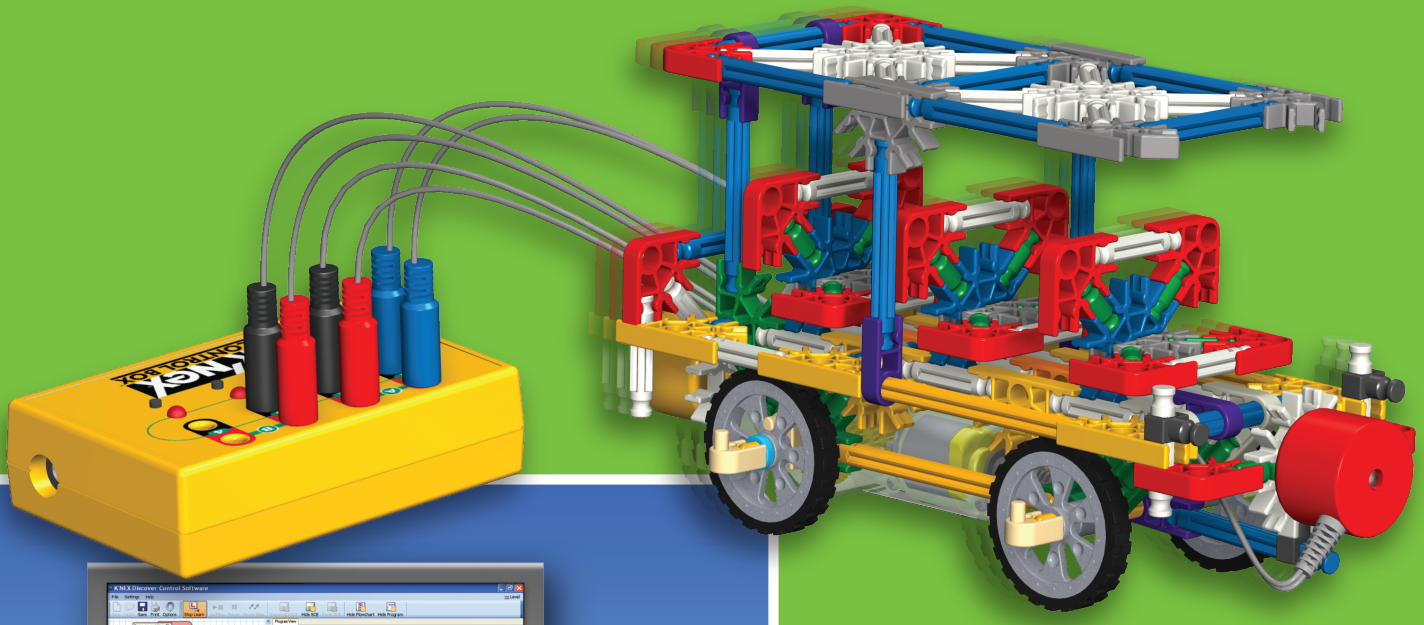
K'NEX® Education™

DISCOVER CONTROL™

Teacher's Guide



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DISCOVER CONTROL™

Teacher's Guide

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⚠ WARNING: CHOKING HAZARD – SMALL PARTS. Not for children under 3 years.

⚠ CAUTION - ELECTRIC TOY:
Not recommended for children under 8 years of age. As with all electric products, precautions should be observed during handling and use to prevent electric shock.

The toy must only be used with the recommended transformer.

Disconnect transformer before cleaning any components.

The transformer is not a toy.

All components of this set must be regularly examined for damage. This includes the cord, plug, enclosure and other parts, and in the event of such damage, they must not be used until the damage has been repaired.

Table of Contents

Introduction:

Your class is about to embark on an excellent adventure using the K'NEX Education Discover Control Set to investigate STEM (Science, Technology, Engineering and Mathematics) concepts.

The Discover Control Set includes five dynamic K'NEX models which students will build, control and explore.

The K'NEX Control Box enables students to control the models using motors, and add other outputs including LEDs, and a buzzer to replicate real world machines, structures and amusement park rides.

The Discover Control Software recreates the control experience for students, right on their computer screens. **Simulated Control Environments** or SCEs bring the K'NEX models to life on-screen making learning easy, high tech, and exciting.

The Discover Control Software offers a simple flowchart based programming language that allows students to control the outputs of on-screen Simulated Control Environments (SCE). There are five SCEs, one for each of the five K'NEX models in the set. The SCEs will allow students to control multiple output devices (LEDs, motors, and a buzzer) on a simulation of the K'NEX model right on their computer screens. Just as students can press the buttons on the Control Box to operate the LEDs, motors, and buzzer on the real K'NEX model, they can click the same buttons on the computer simulation of the Control Box to make the on-screen devices operate. Or, they can click directly on the devices in the simulation to activate the on-screen K'NEX model.

The SCE provides students with the opportunity to practice writing programs on their computers before they operate the real K'NEX models with the Control Box.

The first step for students is to open an SCE.

