http://btc.montana.edu/olympics/physbio/default.htm

Many Winter Olympic sports are greatly dependent on technique, engineering, and/or gravity. For example, during luge, while gravity is accelerating the sled up to 80 mph down the track, the slider must use good technique to steer the sled and minimize air resistance.

To excel in these types of sports, it is helpful to have a full appreciation of physics and biomechanics. Physics is a broad field, which includes mechanics, electricity, magnetism, optics, etc., and biomechanics is the study of the mechanics of living systems.

In the module we will use the sports of luge and figure skating to teach you four basic mechanical concepts: linear kinematics, linear dynamics, projectile motion, and conservation of angular momentum.

In addition, we have developed a glossary, which defines and illustrates all the physics terminology you will need to complete this module.

Anthropometry of Figure Skating

Introduction

Anthropometry is the study of body shape and sizes. As you watch the Olympics you may notice skaters of all sorts of body builds competing; however, there are certainly some builds which are more suited for skating than others.

Additionally, due to difference in body size, strength, and power, there are a few differences in the ladies’ programs as compared to he men’s programs. With the advances in off-ice training methods; though, these differences appear to be narrowing.

Objectives

This unit on anthropometry and figure skating is to provided you with additional information which you may share with your class which may provided either a better appreciation of the sport of figure skating, or some interesting scientific facts to enhance your science classes.

Body Shape

Generally speaking, one would expect, smaller athletes with slightly shorter than average limbs to excel at figure skating, since this would allow them to obtain a smaller moment of inertia while spinning and jumping, and thus spin faster. Obviously not all figure skaters fall into this category, many other components go into making a champion skater.

Strength and power are very important for jumping and for holding tight body positions against large g-forces during spins. Many skaters are concerned with developing sufficient strength without developing muscle bulk.

Muscle bulk would tend to make the skater larger, which would mean his or her moment of inertia would increase. However, with proper weight training skates can develop strength and power without increasing muscle bulk and this problem can be eliminated.

Gender

Many of the gender differences observed in skating are actually due to body size. On average, women tend to be smaller than men, so they usually can spin faster. As you watch the Olympics, you may notice some ladies completing jumps which have very low jump heights.

They are often able to do this because they can rotate so fast in the air that they don’t need much height. Usually, though, the ladies who win the competitions not only rotate fast, but actually do have fairly high powerful jumps.

Since women tend to be smaller, they are also usually, on average, not as strong as men. Thus there a few ladies who have completed triple Axels, the hardest triple jumps, and none have yet to branch into quadruple jumps.

For these more complicated jumps, many of the ladies do not have the power or strength necessary to jump high enough to get 3.5 to 4 revolutions completed before landing, despite their fast rotation speeds. However, with improvements and more emphasis on off ice strength training both the ladies and men are rapidly improving and completing more and more complicated jumps.
Jumping and rotating: The biomechanics of skating

Projectile motion
http://btc.montana.edu/olympics/physbio/biomechanics/pm-intro.html

- Introduction
- Getting started
- Horizontal displacement
- Vertical displacement
- Parabolic shape
- Take-off velocity
- Vertical velocity
- Horizontal velocity
- Vectors
- Calculations Help page #1
- Vertical displacement Help page #2
- Horizontal displacement
- Ground reaction forces
- Review
- Think

Conservation of angular momentum
http://btc.montana.edu/olympics/physbio/biomechanics/cam-intro.html

- Introduction
- Getting started
- Generating angular momentum
- Conservation of angular momentum
- Review
- Think

Other Issues
- Environmental conditions for figure skating:
  The ice rink
  http://btc.montana.edu/olympics/physbio/biomechanics/other01.html
- Equipment for figure skating: The boot
  http://btc.montana.edu/olympics/physbio/biomechanics/other02.html
- Anthropometry of figure skating
  http://btc.montana.edu/olympics/physbio/biomechanics/other03.html

You should be familiar with the following terms prior to beginning the projectile motion and conservation of angular momentum units.

After reviewing these terms you should have enough knowledge to understand the projectile motion unit, the linear kinematics unit, and the linear dynamics unit.

Terms & Definitions

Angular Acceleration  Linear Displacement
Angular Displacement  Linear Momentum
Angular Momentum    Linear Velocity
Angular Velocity     Mass
Center of Mass       Moment of Inertia
Force               System
  ground reaction
  weight
  friction
  centripetal
Inertia
Linear Acceleration

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