ScienceCube

Impulse

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1. **Obtain and compare the magnitude of the impact force varying with collision time through experiments and explain it.**
2. **Understand and explain the principles and importance of protective equipment through impulse experiments.**

Fundamental Concept

1. Impulse

Impulse is a physical quantity that indicates the extent of impact a body receives.

$$I(\text{Impulse}) = F(\text{Force})\Delta t(\text{Time})$$ [Unit: N·s]

A. Impulse is proportional to the force acting on an object during the collision and the time the force acts.

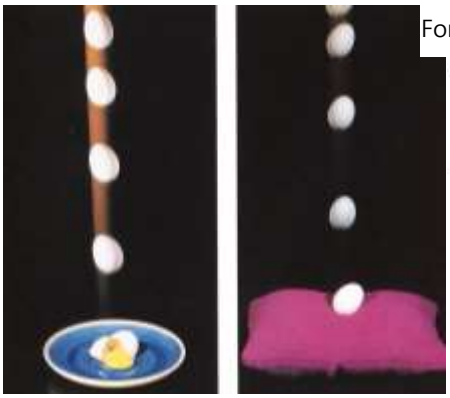
B. Magnitude of Impulse: The magnitude of impulse is calculated as the product of the magnitude of the impact force and the time it acts.

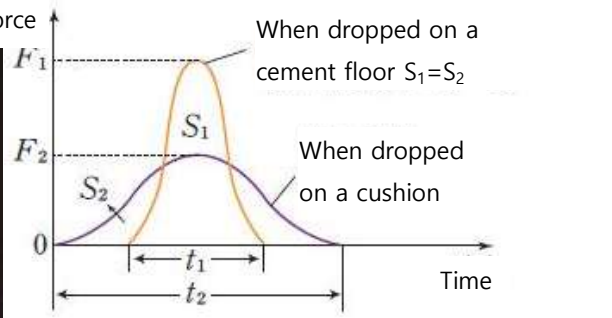
C. Direction of Impulse: The direction of impulse is the same as the direction of the force (impact force).

D. Momentum and Impulse: The change in momentum is equal to the impulse applied to the object.

2. Impulse in Daily Life

When the impulse is the same, the longer the force acts, the smaller the magnitude of the force.





Magnitude of force and time (impulse constant)

Category	When the change in momentum is the same	When the magnitude of force is the same
Feature	The longer the collision time, the smaller the force (impact force) acting on the object.	The longer the collision time, the greater the impulse (change in momentum).
Example	- Car airbags reduce the force during a collision - When catching a baseball, pulling the hand back reduces the force on the hand.	- A baseball player swings the bat fully through the hit. - The longer the cannon barrel, the farther the cannonball flies.

Experiment

Materials Needed

Interface, Science# Program, Force Sensor, Rubber Stopper (Force Sensor Accessory), Clay (8kg), Helmet, Ruler