- Start the K'NEX Discover Control Software
- Click on 'Connect SCE'
- A file dialogue box will appear listing all of the SCEs.
- Direct students to open the appropriate SCE.

The SCE of the selected K'NEX model will appear on the screen with a small tool bar. Describe each of the buttons on the tool bar (labels will appear as you pass the cursor over the buttons). Ask students to click on the button with the upper case 'I' (instruction). They will see the text that will guide their exploration.

This Teacher's Guide outlines a series of 6 comprehensive lessons that introduce students to computer control technology, writing programs to operate models, and rigorous content in science, technology, engineering, and mathematics.

The lessons are built around NSES Science Content Standards, ITEEA Standards for Technological Literacy, and NCTM Standards and Expectations for Mathematics. The objectives for each lesson highlight what students will learn and the processes they will use to meet those objectives. Science process skills, the engineering design process, the core concepts of technology, science inquiry, and the role of invention and innovation in technology will be emphasized throughout the lessons.

Students will build the K'NEX models from full-color diagrams found in the building instructions (Provided on CD). Construction is not just matching colors with the instructions but an opportunity to watch a three-dimensional model come to life through the use of a two-dimensional design. As students build they will be constructing many systems that will work together in the final model. The construction phase of the lessons also requires students to wire various electronic devices to their models and then to the Control Box. Following directions, troubleshooting, and attention to detail will enable students to produce models that will work the first time every time.

The models in the building instructions were designed to provide a themed approach to learning and to coincide with identical, functioning models on the computer screen. The Simulated Control Environments (SCE) can complete many of the same functions as the actual models right on the computer screen and provide students with a chance to develop the skills to successfully control the actual models. Students will be directed to complete Learning Tasks and Challenge Activities to guide their learning while fostering critical thinking and problem solving skills.

Teacher's Notes:

The K'NEX Education Discover Control Set provides materials and lessons that will help you guide and facilitate student learning. Using K'NEX parts, the K'NEX Control Box and Discover Control Software with the direction provided in this guide, you will be able to offer students a program of study that uses hands-on exploration in conjunction with an engaging inquiry-based approach to learning. Students work cooperatively and should be encouraged to interact with each other as they build, program, investigate, discuss, and evaluate ideas.

The Discover Control Set provides students with an excellent introduction to control systems and allows them to control a series of five models by pressing buttons on the Control Box. The Control Box is essentially a small computer system that keeps track of each of the student's button presses and stores them on a computer chip. Each of those button presses turns on a motor, lights an LED or sounds a buzzer. The series of button presses, their duration, and the length of inactive periods can be repeated at any time as long as no other commands are programmed over them. Additionally, once the programmed information has been replayed, it will continue to loop until it is turned off.

Essentially, the system allows students to write a computer program in easy to understand steps using a model and electronic devices that respond to every press of the buttons. As an added benefit, the Discover Control Software allows the students to program the K'NEX models on the computer screen in the same manner as the actual K'NEX models. As the on-screen models are programmed to move, light, and buzz the software displays two presentations of the program that is being created by the students, a standard computer flow chart and a text version of the actions completed. When students have prepared a program that they are proud of they can save the program and replay it at any time. These activities are helping students to learn aspects of linear computer programming. With the skills they develop through the use of the K'NEX Discover Control Set they will soon be ready to move on to actual computer control systems like the K'NEX Computer Control Set that enables students to drag programming symbols into a program that is linear and beyond. Soon students are programming complex machines to complete complex tasks. Let's get started with the basics and begin the first lesson of the Discover Control Set with your class.

Teacher's Guide:

This guide is intended as a resource for teachers and students as they tackle meaningful STEM content in the classroom. *Each lesson includes:*

- **Student Objectives:** Objectives are provided for each of the six lessons included in the Teacher's Guide.
- **Requirements:** A list of the items that students are responsible for as they complete the activities outlined in each lesson.
- **Context:** Introductions to each lesson that will pique student interest and establish the reason for the activity.
- **Construction:** Direction to follow the full-color building instructions to build the models and to connect the K'NEX Control Box.
- **Learning Tasks:** Investigations that are to be completed first using the SCE for each model and then with the K'NEX models. These Learning Tasks sharpen students' skills with the features of the Control Box so they will be successful with the Challenge Activities that follow.
- **Challenge Activities:** Extended learning opportunities to include specific programming, science, engineering, math, and technology explorations.
- **Written copies of the students' lessons:** The lessons are divided into two levels of Learning Tasks and Challenge Activities. The science and mathematics activities in Level 1 are more appropriate for students in 2nd and 3rd grade. Level 2 is intended for students in grades 4 through 6. Level 2 includes both levels of Learning Tasks and Challenge Activities to support a wide range of student abilities in the same classroom.

Students can scroll through the text and complete the Learning Tasks and Challenge Activities in an orderly fashion. Written copies of the same lessons are provided in the Teacher's Guide for your planning purposes. There are important Teacher Notes included in your copy of the lessons to clarify activities and to provide reminders that will help you to better guide students and provide support.

