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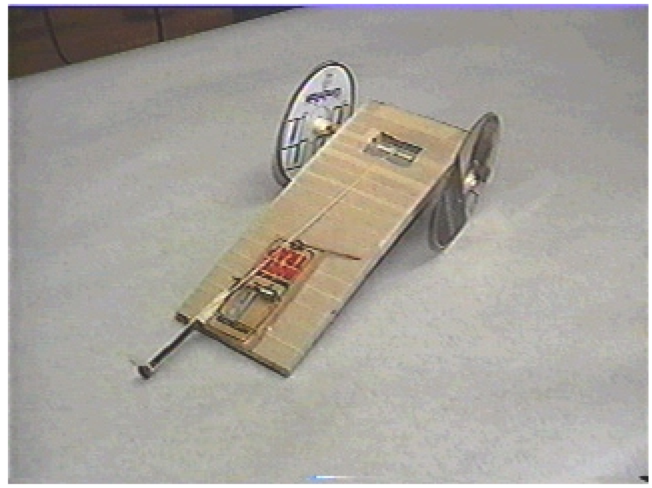

Mousetrap Cars – Student Worksheets

Class and Period: ___________________________________ Date: _____________

List Students in Group:

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Materials you will need: ˆ Mousetrap car parts including: a conventional mousetrap; nylon fish line (6-10 pound test); wire coat hanger or 1/8" wire rod (15" length); ¼" x 2" x 24" basswood; ¼" dowels or ¼" metal rod; 1/8" dowels or 1/8" metal rod; a variety of wheels of different diameters (1" to 8"- CDs can be used); 1/8" ID rubber faucet washers; ¼" ID rubber faucet washers; 1/8" and ¼" metal washers; OR, ˆ a mousetrap car kit such as can be acquired from Kelvin Electronics or The Science Source. Hot glue gun and glue sticks; safety goggles. Straws

State what the design challenge is:

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1. Clarify the design specifications and constraints. (What are the specifications and constraints the design must meet?)

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2. Research and Investigate

In order to better complete the design challenge, you need to first gather information to help you build a knowledge base.

Knowledge and Skill Builder 1: Factors that affect the performance of the mouse trap car.
Try out your mousetrap car model. Measure how far it travels. The mousetrap car is a system with several subsystems. Can you list several of these subsystems?

Subsystem 1:

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How can you improve this subsystem?

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Subsystem 2: ____________________________

How can you improve this subsystem?

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Subsystem 3: ____________________________

How can you improve this subsystem?

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Now that you have thought about improvements to each of the subsystems, can you list some of the factors that affect the distance the mouse trap car can travel? Please list those factors.

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Knowledge and Skill Builder 2: The Relationship between force, speed, and distance traveled.

Where would you attach the string on the extension rod to make the car go **further** - toward the top, or toward the bottom of the rod? Where would you attach the string on the extension rod to make the car go **faster** - toward the top, or toward the bottom of the rod? With your hand, try pulling the rod from the very tip. Then try pulling it from a point toward the bottom (near the spring). Does the rod exert more force at the tip or at the bottom?

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Attach the string to the top of the rod and wind it around the axle. Measure the distance the car travels and observe its speed. What have you measured and observed?

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Now change the place the string is attached to the rod. Attach the string toward the bottom, near the spring, and wind the string around the axle. Measure the distance the car travels and observe its speed. What have you measured and observed?

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Which position results in a car that travels further?

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Which position results in a car that travels faster?

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What can you conclude about the relationship between the force pulling on the axle and the distance the car travels?

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Knowledge and Skill Builder 3: Friction.

Do research in the library or on the Internet. The research question is: What is rolling friction? Summarize your research below.

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Without friction, the wheels will spin. If there is too much friction, the car won’t move. Experiment with changing friction between moving parts. For example, change the friction between the axles and the bearings that hold them. You might want to try to slide straws over the axles to serve as bushings. You might want to use washers; you might also like to try wheels that have bearings inside them. Write down the results of your investigations.

Change the friction of the wheels against the surface they roll on. You might want to put rubber bands around the wheel. Another interesting experiment is to cut up a small balloon and stretch it over the wheel. What does the rubber do to the friction between the wheel and the surface? Write down the results of your investigations.

Knowledge and Skill Builder 4: Size of the wheels.

Take four wheels with different diameters. Make a mark with a pencil on the rim of each wheel. Then roll each wheel along a table and measure the distance the wheel travels in one revolution. Determine the relationship (the ratio) between the distance the wheel travels in one revolution and the diameter of the wheel. To do that, divide the distance traveled by the diameter of the wheel. Record your information on the chart below.