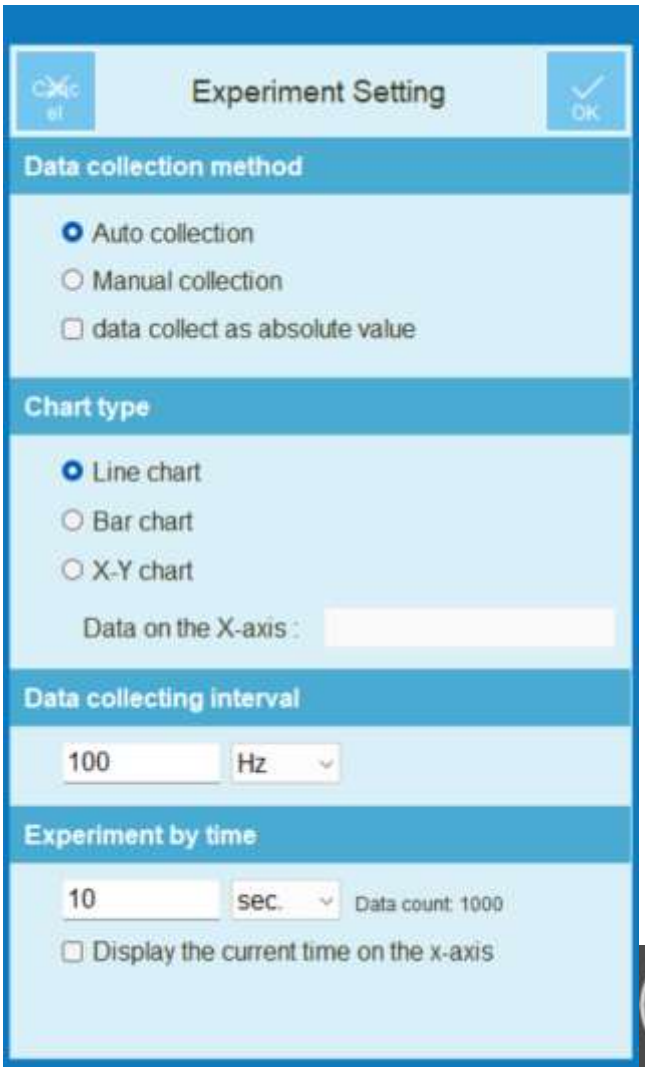
Preparation of Experimental Setup

1. Make two human face models with 4kg of clay each.
2. Carve a hole in the center of the head to fit the force sensor, then insert and remove the force sensor.
3. Create a hole on the side for the force sensor cable.
4. Let the clay dry in a cool place for about a day to harden.

5. Remove the ring from the force sensor and attach the rubber stopper.
6. Insert the force sensor into the hardened clay model and connect the cable as shown in the figure below.
7. Wear the helmet ensuring the rubber stopper on the force sensor points directly downward.

Interface Setup

1. Launch the Science# program.
2. Connect the force sensor to the interface.
3. Set up the experimental environment as shown below, or use the automatic setting option..



Automatic setup

Data Collection

1. Press to start collecting data.
2. Drop the helmet from a height of 1m with the helmet facing downwards.
3. Record the magnitude of the impact force and the state of the face model at the moment of impact.

4. Repeat the process without the helmet, dropping the face model and sensor only to collect data.

Data Analysis

Recording Data

1. Compare the graphs of the impact force at the moment of dropping the helmet from the same height with and without the helmet.

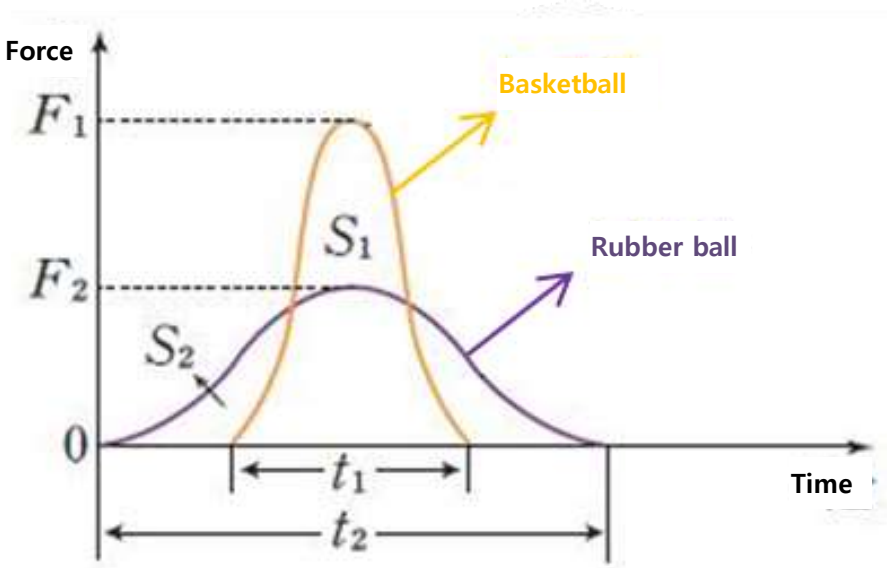
2. Take pictures and record the changes in the face model with and without the helmet.

Data Application

1. Compare and explain the impact forces with and without the helmet using the recorded data.

2. Explain the reasons for wearing a helmet from various perspectives.

3. The right figure shows the net force acting on a stationary basketball and a rubber ball when kicked over time. The basketball is heavier than the rubber ball, and the area under the two curves is the same. Select and write down the correct statements from the options below.



- Options -

① The magnitude of the impulse on both balls is the same.

② The average force per unit time on both balls is the same.

③ The net force acts on the basketball for a shorter time than on the rubber ball..

Answer:

Extension Activities

1. Measure the impact force using other protective equipment in a similar way, and within safe limits, personally experience and record the difference with and without the protective equipment.

2. Find and describe examples from daily life where the impact force is controlled by adjusting the collision time when the impulse is constant.