There are two forms provided in the Teacher's Guide that you may copy for student use. These include a set of eight (8) Control Box K'NEXions Charts that are an important record keeping tool for students. Each time students write a new program for their SCE or model, they will need to record the locations where the various Output devices (motor, LEDs, and buzzer) are plugged into the Control Box. The K'NEXions Charts will make it easy for the students to record this information.

K'NEXions Chart

Model: _____

Output	Device
1	
2	
3	LED
4	BEZZER
A	MOTOR
B	

The second form is a two-page, Program Presentation Sheet (See below.). This Sheet is especially useful for students with limited writing skills. The sheet provides a simplified way for students to record the programs they write. The top of the sheet includes a K'NEXions Chart for easy reference. The remainder of the sheet includes rows of four circles (numbered 1 – 4) for students to color in and two blank spaces on each line. Each circle represents one of the Output buttons on the Control Box. Students color in the circles that represent the buttons they push on the Control Box. In the two blank spaces left on the line, students enter first the action that occurred when they pushed the button and secondly the amount of time the action lasted (i.e., "Motor ran" and "5 seconds"). Students can also show lines with no circles colored in and list the action as, "Motor stopped" and the amount of time the action was stopped.

K'NEX Discover Control Program Presentation Sheet:

Discover Control K'NEXions Chart

Model: _____

Output	Device
1	
2	
3	
4	
A	
B	

Program Presentation

STEP	Button Number 1	2	3	4	Action	For (Time)
1	●	○	○	○	Motor ran	5 seconds
2	●	○	○	○	Motor Stopped	5 seconds
3	○	○	○	○		
4	○	○	○	○		

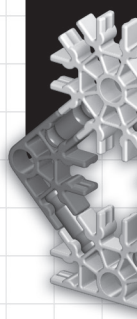
K'NEX Control Box and Software Manual and User's Guide:

This information is combined into a single document (Included on the software CD.) This document will serve as a valuable resource as you plan and prepare a comprehensive unit of study in computer control technology. All of the details related to the electronics, programming strategies, and use of Discover Control set are included in a clear and concise format. It is highly recommended that you read through this material before you begin this unit with your students.

You will be glad you did!

Your Discover Control Set Includes:

- **336 K'NEX Rods & Connectors** – Enough to serve a group of 1 to 3 students working as a team.
- **K'NEX Control Box** – An intelligent box that stores the sequence switches are pressed, their duration and the time between presses. These sequences of actions can be played back from the Control Box memory exactly as they originally occurred. The Control Box memory can store up to 64 actions to operate LEDs, a motor, and a buzzer individually or simultaneously.
- **Discover Control Software** – The software allows students to program an on-screen Control Box to operate SCEs of each of the five K'NEX models included in the set. The software also guides the investigation of fully-functioning K'NEX models through on-screen directions, Learning Tasks and Challenge Activities. The software has two instructional levels to support students with a range of abilities.
- **Electronic Output Devices** –
  - Two motor
  - Two LEDs
  - One buzzer
- **Building instructions** – These full-color graphics allow students to easily construct the models included in this set and to expertly connect the models and the Control Box.
- **K'NEX Models** – Students will construct the following models one at a time.
  - Amusement Park Gateway
  - Swing Ride
  - Spinning Carpet Ride
  - Double Ferris Wheel Ride
  - Tramcar



As with any classroom manipulative and especially this high tech control system, it is strongly suggested that you provide time for students to explore the use of the Control Box, motors, LEDs, and buzzer by completing Lesson 1 in this guide. While many of the students in your classroom will be familiar with K'NEX Rods and Connectors, students are curious and will want to explore and investigate. Consider providing some time at the beginning of the Amusement Park Gateway lesson for students to do so.

When you first introduce K'NEX in the classroom, ask for a show of hands to indicate which students have used K'NEX in other classrooms or at home. When you form groups for instruction, include an experienced K'NEX builder in each group. Also, assign groups carefully so that students of varying abilities are in each group. Research findings recommend that the teacher assign students to the work groups and not allow students to self select groups. Also, It is important to change group makeup from time to time.

Student Journals:

Journaling is a critical component of a STEM program. Students need to keep records of all of their work and all of their ideas. Working scientists use lab notebooks or field notebooks and engineers use design journals to record their work. It is strongly suggested that the students maintain a STEM Journal throughout these six lessons to document their work. A loose-leaf format serves this purpose well. Students should include notes, drawings, conjectures and reflections in addition to copies of programs they write with each lesson. The journal will provide a comprehensive record of the growth of individual students and provide you with an excellent source for assessment data.

