**2023**

**Year 12 Integrated Science – Unit 4**

**Task 8: Mouse Trap Vehicle Investigation**

**Assessment Type: Science Inquiry**

**Weighting: 10%**

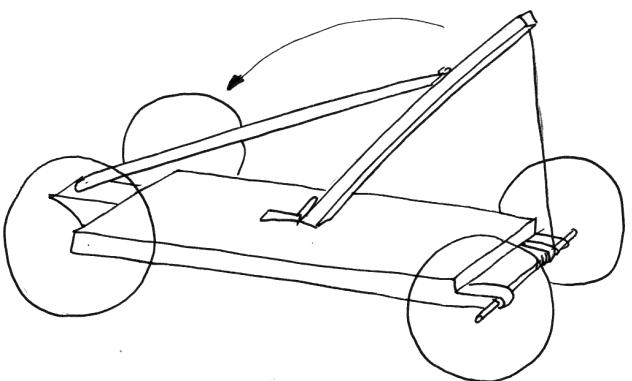
**MARKING KEY**

**Names: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Due Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

|  |  |
| --- | --- |
| **Checkpoints** |  |
| **Construction & Design** |  |
| **Performance** |  |
|  |  |
| **Total Mark** |  |

*Please see SEQTA for teacher feedback and comments.*

**Introduction**: Working in pairs, you will build an originally designed vehicle powered solely by with energy of one standard-sized mousetrap.

A very popular method of propulsion is to tie one end of a string to the arm (or an extended lever arm) on the mousetrap and the other end to the axle. By winding the string around the axle, the mousetrap's spring, when released, pulls on the string causing the wheels to turn and thus making the car move (there are, however, other creative ways to convey power from the mousetrap to the car).

**Objectives:** The objective of this project is to...

1. Design a mousetrap car that will travel a maximum speed/acceleration over a 5meter race.
2. Demonstrate an understanding of the physics principles incorporated in your design (in a report).

The project consists of 5 phases:

1. Mousetrap Car Design
2. Obtaining parts
3. Mousetrap Car Construction
4. Mousetrap Car Performance Evaluation - Race day
5. Mousetrap Car Physics Analysis (Validation Report)

**Design Requirements:**

The vehicle must be powered by the provided mousetrap (you will only get one- be careful).

You have complete design freedom concerning vehicle size, vehicle weight, and materials used (except for the mouse trap "engine"). However use common sense, nothing sharp or dangerous may be used on the car.

You will not be permitted to "push start" your vehicle i.e. upon release, your vehicle must start moving on its own.

Displacement will be measured from the starting line position to the front-most part of the vehicle at its final resting point.

Your goal is 5 meters or more. All cars entered must achieve a minimum of 3 meters displacement to pass the performance part of the grade. Please examine the grading rubric (see link below); *car performance is a major part of your project grade so test your design, make improvements, and then test some more.*

**CAR NAME: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**STUDENT #1 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ STUDENT #2 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**PART ONE: CHECKPOINTS (27 marks)**

These checkpoints are designed for you to check your progress on the design, construction, and performance of your mousetrap vehicle.

Each checkpoint needs to be completed and signed off by the designated date to receive full marks.

**Checkpoint #1:**

1. List of materials (3 marks)

|  |
| --- |
| 0 marks – no materials  2 marks – limited materials list provided  3 marks – detailed list of materials provided  *Material list must be supplied at least 1 day* ***BEFORE*** *constructing vehicle* |

1. Initial scientific diagram of vehicle (labelled) (3 marks)

|  |
| --- |
| 1 mark – basic diagram provided  2 marks –detailed diagram provided. diagram not labelled  3 marks – detailed and labelled diagram provided |

1. Initial car constructed ⬜ Yes ⬜ No (1 mark)

Completed by **P1 Thursday 20/07** Teacher signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Checkpoint #2:**

1. Description of observations/concerns of initial vehicle (3 marks)

|  |
| --- |
| 1 mark – basic notes of vehicle concerns  2 marks – some notes of vehicle concerns  3 marks – detailed notes of vehicle concerns |

1. Modified car – scientific diagram (labelled) (3 marks)

|  |
| --- |
| 1 mark – basic diagram provided  2 marks –detailed diagram provided. diagram not labelled  3 marks – detailed and labelled diagram provided |

1. Clear explanation of modifications (3 marks)

|  |
| --- |
| 1 mark – basic notes on modifications made  2 marks – some notes on modifications made  3 marks – detailed notes of modifications made |

1. Modified car constructed ⬜ Yes ⬜ No (1 mark)

Completed by **P2 Monday 24/07** Teacher signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Checkpoint #3:**

Final car modification before race.

