ScienceCube

Bungee Jumping

Create a bungee jump model, measure acceleration, and predict and explain the motion in an actual bungee jump.

Fundamental Concept

In the small island nation of Vanuatu in the South Pacific, boys over the age of ten used to demonstrate their bravery by tying elastic vines similar to bungee cords to their ankles and jumping off heights. This custom evolved into the sport of bungee jumping. Jumping from a high place accelerates the speed, providing a thrilling experience. For instance, jumping from a height of about 70 meters results in a speed of over 35 meters per second at the lowest point.

Why does the speed increase? The cause is the force of gravity. When the direction of the jump and the direction of the gravitational force are the same, the speed increases. When the bungee cord's elastic force propels the jumper upwards at the lowest point, the speed decreases because the direction of the movement and the gravitational force are opposite. At the highest point, the speed becomes zero.

Thus, in bungee jumping, the speed increases when the force direction matches the movement direction and decreases when they are opposite, resulting in thrilling acceleration motion.

State	Net Force	Magnitude of Acceleration	Direction of Acceleration
At rest	None	0g	None
↓			
Start to fall	Only gravity applied	-1g	- (Direction of gravity)
↓			
Falling while bungee cord stretches	Gravity and elastic force both applied	-1g ~ +1g	Changes from - to +
↓			
Bungee cord fully stretched	Elastic force greater than gravity	+1g or more	+ (Direction of elastic force)

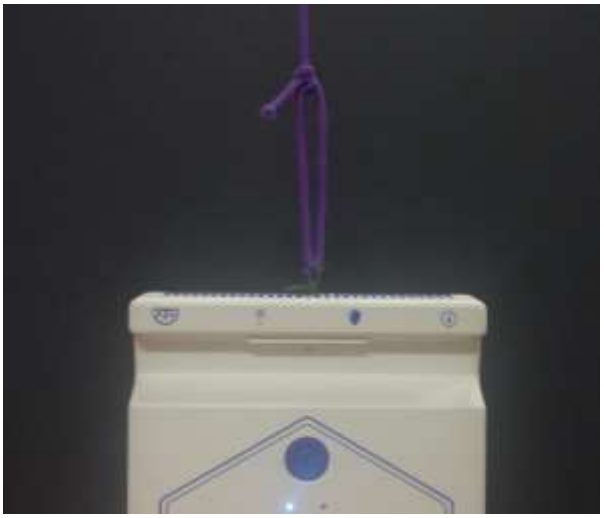
Experiment

Materials Needed

Smart sensor box, Science# program (smart device), Rubber band (at least 40 cm), Stand, Ring clamp, Doll, Floral wire, Measuring tape, Electronic scale

Experiment Preparation

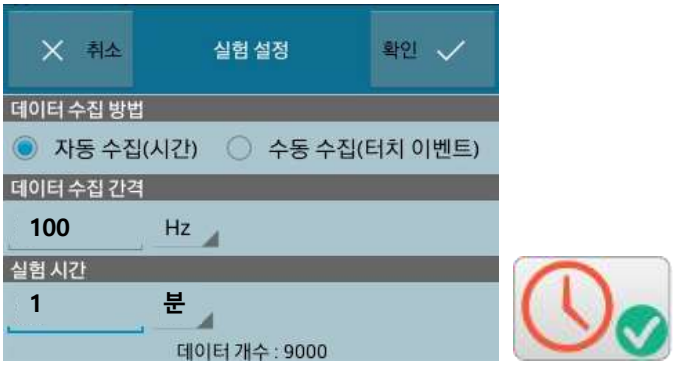
1. Measure and record the weight of the smart sensor box and the doll.
2. Align the Y-axis of the smart sensor box with the direction of gravity and create a loop with floral wire at the bottom center to hang the rubber band.



3. Attach the ring clamp to the stand and secure it to the edge of a desk.
4. Tie the rubber band to the ring clamp, ensuring its initial length is 30 cm.

Interface Setup

1.  Run the Science# program.
2. Select '3-Axis Acceleration' by pressing  .
3. Stabilize the smart sensor box and press  to zero all three axes..
4. Press  to set up the experiment environment as shown below or press  for automatic setup.



Data Collection

1. Position the smart sensor box at the height of the ring clamp.
2. Press  to start data collection
3. Release the smart sensor box after 2 seconds to simulate bungee jumping.
4. Measure the maximum stretched length of the rubber band with a measuring tape.

5. When the bungee jump motion is complete, press  to stop data collection.
6. Analyze only the Y-axis (gravity direction) acceleration data.

Data Analysis

Recording Data

1. Measure and record the weight of the smart sensor box.

Object	Smart Sensor Box	Smart Sensor Box + Doll
Weight (kg)		

2. Draw the acceleration graph (Y-axis) of the smart sensor box during the bungee jump motion.

3. Measure and record the initial and maximum stretched lengths of the rubber band.

Rubber Band State	Unstretched	Maximum Stretched	Stretched Length (x) (Maximum Stretched - Unstretched)
Length (m)			

Data Application

1. Indicate on the graph the position when the smart sensor box falls to the lowest point, noting the acceleration magnitude and direction, and explain the reason

Category	Answer	Reason
Position (seconds)		
Acceleration Magnitude (g)		
Acceleration Direction		

2. Indicate on the graph the position when the smart sensor box reaches the highest point in the first oscillation, noting the acceleration value and direction, and explain the reason.

Category	Answer	Reason
Position (seconds)		
Acceleration Magnitude (g)		
Acceleration Direction		

3. Using the same elastic coefficient from the experiment and assuming the weight and stretched length of the bungee cord are inversely proportional, predict the appropriate length of the bungee cord for a 50 kg person jumping from a height of 100 meters.