ITEEA Standards Alignments with K'NEX Discover Control Lessons

ITEEA Standards Grades K - 8 *Students will develop an understanding of:*	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
THE CHARACTERISTICS AND SCOPE OF TECHNOLOGY						
Grades K – 2						
All people use tools and technology to help them do things.	❋	❋	❋	❋	❋	❋
Grades 3 - 5						
Tools, materials, and skills are used to make things and carry out tasks.	❋	❋	❋	❋	❋	❋
Grades 6 – 8						
New products and systems can be developed to solve problems or to help do things that could not be done without the help of technology.		❋	❋	❋	❋	❋
Technology is closely linked to creativity, which has resulted in innovation.		❋	❋	❋	❋	❋
THE CORE CONCEPTS OF TECHNOLOGY						
Grades K – 2						
Systems have parts or components that work together to accomplish a goal.	❋	❋	❋	❋	❋	❋
Grades 3 – 5						
Requirements are the limits to designing or making a product or system.		❋	❋	❋	❋	❋
Grades 6 – 8						
Systems thinking involves considering how every part relates to others.	❋	❋	❋	❋	❋	❋
Technological systems can be connected to one another.	❋	❋	❋	❋	❋	❋
Different technologies involve different sets of processes.	❋	❋	❋	❋	❋	❋
RELATIONSHIPS AMONG TECHNOLOGIES AND THE CONNECTIONS BETWEEN TECHNOLOGY AND OTHER FIELDS						
Grades 3 – 5						
Various relationships exist between technology and other fields of study.		❋	❋	❋	❋	❋
Grades 6 – 8						
Knowledge gained from other fields of study has a direct effect on the development of technological products and systems.		❋	❋	❋	❋	❋
THE CULTURAL, SOCIAL, ECONOMIC, AND POLITICAL EFFECTS OF TECHNOLOGY						
Grades 6 – 8						
The use of technology affects humans in various ways, including their safety, comfort, choices, and attitudes about technology's development and use.		❋	❋	❋	❋	❋
THE ATTRIBUTES OF DESIGN						
Grades K – 2						
Everyone can design solutions to a problem.	❋	❋	❋	❋	❋	❋
Grades 3 – 5						
Requirements for a design include such factors as the desired elements and features of a product or system or the limits that are placed on the design.		❋	❋	❋	❋	❋

ITEEA Standards Grades K - 8 *Students will develop an understanding of:*	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
Grades 6 – 8						
Design is a creative planning process that leads to useful products and systems.		❄	❄	❄	❄	❄
ENGINEERING DESIGN						
Grades K – 2						
The engineering design process includes identifying a problem, looking for ideas, developing solutions, and sharing solutions with others.		❄	❄	❄	❄	❄
Grades 3 – 5						
When designing an object, it is important to be creative and consider all ideas.		❄	❄	❄	❄	❄
Models are used to communicate and test design ideas and processes.		❄	❄	❄	❄	❄
Grades 6 – 8						
Modeling, testing, evaluating, and modifying are used to transform ideas into practical solutions.		❄	❄	❄	❄	❄
APPLY DESIGN PROCESS						
Grades K – 2						
Build or construct an object using the design process.		❄	❄	❄	❄	❄
Grades 3 - 5						
Improve the design solutions.		❄	❄	❄	❄	❄
Grades 6 - 8						
Apply a design process to solve problems in and beyond the laboratory-classroom.		❄	❄	❄	❄	❄
Make a product or system and document the solution.		❄	❄	❄	❄	❄
USE AND MAINTAIN TECHNOLOGICAL PRODUCTS AND SYSTEMS						
Grades 3 - 5						
Use computers to access and organize information.		❄	❄	❄	❄	❄
Follow step-by-step directions to assemble a product.		❄	❄	❄	❄	❄
Grades 6 – 8						
Use computers and calculators in various applications.	❄	❄	❄	❄	❄	❄
SELECT AND USE ENERGY AND POWER TECHNOLOGIES						
Grades 6 – 8						
Energy can be used to do work, using many processes.		❄	❄	❄	❄	❄
Power systems are used to drive and provide propulsion to other technological products and systems.		❄	❄	❄	❄	❄

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NSES Standards Alignments with K'NEX Discover Control Lessons

National Science Education Content Standards *Students will develop an understanding of:*	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
UNIFYING CONCEPTS AND PROCESSES						
Systems, order, and organization	✻	✻	✻	✻	✻	✻
Evidence, models, and explanation		✻	✻	✻	✻	✻
Measurement		✻	✻	✻	✻	✻
Form and function	✻	✻	✻	✻	✻	✻
A. SCIENCE AS INQUIRY						
Abilities necessary to do scientific inquiry	✻	✻	✻	✻	✻	✻
Understandings about scientific inquiry	✻	✻	✻	✻	✻	✻
B. PHYSICAL SCIENCE						
Grades K-4						
Position and motion of objects	✻	✻	✻	✻	✻	✻
Grades 5 - 8						
Motions and Forces		✻	✻	✻	✻	✻
Transfer of energy		✻	✻	✻	✻	✻
E. SCIENCE AND TECHNOLOGY						
Abilities of technological design		✻	✻	✻	✻	✻
Understandings about science and technology		✻	✻	✻	✻	✻
G. HISTORY AND NATURE OF SCIENCE						
Understanding of science as a human endeavor		✻	✻	✻	✻	✻
Understanding the Nature of Science		✻	✻	✻	✻	✻

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NCTM Standards Alignments with K'NEX Discover Control Lessons