Wheel	Diameter	Measured distance for one revolution	Ratio of distance traveled in one revolution to the wheel diameter.
Wheel # 1			
Wheel # 2			
Wheel # 3			
Wheel # 4			

Knowledge and Skill Builder 5: Finding the circumference.

Mathematically speaking, the distance around a circle called the **circumference**.

What is the average relationship that you have found to exist between the circumference of the wheels and the wheel diameter? Do you remember how to calculate an average? The average is referred to as the *arithmetic MEAN*. If you need help, ask one of your group members or your teacher.

Using the average (the arithmetic mean) that you have found, can you develop a formula for circumference (C) with respect to its diameter (D)?

How close did you come to developing the mathematical formula for the circumference of a circle, $C = \pi D$. Hint: To answer this question, you need to look up the approximate mathematical value of π.

In the table below, tell what the circumference would be for the wheels of various diameters.

Diameter	Circumference
1 inch	
5 inches	
8 inches	
1 foot	
5 feet	

Knowledge and Skill Builder 6: Testing different diameter wheels.

If you are building a mouse trap car to travel the greatest distance it can, would you want to use small driving wheels or large driving wheels? Measure the distance the standard model travels with the original wheels. Now try different diameter wheels on your mousetrap car and summarize your results below. Before you try out different wheels, make a prediction about the distance you think the car will travel with wheels of different diameters.

Wheel Diameter	Predicted Distance	Actual Distance Traveled
Wheel # 1 (Standard model)		
Wheel # 2		
Wheel # 3		
Wheel # 4		

Why did you make the prediction that you did?

Explain what you have found as a result of this investigation.

3. Generate Alternative Designs

Describe two of your possible solutions to the problem of redesigning the mousetrap car to travel the greatest distance. Remember to consider the specifications and constraints. In your description, indicate what you consider to be each solution's strengths and weaknesses.

You will want to consider the diameter of the wheels, the length of the lever arm, and frictional effects.

Describe two alternative solutions to improve your design in the space below. Use additional sheets of paper if necessary.

4. Choose and Justify the Optimal Solution

Choose your preferred solution. Explain why your solution meets the specifications and constraints. Why makes this alternative better?

What tradeoffs if any, did you make in selecting this alternative?

5. Develop a Prototype

Construct your redesigned mousetrap car. Include a scale drawing of your final design, showing the size and location of the wheels, arm, mousetrap, and body. Include a photograph of your group's car. Use additional sheets of paper if necessary.

6. Test and Evaluate

Did your design meet the initial specifications and constraints? Indicate the tests you conducted and the experiments you performed to verify this.

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Besides the initial specifications, did your particular design include any other specifications, such as the size of the wheels or the specific materials to be used? Describe the testing procedure and explain how the design meets all the specifications.

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7. Redesign the Solution

What problems did you encounter that would influence a redesign of your solution? Did you change your original design concept? Why?
If you had to redesign your model, what changes would you recommend in your new design? Explain your reasoning. What additional tradeoffs, in any, would you have to make?

8. Communicate Your Achievements

Describe the plan you will use to present your solution to your class, and show what handouts you will use. (You make include Power Point slides).

Name______________________________ Class__________________ Date ______________

SELF-ASSESSMENT

Use this scoring guide to judge your success.

	Excellent (4)	Good (3)	Adequate (2)	Resubmit (1)
Research and Investigation: I completed all the Knowledge and Skill Builders. I fully answered all the questions asked within them.				
Alternative Designs: I provided at least two sketches with good detail and with all important elements included.				
Optimal Design: I justified the optimal design solution with a detailed explanation as to why it was the best alternative and why it would meet the specifications and constraints.				
Constructing a Prototype: I constructed a prototype based on the optimal solution. I explained changes I made. I included a final sketch of the prototype.				
Testing and Evaluation: I tested and evaluated the final design. The tests were conducted in a reliable and scientific fashion, and I repeated the tests. I explained why the testing was reliable.				
Data Analysis: I constructed data tables based on the testing and used this information to explain the results from testing.				
Meeting Specifications and Constraints: The design worked; it solved the problem and met the specifications and constraints.				
Redesign: I analyzed the results from testing and made sense of them using math, science, and technological knowledge. Based on this, I made recommendations for design improvements.				
Communication: I made a well-organized, clear, written and oral presentation to my class. I discussed each aspect of the design during the presentation.				
Teamwork: Our group worked well together during the entire project. We planned tasks and helped each other, maintaining interest and effort throughout.				
TOTAL POINTS =				