Internet Activities

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Forces in an Elevator
Have you ever been in a fast-moving elevator? Was the ride comfortable? How about an amusement ride that quickly moves upward or one that free-falls? What forces are acting on you during your ride? In this experiment, you will investigate the forces that affect you during vertical motion when gravity is involved with a bathroom scale. Many bathroom scales measure weight in pounds mass (lbm) or pounds force (lbf) rather than newtons. In the experiment, you will need to convert weights measured on common household bathroom scales to SI units.

Question
What one-dimensional forces act on an object that is moving in a vertical direction in relation to the ground?

- **Measure** Examine forces that act on objects that move vertically.
- **Compare and Contrast** Differentiate between actual weight and apparent weight.
- **Analyze and Conclude** Share and compare data of the acceleration of elevators.

- **Use caution when working around elevator doors.**

- **Do not interfere with normal elevator traffic.**
- **Watch that the mass on the spring scale does not fall and hit someone's feet or toes.**

Possible Materials

elevator
bathroom scale
spring scale
mass

Procedure

1. Securely attach a mass to the hook on a spring scale. Record the force of the mass in the Data Table.

2. Accelerate the mass upward, then move it upward at a constant velocity, and then slow the mass down. Record the greatest amount of force on the scale, the amount of force at constant velocity, and the lowest scale reading.

3. Get your teacher's permission and proceed to an elevator on the ground floor. Before entering the elevator, measure your weight on a bathroom scale. Record this weight in the Data Table.

4. Place the scale in the elevator. Step on the scale and record the mass at rest. Select the highest floor that the elevator goes up to. Once the elevator starts, during its upward acceleration, record the highest reading on the scale in the Data Table.

5. When the velocity of the elevator becomes constant, record the reading on the

scale and record it in the Data Table.

6. As the elevator starts to decelerate, watch for the lowest reading on the scale and record it in the Data Table.

Analyze

1. **Explain** In step 2, why did the mass appear to gain weight when being accelerated upward? Provide a mathematical equation to summarize this concept.

2. **Explain** Why did the mass appear to lose weight when being decelerated at the end of its movement during step 3? Provide a mathematical equation to summarize this concept.

3. **Measure in SI** Most bathroom scales read in pounds mass (lbm). Convert your reading in step 4 in pounds mass to kilograms. (1 kg = 2.21 lbm) (Note: skip this step if your balance measures in kilograms.)

4. **Measure in SI** Some bathroom scales read in pounds force (lbf). Convert all of the readings you made in steps 4-6 to newtons. (1 N = 0.225 lbf)

5. **Analyze** Calculate the acceleration of the elevator at the beginning of your elevator trip using the equation $F_{scale} = ma + mg$.

6. **Use Numbers** What is the deceleration of the elevator at the end of your trip?

Conclude and Apply

How can you develop an experiment to find the acceleration of an amusement park ride that either drops rapidly or climbs rapidly?

Going Further

How can a bathroom scale measure both pounds mass (lbm) and pounds force (lbf) at the same time?

Real-World Physics

Forces on pilots in high-performance jet airplanes are measured in *g*'s or *g*-force. What does it mean if a pilot is pulling 6 *g*'s in a power climb?