National Council of Teachers of Mathematics Standards and Expectations Grades 3 - 8 *Students will develop an understanding of:*	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
NUMBERS AND OPERATIONS						
Understand numbers, ways of representing numbers, relationships among numbers, and number systems.		✻	✻	✻	✻	✻
Grades 6 - 8						
Work flexibly with fractions, decimals, and percents to solve problems.		✻	✻	✻	✻	✻
Understand and use ratios and proportions to represent quantitative relationships.		✻	✻	✻	✻	✻
Understand meanings of operations and how they relate to one another.		✻	✻	✻	✻	✻

National Council of Teachers of Mathematics Standards and Expectations Grades 3 - 8 *Students will develop an understanding of:*	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
Grades 3 - 5						
Understand various meanings of multiplication and division.		✻	✻	✻	✻	✻
Understand the effects of multiplying and dividing whole numbers.		✻	✻	✻	✻	✻
Compute fluently and make reasonable estimates.		✻	✻	✻	✻	✻
Grade 3 - 5						
Develop fluency in adding, subtracting, multiplying and dividing whole numbers.		✻	✻	✻	✻	✻
Select appropriate methods and tools for computing with whole numbers from among mental computation, estimation, calculators, and paper and pencil according to the context and nature of the computation and use the selected method or tools.		✻	✻	✻	✻	✻
Grades 6 - 8						
Select appropriate methods and tools for computing with fractions and decimals for among mental computation, estimation, calculators or computers, and paper and pencil, depending on the situation, and apply the selected methods.		✻	✻	✻	✻	✻
ALGEBRA						
Analyze change in various contexts.	✻	✻	✻	✻	✻	✻
MEASUREMENT						
Understand measurable attributes of objects and the units.	✻	✻	✻	✻	✻	✻
Apply appropriate techniques, tools, and formulas to determine measurements.		✻	✻	✻	✻	✻
Grades 6 - 8						
Solve simple problems involving rates and derived measurements for such attributes as velocity and density.			✻	✻		
DATA ANALYSIS AND PROBABILITY						
Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.		✻	✻	✻	✻	✻
Grades 3 - 5						
Collect data using observation, surveys, and experiments.		✻	✻	✻	✻	✻
Represent data using tables and graphs such as line plots, bar graphs, and line graphs.		✻	✻	✻	✻	✻
Select and use appropriate statistical methods to analyze data.		✻	✻			✻
Develop and evaluate inferences and predictions that are based on data.		✻	✻			✻
Understand and apply basic concepts of probability.		✻	✻			✻
PROCESS						
Problem Solving						
Solve problems that arise in mathematics and in other contexts.		✻	✻	✻	✻	✻
Communication						
Organize and consolidate their mathematical thinking through communication.		✻	✻	✻	✻	✻
Communicate their mathematical thinking coherently and clearly to peers, teachers, and others.		✻	✻	✻	✻	✻
Connections						
Recognize and apply mathematics in contexts outside of mathematics.		✻	✻	✻	✻	✻

Lesson 1 The K'NEX Control Box

Objectives:

The students will demonstrate the ability to:

- ☑ Problem solve as they explore the features of the Control Box. ***(Science and Technology)***
- ☑ Design and alter a series of commands made to the Control Box as they operate a motor, LEDs, and a buzzer. ***(Science and Technology)***
- ☑ Order the commands made to the Control Box to repeat a pattern of actions. ***(Science, Technology, and Mathematics)***
- ☑ Use the looping function of the Control Box to repeat a pattern of actions. ***(Science and Technology)***

Context:

Your team is about to begin an exciting project!

You will be building and operating amusement park rides. You will be in control and you will decide how each ride works. Before you can begin, you need to be able to operate the Control Box. This device will allow your team to control all of the amusement park rides and attractions. It will also allow your team to write programs that repeat themselves over and over again.

It doesn't get any easier than that!
Let's get to work.

Requirements:

For this activity you are required to:

1. Make daily entries in your STEM Journal. ***(Teacher Note: Help students to realize the importance of keeping records and journaling. Inform students of the materials they must include in their STEM Journals such as notes, drawings, conjectures and reflections and copies of programs.)***
2. List the K'NEXions Chart for all Challenge Activities your team completes. ***(Teacher Note: If you are using the simplified Program Presentation Sheet, the K'NEXions Chart will be at the top of that sheet or you can use the K'NEXions Chart page. This introductory lesson is a great opportunity to review how students will report where they have connected their motor, LEDs, or buzzer to the Control Box.)***
3. List and describe the steps in your programs. Keep a record of any changes you made to programs as you improved them. ***(Teacher Note: The simplified Program Presentation Sheet will help students with limited writing skills to describe their program in a graphic as well as a written form. Students with better writing skills can list and describe their programs directly in their STEM Journals. As students work through this introductory activity help them to record their programs. If they will be using the Program Presentation Sheet, it is recommended that you complete the sheets as a class for the first few programs.***

Construction:

Attach the motor, LEDs and buzzer to the Control Box as shown.
(Teacher Note: It is suggested that the Control Boxes be plugged into the wall outlet prior to students plugging in the motor, LEDs and Buzzer. Review appropriate safety procedures related to the use of electricity in the classroom.)
(Science, Technology, and Engineering)

(The K'NEXions Chart below outlines the placement of the motor, LEDs, and buzzer for Control Box as shown above. This is an excellent opportunity to provide students with the K'NEXions Chart you wish them to use. Guide them through the process of filling out the chart as shown below.)

