Step Four: What is the Question to Answer

Write down the question you want to answer:

Hint: Keep it simple! Some ideas…

"In a figure skating jump, how does the preparation stage speed of a skater relate to the to the rotation rate in the flight and rotation stage?"

"How do different types of wax effect the performance of a skier? Does it matter if one ski has one type of wax and the other ski has another type of wax?"

"What is the best formation for luge players to travel in the luge – heaviest person in front and lightest in back OR lightest in front and heaviest in back?"

What are the conditions that change (the variables)?

Example:

"In the luge event, many things change. Size of the athletes. Type of shoes and traction. Luge. Wind and other weather conditions."

What are the conditions that are not changed (the controls)?

Example:

"Physical dimensions of the luge track."

Choose one part of the system to vary at a time:

Example:

"I'll model the luge with a toy car and use clay as the athletes. I'll model a luge track with some PVC piping. I want to know how best to load the clay on the model car to have the fastest track run."

Step Five: Creating a Hypothesis

Back to Research

Start thinking about how you can answer your own question. Educate yourself about your topic. How?

1. Look for answers on the Web, Books, Magazines, Videos or at Events.
2. Ask an athlete.
3. Ask a sports professional.
4. Ask someone at the science museum for help.

Write down what you think will happen. A hypothesis is an "educated guess".

Write this in the form of a statement. A good hypothesis:

- Is based on known information
- Is specific and brief
- Can be tested

Examples:

"A skater will spin faster when arms are being pulled in and slower when arms are extended out."

"A luge will go faster if the heaviest person is in the front and the lightest is in the back."

"A snowboard will go faster in a parabolic shape halfpipe then a circular halfpipe."

Step Six: Designing the Investigation

Define your procedure and materials

The problem is the question that the investigation will attempt to answer.

1. Make a list of what you need (Materials)
2. Write down the steps you followed (Procedure) This should be a step-by-step list that anyone could follow to duplicate your experiment. Include things like the sample size, the number of trials, control groups, "operational definitions" for how you will make measurements.
3. Write down what you found out (Results)
4. Write down what you think it all means (Conclusion)

Experiment

An experiment is a test of a cause-effect relationship. It is a test carried out in order to discover whether a theory is correct or what the results of a particular course of action would be. Based on past knowledge, you form a hypothesis, a prediction about what will occur when part of a system changes. Next you define the procedure for your experiment and a list of materials you need. You identify the independent and dependent variables. Establish a way to record your data. Then do the experiment.

Olympic examples: At the Utah Olympic Park, engineers fine-tuned the 120-meter ski jump by experimentation.

Observation

Specific behaviors, movements, or actions in nature are observed over a period of time. Gather many observations, then look for patterns.

Olympic examples: By making careful observations of skaters jumping

Step Three: Analyze the System

What are the parts of the system?

Brainstorm a list of parts, components and aspects of the event/system.

1. What are the parts of the system?
2. What equipment is used?
3. Are there any analogies to basic tools or machines?
4. Can you define a step-by-step process? (If describing the whole hockey game is too complex, just describe the steps needed to score a goal.)
5. What are the weather conditions or other variable environment conditions (such as the surface of the ice after several skaters vs after the ice has been cleaned)?
6. Can you identify any of the concepts of the physics of motion?

Focus Your Topic

A quality topic addresses these questions…

Is it innovative? Does it contribute a new idea, approach or solution to a problem?
Is it useful for solving a problem?
Is it understandable?
Can you define a procedure that other people can repeat with similar results?
Can you accomplish it with available resources?
Can you accomplish it in a reasonable amount of time?
Is it interesting to ***you***?

What are the parts of the system of the focus area?

Brainstorm list the parts of the system for your focus area. Add procedures, processes, how-to's of the system.

Example

A critical moment in the 2002 Ladies' Figure Skating is likely to be Sasha Cohen's attempt to be the first woman to land a quad in the Olympics. A Salchow jump is an edge jump, taken off from the back inside edge of one foot and landed on the back outside edge of the opposite foot. It was created by Ulrich Salchow.

There are 5 steps to a jump:

1. The Preparation (important factors: back upright, head high, arms extended)
2. The Take-Off (use toe pick)
3. The Flight and Rotation (body positioned to spin rapidly)
4. The Landing (on one foot on the backward outside edge)
5. The Exit (hold on outside edge as long as possible to show control)

Step Two: Research Olympics Event or Topic

Find out about that sport…

1. Read about it on the Web, Books, and Magazines.
2. Go to a sports event or watch one on TV.
3. Talk to athletes.
4. Talk to sports professionals (coaches, equipment manufacturers,…).
5. Take a class to learn the sport.

