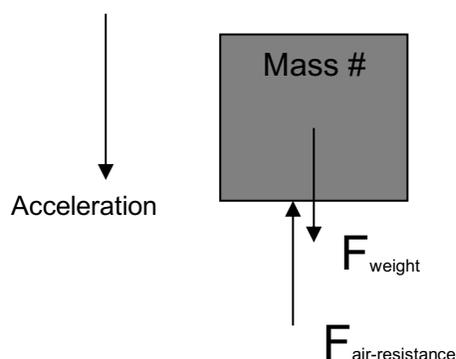
In this experiment, we are going to first determine the acceleration that an object experiences using two photogates. The second part is going to consist of a similar experiment but instead we are going to account for an additional force and then measure the acceleration produced as a result of that force in addition to the gravitational force.



### Background

1. Newton's second law of motion is fundamentally simple to understand since experimentally it has been determined that the net force is directly proportional to the acceleration produced. As well as the acceleration is inversely proportional to the mass of the accelerated object. Finally, Newton's second law can be formulated as follows:

- I. Net Force = Mass • Acceleration
2. In this experiment, we are first going to observe the free fall acceleration of different masses and hence make the conclusion about the gravitational acceleration that is exerted by the gravitational field and compare the theoretical values with the experimental values.
  - The measurement can be made by using two photogates and the force balance to calculate the acceleration.
  - In addition, we will use different masses in which the air-resistance is no longer negligible, therefore the resulting resistance force can be calculated by a force balance and an acceleration measurement will be used to calculate how much of that force was actually developed.



## Equipment List

- 1) Power Macintosh or Windows PC
- 2) LabPro
- 3) Vernier Photogates
- 4) Logger *Pro*
- 5) Several Masses
- 6) Electromagnet
- 7) Ring Stand

## Experimental Procedure

### Part I. Object Drop – Free Fall

1. Lift the apparatus to a desired height.
2. Measure the mass.
3. Place the first mass on the electromagnet and turn the switch on.
4. Start the program by pressing the collect button and switch the switch off to release the mass.

5. While the data is still being acquired from LabPro, repeat steps 3-5 three more times.
6. Average the calculated acceleration values and the time values and place it in the result section.
7. Stop the program and record your data.
8. Repeat steps 1-7 with the remaining masses.

**Part II. Object Drop – With an additional resisting force**

1. Measure the mass and height of the mass as in part I. Unlike in the first part we are going to use masses where the air resistance is no longer negligible, therefore there is an additional force that we have to take into account. This drag force is the force that is going to be calculated. Since we are weighing the object and measuring the acceleration, the only unknown variable is that due to the air-resistance.
2. Start the program
3. Place and the mass on the electromagnet and switch the electromagnet lab off.
4. Stop the program and record your data.
5. Repeat steps 1-4 with the remaining masses.

**Results**

**Part I. Object Drop – Free Fall**

Mass, [g]	Time 1, [sec.]	Time 2, [sec.]	Acceleration, [m/s <sup>2</sup> ]	Force due to Gravity, [N.]

**Part II. Object Drop – With an additional force**

Mass, [g]	Time 1, [sec.]	Time 2, [sec.]	Acceleration, [m/s <sup>2</sup> ]	Force due to Gravity, [N.]

### Analysis

1. Determine the average acceleration of each mass for both parts of the experiment.
2. From the weight measured compare the theoretical and the experimental values of the acceleration.
3. Graph the force due to gravity as a function of the mass for each part.
4. After determine the slope of the graph.
5. What does the slope represent?
6. Is the slope measurement in part I relevant to the experimental value?
7. For part II determine the force due to the air-resistance by applying Newton's second law.