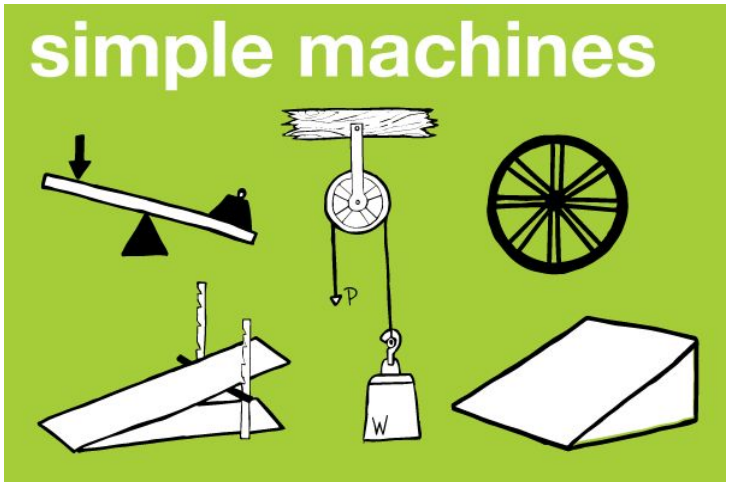
MINNESOTA 4-H STEM PROGRAM

Mechanical Engineering and the 4-H Engineering Design Challenge Level 1 and 2

One of the exciting aspects of building the 4-H Engineering Design Challenge machine is learning about the various categories of machine construction. This information addresses the mechanical (simple machines) component of the engineering and design machine.



WHAT IS A SIMPLE MACHINE?

The 4-H Engineering Design Challenge incorporates machines into the build. For the Mechanical component it will be defined as “Simple Machine.”

Once upon a time a person needed to move something heavy. He or she picked up a long stick and stuck it under the edge of the heavy object and then pushed down on the other end of the stick. The first simple machine was invented. Simple machines are just that. The simplest form of using one thing to accomplish something faster or easier. A tool. They were the first ones created and we still use them today.

There are 6 basic simple machines;

- Lever
- Wheel and axle
- Inclined plane
- Wedge
- Pulley
- Screw

Several of these simple machines are related to each other. Each has a specific purpose in the world of doing work.

What is work? Work is the amount of energy necessary to move an object. The further you move an object, the more work is required.

NEWTON'S LAW

Newton's first law is often called the law of inertia. It asserts, "A body continues to maintain its state of rest or of uniform motion unless acted upon by an external unbalanced force." In other words, an object will not start or stop moving unless something else causes it to do so. Or, as you might have heard in school: Objects at rest stay at rest, and those in motion stay in motion, unless acted upon by an outside force.

First Law
Objects at rest remain at rest and objects in motion remain in motion in a straight line unless acted upon by an unbalanced force.

Second Law
Force equals mass times acceleration (or f = ma).

Third Law
For every action there is an equal and opposite reaction.

The second law states that when F is the force applied to an object, m is the object's mass, and a is its acceleration, then F = ma. The greater the force applied to an object and the lower the objects mass, the faster it will accelerate. In other words, it takes less force to move an object with a lower mass than an object with a higher mass.

Newton's third law of motion is the most well-known. It is states, "To every action there is an equal and opposite reaction." Every time something moves, there is an equal force in the opposite direction acting on the object that caused the motion.

MECHANICAL ENGINEERING (SIMPLE MACHINES) AND THE 4-H LEVEL 2 ENGINEER DESIGN CHALLENGE

To visualize your machine, think about the task and how simple machines can play a role in completing the task. Think about the six different simple machines and their functions on your engineer design machine.

For the Mechanical component of the 4-H Engineering Design Challenge, there should be a minimum of **three different simple machines** included in the design of the machine.

WHAT IS THE ADVANTAGE OF SIMPLE MACHINES?

We use simple machines because they make work easier. The scientific definition of work is the amount of force that is applied to an object multiplied by the distance the object is moved. Thus, work consists of force and distance. Each action takes a specific amount of work to accomplish it, and amount of work does not change. Simple machines allow us to do the same work but change the force and distance necessary to complete the action. For example, if you want to exert less force, you need to apply the force over a greater distance. On the other hand, if you want move something a smaller distance you need to exert a greater force. This is the force and distance trade off, or mechanical advantage, which is common to all simple machines. With mechanical advantage, the longer an action takes, the less force you need to use throughout the job. Most of the time, we feel that a task is hard because it requires us to use a lot of force. Therefore, using the tradeoff between distance and force can make our task much easier to complete.

MAKING WORK EASIER?

Because work is defined as force acting on an object in the direction of motion, a machine makes work easier to perform by accomplishing one or more of the following functions:

- Transferring a force from one place to another,
- Changing the direction of a force,
- Increasing the magnitude of a force, or
- Increasing the distance or speed of a force.

Many machines combine more than one of these devices to make work easier. For instance, we might use a pulley to pull a load up a ramp or attach a handle to an object to help make it move. While machines may seem simple, they continue to provide us with the means to do many things that we could never do without them.

WHERE DO TEAMS OBTAIN THE MATERIALS?

As teams begin to plan and build their machines they need to remember that simple machines but be a part of their machine. Look around your house, at school, in your garage, ask a friend, teacher or neighbor. Simple machines can be found anywhere. Just make sure you ask before you take or remove a simple machine piece.

Team members should be able to name the simple machines used in their Engineer Design Challenge machine and their functions. That is part of the evaluation process of the competition.

LEARN MORE ABOUT MECHANICAL (SIMPLE MACHINES)

https://www.youtube.com/watch?v=fvOmaf2GfCY
https://www.neok12.com/video/Simple-Machines/zX5879664d767e550f536d73.htm

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