

## Project 2.4 Harnessing Energy

### Introduction

Finally your parents have built the tree house in the backyard that you and your friends have been wanting so badly. Now it's up to you to furnish it. You and your friends have put together a crate of food, a box of games, and a few chairs. All of these items are too heavy for you to directly lift up the ladder safely or hoist by a rope that you hang over the edge of the tree house railing. What ideas do you have for getting your supplies into the tree house?

In this project you will use two devices built with VEX IQ<sup>®</sup> equipment to work toward a solution to this problem. You may use the bike you built in an earlier activity as well as a pulley system that you will construct in Part 1 of this project.

### Equipment

- VEX IQ<sup>®</sup> Construction Kit
- VEX IQ<sup>®</sup> Bicycle built in Activity 2.1
- iPad<sup>®</sup> tablet
- Tablet applications
  - Canvas by Instructure
  - Autodesk<sup>®</sup> Inventor<sup>®</sup> Publisher app
  - Popplet Lite
- 48 Inch string
- Launch Log

### Procedure

#### Part 1 – Constructing a Mechanical Device

Engineers often use energy conversion as they design solutions to problems. Converting human chemical energy to mechanical energy could offer a way to solve the problem of lifting the supplies into the tree house. Before you develop a solution to the problem, you will work with a group to build a VEX IQ<sup>®</sup> pulley device to provide one source of mechanical energy. You will also be able to use the bike model you built earlier when you are ready to design a solution. A compound machine can make the work much easier. We would say that it has a mechanical advantage. It is certainly safer than trying to lift the items.

1. Follow the directions below to build a pulley system using VEX IQ<sup>®</sup> equipment.
  - a. Open the Autodesk<sup>®</sup> Inventor<sup>®</sup> Publisher app on your tablet.
  - b. Use the table of contents to select EC2\_Pulley\_01 and follow the directions to build the structure.

- c. 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.
- d. Work through the building steps shown below to build your bicycle. As you complete each step, make a note to track your progress.

<b>Building Step</b>	<b>Completed</b>
EC2_Pulley_01_LeftSide	
EC2_Pulley_02_RightSide	
EC2_Pulley_03_Top	
EC2_Pulley_04_LowerPulley	
EC2_Pulley_05_FinalAssembly	

- e. When you begin to solve the problem, you will use a 48 inch string to make your pulley system work.

## **Part 2 – Developing a Solution**

As part of a team, you will follow the steps of the design process to develop a solution to the problem of lifting objects into a tree house. Label a section of your Launch Log with the heading “Harnessing Energy.” You will use this section to record your work on this project.

### **1. Ask**

- What is the problem you are trying to solve?
- After reading the introduction to this project, identify the problem. Discuss it with your group and then record your response in your Launch Log. Include criteria and constraints for the solution.

### **2. Explore**

- Discuss with your group some possible solutions to the problem you have identified. Consider how you could use the bike and/or the pulley system to solve the problem.
- Remember that you will need the string to make your pulley system work. How could you use the string to connect the pulley system to the back axle of the bike to create a solution?
- Sketch one or two of your possible solutions in your Launch Log.

### **3. Model**

- Allow each group member to share his or her ideas of how to solve the problem using the devices you have constructed.
- Decide as a group the best solution to the problem.
- Work together to build a model of your solution. Select VEX IQ® pieces or other materials to represent the items that need to be lifted to the treehouse.
- Draw a diagram of how you connected the system in your Launch Log.

#### **4. Evaluate**

- Test your model to get a feel for how much effort force you must put into the system to raise your items to a certain height as determined by your teacher.
- Use the camera app on a tablet to take a picture of your model.
- Reconfigure your pulley system and test again to see if you can lessen the effort force needed. Use the camera app on a tablet to take a picture of this setup.
- Discuss with your group which model worked best and whether or not the model solved the problem. In your Launch Log, describe the results of your testing. Which model used the least amount of force to lift the load?
- Take a picture of your final arrangement of the pulley system.
- Hold your bike up off the table to represent it being located in the tree house.

#### **5. Explain**

- Create a popplet showing your model, and label the images with a description of the effort force needed to lift the materials.
- Create a sketch of how this system might be used to raise the materials into the treehouse. Use the camera app to take a picture of your sketch. Add this image to your popplet.
- Share your popplet with the class as directed by your teacher.

### **Conclusion Questions**

Answer the following in your Launch Log or submit your answers using the Canvas app on your tablet.

1. List examples in which energy is converted between potential and kinetic energy in your problem solution.
  
2. Explain how you converted energy to meet a human need or want.