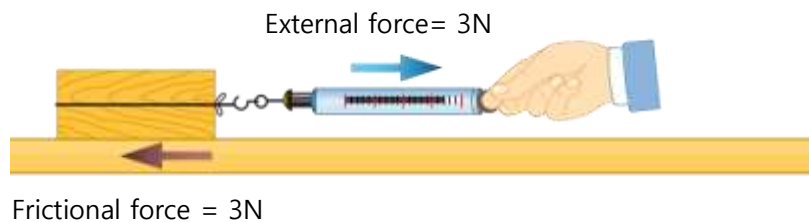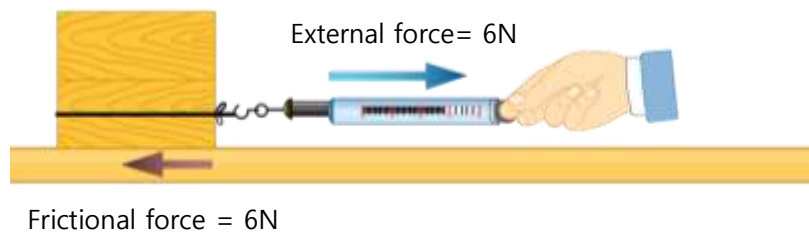# Friction

1. Compare and explain the magnitude of friction based on the weight of the object, the surface area of contact, and the roughness of the contact surface.

2. Observe changes in friction in a stationary or moving object.
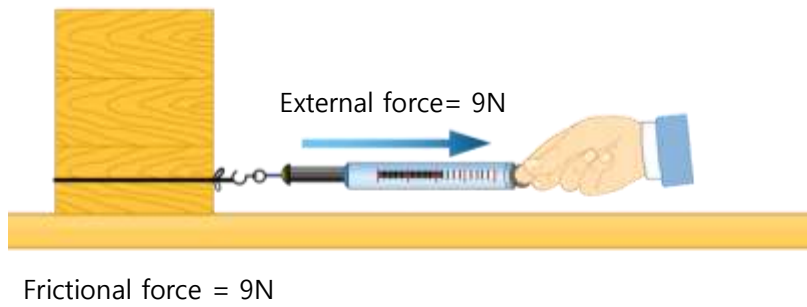
Fundamental Concept

1. **Weight of the Object and Friction**

External force= 3N

Frictional force = 3N

< Single Wooden Block>

External force= 6N

Frictional force = 6N

< Double Wooden Blocks>

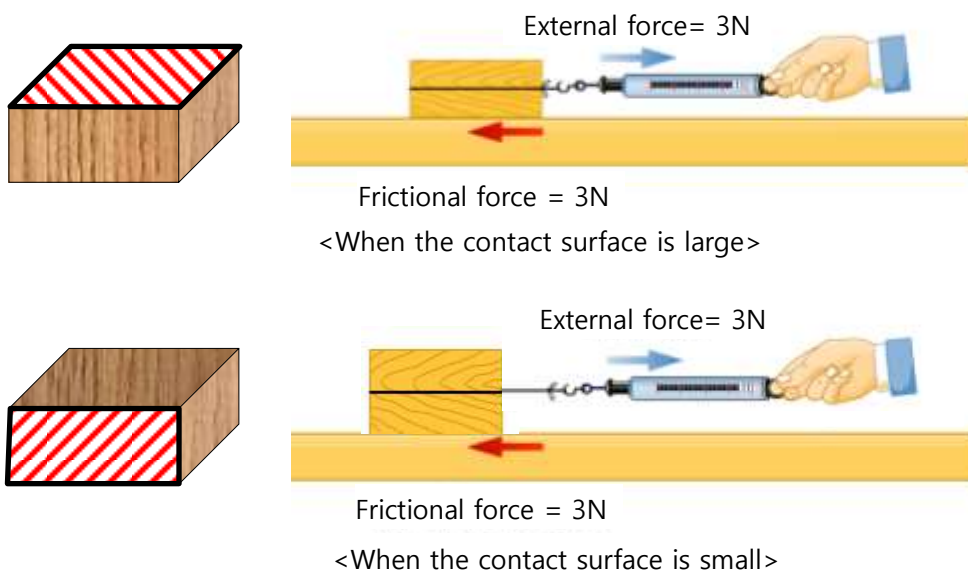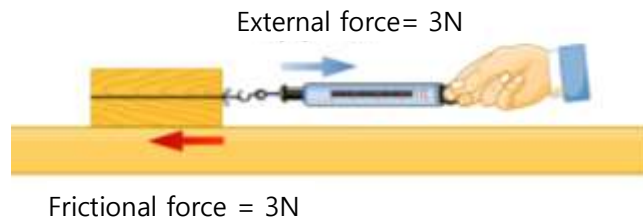External force= 9N

Frictional force = 9N

< Triple Wooden Blocks>

(1) The force required to drag an object is proportional to the weight of the object.

