

Activity 2.2 Simple Machines and Forces

Introduction

Energy is the ability to do work. This work is done by applying **force** to an object for a given distance. **Force** is a push or a pull that can make the object move, stop moving, or change directions.

A **simple machine** is a device that makes the work seem 'easier'. The greater the distance the object moves, the less force you need to move the object. Simple machines include levers, inclined planes, pulleys, wheels and axles, wedges, and screws. Did you know that you see and use these simple machines every day? Common items such as scissors, skateboards, ramps, baseball bats, and door knobs are all simple machines. Many simple machines transfer energy from a person to apply a force to an object.

In this activity you will build, sketch, and work with simple machines such as an inclined plane, lever, and pulley.

Equipment

- VEX IQ[®] equipment
- iPad[®] tablet
- Autodesk[®] Inventor[®] Publisher app
- 18 inch string
- Launch Log

Procedure

You will work with a group to build, sketch, and work with three types of simple machines made from VEX IQ[®] components. The directions for building the inclined plane, lever, and pulley are found on the Autodesk[®] Inventor[®] Publisher app on your tablet. Follow the procedures found below to complete this activity. Record all of your drawings and answers in your Launch Log.

Part 1 – Inclined Plane

An **inclined plane** is a simple machine that is a sloping (or slanted) ramp that can be used to raise or lower a load by sliding. The slanted ramp helps to move things between lower and higher levels.

1. Open the Autodesk[®] Inventor[®] Publisher app on your tablet.
2. Use the table of contents to select SM2.2a_Inclined Plane Box and follow the directions to build the box.

- a. Remember that you can compress the table of contents to view the full screen by selecting the left arrows at the top of the screen.
3. Work through the building steps shown below to build the inclined plane. When you complete each step, check it off before moving on to the next step.

Building Step	Completed
SM2_Inclined Plane_Step1	
SM2_Inclined Plane_Step2	
SM2_Inclined Plane_Step3	
SM2_Inclined Plane_Step4	
SM2_Inclined Plane_Step5	

4. Place the box on the inclined plane you built in steps 1-4 and slide the box up the ramp several times. Get a sense for how much effort force you need to push the box up the ramp.
5. Now place the box on the surface next to the tallest part of the inclined plane and then lift the box up to the same height as the top of the ramp. Again, get a sense for how much effort you needed to lift the box up to the top of the ramp.
6. Draw the box on the inclined plane in your Launch Log.
7. Measure the tallest part of the inclined plane and the length of the ramp. Label the drawing with your measurements.
8. Which distance is greater, the length of the ramp or the height of the ramp?
9. Did lifting the box or pushing the box up the inclined plane require more effort on your part? Explain your thinking.

Part 2 – Lever

A **lever** is a simple machine that moves a load around a fulcrum using a force. The force is applied to the lever arm which pivots at the fulcrum.

10. Follow the Autodesk® Inventor® Publisher app directions starting at SM2.2c_Lever_Step1 to build the lever. Make sure to check off each step as you complete it.

Building Step	Completed
SM2_Lever_Step 1	
SM2_Lever_Step 2	
SM2_Lever_Step 3	
SM2_Lever_Step 4	
SM2_Lever_Step 5	

11. Draw the lever and label the **lever arm** and **fulcrum** in your Launch Log.
12. Test the function of the lever you constructed by pressing down on one side and then the other. Try to get a sense of how much effort force you must exert to lift the other side.

13. Remove one of the tires and stack it on top of the one at the other end as shown at right.



14. Use one hand to move the lever so the tires move up and down.

15. Again, try to get a sense of how much effort force you must use to lift the other side.

16. Change the position of the fulcrum by moving the pivot point away from the tires as shown at right. Press on the lever arm on the opposite side of the fulcrum (furthest from the tires) in order to move the tires up and down.



17. Did this require more or less effort force than when the pivot point was in the center of the lever? Explain your answer.

18. Change the position of the fulcrum by moving the pivot point close to the tires as shown at right. Move the tires up and down again.



19. How did moving the fulcrum close to the tires change the amount effort force you needed to move the tires up and down? Why do you think there was a difference?

Part 3 – Pulley

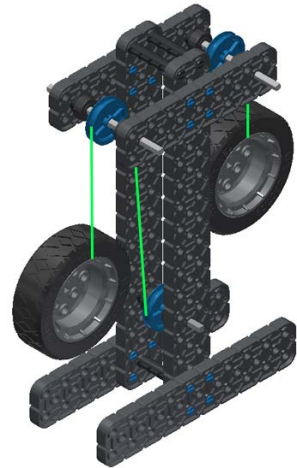
A **pulley** is a simple machine that uses grooved wheels and a rope, cable, or chain to raise or lower a load.

20. Follow the Autodesk® Inventor® Publisher app directions to build the pulley. Make sure to check off each step as you complete it.

Building Step	Completed
SM2_Pulley Step1	
SM2_Pulley Step2	
SM2_Pulley Step3	
SM2_Pulley Step4 Remember to thread your string through the tire before you insert the wheel hub.	
SM2_Pulley Step 5 Before you complete this step, place the string over the two pulley wheels and then complete the assembly.	

21. Draw the pulley system you created in your Launch Log. Label the pulleys and the load they are supporting.
22. When you pull down on one tire, which way does the other tire go? Add arrows showing the movement directions to your drawing. Then label the arrows with the words “Effort” and “Resistance”.
23. Repeat pulling down each tire several times until you get a sense of how much effort force you need to apply to move the other tire.
24. Add a third pulley wheel to the mechanism as shown at right. Construction changes are also demonstrated in Autodesk® Inventor® Publisher app Pulley Step 6.

Building Step	Completed
SM2_Pulley Step6	



25. Did you apply more or less effort force to move the wheel after adding the third pulley wheel? Explain.
26. When you pull one tire down on the pulley, what direction does the other tire move? Explain.

Conclusion

1. How do simple machines transfer energy?
2. Describe one common simple machine in your life and how it makes your work effort easier for each of the following:
 - a. An inclined plane
 - b. A lever
 - c. A pulley