PHYSICS SPRING CHALLENGE

The Mousetrap Car Challenge

This challenge will consist of building and testing of a student-built mousetrap car (MTC). Your MTC will be tested using various speed, strength, energy, and collision criteria.

Mousetrap Car Material / Building Criteria:

1. The physical dimensions of the mousetrap car must be such that it fits in a standard adult size shoe or boot box. The box will serve as your travel case to and from school.
2. You may use up to six mousetraps to power your car. The mousetraps must be standard store-bought mousetraps…you cannot build your own mousetrap. Rat Traps MAY NOT be used.
3. The trap must be carried on and along with the vehicle.
4. You can use any household materials and any commercially available glue to build your car. Except for wheels, no recycled toy/model car parts are allowed. You are not allowed to use "Mousetrap Car Kits".
5. No catapult systems may be used (i.e. nothing may be expelled from the car).
6. Mousetraps are the only devices that may be used to provide energy to MOVE the car (no electrical motors, solar panels, nuclear reactors, etc. can be used).
7. Your car must include a simple lighting system (e.g. headlights) powered by a battery that will be carried on and along the battery. The light must be able to be switched "on" and "off". You may also include a battery powered sound system in your mousetrap car. Phase FOUR will require a simple electrical switch with your circuit that will be used as "Collision-Detection Device" (CDD).
8. Each phase is independent of the other phases; you may build a new car for each phase in order to achieve each challenge criteria.
9. In addition to meeting the "Performance Criteria" below, your car will also be graded on the quality of its construction, i.e. no loose parts, wheels that fall off with minimal movement, loose electrical wires that need to be held by hand to operate, etc.
10. Your name must be clearly placed on your car in 72 point font at the "driver's side door" location so that it can be seen when filmed in action.

Safety

You MUST purchase a pair of safety goggles to use at home when working on your MTC. You and your parents must sign the "Goggle Safety Form" before you begin working on your MTC.

Mousetrap Car Performance Criteria:

The measurement of your MTC performance will be measured in FOUR phases:

1. Kinematics – "Top Speed"
2. Force – "Tractor Pulls"
3. Energy – "Up the Incline"
4. Momentum – "Crash Test Dummies"
5. Mousetrap Car Drag Races!

Phase 1: Kinematics – "Top Speed"

1. Performance Criteria:

Incline: Your car must be able to roll down an incline between 30 and 60 degrees under its own weight (i.e. gravity propelled, NOT mousetrap propelled). The length of the incline (distance it must travel) will be between 1 and 2 m. The MTC car light will be "ON" during the test.

One Meter Dash: Using energy from its mousetrap(s), your car must be able to complete at "One Meter Dash" on flat, level ground. Completing the "1 m dash" means that your MTC will pass the finish line. If your MTC veers left or right and does not pass the finish line, then this task will not be considered complete. MTC car lights will be "ON" during the test.

2. Data Collection/Calculations:

"Incline"

Average Velocity
Average Acceleration
Maximum Kinetic Energy attained by your car
Potential Energy of car at the top of the incline

"One Meter Dash"

Average Velocity
Average Acceleration
Maximum Kinetic Energy attained by your car

3. Post Performance Calculations (for both tests unless otherwise noted)

a. What was the average velocity of your cart?
b. What was the maximum velocity of your car?
c. What was the gravitational potential energy of your cart at the top of the ramp? (for ramp only)
d. What was the maximum kinetic energy of your cart?
e. How much energy was lost due to frictional forces? (for the ramp situation only)

4. Debrief

Debrief ("Be simple as possible, but no simpler" – Einstein)

A. Energy Diagram – complete the Energy Diagram below. Specifically,

i. describe who or what did work to supply energy to the system

ii. draw the energy in the "Work" bucket being poured into the appropriate bucket(s) in the BEGINNING set of Energy Buckets.

ii. fill in the energy buckets at the BEGINNING, MIDDLE, and END of the motion Explain the "Energy Transformations" in this Phase starting