Places: School, Library, Home, Science Museum, Sports Event, Sport Equipment Store
People: Teachers, Librarians, Family, Friends, Science Museum Explainers, Athletes, Sports Doctors, and Equipment Storekeepers
Literature: Science Books, Sports Books, Newspapers, Magazines, Web Sites

Answer questions like…

1. What is the history of the sport? (How it got started, history in the Olympics, famous athletes of that sport, etc.)
2. Who are some of the top athletes?
3. What equipment is necessary to perform the sport?
4. How do the athletes learn the sport?
5. How do the athletes train for competition?
6. What science is currently done, for example, aerodynamic modeling of ski jumps?
7. What are the rules for that event in the Olympics?
8. Create a glossary of terms
9. When will this event be broadcast?

Sources

http://www.saltlake2002.com – when the event takes place, venue, cost of tickets, rules of the games
http://www.cbc.ca/olympics/schedules/tv-schedule/feb09 – when the event is televised
Three Main Time Blocks for Broadcasting Events on CBS:
Olympic Morning (MacLean) On Sundays Only
Olympic Daytime (MacLean or Williams)
Olympic Prime Time (Williams)
Olympic Late Night (Leibel)

Model

A model is a simplified version of something complex used, for example, to analyze and solve problems or make predictions. It can be a physical model built to scale, or it can be purely mathematical.

Olympic examples: Professor Helge Norstrud created an aerodynamic computer analysis of a ski jumper using the V style and works with the Norwegian Ski Association and the

Invention

An invention is a process or device that someone has created. It can be something never seen before or an improvement on an existing process or device.

Olympic examples: The “Fosbury Flop” is a new way of performing a high jump. The slapstick is a new speed skate blade.

Collection

An collection is a set of objects collected for their interest, value, or beauty. For scientific study, collecting objects involves describing them then grouping them or classifying them, and identifying them.

Making Measurements from Video

Distance: Can find metrics within images to use as a “yardstick”. For example, the skater’s skate blade, the distance between the skater’s shoulders, or the height of the rink wall.

Rate is distance traveled divided by travel time. For video, check the frame rate (number of frames per second). Use this rate to determine the number of seconds between to video frames.

Step Seven: Conducting the Investigation

Create log books for record keeping. Include…

- Date and time for each entry.
- Your data – the measurements and observations.
- Notes and Comments.

Gather data by…

- Following the procedure you created in Step 6.
- Make and record your measurements.
- You may find that you need to modify your procedure. Be sure to take careful notes in your log book.
- You may results that are different from what you were expecting. Sometimes there will be no measurable change. “No change” is a valid result.

Create Tables and Logs to Record Your Data. Example:

Weight of front clay	Weight of clay in back	Time (seconds) of luge run
1 oz	1 oz	
2 oz	1 oz	
3 oz	1 oz	

Step Eight: Results and Conclusions

Organizing, Analyzing, Graphing, and Visualizing Data

From the data you recorded, what calculations can you make?

Front Weight	Back Weight	Time (sec) of luge run	Average Speed (meters/second)
1 oz	1 oz		
2 oz	1 oz		
3 oz	1 oz		

Write down your conclusion.

Your results presented what happened during your investigation: what you measured, what your measurement values were. The conclusion is your analysis of these results. In the conclusion, you

- Discuss what you learned during your testing and analysis of results
- Return to your original hypothesis and decide if it is true, false, or inconclusive (can’t be determined) based on your testing.
- Discuss possible future investigations.

Alpine Skiing
Downhill
Combined: Downhill and Slalom
Super-G
Slalom
Giant Slalom

Cross-Country Skiing
Women’s 15 km Freestyle
Men’s 30 km Freestyle
Women’s 10 km Classical
Men’s 15 km Classical
Women’s Combined Pursuit: 5 km Classical
Women’s Combined Pursuit: 5 km Freestyle
Men’s Combined Pursuit: 10 km Classical
Men’s Combined Pursuit: 10 km Freestyle
Women’s 4x 5km Relay
Men’s 4x 5km Relay
Women’s 1.5 km Sprint
Men’s 1.5 km Sprint
Women’s 30 km Classical
Men’s 50 km Classical