K'NEXions Chart

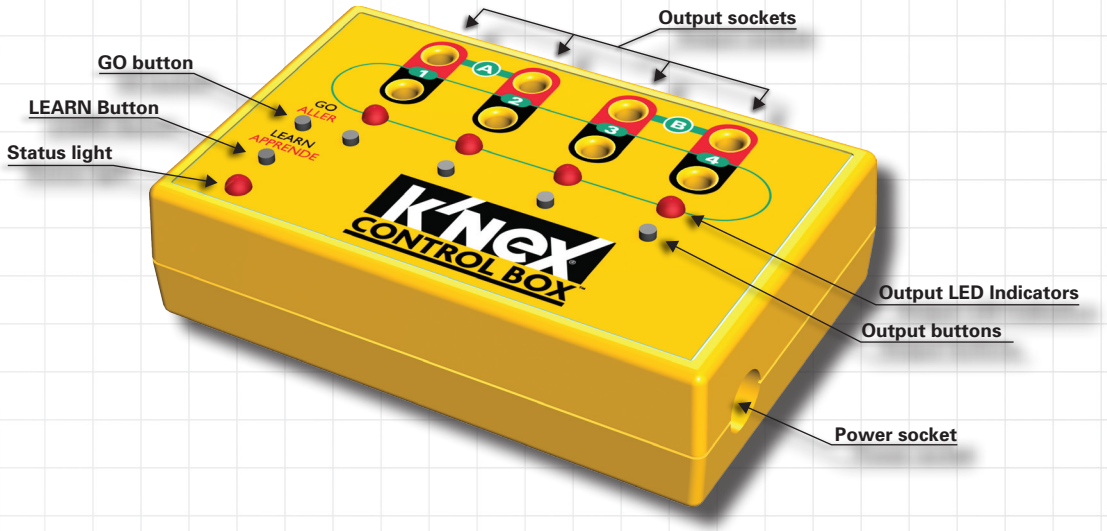
Control Box Introduction

Output	Device
1	MOTOR
2	LED # 1
3	LED # 2
4	BUZZER
A	
B	

Learning Tasks:

Complete these learning tasks using the K'NEX Control Box as shown above.

Complete the tasks below as you learn to use the Control Box to power and control the motor, the LEDs and the buzzer. Further exploration will allow you to program the devices to work together over and over again.



1. * Complete the following list of actions and button presses. Describe what happens as you press each of the buttons.

- * The Status Indicator Button should have started blinking when the Control Box was plugged into the power adaptor. Press each of the Output Buttons. What happened? *(Nothing.)* *(Technology)*
- * Press the LEARN Button. What happened? *(The Status Indicator LED stops blinking and remains lit.)* *(Technology)*
- * Press the Output 1 Button and hold it down. What happened? *(The motor turns on and stays on. The Output 1 LED Indicator lights.)* *(Science and Technology)*
- * Release the Output 1 Button. What happened? *(The motor stops and the LED Indicator turns off.)* *(Science and Technology)*
- * Try all of the other Output Buttons. What happened? *(The LEDs light, the buzzer sounds, and the LED Indicators light when their Output Buttons are pressed.)* *(Science and Technology)*

- * What have you learned so far?
  (The motor, LEDs, and Buzzer do not operate when the Status Indicator LED is blinking. If you press the LEARN Button, the Status Indicator LED stops blinking and stays lit. The Output Buttons now operate the motor, LEDs and buzzer and the Output Indicator LEDs light when the corresponding buttons are pressed.)
  (Science and Technology)

- * Press the LEARN Button again and press each of the Output buttons one at a time while you count to three. Press the GO Button. What happened?
  (As the buttons are pressed the devices turn on for a count of three. The devices stop operating and the Status Indicator LED flashes when the GO Button is pressed.)
  (Science and Technology)

- * Press the GO Button again. What happened?
  (The motor, LEDs, and buzzer all operate one at a time for a count of three and repeat the pattern over and over again. The Control Box saved the series of button presses and is repeating them.
  (Science and Technology)

- * Press the LEARN Button. What happened?
  (The repeating pattern stopped and the Status Indicator LED is blinking.)
  (Science and Technology)