(2) The magnitude of friction is proportional to the weight of the object.

2. **Surface Area of Contact and Friction**

External force= 3N

Frictional force = 3N

<When the contact surface is large>

External force= 3N
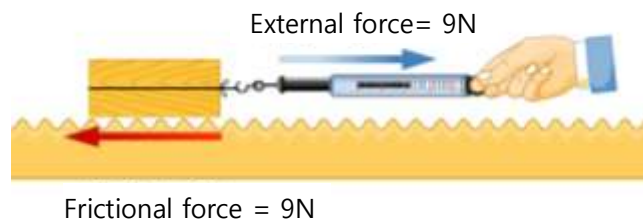
Frictional force = 3N

<When the contact surface is small>

(1) Even when dragging objects with different surface areas, the same force is required.

(2) The magnitude of friction is independent of the surface area of contact..

3. Roughness of Contact Surface and Friction

External force= 3N

Frictional force = 3N

< Smooth Surface>

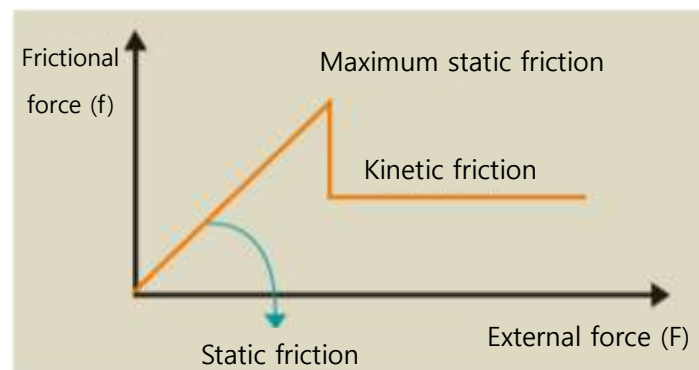External force= 9N

Frictional force = 9N

< Rough Surface>

(1) More force is required to drag an object on a rough surface.

(2) The magnitude of friction is proportional to the roughness of the contact surface..

4. Relationship Between Friction and External Force

Frictional force (f)

Maximum static friction

Kinetic friction

Static friction

External force (F)

(1) The magnitude of static friction is equal to the external force.

(2) The maximum static friction is the force just before the object starts to move and is greater than kinetic friction.

(3) Kinetic friction is the force during the movement of the object and is less than the maximum static friction..

Experiment

Materials Needed

Interface, Science# Program, force sensor, wooden blocks (3), string, scissors, sandpaper

Preparation of Experimental Apparatus

Tie a string horizontally around the wooden block and connect it to the force sensor as shown below
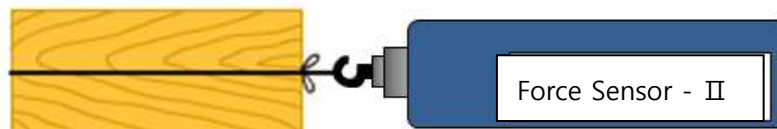
Interface Setup

1. Run the Science# program.
2. Connect the force sensor to the interface.
3. Click [O] to set the force sensor value to 0.0N for zero calibration
4. Click ⚙ to set up the experimental environment as shown below or click 🕐✓ to automatically set up.
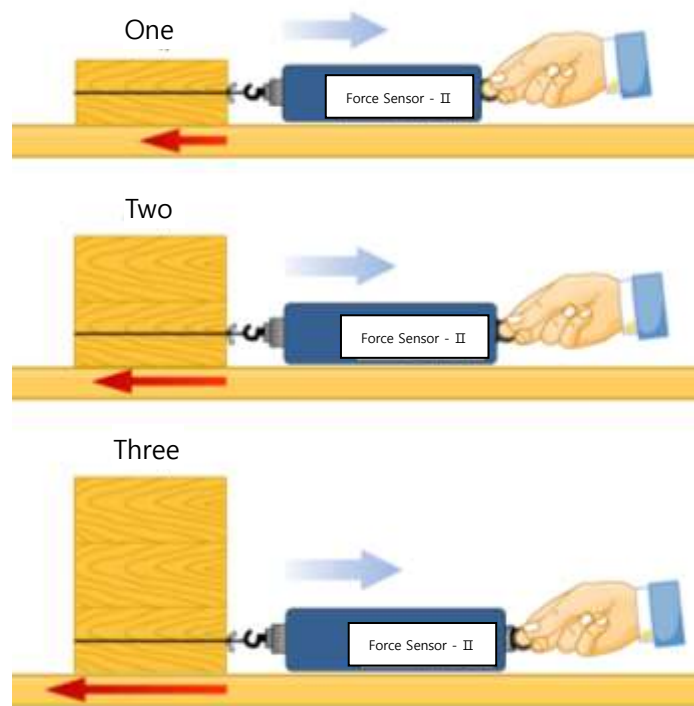
[Automatic Setup]

