ScienceCube

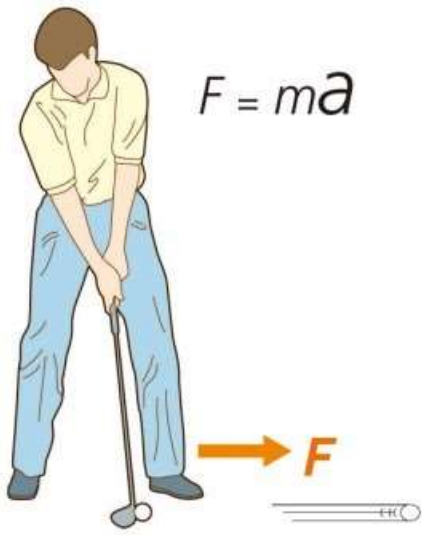
# Newton's Second Law

**Understanding and explaining the law of acceleration by comparing the speed of a cart moving under different forces and masses..**

## Fundamental Concept

### 1. Newton's Second Law

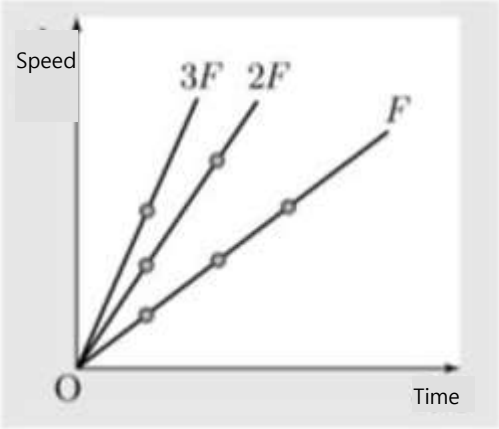
The change in velocity is directly proportional to the applied force when the mass is constant and inversely proportional to the mass when the applied force is constant.



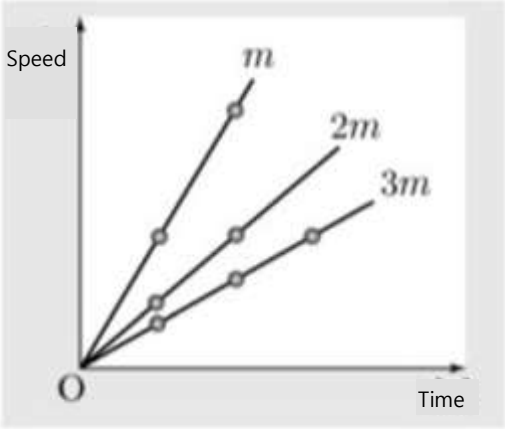


Using Newton's Second Law, we can compare the results when the same force is applied to objects of different masses. The force applied to a larger mass results in a relatively smaller acceleration.

