

## Spring Scales

### Question:

A diver is standing motionless at the end of a spring board and the board bends downward. If her identical twin joins her at the end of the board, how far downward will the board bend?

1. The same amount.
2. Twice as far.
3. Four times as far.

## How Much Is There?

- How can you measure quantity?
  - Number
  - Length
  - Volume
  - Weight
  - Mass

## Mass as a Measure

- Independent of measuring location
- Measured directly by acceleration
- Acceleration measurements are difficult

## Weight as a Measure

- Dependent on measuring location
  - Depends on Acceleration Due to Gravity
  - Acceleration Due to Gravity varies with location
- Exactly proportional to mass at one location
- Easier to measure than mass
- Can't be measured directly
- Measured via an equilibrium technique

## Equilibrium

- An object in equilibrium
  - experiences zero net force
  - is not accelerating
- At equilibrium,
  - individual forces balance one another perfectly
  - an object at rest remains at rest
  - an object in motion coasts

## Weighing Via Equilibrium

- Use upward support force to counter gravity
- Attain equilibrium
- Support force balances weight
- Measure the support force

## A Free Spring

- A free spring adopts a certain length
- Its ends experience zero net force
- Its ends are in equilibrium
- The spring is at its equilibrium length

## A Distorted Spring

- If you distort a spring, forces act on its ends
- These forces
  - act to restore the spring to equilibrium length
  - are called “restoring forces”
  - make the equilibrium length “stable”
  - are proportional to the distortion

## Hooke’s Law

The restoring force on the end of a spring is equal to a spring constant times the distance the spring is distorted. That force is directed opposite the distortion.

$$\text{Restoring Force} = - \text{Spring constant} \cdot \text{Distortion}$$

## A Spring Scale

- To weigh an object with a spring scale
  - Support the object with a spring
  - Allow spring to distort until equilibrium is reached
  - Measure distortion of spring
  - Use spring constant to relate distortion to force
  - Report the force

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## Spring Scales and Acceleration

- Weight measurement requires equilibrium
- Without equilibrium,
  - spring force doesn't balance weight
  - “measurement” is meaningless and inaccurate
- You must not bounce on a scale!
- Wait for the scale to settle before reading!