Spinning Your Wheels

INTRODUCTION:

Have you ever had to replace the wheels on your roller blades? There are several types of wheels available. There are 2 different numbers that you must select. One number is for the diameter and the other indicates the hardness of the wheel. Why are some roller blade wheels harder than others? What about bicycle tires? Some bikes have smooth, narrow tires; some have wide, knobby tires. Why are there different types of tires for bicycles?

Have you ever been skateboarding in the rain? It is probably not a safe thing to do. What about riding your bike on loose gravel? Can you roller blade on ice? How does the surface affect your experience?

Decisions about roller blade wheels, bike tires, and skateboarding in the rain are all based on patterns. Strategies are used by experts in roller blading, bike riding, and skateboarding to discover patterns. They apply these patterns when they design new tires and make suggestions for their use.

You are now a mousetrap car expert working on tire designs. If you follow strategies to discover patterns and apply your findings correctly you will be amazed how fast and far a mousetrap car can go.

ACTIVITY OBJECTIVE:

Upon completion of this learning cycle, you will be able to:

1. Explain how road conditions affect traction.
2. Describe various tire designs.
3. Explore how friction occurs differently on different surfaces.

EXPLORING I:

If we didn't have forces that acted and reacted to other forces in the world, the results would be disastrous. Balanced forces and unbalanced forces are important to cause motion, continue motion, and stop motion. For instance, consider what rubbing as a force does to objects. What is the effect of rubbing? When and where can you see rubbing occurring on the mousetrap car itself?

Now consider how the way the car travels can be affected by other conditions. How would conditions affect the forces acting on the car? The road surface is always carefully considered by engineers who design vehicles. This is especially important with tires. You have probably seen advertisements for tires that provide excellent traction on wet or icy roads. These tires are designed to increase friction between the tire and the road regardless of rain and ice. In some situations, like

bicycles and electric cars, it is necessary to reduce friction so the vehicle performs well with limited power. Tires can be designed to do this also.

1. Consider the way the car moves. Run the car again. Look for places that rub on the car. List a few ideas.

    - Is there anything on your vehicle that rubs together?
    - What can this rubbing do to the motion of your vehicle?
    - What vehicle design features help reduce the amount of rubbing between the wheels and the axle and frame of the vehicle?
    - How does rubbing influence your vehicle's motion?
    - How did you get the car to move?

2. As a group, decide to try a few of your ideas. Consider these questions.
    - How could you make the car run smoother?
    - What car features or other features of the setting of the car affect the performance of the car?

3. Consider the other variables in running a mousetrap car that could create rubbing or friction. Where would this occur? How could this affect the performance of the car?
4. Write a question that you would like to have answered concerning car performance on different materials.
5. Select different materials to test. Some options from your teacher are aluminum foil, waxed paper, tabletops of various materials, tiled floors, carpet, notebook paper, or fabric.
6. What do you already know about rubbing at this point? What is rubbing? What does it do? How is it helpful? How is it harmful?
7. Set up an experiment to test rubbing with these materials. Your purpose is part of your experiment choice and design.
8. Make some predictions about what you think might happen when you test friction.
9. Your predictions will be dependent on your experiment, the purpose, the question, and the method.
10. One suggested method for using the mousetrap car to measure friction follows. To set up the mousetrap car, attach the looped end of the string to the hub. Tie the other end of the string to the spring scale. Wrap the extra string around the hub. The spring scale hangs from the apparatus that was used for Exploring I of "Big Wheels Keep on Turnin'". Adjust the stand to keep the scale vertical.
11. To get a reading from the scale the car should be pushed slowly backwards until the wheels skid. Does it matter where you push on the car?
12. Consider the variables you want to test. What variables will you

control?

13. You may have other ideas about how to measure the friction. What other parts could you change in your investigation to test friction in a different way? How will you know that your methods are sound and that the information is accurate?
14. Organize your data. Look for patterns and write a conclusion.

Share your conclusions with the class.

GETTING THE IDEA I:

1. How are patterns seen in your data?
2. How effective were your methods of collecting and recording data?
3. How would deceleration or slowing down of the car after acceleration involve rubbing?
4. How does your mousetrap car's motion influenced by rubbing?
5. What mousetrap car design features increase the friction between the floor or the work surface and the wheels?
6. How is friction helpful?
7. How does coasting and stopping involve friction?
8. How is the performance of your car affected by friction?
9. How did your previous ideas about friction mix and match with what you learned from the investigation?
10. What generalizations to real life does this investigation hold for you?
11. How do conclusions lead into generalizations? How can generalizations be helpful in science?

APPLYING THE IDEA:

From the activities that you have completed, you have learned about the power supplied by the mousetrap and friction. It is time to apply these patterns as you change the wheels for various surfaces.

1. One of the following challenges should be selected by your team:
    a. Design, build, and test a rear tire design that will not spin on ice. The largest hub and the shortest arm length possible must be used. Weight cannot be added to the vehicle.
    b. Design, build, and test a rear tire design that will allow the car to move the greatest distance on carpet. The smallest hub and the longest arm length possible must be used.

    Design, build, and test a rear tire design that will allow the mousetrap car to travel over loose, dry sand. Any hub and arm length can be used.
2. Use the DAPIC process to solve the design problem. The following questions may be helpful.
    a. Define-
        i. What problem are you trying to solve?
        ii. What are the characteristics of the road surface?

iii. Where could you get information on tires designed for this type of surface?
iv. What ideas have you seen that may work here?
v. What design criteria are given?
vi. What performance will be considered a success?

b. Assess-

i. What ideas are most likely to work? Why?
ii. What data do you have to help make design decisions?
iii. What additional data is needed?
iv. What performance will be considered a success?
v. How will performance be measured accurately?

c. Plan-

i. What is going to be built?
ii. What materials are needed?
iii. Where will the materials be obtained?
iv. Who will build what?
v. What tools will be needed?

d. Implement-

i. How did your car turn out?
ii. What changes are necessary to your design?

e. Communicate-

i. How can you communicate your ideas to the others on your team?
ii. What would be the most effective method for communicating your ideas to your classmates?

3. Demonstrate your design to the class and explain how it works.

EXPANDING THE IDEA:

- How do roller blade wheels differ? Which type of wheel works best for indoor skating or outdoor skating?
- Compare shoe soles for friction on different types of floors. What activities require shoes with lots of friction and what activities require shoes that slide easily?
- What is the advantage of anti-lock brakes on automobiles?
- How are drag racing tires different than tires for oval track racing?
- Read the Making Connections information immediately following this learning cycle.

CAREER CONNECTIONS:

Tire sales person
Pit crew chief
Truck driver
Civil engineer (road design and construction)
Astronau

Cyclist