★Keep this in your Notebook.★

Physics
Mousetrap Car Experiment Directions

Name: _____

** **Note:** This handout is also available on the school's M, drive, in the "Stapleton" folder. Within the Stapleton folder, it is in a subfolder called "Read Only"

Overview: Using your mousetrap car, conduct an experiment to see how a design change affects the distance that your car travels. Follow the steps below. Your grade will be based on your lab procedures and your final lab report.

Directions:

1) Pick one of the following questions:
   a) How does the **length of our mousetrap car's pulling arm** affect the distance that the car travels?
   b) How does the **diameter of our mousetrap car's drive axle** affect the distance that the car travels?
   c) How does the **diameter of our mousetrap car's drive wheels** affect the distance that the car travels?
   d) How does the **mass of our mousetrap car's wheels** affect the distance that the car travels?
2) Generate a hypothesis, and write it down.
3) Plan an experiment to test your hypothesis and answer the question.
   a) Try a few practice trials to see if things work the way you think they will. Before you actually begin your experiment, spend some time carefully thinking through all of the steps below.
   b) Think about all of the variables that you need to control in your experiment.
   c) Think of all of the materials that you will need to be precise and accurate in your procedures.
   d) Write out a rough draft of your procedure section of your lab report. This should be a step-by-step plan that you will follow in #5, below.
4) Create a rough draft data table. You will be recording your actual data in this table. Later, you will need to make a neater version of this data table. You will include the neater version in your lab report.
5) Begin your experiment. Follow the steps that you wrote out in #3d, above.
6) Complete your data table by calculating averages.
7) Prepare a rough draft version of your lab report
   a) Decide who is responsible for each section, or which sections you will work on together.
   b) Review the lab report grading rubric to make sure that you are properly completing all of the sections.
   c) Complete rough drafts of the following sections: Title, Question, Hypothesis, Materials, Procedure, Results (data table and graph), Conclusion, Application.
8) Prepare a typed final version of your lab report.

Grading: You will receive two separate grades for this experiment.

1. Lab report grade – based on the grading rubric **on the back of this sheet**
2. Lab procedures grade – based on the care and diligence with which you conduct your investigation. In other words, did you really measure carefully and do all of the other things you were supposed to do? Were you goofing around inappropriately? Did your partner do all of the work?

Completion Time: 2 class periods

Lab Report Grading Rubric Name(s): _____

25 POINTS POSSIBLE

Conventions (2pts)

_____ Is the lab report neat and organized, and are the sections in the order below?
_____ Is proper grammar used, with correct punctuation?

Lab Report Sections:

Title (1pt)

_____ Is the title appropriate? (A good format for the title is "The Effect of _____ on _____," but you don't have to stick to that format.)

Question (1pt)

_____ Is the question clearly stated?

Hypothesis (2pts)

_____ Does the hypothesis clearly explain the expected relationship between the independent and dependent variables?
_____ Is a sensible reason given for selecting the hypothesis?

Materials (2pts)

_____ Are there appropriate measuring devices for measuring the independent variable (when applicable) and the dependent variable (when applicable)?
_____ Are all other important materials listed? (including safety materials, when applicable)

Procedure (6pts)

_____ Does the experiment really test what is stated in the question and hypothesis? Are there enough steps described with enough clarity so that a reader could actually repeat the experiment?
_____ Is it clear how the independent variable is manipulated?
_____ Is it clear how the dependent variable is measured (with an appropriate measuring device)?
_____ Is it obvious that at least three experimental trials were conducted for each condition of the independent variable?
_____ (2 points) Is it clear that the experimenter has made an effort to control all important variables?

Results: **Data Table** (3pts)

_____ Does the data table have a row or column for each trial, as well as one row or column for averages?
_____ Are correct units included for each measurement?
_____ Are the independent and dependent variables' columns (or rows) titled in a way that the independent and dependent variable are easily understood?

Results: **Graph** (3pts)

_____ Is there an appropriate **graph** (not a data table) that communicates the results in an easy-to-understand format?
_____ Are the items on the graph (including the axes) appropriately titled?
_____ Does the graph include proper units of measurement?

Conclusion (4pts)

_____ Is there a correct statement about whether or not the hypothesis is supported (based on the results of the investigation)?
_____ Is some (but not too much) useful data (from the data table) included as evidence in this section? "Useful data" usually means averages or differences between averages.
_____ Is there a discussion of mistakes or error that may have affected this experiment?
_____ Is there a discussion of how those mistakes could be fixed?

Application (1pt)

_____ Is there a discussion of how the investigation might apply to science, to another profession, or to real life in general?

