Weightlessness in Orbit
Lesson Notes

Learning Outcomes

- What is meant by the term *weightlessness*?
- Why do orbiting astronauts experience weightlessness?

Weightlessness - What Do You Believe?

An astronaut and a roller coaster rider (e.g., going over the crest of a hill) feel weightless. What causes weightlessness? Like many topics in Physics, a grasp of the answer is made difficult by what you already know (or mis-understand) than by what you don't know or understand. Test your pre-conceived beliefs with this short True-False belief survey:

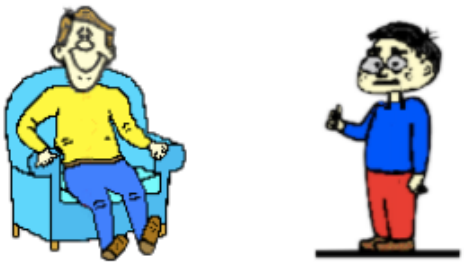
1. Astronauts on the orbiting space station are *weightless* because there is no gravity in space and they do not weigh anything.
2. Astronauts on the orbiting space station are *weightless* because space is a vacuum and there is no gravity in a vacuum.
3. Astronauts on the orbiting space station are *weightless* because space is a vacuum and there is no air resistance in a vacuum.
4. Astronauts on the orbiting space station are *weightless* because the astronauts are far from Earth's surface at a location where gravitation has a minimal effect.

Contact vs. Non-contact Forces

Contact forces: forces that result from the physical touching of two objects. Examples: normal, tension, friction, air resistance, applied.

Non-Contact forces: forces that can act over a distance and even through space in the absence of *touching*. Examples: gravity, magnetic, electrical.

Non-contact forces cannot be felt. So our sense of how much we weigh comes from our sensing of the counter-acting contact force.



F_{norm} is the contact force.
F_{grav} is the non-contact force.

The Elevator Ride

Consider the sensations experienced by an elevator rider during the various stages of a ride: at rest, constant speed, and accelerating upward and downward. The sensation of weight (F_{norm}) is constantly changing.

The rider feels less than normal weight when _____.

The rider feels more than normal weight when _____.

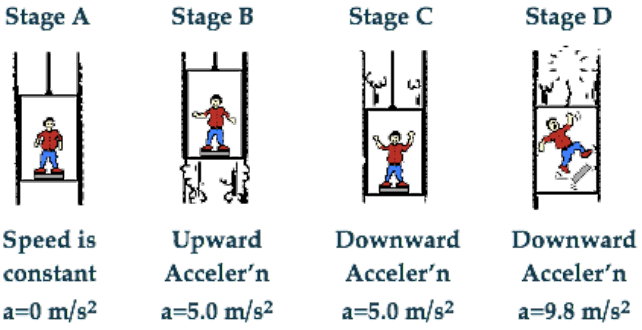
The rider feels normal weight when _____.

Scale Readings and Weight

A scale reading is a measure of the upward force applied to your body to balance your weight. The scale reading is equal to my weight when _____ and the scale reading is not equal to my weight when _____.

Elevator Ride Revisited

Show how to calculate the Fnorm on 80.0-kg Otis in each stage of the elevator ride:



Weightlessness in Orbit

- Orbiting astronauts are free-falling objects. That is, the only force on their bodies is the force of gravity.
- There are no contact forces pushing or pulling upon their body to give them any sensation of their weight.

Misconceptions Regarding Weightlessness.

Explain the error in each *mis-belief* shown below.

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