The Mouse Trap Car (**MTC)** is going to travel a certain amount of distance (d) in a specific amount of time (t). To accomplish this, a lot of things will be taking place. **Energy** will have to be applied to generate a **force**, which in turn, will apply itself directly to the object causing the object to move in the direction in which the greater force is applied.

Energy- The ability to due work; expressed in ***joules*** or ***Newton-meters (n-m).*** Energy is classified as the following:

Potential Energy (P.E.) – stored energy due to position.

P.E. = *weight x height* or **P.E. = w *x* h**

Kinetic Energy (K.E.) – energy of motion. Derived from the Greek word kinein, Meaning, "to move."

K.E. = 1/2 *mass x velocity* (squared) or **K.E. – 1/2mv(squared)**

The MTC will begin from a position of rest (**Potential Energy)** and as the force is applied the energy in the MTC will change into **Kinetic Energy.** The importance of transferring energy from a potential state to a kinesthetic state is that once an object is moving it has the capacity to do work (*force x distance*). For example, we have been able to harness the moving energy of water and wind to generate electrical power that is used by many cities all over the world. The recent "Black out" in New York, Pennsylvania, Ohio, New Jersey, and Canada happened in energy storage and transfer equipment that handled the energy generated from the Niagara and St. Lawrence Rivers and Niagara Falls. These rivers and falls generate enough energy to provide service to over 50 million people!

Force is the amount of push or pull on an object; measured in Newtons(N).

Force = *mass x acceleration* or m x a

After the force has been applied to the MTC and it begins to move in a direction (vector). The **velocity** of the MTC is the measurement of how fast an object is moving in a specific direction.

Velocity = distance/ time *or* d/t

As the force applied to the MTC gets it moving from rest to a maximum velocity. This change in velocity is called **acceleration.** Acceleration is the change in velocity per unit of time.

Acceleration = (final velocity – initial velocity) / time

Or

$$\mathbf{A} = \frac{\mathbf{v}_{(final)} - \mathbf{v}_{(initial)}}{\mathbf{T}}$$

Once the maximum velocity is reached constant external forces will eventually cause the MTC to slow down to a rest position (**deceleration)**. Deceleration can be calculated the same way that we calculate acceleration.

The external forces that are working against the car the following:

Friction
Gravity
Drag
Wind (if applicable)
Inertia (weight of the vehicle)

Remember the Rocket Experiment.

Ultimately, you are going to have a MTC that travels a certain amount of distance in a certain amount of time. Some cars will travel faster than others, while some will travel farther than others. There are a lot of external forces that you will have to overcome in order to get your MTC to achieve your desired goal. Analyzing your objective and understanding the constraints (resources, external forces, and the dynamics of your vehicle) will all come into play when you design your Mouse Trap Car.

Newton's Laws of Motion (and how they impact MTC):

Newton's First Law of Motion: Every object continues in its state of rest or in uniform motion in a straight line unless it is compelled to change that state by forces acting on it.

Inertia is a fancy word meaning "resistance to change". Inertia deals with the mass that the object has. It is the weight plus the force of gravity on a specific object. This is why you weigh more on earth than you would on the moon. The gravitational forces are less on the moon. Your MTC at rest has inertia. You most generate enough force to overcome the inertia of your MTC in order to get the car moving.

Newton's Second Law of Motion: The acceleration of an object is directly proportional to the net force acting on the object (in the direction of the net force) and inversely proportional to the mass of the object.

In simple terms, mass resists change or acceleration (change in velocity), and force causes acceleration. If you want to triple the acceleration of an object, you have to triple the force. If you cannot increase the force and you still want to accelerate, then you have to remove mass.

Example: Have you ever watched a show or a movie when someone is in a balloon, ship or spacecraft and they have to jettison (get rid of) extra ballast (objects) in order to go faster. Recently, in the movie " Master and Commander" dealing with France and England competing for control of the Sea and their empire expansion. The French ship had recently damaged the British ship and was closing in for the kill. The Commander of

the British vessel instructed his crewmen to throw all non essential equipment and supplies of the ship to lighten the load, which enabled the ship to move faster (accelerate) and escape the quickly approaching French warship.

Force = mass x acceleration

You will have to take into account the mass of your MTC and your ability to generate enough energy to create a great enough force allowing you to achieve maximum acceleration.

Newton's Third Law of Motion: Whenever one object exerts a force on a second object, the second object exerts an equal and opposite force on the first.

For every action there is an equal and opposite reaction.

Here is where we look at" push and pull". Newton recognized that a force is actually the interaction between two objects. For example, if you push against a brick wall, the brick wall is actually pushing back on you! You and the brick wall are an interaction pair, you apply a force to the wall, and the wall applies a force back. The evidence of this is in your bent fingers.

You sit on a chair and you exert a force on the chair since you do not fall, the chair is exerting a force against you.

A MTC car is propelled because the drive wheels push on the floor and the floor pushes back on the car causing the MTC to move or accelerate. A vehicle's acceleration is limited by the interaction between the wheels and the floor.

A "speed car" or any vehicle that produces a lot of torque, the wheels can only push as hard as the vehicle can push back. Therefore, if the floor can not push back with the same force as the wheels push, then the wheels spin in place and the car will not accelerate to it's maximum velocity. (Hint: increase traction (friction) between the two surfaces).

A final note on Newton:

Remember mass is resistant to change. The more massive your vehicle the more energy and force you will need to start your vehicle moving, compared to smaller and lighter vehicles.

On the other hand, if your vehicle is too light, you will not have enough friction to start your vehicle moving.

Only through experimentation will you find your target mass. And do not forget to consider the impact of your lever arm.