B. Questions:

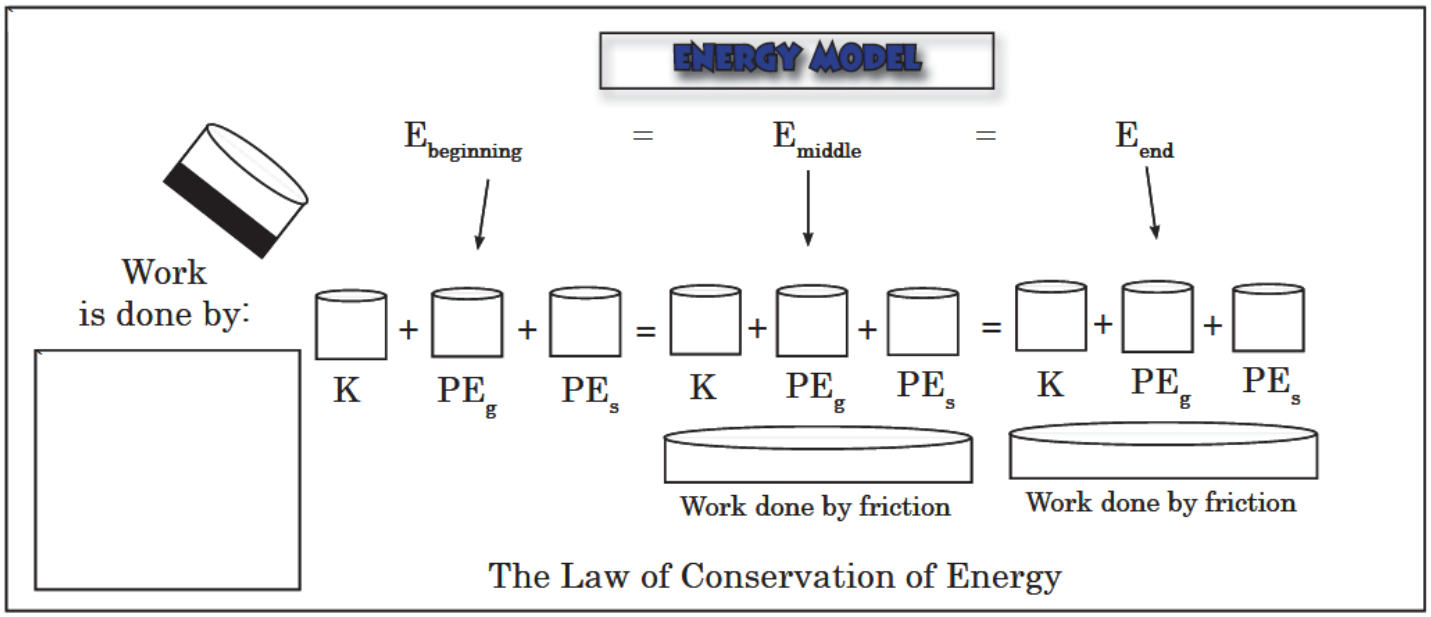
i. On a scale of 1-10, what was the "interesting" level of this phase of the challenge? ("10" is "Highly Interesting")

ii. Describe at least TWO Physics concepts that you learned and/or were <u>solidified</u> in this phase of the challenge. Be specific in your explanation.

iii. Describe at least ONE Physics concepts that you that is still <u>unclear</u> to you in the phase of the challenge. Be specific in your explanation.

iv. What other physics concepts related to moving objects to you want to learn more about?

v. What did you think of this phase of the challenge?



Grading Criteria:

1.	Car meets performance criteria	100 points
2.	Post Performance Interview	50 points
3.	Debrief	
	-Energy Explanation/Diagram	25 points
	-Debrief Questions	25 points

Phase 2: Force – "Tractor Pulls"

1. Performance Criteria:

Tractor Pull: Using energy from its mousetrap(s), your MTC will be able to pull a wood block a distance of 5 cm on flat, level ground. The mass of the wood block will be at 100 g. MTC lights will be "ON" during the test.

2. Data Collection/Calculations:

Coefficient of friction of wood block on ground
Coefficient of friction of MTC tires on ground

3. Post Performance Calculations

a. What does the coefficient of friction physically represent? (Question…no calculation here)
b. What is the static coefficient of friction between the block and the floor?
c. What is the kinetic coefficient of friction between the block and the floor?
d. What is static coefficient between your MTC tires and the floor?
e.

4. Debrief

Debrief ("Be simple as possible, but no simpler" – Einstein)

A. Energy Diagram – complete the Energy Diagram below. Specifically,
- i. describe who or what did work to supply energy to the system
- ii. draw the energy in the "Work" bucket being poured into the appropriate bucket(s) in the BEGINNING set of Energy Buckets.
- ii. fill in the energy buckets at the BEGINNING, MIDDLE, and END of the motion Explain the "Energy Transformations" in this Phase starting

B. Questions:
- i. On a scale of 1-10, what was the "interesting" level of this phase of the challenge? ("10" is "Highly Interesting")
- ii. Describe at least TWO Physics concepts that you learned and/or were solidified in this phase of the challenge. Be specific in your explanation.
- v. Describe at least ONE Physics concepts that you that is still unclear to you in the phase of the challenge. Be specific in your explanation.
- vi. What other physics concepts related to moving objects to you want to learn more about?
- v. What did you think of this phase of the challenge?