Data Table

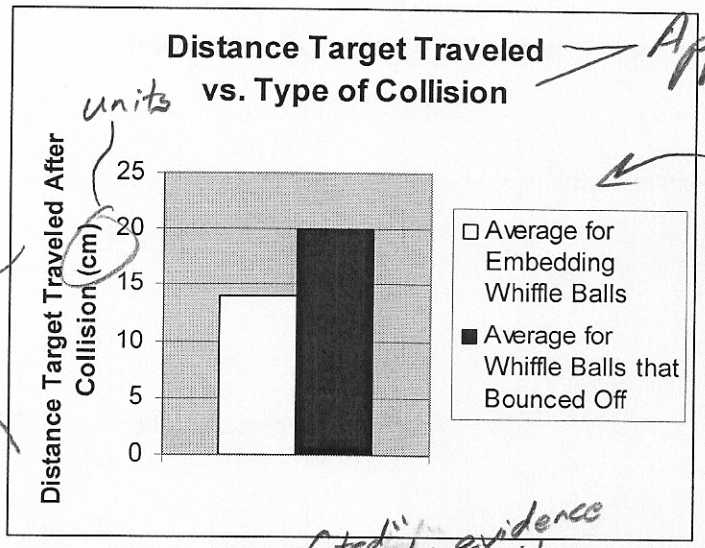
How the dependent variable (momentum) was measured

appropriate units

Results

	Distance Traveled By Target After Collision (cm)			
	Trial 1	Trial 2	Trial 3	**Average**
Whiffle Ball Embedded In Target	16cm	14cm	12cm	**14cm**
Whiffle Ball Bounced Off of Target	20cm	21cm	19cm	**20cm**

Two different conditions of the independent variable



Appropriate Title

units

Graph is easy to read and understand

Clear labeling of axis (with appropriate units)

Conclusion

"refuted" means the evidence is against it.

Correct statement about hypothesis

Cite Averages from results section as evidence.

According to the data collected in this investigation, the hypothesis is refuted. On average, the target traveled six centimeters farther when the whiffle ball bounced off of it. A longer travel distance means that a target had a higher velocity and, therefore, more momentum. Therefore, the target received the most momentum when the whiffle ball bounced off of it. This is the opposite of what we expected.

In some of our trials, the target spun in addition to sliding backward. This may have affected our measurements of how far the box actually moved. It would have been better for us to not include data from trials when the box spun. We should have repeated the trials until we had three trials in which the box moved directly backward.

mistake described

How mistake could be fixed.

Application

This discovery could be helpful to people who are concerned with safety during automobile accidents. The results of this study suggest that, in a crash, it would be better for the crashing cars to stick together. If someone hits a car from behind, the car that gets hit will be pushed less if the two cars stick. Therefore, it might be advantageous to incorporate some type of sticking mechanism into bumpers. They could, for example, be magnetic. Bumpers could also be designed to break and crumple in such a way that they would interlock during a collision.

Explains how this could apply to the real world -- how we could use this knowledge in some way.

EXAMPLE ★★★ (A clean copy is on the M: drive, in the "Stapleton" folder, under "Read only", "Physics")

Physics
Inquiry: Designing and conducting Experiments
A+ example

The Effect of Collision Type on Momentum Transfer

Title

Question

Independent variable

Dependent variable

In which case does a flying whiffle ball transfer more momentum to a target; when it embeds in the target or when it bounces off of the target?

Hypothesis

Expected relationship between independent and dependent variables

If a flying whiffle ball strikes a target and embeds itself in the target, it will transfer more momentum to the target than if it strikes the target and bounces off. We expect this to be the case, because, when the whiffle ball embeds in the target, the ball and all of its energy should be trapped in the target. When the ball bounces off, the target should not receive as much energy, because some of it "bounces out" of the target. We think that the loss of this energy means that the target will not receive as much momentum from the ball.

Materials

- Small plastic "whiffle" ball (approximately golf ball sized)
- Meter Stick ← For measuring dependent variable
- Smooth Table
- Target
  - Box-shaped, with construction paper sides. Stuffed with loosely crumpled paper towel.
  - One open end. One end covered by flat cardboard.
- Sling-shot style whiffle ball launcher
- Safety glasses

Procedures

Underlined parts indicate variables that were controlled

1. The target was placed on a table top, with the open end pointing toward the table edge. The open end of the target was 2cm from the table edge. The target was oriented perpendicularly to the table edge.
2. A whiffle ball was loaded into a launcher that was held horizontally, pointing directly at the open end of the box. The end of the launcher was touching the table edge. The vertical position of the launcher was adjusted so that the whiffle ball, when fired horizontally, would fire directly into the center of the open end of the target.
3. At this point, the experimenters put on safety glasses and left them on until all testing was complete.
4. The whiffle ball was pulled back 60 cm from the table edge and then released. Care was taken to warn other students who were standing behind the target.
5. When the whiffle ball hit the target, it slid away from the launcher along the table. A meter stick was used to measure the distance from the target's starting point (2cm from the table edge) to the part of the target that was closest to the table's edge after the slide. This information was recorded in a data table.

measurement of dependent variable

6. Steps 4 and 5 were repeated two more times, for a total of three trials.

Repeated 3 times

7. Next, steps 4 and 5 were repeated three more times, but in these three trials the target was turned around. The whiffle ball was fired in exactly the same manner, but it was fired against the cardboard end of the target. This caused the whiffle ball to bounce off, rather than embed itself in the target.

Explains how independent variable was manipulated (changed)