$$F=ma$$




When mass is constant




When force is constant

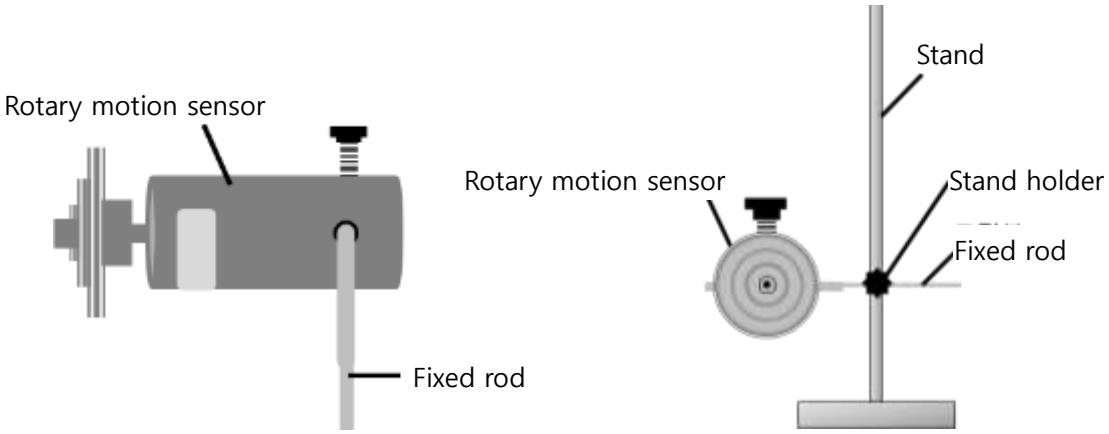
# Experiment

## Materials Needed

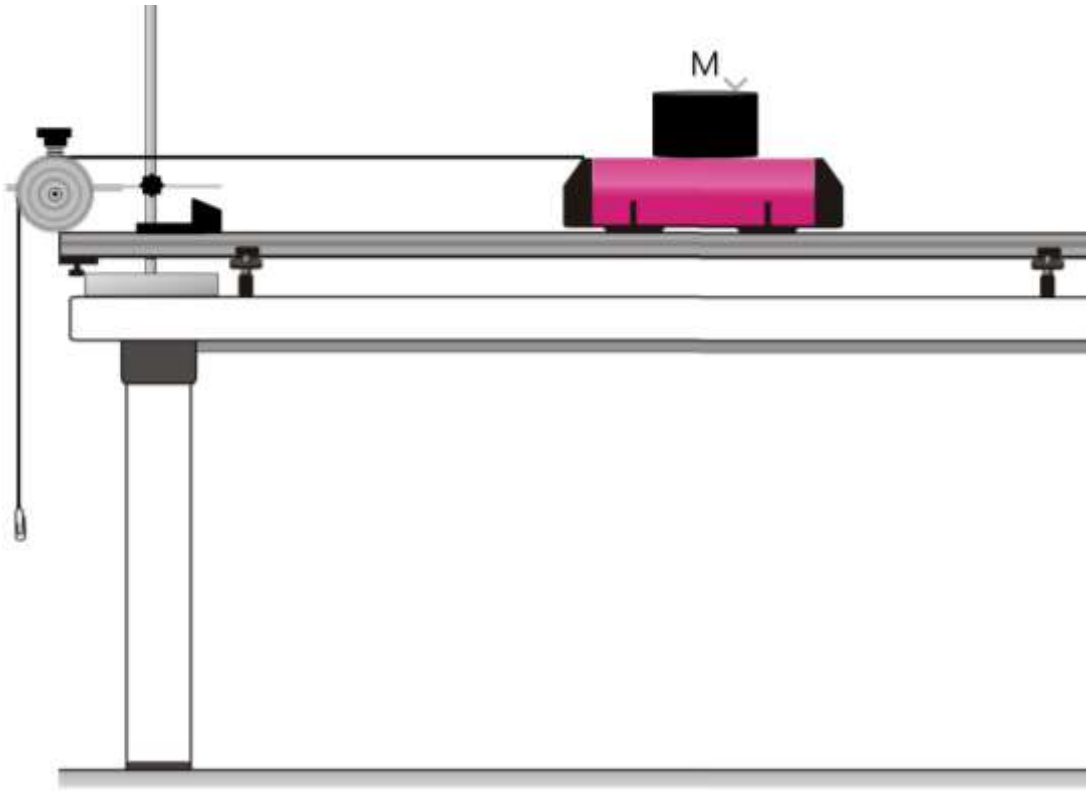
Interface, Science# Program, rotary motion sensor, dynamics experiment apparatus, weights (50g, 100g, 150g), string, stand, support rod.

## Preparation of Experimental Apparatus

1. Attach the support rod to the rotary motion sensor and tighten it with a screw.
2. Insert the support rod into the stand holder to secure the rotary motion sensor..