1. Description of observations/concerns of modified vehicle (3 marks)

|  |
| --- |
| 1 mark – basic notes of vehicle concerns  2 marks – some notes of vehicle concerns  3 marks – detailed notes of vehicle concerns |

1. Modified car – Scientific diagram (labelled) (3 marks)

|  |
| --- |
| 1 mark – basic diagram provided  2 marks –detailed diagram provided. diagram not labelled  3 marks – detailed and labelled diagram provided |

1. Clear explanation of modifications (3 marks)

|  |
| --- |
| 1 mark – basic notes on modifications made  2 marks – some notes on modifications made  3 marks – detailed notes of modifications made |

1. Modified car constructed ⬜ Yes ⬜ No (1 mark)

Completed by **P5 Friday 28/07** Teacher signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**PART TWO: PHYSICS BEHIND MOUSETRAP CARS (0 marks)**

To be completed by the end of Checkpoint #3 (Due P5 Friday 28/07)

***NOT ASSESSED – but will help you in the validation!***

1. Friction:
   1. What is friction?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* 1. What are the types of friction?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* 1. What types of friction act on the mousetrap car and how could you overcome them?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Did you choose to use large or small wheels for your mouse trap car? Explain why you chose what you did.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Newton’s Laws of Motion
   1. Explain what Newton’s Laws of Motion are and how they could impact your vehicle.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Did you choose to have a long or short lever arm on your mousetrap car? Explain why you chose what you did.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Energy
   1. What types of energy transformation occur in your car?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* 1. Identify the useful and wasted energy in your car how you could make it more efficient.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**PART THREE: CONSTRUCTION AND DESIGN (15 marks)**

***Teacher to assess:***

* 15 marks – excellent application of design, construction and assembly of mousetrap car
* 13 marks – very good construction and assembly and very good attention to detail
* 10 marks – good construction and assembly and some attention to detail
* 8 marks – fair construction and assembly. Minimal attention to detail
* 3 marks – last minute project. No attention to detail
* 0 marks – no car submitted

**PART FOUR: PERFORMANCE – RACE DAY! (18 marks)**

***Teacher to assess:***

* 15 marks – final displacement 5m or greater.
* 6 marks – final displacement 3m – 5m
* 0 marks – final displacement less than 3m
* + 3 marks – Race day data shown/completed

**Race Day Data:**

|  |  |  |
| --- | --- | --- |
|  | **Distance travelled (m)** | **Time taken (secs)** |
| **Trial #1** |  |  |
| **Trail #2** |  |  |
| **Trial #3** |  |  |
| **Average** |  |  |

**Mousetrap Car Building Basics**

A mousetrap powered car is a vehicle that is powered by the energy of a wound-up mouse trap's spring. The most basic design is to tie one end of a string to the tip of a mousetrap's snapper arm and then the other end of the string has a loop that is designed to "catch" a hook that is glued to a drive axle. Once the loop is placed over the axle hook, the string is wound around the drive axle by turning the wheels in the opposite direction to the vehicle intended motion. As the string is wound around the axle by the turning of the wheels, the snapper's lever arm is pulled closer to the drive axle causing the mousetrap's spring to "wind-up" and store energy. When the drive wheels are released, the string is pulled off the drive axle by the mousetrap causing the wheels to rotate.

1. A string is attached to the mouse trap's lever arm and then hooked to the drive axle. The string has a loop knot tied at one end that is designed to "catch" a hook attached to the drive axle. The string's loop knot is designed so that the string can release itself after the pulling force is spent. If the axle's hook is too long or the string's loop knot is too tight, the string will not properly release from the axle causing the vehicle to suddenly stop.
2. To wind the string around the axle, the wheels are turned in the direction opposite to the motion of the vehicle's travel. It is important that the string NOT be wound loosely or it will snag itself as it is pulled from the axle by the lever arm, the string should carefully be wound tight and uniform around the axle. Do not push on the mousetrap's lever arm during this process; you want the string to be tight and to pull the lever arm over.
3. Once the car is released, the string is pulled off the axle causes the wheels to rotate propelling the vehicle. If the mousetrap is located to close to the drive axle the wheels can spin at the start wasting energy.

**How to Build a “Speedy” Mousetrap Car**

When you build a vehicle for speed, you want to release the mousetrap's energy very quickly or at a high power output. This way your vehicle can get to top speed as soon as possible. You can change the power output of your vehicle by changing one or all of the following: where the string attaches to the mouse-trap's lever arm, the drive wheel diameter, or the drive axle diameter. The amount of energy released by using a short lever arm or a long lever arm is the same, but the length of the lever arm will determine the rate at which the energy is released and this is called the power output. Long lever arms decrease the pulling force but increase the pulling distance, thereby decreasing the power output. Short lever arms increase the pulling force over a shorter pulling distance thereby increasing the power output. If you are building a mouse-trap car for speed, you will want the maximum power output, just before the wheels begin to spin-out on the floor. Maximum power output means a higher rate of energy being transferred into motion or greater acceleration of the vehicle.

Greater acceleration can be achieved by:

• increasing the power torque

• using a short length lever arm

• having a small axle to large wheel ratio.

• build a light-weight vehicle.

• wheels should have low rotational inertia.

If you are building a distance vehicle, you want to minimize the power output or transfer stored energy into energy of motion at a slow rate. This usually means having a long lever arm and a large axle-to-wheel ratio. If you make the lever arm too long, you may not have enough torque through the entire pulling distance to keep the vehicle moving, in which case you will have to attach the string to a lower point or change the axle-to wheel ratio. Pictures of “Speed” class cars.