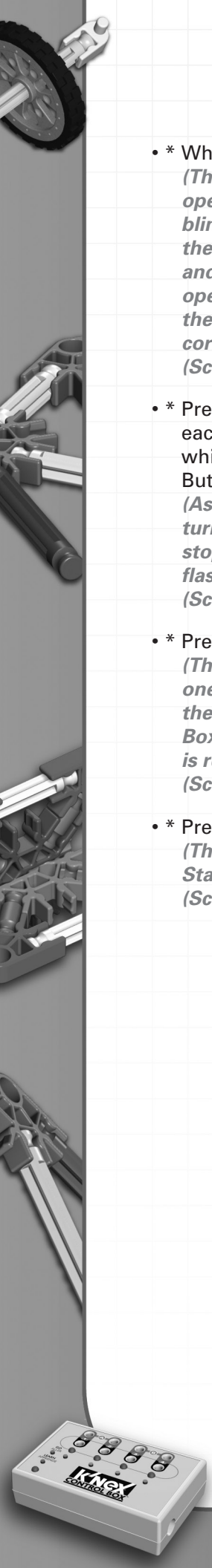
- * Press the GO Button again. What happened?
  (The repeating pattern started again. The pattern of button presses is still saved in the Control Box.)
  (Science and Technology)

- * Press the LEARN Button to stop the repeating program.
  (Technology)

- * Experiment with the Control Box, motor, LED, and buzzer and write several other programs that can be repeated over and over again.
  (Science and Technology)

- * Switch the plugs of LED # 1 in Output 2 of the Control Box. Press the LEARN Button and then press and hold the Output 2 button. What do you notice?
  (The LED lights with a different color.)
  (Science and Technology)

- * What happens if you switch the plugs on the other LED, and the motor?
  (The motor changes direction and the LED changes color. The students may not realize the motor has changed direction unless they place a red or gray rod through the motor to emphasize any changes in the motor's action.)
  (Science and Technology)



Challenge Activities:

Your design team has been challenged to:
(Teacher Note: Remind students that the output devices may need to be plugged into different locations on the Control Box for Challenge Activities.)

1. * **Write a program for the Control Box that flashes one LED red and the other LED green. Allow the Control Box to repeat the program several times.**
   (Science and Technology)

2. * **Write a program for the Control Box that flashes the LEDs four times each and then sounds a buzzer for a count of three. Allow the Control Box to repeat the program several times.**
   (Science, Technology, and Mathematics)

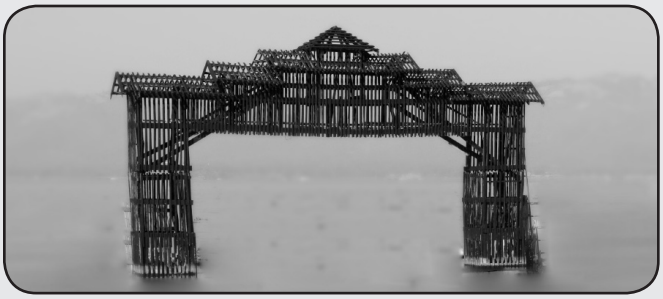
3. * **Design and build a small stand to hold the motor above the table top.**
   - Place a red or gray rod through the motor and attach an orange connector to each end of the rod.
   - Write a program to operate the motor, LEDs, and buzzer.
   - Allow the Control Box to repeat the program several times.
     (Science, Technology, and Engineering)

4. * **Investigate the use of Output A.**
   - Use the stand your team built in the previous activity.
   - Remove the plugs from Outputs 1 and 2.
   - Plug the motor into the Output A positions.
   - Press the LEARN button and then press and hold the Output 1 and 2 buttons one at a time. What happens?
     (The motor changes direction.)
     (Science and Technology)

5. * **Investigate the use of the Output B.**
   - Remove the plugs from Outputs 3 and 4.
   - Plug one of the LEDs into the Output B positions.
   - Press the LEARN Button then press the Output 3 and 4 buttons one at a time. What happens?
     (The LED changes color with the press of each Output button.)
     (Science and Technology)

6. * **Write a program that operates the motor in Output A and an LED in Output B.**
   - Run the motor in one direction for a count of three.
   - Light the LED red for a count of two.
   - Run the motor in the opposite direction for a count of four.
   - Light the LED green for a count of two.
   - Allow the Control Box to repeat the program several times.
     (Science, Technology, and Mathematics)

Lesson 2 Amusement Park Gateway



Objectives:

The students will demonstrate the ability to:

- ☑ Use sequential thinking to design programs to control LEDs on a model.
  (Science and Technology)
- ☑ Communicate ideas and outline programs by maintaining a STEM Journal.
  (Science, Technology, Engineering, and Mathematics)
- ☑ Compute fluently to solve addition and multiplication problems.
  (Engineering and Mathematics)
- ☑ Identify and describe geometric shapes and patterns
  (Engineering and Mathematics)

The first step for students is to open the SCE for the Amusement Park Gateway. Once students have opened the Discover Control Software they should click the Connect SCE icon at the top of the screen. A file dialogue box will appear. Instruct students to open the Gateway SCE. The Gateway image will appear on the screen with a small tool bar. Describe each of the buttons on the tool bar (labels will appear as you pass the cursor over the buttons). Ask students to click on the button with the upper case 'I' (instruction) and they will see the following text appear to guide their exploration.

