Effect of Tension on Spring Oscillation Frequency in Microgravity

Partner Experiment (Effect of Mass on Oscillation Frequency) found at:
[Effect of Mass on Oscillation Frequency in Microgravity]

Introduction

This is one of two experiments conducted on board G-Force One to determine whether mass and/or tension changes oscillation frequency of a spring-mass system.

The purpose of this experiment is to determine whether tension affects oscillation cycle of a spring system in microgravity. A common misconception among students is that, due to weightlessness, tension will not affect spring oscillation in microgravity, or that oscillation will not occur at all. This experiment will help students understand that spring force is independent of gravitational force. In fact, spring-mass systems are used on board the International Space Station to determine weight of many things, including astronauts.

Students design, build, and develop testing procedures for flight on G-Force One. The experiment is tested at 1-g in the classroom and subsequently repeated in microgravity on board G-Force One.

Students are engaged in potential and kinetic energy, forces, engineering, experimental design, and critical thinking, even before the actual flight. These projects can be modified to suit any classroom.

Target grade level- 6th -12th grade

US Next Generation Science Standards (NGSS)

PS2.A: Forces and Motion
PS3.A: Definitions of Energy
ETS1.A: Defining and Delimiting Engineering Problems
ETS1.B: Developing Possible Solutions, ETS1.C: Optimizing the Design Solution.

Objectives

- To determine if tension will affect oscillation cycle of a spring in microgravity.
- To demonstrate that spring force is distinct from gravitational force.
- To deepen student understanding of Newton's laws
- To deepen student understanding of potential and kinetic energy

Procedures

Build apparatus for use on G-Force One

- Three spring systems will be secured in a frame, with a mass secured between two springs (see photo).
- Spring system 1 and 2 will have springs with the same tension but different masses (25g and 50g).
- Spring system 2 and 3 will have springs with different tension and the same mass (50g).
- Upon weightlessness, the masses will be pulled down and released simultaneously.
- Oscillation cycle will be determined by counting the number of oscillations in a 10 second period.

Procedures (Classroom Experiment)

1. Start video camera
2. Set timer to 10 seconds
3. Pull down weight "B" to the mark and release. Start timer at same time as release.
4. Count the number of full oscillation cycles in 10 seconds. Stop movement at 10 seconds. Record number of oscillation cycles on data table below
5. Repeat with weight "C"
6. Repeat experiment 3 times.

Results- Student (1-g)

	Oscillations in 10 seconds Less tension “B”	Oscillations in 10 seconds Greater tension “C”
Rep 1 (classroom 1-g)		
Rep 2 (classroom 1-g)		
Rep 3 (classroom 1-g)		

- What force causes the mass to move?

- What is the relationship between tension of spring and oscillation cycle?

- Do you think tension of a spring would affect the oscillation cycle in a microgravity? EXPLAIN

Procedures (In-flight)

1. Start video camera
2. Set timer to 10 seconds
3. Upon weightlessness, the masses on “B” and “C” will be pulled down and released simultaneously. These systems have the same mass with different spring tension.
4. Count the number of oscillations in a 10 second period.

Procedures (Post-Flight)

1. Watch video of results.
2. Complete data form below and answer questions.

Results (Microgravity)

	Oscillations in 10 seconds Less tension “B”	Oscillations in 10 seconds Greater tension “C”
Rep 1 (microgravity)		
Rep 2 (microgravity)		
Rep 3 (microgravity)		

Conclusion

- How does tension of spring affects its oscillation cycle?
- What other factors determine oscillation frequency of a spring?
- How can spring tension and oscillation frequency be used to determine mass?
- Research, diagram, and describe a tool used in space research that works using spring tension.

Additional Resources

Article: The Complex Contraption Astronauts Use to Weight Themselves in Space

https://www.popularmechanics.com/space/a14427198/the-complex-contraption-astronauts-use-to-weigh-themselves-in-space/

Video: Weight in Space https://nerdfighteria.info/v/Zzi4EQKBbOY/

pHET Masses and Springs (Simulations)

https://phet.colorado.edu/en/simulations/masses-and-springs-basics

https://phet.colorado.edu/en/simulations/masses-and-springs

https://phet.colorado.edu/en/simulations/hookes-law