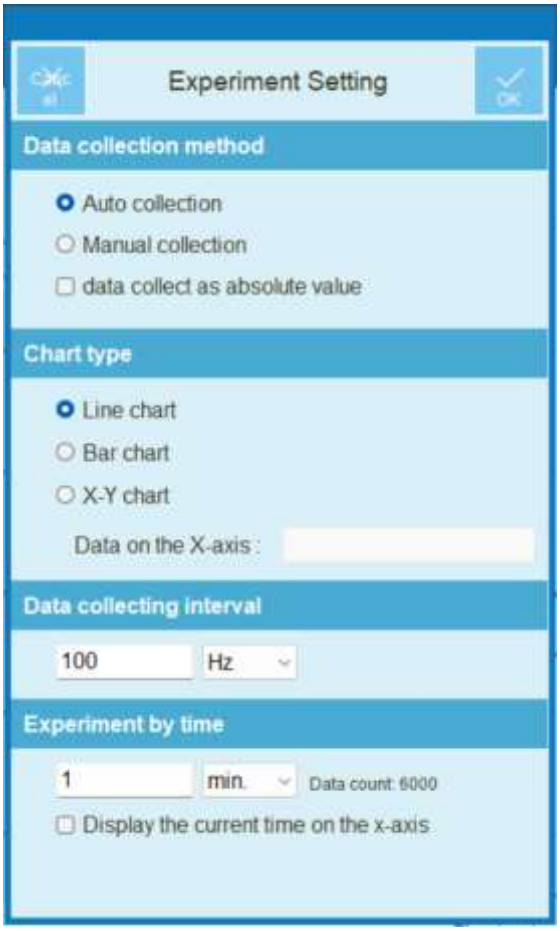


3. Horizontally install the rail of the dynamics experiment apparatus at the edge of the table.
4. Secure the rotary motion sensor to the rail with the stand.
5. Place a 500g weight on the cart and secure it.
6. Tie a string to the cart and hang it over the largest wheel of the rotary motion sensor.
7. Attach a clip to the other end of the string to easily attach weights.
8. Before the experiment, wind the rotary motion sensor clockwise to set it to 0°..




## Interface Setup

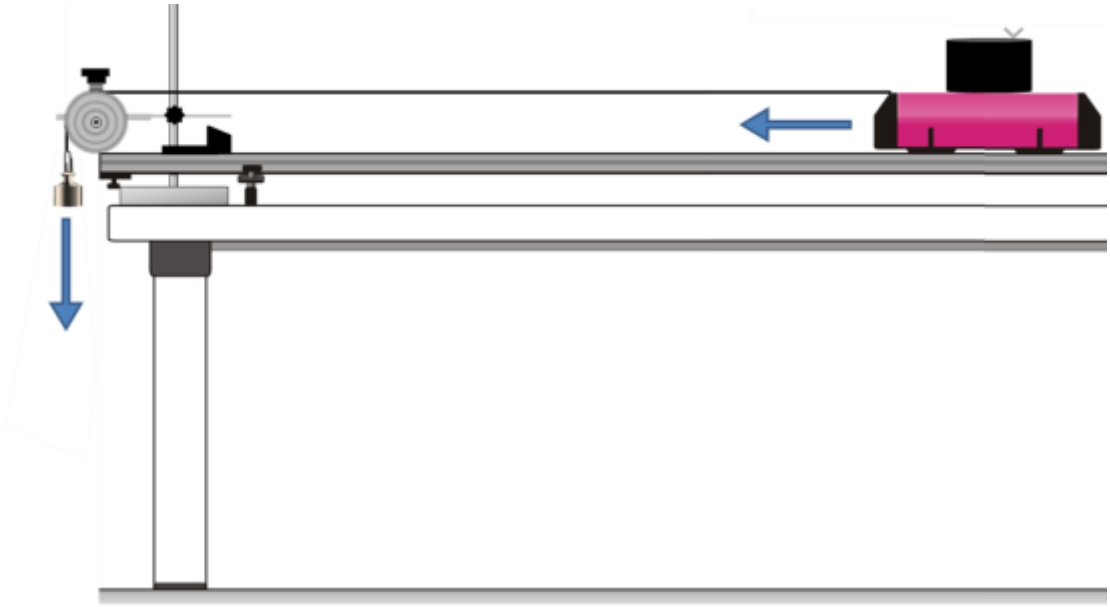
1. Run the Science# program
2. Connect the rotary motion sensor to the interface.
3. Click to set up the experimental environment as shown below or click to automatically set up.




 automatically set up

## Data Collection

1. Click  to start data collection.



2. Place the cart at the end of the rail and attach a 50g weight to the clip.
3. When the measurement is complete, click  to stop data collection.
4. Increase the weight to 100g and 150g and collect data in the same manner.

