Spring Scales 1

Spring Scales

Spring Scales 2

Question:

- A diver stands motionless at the end of a spring board, which bends downward. If her identical twin joins her, how far downward will the board then bend?

- The same amount.
- Twice as far.
- Four times as far.

Spring Scales 3

Observations About Spring Scales

- They move when you weigh things
- They take a moment to settle down
- They weigh best when all is still
- The “zero” often drifts
- They must be positioned carefully
- They grow inaccurate with age

Spring Scales 4

How Much Is There?

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

Spring Scales 5

Mass as a Measure

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

Spring Scales 6

Weight as a Measure

- Pros:
  - Proportional to mass (at one location)
  - Easier to measure than mass
- Cons:
  - Dependent on measuring location
  - Can’t be measured directly
- Measured via an equilibrium technique

Spring Scales 7

Equilibrium

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

Spring Scales 8

Weighing Via Equilibrium

- Use an upward support force to balance an object's downward weight
- Attain equilibrium
- Measure the support force
- The object's weight is equal in magnitude to the measured support force.

Spring Scales 9

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

Spring Scales 10

A Distorted Spring

- Forces act on ends of a distorted spring
- These forces
  - act to restore the spring to equilibrium length
  - are called "restoring forces"
  - make the equilibrium length "stable"
  - are proportional to the distortion

Spring Scales 11

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.

Restoring force = – Spring constant · Distortion

Spring Scales 12

A Spring Scale

- To weigh an object with a spring scale
  - Support the object with a spring
  - Allow spring to distort to an equilibrium
  - Measure distortion of spring
  - Spring constant relates distortion to force
  - Report the force

Spring Scales 13

Question:

- A diver stands motionless at the end of a spring board, which bends downward. If her identical twin joins her, how far downward will the board then bend?

- The same amount.
- Twice as far.
- Four times as far.

Spring Scales 14

Spring Scales and Acceleration

- Weight measurement requires equilibrium
- Without equilibrium,
  - spring force doesn't balance weight
  - "measurement" is meaningless
- An accelerating object is not at equilibrium
  - You must not bounce on a scale!
  - Wait for the scale to settle before reading!

Spring Scales 15

Summary about Spring Scales

- The spring stretches during weighing
- This stretch is proportional to the weight
- The scale measures the spring's stretch
- The scale reports weight based on stretch