Short Track Long Track Speed Skating
Ladies’ 500 Meters
Ladies’ 1000 Meters
Ladies’ 1500 Meters
Ladies’ 3000 Meters
Ladies’ 5000 Meters
Ladies’ 3000 Meter Relay
Men’s 500 Meters
Men’s 1000 Meters
Men’s 1500 Meters
Men’s 5000 Meters
Men’s 10,000 Meters
Men’s 5000 Meter Relay

Biatholon
Men’s 20 km Individual
Women’s 15 km Individual
Men’s 10 km Sprint
Women’s 7.5 km Sprint
Men’s 12.5 km Pursuit
Women’s 10 km Pursuit
Men’s 4x7.5 km Relay
Women’s 4x 7.5 km Relay

Nordic Combined
Individual: K90
Individual: 15 km
Team: K90
Team: 4x 5 km Relay
Sprint: K120
Sprint: 7.5 km

Luge
Men’s Singles
Women’s Singles
Doubles

Freestyle Skiing
Women’s Moguls
Men’s Moguls
Women’s Aerials
Men’s Aerials

Figure Skating
Men’s Figure Skating
Ladies’ Figure Skating
Pairs
Dance

Ice Hockey
Men’s
Women’s

Skeleton
Men’s
Women’s

Snowboarding
Halfpipe
Parallel Giant Slalom

Ski Jumping
Individual K90
Individual K120
Team K120

Bobsleigh
Two-Man
Two-Woman
Four-Man

Curling
Men’s
Women’s

Step One: Select Your Olympics Event or Topic

The first task is to select a sporting event or topic that you would like to research. How do we do this? First, brainstorm a list of possible topics or events of the Olympics. Then, chose the event that interests ***you***. Possible steps:

1. Brainstorm a list of ideas.
2. Look over the list and pick something you want to learn more about.
3. Narrow your idea to one question that you want to answer.
4. Your question will be the basis of your project.

For the 2002 Winter Olympics in Salt Lake City, Utah, this is a list of the events and topics that might be of interest:

Weather Forecasting

Emergency Management and Planning

Security

Sports Equipment

Sports Medicine

Drug Testing

Advertising

Logistics

Sports Photography

Skills Used In Science

Observing
Communicating
Estimating
Measuring
Collecting and Recording Data
Classifying Data
Inferring

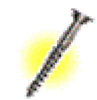
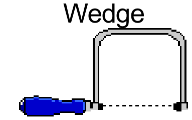
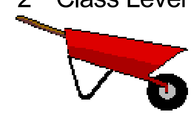
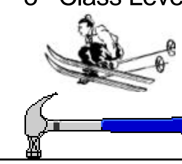
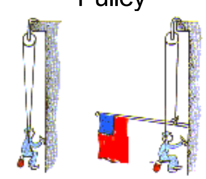
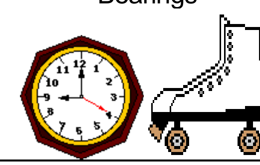
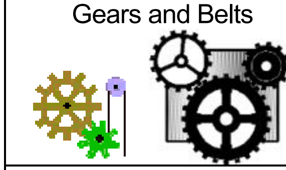
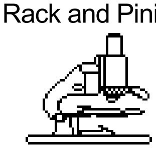
Predicting
Making Models
Interpreting Data
Comparing and Contrasting
Questioning
Hypothesizing
Making Graphs
Controlling Variables

Designing Experiments
Defining Operationally
Investigating
Using Numbers
Using Equipment
Using Research
Inventing

Simple Machines

Sometimes, identifying an analogous simple machine is a good way to begin the design of a model or experiment and to research the mechanics of motion.

http://sln.fi.edu/qa97/spotlight3/spotlight3.html

Inclined Plane 	Screw 	Wedge 
1st Class Lever 	2nd Class Lever 	3rd Class Lever 
Pendulum 	Pulley 	Wheel and Axle, Bearings 
Gears and Belts 	Rack and Pinion 	Cams and Cranks
Spring	Gyroscope	Friction

Related Concepts of the Mechanics of Motion

Linear Motion

Mass vs. Weight
Displacement or Distance
Speed
Velocity
Direction
Acceleration
Pendulum Motion or Oscillations or Spring Forces
Projectile Motion – Kinematics and Rotational Kinematics
Acceleration due to gravity
Gravity
Center of Mass, Center of Gravity
Gravitational Potential Energy
Kinetic Energy
Force
Contact Friction
Inertia
Stability
Conservation of Energy
Collisions

Newton's Laws of Motion

A body in motion stays in its state of rest or uniform motion unless an external force is applied. (If no net force acts on a body, its acceleration is zero.)