Grading Criteria:

1.	Car meets performance criteria	100 points
2.	Post Performance Interview	50 points
3.	Debrief	
	-Energy Explanation/Diagram	25 points
	-Debrief Questions	25 points

Phase 3: Energy "Up the Incline"

1. Performance Criteria:

Incline: Using energy from its mousetrap(s), your MTC will be able to travel UP a 20 degree incline. Points will be awarded as follows:

0.25 m	25 point
0.50 m	50 points
0.75 m	75 points
1.00 m	100 points

2. Data Collection/Calculations:

Elastic Potential Energy Stored in MTC at bottom of ramp
Maximum Gravitational Potential Energy gain by MTC
Power generated by MTC in climbing incline

3. Post Performance Calculations

a. How much elastic potential energy (PEs) is stored in your MTC at the bottom of the incline?
b. What is maximum gravitational potential energy (PEg) gained by your MTC?
c. How much work does your MTC in reaching its maximum height on the incline?
d. How much energy is lost due to frictional forces?
e. Qualitatively describe how energy is lost as your MTC moves up the incline. Be specific and include references specific to YOUR MTC.

4. Debrief (template of debrief form is last page in this document)

Debrief ("Be simple as possible, but no simpler" – Einstein)

A. Energy Diagram – complete the Energy Diagram below. Specifically,
- i. describe who or what did work to supply energy to the system
- ii. draw the energy in the "Work" bucket being poured into the appropriate bucket(s) in the BEGINNING set of Energy Buckets.
- ii. fill in the energy buckets at the BEGINNING, MIDDLE, and END of the motion Explain the "Energy Transformations" in this Phase starting

B. Questions:
- i. On a scale of 1-10, what was the "interesting" level of this phase of the challenge? ("10" is "Highly Interesting")
- ii. Describe at least TWO Physics concepts that you learned and/or were solidified in this phase of the challenge. Be specific in your explanation.
- vii. Describe at least ONE Physics concepts that you that is still unclear to you in the phase of the challenge. Be specific in your explanation.
- viii. What other physics concepts related to moving objects to you want to learn more about?
- v. What did you think of this phase of the challenge?

Grading Criteria:

1.	Car meets performance criteria	100 points
2.	Post Performance Interview	50 points
3.	Debrief	
	-Energy Explanation/Diagram	25 points
	-Debrief Questions	25 points

Phase 4: Momentum – "Crash Test Dummies"

1. Performance Criteria:

Collision with "Wall": Your MTC will collide head-on with a stationary wall. The force that the MTC exerts on the wall will be measured.

Collision with "Block": Your MTC will collide head-on with a block that is free to move. Using data from the collision, you will determine the frictional force acting on the block while it was sliding due to the collision.

2. Data Collection/Calculations:

The change in momentum of the MTC during the collision with the "wall".

3. Post Performance Calculations

a. What is the momentum of your MTC the instant before the collision?
b. What is the momentum of your MTC the instant after the collision?
c. What is the change in momentum of your MTC due to the collision?
d. What is the time duration of the collision?
e. What average force is exerted on your MTC during the collision?

4. Debrief

Debrief ("Be simple as possible, but no simpler" – Einstein)

A. Energy Diagram – complete the Energy Diagram below. Specifically,
- i. describe who or what did work to supply energy to the system
- ii. draw the energy in the "Work" bucket being poured into the appropriate bucket(s) in the BEGINNING set of Energy Buckets.
- ii. fill in the energy buckets at the BEGINNING, MIDDLE, and END of the motion Explain the "Energy Transformations" in this Phase starting

B. Questions:
- i. On a scale of 1-10, what was the "interesting" level of this phase of the challenge? ("10" is "Highly Interesting")
- ii. Describe at least TWO Physics concepts that you learned and/or were solidified in this phase of the challenge. Be specific in your explanation.
- ix. Describe at least ONE Physics concepts that you that is still unclear to you in the phase of the challenge. Be specific in your explanation.
- x. What other physics concepts related to moving objects to you want to learn more about?
- v. What did you think of this phase of the challenge?

Grading Criteria:

1.	Car meets performance criteria	100 points
2.	Post Performance Interview	50 points
3.	Debrief	
	-Energy Explanation/Diagram	25 points
	-Debrief Questions	25 points

Phase 5 – Races

Contest Rules:

1. Three cars will be raced at a time. This is a race for SPEED. The car that passes the three-meter mark first wins each heat.
2. The winner from each heat will advance to the next heat.
3. Winners will advance from heat to heat until the top three cars meet in the "FINALS". The first place winner will earn 25 extra credit points, the second place winner will earn 15 extra credit points, and the third place winner will earn 5 extra credit points.
4. The "FINALS" will consist of four heats. The car that wins two out of three heats will be the "Mousetrap Car Champion"
5. Be sure to bring extra mousetraps and any other tools you need to race your car. You will be given 2 minutes between heats to repair any broken parts. Reliability in your design is an important factor!!