# Data Analysis

## Recording Data

1. Plot the measured data as a time-angle graph according to the force magnitude (weight mass).

2. The rotary motion sensor measures data in angles as it rotates. Describe how to convert this to distance values. (Rotary motion sensor diameter = 64 mm)

3. Draw the time-velocity graph and time-acceleration graph according to the weight mass.

   [Time-Velocity Graph]

   [Time-Acceleration Graph]

## Data Application

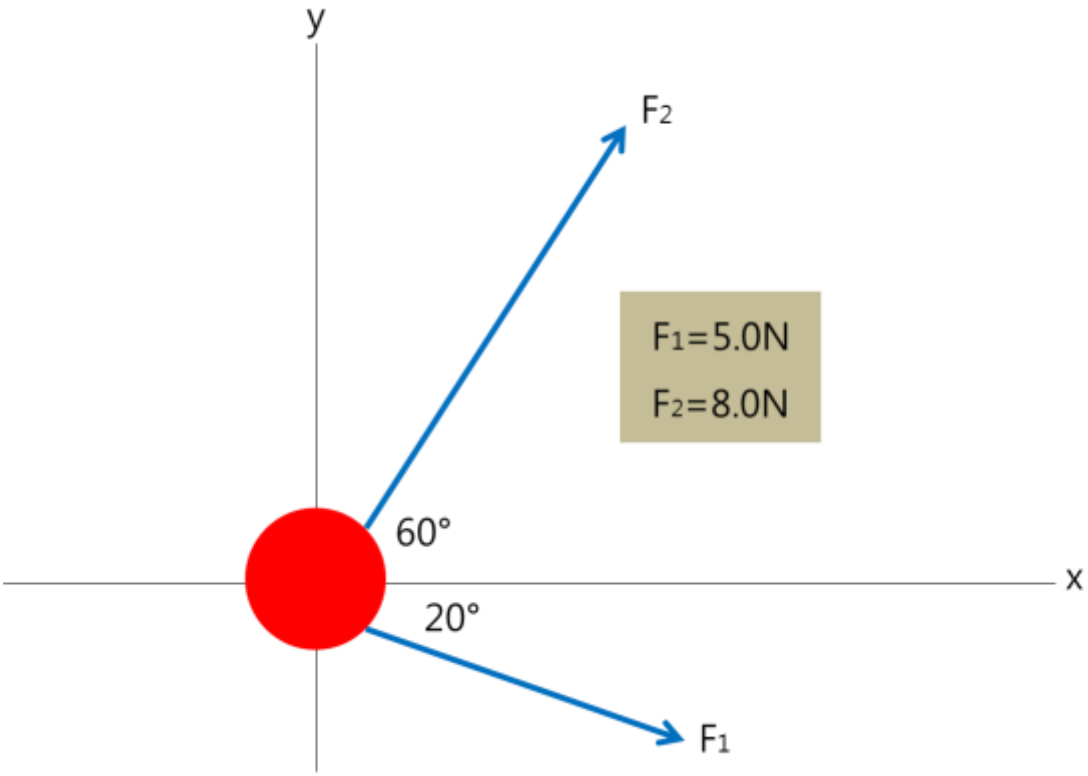
1. Based on the measured data, record and explain the magnitude of acceleration according to the force magnitude in the table below.

| Weight Mass (kg) | 0.05 | 0.10 | 0.15 |
|---|---|---|---|
| Force Magnitude (N) | | | |
| Acceleration ($m/s^2$) | | | |

2. Using the data from step 1, calculate and prove whether Newton's Second Law $F=ma$ holds true.

3. On a frictionless horizontal surface, a 2 kg object is subjected to forces of 10N and 20N in opposite directions. Describe the acceleration of the object.


4. A 0.3 kg hockey puck is sliding frictionlessly on an ice rink. At this time, two hockey sticks simultaneously hit the puck as shown in figure 5.4. $F1$ is 4.0N, and $F2$ is 8.0N. Describe the magnitude and direction of the acceleration the puck will have.




## Extended Activity

1. Conduct an experiment by changing the mass of the cart instead of the force magnitude (weight mass). Describe the changes observed