Force is the product of mass and acceleration.

For every action there is an equal and opposite reaction.

Weather

Wind
Air Density (altitude above sea level)
Clouds, Fog, Humidity
Temperature
Precipitation
Sun

One Way To Explore The Olympics

Although scientific study is more involved that the mythical "scientific method", a generic set of steps can be used as an outline for investigating. Here is a recipe for exploring the science of the Olympics:

1. **Select Your Olympics Event or Topic of Interest**
2. **Research Olympics Event or Topic of Interest**
3. **Analyze the System**
4. **Decide What Question You Want To Answer**
5. **Creating a Hypothesis**
6. **Designing the Investigation**
7. **Conducting the Investigation**
8. **Results and Conclusions**



Why Study The Science Of Olympics?

Science is the study of the physical world by using systematic observation and experiment. It is a search for answers. When investigating the nature of how things move, scientist often consider minimums and maximums that define the limitations and boundaries that might be experienced.

The Olympics is a natural beginning point for science investigations because it about superlatives of human performance. The Olympics venues are physics laboratories on a grand scale. The athletes compete to find out who is the fastest, who can jump the highest, who has the most twists, turns or spins and who is the strongest.

Sports Careers

Sports is big business, and while the athletes hold the most prominent and glamorous roles, they are not the only "players." Many sports related careers require some knowledge of science:

skating choreographer
costume design
trainer
coach
manager
sports photographer
sports analyst
equipment designer / manufacturer
arena maintenance and management
weatherman
sports journalist
biographer
fundraising event coordinator
sports doctor
fitness expert
ski resort operator

Mechanics

Simple Machines
Work is the product of the force applied and the distance moved.

Motion of Rotation

Angle - a figure formed by two lines diverging from a common point or two planes diverging from a common line.
Angular Measurements
Rate of Rotation
Angular acceleration is a measure of the change in angular velocity over time.
Moment of inertia, also called rotational inertia, is a measure of an object's resistance to rotation.
Angular Momentum – tendency of a spinning body to keep spinning
Conservation of Angular Momentum
Centrifugal Force (fictitious force)
Centripetal Force (center seeking)
Torque
Resonance

Motion of Contact

Friction
Atmospheric Drag

Aerodynamic Forces

Air Pressure
Aerodynamic Lift
Drag
Projectile Motion and Airfoils

Properties of Objects

Vibration
Sweet spot
Wave
Ice Surface Properties / Conditions
Contact surface properties (wax, smoothness, sharpening blades)
Coefficient of friction

Science Museum Connections

1. In the lobby, the penny race shortest path is not the fastest path. How is this like the luge? Does a luge take the shortest path down the track or does it travel faster by rising up a bank.

2. How is the underwater acoustics related to hearing and balance processes?

3. How is the potential well (the marble run) related to a figure skater spinning? Doe the ball orbit faster when the radius is smaller? Is this because of the conservation of angular momentum? Can a comparison be made to the water vortex?

4. The ball launch catapults balls into a free flight. How is that similar to the path of an acrobatic ski jumper?

5. Ping pong balls can balance above a blow dryer. How is this like the motion of a ski jumper?

6. How is the ball run like a bobsled race? When the ball is projected up to bounce off the angled trampoline, is that similar to motions of a snowboarder?

7. The cutaway room shows the interior walls of the science museum. Pockets of air and insulation help maintain the temperature inside the building as the weather outdoors changes. What kind of special clothing do athletes need outdoors to maintain their body temperature?

8. The Newton's cradle demonstrates the conservation of linear momentum. How is that shown in the sport of curling or ice hockey? If you ever have the opportunity, try experimenting with a dry ice puck – the puck can be made to move over a smooth horizontal surface floating on a layer of CO2 gas and nearly frictionless!

9. The tuning forks can be used to make waves in a dish of water. Compare those waves to the terrain of the mogul run.

10. Take a look at the sands from around the world. The Jamaican bobsled team actually practices on sand, because there is no snow in Jamaica! How do they do that? Do you think there is as much variance in snow around the world as there is in sand? Why or why not?

How To Do Science Projects

Inspired By The Winter Olympics

A Presentation At the
Acton Science Museum

February 9, 2002

Written By Meg Noah