The Physics of Sport

Background

A 2 inch × 4 inch board (5 cm × 10 cm) and some roller-skate wheels started a phenomenon that is now a bona fide sport, the extreme sport of skateboarding. There is a lot of good physics behind both a good board and a good boarder. The move pictured, called an "ollie" after Alan "Ollie" Gelfand, was invented in the late 1970s. The board seems to stick to the rider's feet, but, in actuality, the rider and the board jump up by pressing down and then controlling specific rotational characteristics of the board.

Remarkable physics lies behind both the equipment and the tricks involved in skateboarding. The "ollie" pictured is a basic boarding manoeuver.

Boarding popularity slumped in the early 1970s, but with the advent of urethane wheels, boarders gained control, coupled with speed, and they have never looked back. Wheels need to cushion the ride, stick to the pavement enough to steer (but not so much as to stop a forced slide), and also allow the rider to move quickly without losing energy. Most wheels deform, or flatten, where they come into contact with the ground. The wheel must push back against the ground quickly, removing the flat spot before losing contact with the ground. If not, the energy that went into deforming the wheel will be "lost" and speed is compromised. A logical question then comes to mind. Why not make the wheel rigid, so it does not flatten? In this case, the pavement would be forced to flatten and then even more energy would be lost — as elastic potential energy transferred to the pavement. Manufacturers are often faced with these questions in designing new equipment.

Pre-lab Focus

In this project, you will systematically analyze sporting equipment of your choice (for example, a hockey helmet, roller blades, a snowboard, etc.) by using the physics knowledge that you have just learned. In Chapter 6, you learned that work is the transfer of energy from one system to another, or from one form to another. You also noted that energy is *always* conserved: it may transfer from one object to another, or from one form to another, but the total energy in the universe remains constant. Power was defined as the rate at which work is done. Understanding these and other concepts will allow you to examine the physics of sports and sports equipment.

Materials

- Collect newspaper, magazine, and Internet articles on sports and sports equipment that are of interest to you. Attempt to gather information that will assist you in analyzing the physics concepts that make the sport possible.
- Review the materials as you collect them. You will need to decide on a theme, such as Safety, Durability, Sport-Specific "How'd They Do That," etc. Begin to focus your search for materials based on the theme you choose. Availability of resources may restrict your final choice, so be sure to collect enough materials to ensure success before locking yourself into any one specific theme.

Initiate a Plan

A. Working with a partner, develop an investigation plan that will allow you to study, through research and experimentation, your selected sport or sporting equipment based on the energy, work, and power concepts that you have studied. Limit the equipment to be studied. Attempt to take one piece of sporting equipment through several rigorous tests, covering as much energy, work, and power content as possible, rather than testing several items in different areas.

B. Design a flowchart depicting the components of your plan (research, laboratory, presentation) and include tentative completion dates. Attempt to predict special needs (equipment, time, supervision) so that once the project is underway, you will not be sidetracked with unforeseen issues. Check with your teacher to ensure that your plan is appropriate for the allotted time.

C. Decide how the final information will be presented. You may work as a class, making decisions about how the final information needs to be presented and what the evaluation scheme will look like. For instance, you may decide as a class that you are each going to promote your selected sports equipment in a pamphlet or on an Internet site. Each promotion may be required to highlight the physics involved, the specific characteristics (safety, elasticity, durability), and the specific selling features. You may work as a class to build the assessment rubric together, ensuring that the criteria for the finished product are explicit and clear. Information presentation possibilities include a technical report; poster presentation; pamphlet or newsletter; multimedia presentation; and web site.

Laboratory Testing

1. Use your plan to develop a suitable laboratory procedure, with equipment that is available to you, to systematically investigate specific characteristics of your selected sport or equipment.
2. Work with your teacher during this phase to ensure safety issues are not overlooked.

Investigation Checklist

As your investigation proceeds, pay attention to the following checklist.

(a) Have you stated the purpose of the experiment (the question you want answered)?

(b) Have you written your hypothesis about what you expect the answer to be?

(c) Have you collected enough information from a variety of sources to design the experiment?

(d) Have you made a complete list of all the materials you will need?

(e) Have you identified the manipulated and controlled variables?

(f) Have you written a step-by–step procedure?

(g) Have you critically analyzed your procedure for possible errors or improvements?

(h) Have you repeated your experiment several times? Were the results similar each time?

Analysis

Discuss your experimental results. Was your hypothesis shown to be correct? Have you evaluated the experimental errors?

Assessing Your Experimental Design

List the successes and difficulties of your investigation. If you were to do it again, what changes would you make?