Data Collection

1. Click to start data collection.

2. Slowly pull the force sensor until the wooden block starts to move, then pull it at a constant speed.

   [Weight of the Object and Friction]

3. Increase the number of wooden blocks to two and then three, and measure the friction in the same way.

One

Two

Three

[Surface Area of Contact and Friction]

4. Stand the wooden block to make the contact surface narrower.

5. Connect the string to the force sensor.

6. Slowly pull the force sensor until the wooden block starts to move, then pull it at a constant speed to measure friction.

When the contact area is large

When the contact area is small
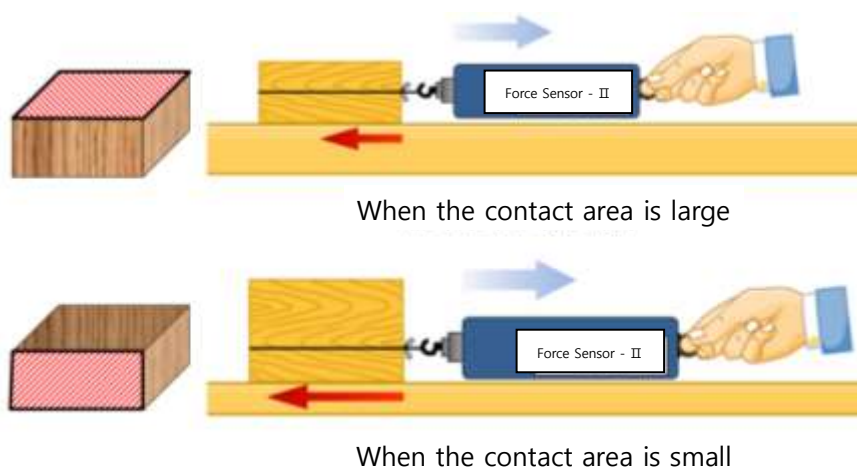
[Surface Roughness and Friction]

7. Place the wooden block on a smooth surface.

8. Slowly pull the force sensor until the wooden block starts to move, then pull it at a constant speed to measure friction.

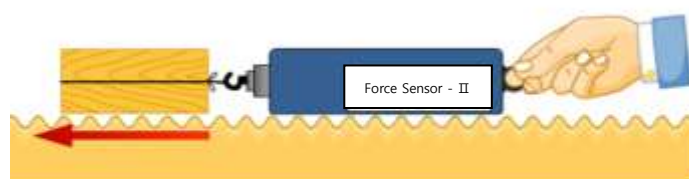9. Change the contact surface to a rough surface like sandpaper and measure friction in the same way.

Smooth contact surface

Rough contact surface

Data Analysis

Recording Data

1. The maximum static friction is the friction when the object just starts to move, and it has the highest value. Record the maximum static friction for 1, 2, and 3 wooden blocks.

Number of Wooden Blocks	1	2	3
Maximum Static Friction (N)			

2. Record the maximum static friction for the same object with different contact surface areas

Contact Surface Area	Wide	Narrow
Maximum Static Friction (N)		

3. Record the maximum static friction for different contact surfaces.

| Contact Surface Type	Sandpaper	
Friction (N)		

Data Application and Extended Activity

1. Explain the relationship between the two physical quantities based on the results obtained by varying the following conditions

Physical Quantity	Explanation
Weight – Friction	
Contact Surface Area – Friction	

Surface Roughness – Friction	

2. List the factors that affect the magnitude of friction.

3. Explain why the maximum static friction is the greatest among static friction, kinetic friction, and maximum static friction
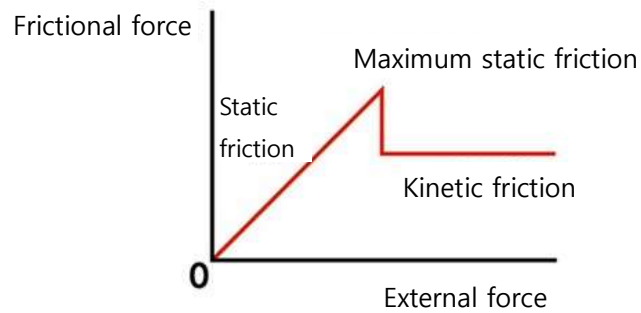
4. Provide and explain at least two examples of situations in daily life where high friction is advantageous and where low friction is advantageous

Category	High Friction Advantageous	Low Friction Advantageous
Examples		

Report

(For Teachers)

Report

(For Students)