Teacher:	Subject Area:	Room No:
William Schraer	STEM - Intro to Engineering Design	513
Lesson Date:	Meeting Time Period:	Day Cycle:
February 2 –February 6	1..5..7..	Monday 2nd

Teaching Aids and Materials:

- Pencils
- Scissors
- Paper
- Printer
- Wallpaper Knives
- Cardboard
- Balsa wood
- Computer for each student (30 Available)
- WhiteBox Software
- Sand Paper
- Glue yellow
- Glue Resign

This week the students will:

- We will be review the lesson and worksheets of the Mouse Trap Car Construction

TEK use sketching and computer-aided drafting and design to present ideas

- We will review the research necessary for Mouse Trap Car construction
- Discuss the Engineering Specifications

TEK Work in teams to discuss the engineering specifications

Standards addressed and expectations of Students for the week:

- Discuss in groups why there design is unique and how why they instituted what was learned. (Do Now)

TEK Use clear and concise written, verbal, and visual communication techniques

- Review the User Interface and finalize modeling of structure. (Independent Practice)
- Complete final designs with revised dimensions (virtual modeling) design tools.
- Review the research for the Mousetrap Car 2.0 and analyze knowledge and understanding

TEK Identify/Describe fundamental processes needed for project, include design and prototype development

Anticipatory Set

Vocabulary: Lever, Wheel and Axel, Pulley, Wedge, Screw, Hand Tools, Simple Machine
Mechanism, Power Source, Power Train, Linkages, Frame, Bearings,
What are Design Specs?
What where the Design Specs for the Mouse Trap Car?
What could happen if we did not have Design Specs?

Do Now

How can we design the MTC for Distance and then speed. What would be different
Vocabulary: Mechanism, Power Source, Power Train, Linkages, Power Source, Power Train
Write lessons learned from the Glider project, and how would they apply to the Mouse Trap Car

Instructional Delivery: Direct Teach

Discuss Math and Specifics for the Mouse Trap Car

Newton's theories on motion defines 3 Laws of Motion
The vehicle can be designed for speed or distance. Either way, there needs to be enough force to overcome resistance to get off the starting line and move forward. Acceleration = a = F/m
Spring Force Calculation
In groups of 4- 5 evaluate the force of spring designated on the chart

Independent Practice: Independent Practice

Research and design of the Mouse Trap Car

Review / Reteach: Reteach

Discuss Design Specs for the Mouse Trap Car
Discuss individual designs of Mouse Trap Car

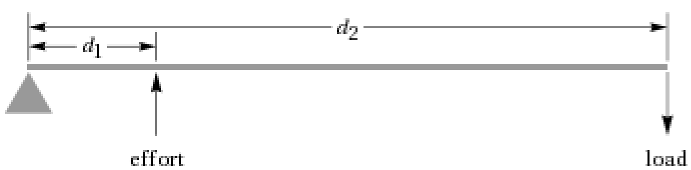
Concepts of Engineering and Technology TEKS:

- 130.362 (c) (1)(E) (2)(A)(C)(D)(5)(A)(B)(C)(6)(A)(C)(D)(E)
- ...use clear and concise written, verbal, and visual communication techniques;
- ...use sketching and computer-aided drafting and design to present ideas;
- ...maintain a portfolio.
- ...work in a team face-to-face or in a virtual environment to solve problems;
- ...use clear and concise written, verbal, and visual communication techniques;
- ...describe and demonstrate how teams function;
- ...identify characteristics of good team leaders and team members;
- ...work in a team face-to-face or in a virtual environment to solve problems;
- ...identify and describe the fundamental processes needed for a project, including design and prototype;
- ...compare and contrast engineering, science, and technology careers;

Worksheet: Lever Arm

The lever arm is a class 3 lever. Class 3 levers increase the distance the force is applied by sacrificing force output. To determine the mechanical advantage of a class 3 lever, you must calculate the ratio of the distance from the fulcrum to the effort (d1) and the fulcrum to the load (d2).

Use the image and formula below to complete the worksheet.



Mechanical Advantage of Lever Arm

$$MA = \frac{d_1}{d_2}$$

Scenario 1:

Question

The length of the fulcrum to the effort of a class 3 lever is 17mm (d1), what is the mechanical advantage (MA) of a 200mm (d2) Arm?

- 0.085
- 0.106
- 0.04
- 1.4

Scenario 2:

Question

What is the MA of a 400mm lever arm?

- 0.085
- 0.106
- 0.04
- 1.4

Question

If the length of the lever arm is increased _____.

- Mechanical Advantage (MA) increases.
- Mechanical Advantage (MA) decreases.

Worksheet: Linkage Mechanism

Rotational force is called torque. On the drive train, torque is equal to the radius of the axle multiplied by the force.

T = Radius x Force

Scenario 1:

Question

If the force produced by the drive train is equal to 1.8N, what is the torque at the axle given a diameter of 0.005m.

- 0.13Nm
- 0.0045Nm
- 0.027Nm
- 1.8Nm

Scenario 2:

Question

If the axle diameter is increased to to 0.03m, what is the resulting torque?

- 0.13Nm
- 0.0045Nm
- 0.027Nm
- 1.8Nm

Question

If the axle diameter is increased, _____.

- torque increases
- torque decreases

Worksheet: Wheel and Axle

The force at the wheel that propels the vehicle is a function of the axle torque and the mechanical advantage of the wheel and axle combination. The force on the road is equal to the axle torque divided by the wheel radius.

$$F = \frac{T}{r}$$

Scenario 1:

Question

Given a wheel radius of 30mm (0.03m), and an axle torque of 0.006Nm, what is the Force propelling the vehicle?

- 0.5N
- 0.32N
- 0.2N
- 0.13N

Scenario 2:

Question

If the wheel radius is increased to 45mm (0.045m), what is the new propulsion force?

- 0.5N
- 0.32N
- 0.2N
- 0.13N

Question

If the wheel diameter is increased, the force propelling the vehicle (propulsion force) _____.

- increases
- decreases

Question

In the previous section, we learned that the distance a wheel will travel in one revolution is its circumference. So if wheel diameter is increased, distance will _____.

- increase
- decrease

The Engineering Design Challenge

When defining an engineering design problem, the purpose or function of the device helps define the design constraints. Mousetrap cars use simple machines in combination to produce the force needed to propel the vehicle forward. The vehicle can be designed for speed or distance, or a combination of both based upon the specs your teacher dials in for your challenge. Vehicles designed for speed must get off the line quick and accelerate fast to the finish line. Designing for distance requires less torque at the starting line with the intent to maximize the number for revolutions under power.

Either way, there needs to be enough force to overcome resistance to get off the starting line and move forward. How can we engineer a vehicle for a designed purpose?

Well, let’s "do the math".

Sir Isaac Newton's theories on motion define 3 Laws of Motion.

His second law of motion states:

The acceleration of an object of constant mass is proportional to the force acting upon it.

In mathematical form, the relationship of force, mass and acceleration is defined as:

Force (F) = mass (m) x acceleration (a)

Solving for acceleration we find that:

a = F / m

Therefore, to calculate acceleration we need to know the force or net force acting on the vehicle and total mass of the vehicle. Let's start with propulsion force.

Spring Force

The engine of this vehicle is spring tension that produces force. When a spring is wound, the force required to wind the spring is converted to spring tension. As you may expect, the force needed to wind the spring increases as the spring is wound. Thus, when the spring is released, the force is greatest when released then decreases as the spring unwinds. The graph below shows the force produced by a standard mousetrap when wound 180 degrees. As you can see from the graph, there is a linear relationship between force and angle when the arm is released. The slope of this line is called the spring constant.