Requirements:

For this activity you are required to:

1. Make daily entries in your STEM Journal.
   (Teacher Note: Help students to realize the importance of keeping records and journaling. Inform students of the materials they must include in their STEM Journals.)
2. List the K'NEXions Chart for all Challenge Activities your team completes.
   (Teacher Note: If you are using the simplified Program Presentation Sheet, the K'NEXions Chart will be at the top of that sheet. If not, a template page for K'NEXions Charts has been provided.)
3. List and describe the steps in your programs. Keep a record of changes you made to programs as you improved them.
   (Teacher Note: The simplified Program Presentation Sheet will help students with limited writing skills to describe their program in a graphic as well as a written form. Students with better writing skills can list and describe their programs directly in their STEM Journals.)
4. Include all calculations, charts, and graphs you prepare in your STEM Journal.

Context:

Your design team has been selected to plan, construct, program and operate the attractions for an amusement park in your community. Your first project is to add excitement to the park gateway that will welcome park visitors.

Follow directions, plan carefully, and complete the activities that have been outlined for this task.

Good Luck!

Construction:

Use the instructions to build the amusement park Gateway model.
(Engineering)

Ensure that all of the electronic components have been plugged into the K'NEX Control Box before you begin work.

(The K'NEXions Chart outlines the placement of the LEDs for the Learning Tasks in this lesson. The students will find this information in graphic form in the building instructions.)

K'NEXions Chart

K'NEX Amusement Park Gateway

Output	Device
1	LED # 1
2	LED # 2
3	
4	
A	
B	

Learning Tasks:

Complete these learning tasks using both the K'NEX Amusement Park Gateway SCE on the computer and the K'NEX Amusement Park Gateway model and Control Box.
(Teacher Note: Encourage students to complete these learning tasks using the SCE on the computer before they program the Control Box to operate the LEDs on the model.)

Light the Gateway to the amusement park using the Control Box and the LEDs.

1. * **Use the Control Box to write a program that makes one of the LEDs blink in an interesting pattern. Allow the Control Box to repeat your pattern several times.**
   (Science, Technology, and Mathematics)

2. * **Use the Control Box to write a program that makes the other LED blink in a different pattern. Allow the Control Box to repeat the pattern several times.**
   (Science, Technology, and Mathematics)

Challenge Activities:

Keep daily notes in your STEM Journal and include all of the programs you write.
(Teacher Note: Remind students that the output devices may need to be plugged into different locations on the Control Box for Challenge Activities.)

1. * **Part 1 - Propose a name for the amusement park and attach a sign and other graphics of your design to the K'NEX Amusement Park Gateway.**
   a. The sign will include the name of the park.
   b. The sign and graphics will be colorful.
   c. Use the Control box to flash the LEDs.
   d. Part 2 - Prepare a back for the K'NEX Gateway that thanks visitors for coming and welcomes them back for another visit in the future.
   (Science, Technology, and Engineering)

2. ** **Use the Control Box to make the pair of LEDs blink in a pattern using one red and one green LED. Allow the Control Box to repeat your pattern several times.**
   (Science, Technology, and Mathematics)

3. ** **Use the Control Box to make both LEDs blink red and green in a pattern. Allow the Control Box to repeat your pattern several times.**
   (Science, Technology, and Mathematics)

4. * **Refer to the building instructions for the Amusement Park Gateway and the Cost per Piece Chart provided by your teacher. Calculate the cost of the materials that are used to build the K'NEX Amusement Park Gateway.**
   a. Make a data chart for this activity in your STEM Journal and include all of your calculations
   b. Place your answer on the board in the spot indicated by your teacher.
   (Teacher Note: Set aside space on the white board or chalk board for each team to list their cost of materials so that the costs are visible to the entire class.).
   • How do your results compare with other groups who have completed the challenge? If answers vary, devise and implement a plan to check your work.
   (Teacher Note: Provide time for the teams to compare their answers and to correct any differences. The Cost Per Piece Chart has been provided in an editable format allowing you to assign costs to the K'NEX Pieces that are appropriate for the students you are working with.
   (Science, Engineering, and Mathematics)

5. ** **Complete the activity above using a spreadsheet program to organize the data, compute the costs, and calculate the total cost of the materials used to build the K'NEX Amusement Park Gateway.**
   (Science, Technology, Engineering, and Mathematics)

6. * **List the different geometric shapes that you can identify on the K'NEX Amusement Park Gateway model.**
   a. How many of each shape do you see in the model?
   b. Draw a table that lists the shapes you found in the left column and the number of each shape in the right column.
   (Engineering and Mathematics)

7. ** **Triangular shapes used in construction are stronger than square or rectangular shapes. Write a paragraph to explain why it is important to use triangles in this model and a real amusement park entrance gate.**
   (Engineering and Mathematics)

Lesson 3 Swing Ride

Context:

Now it is time to get to work on one of the rides that will be a part of the amusement park. Your team has finished the Amusement Park Gateway and is ready to begin work on the Swing Ride. This ride will be a favorite of both children and adults alike.

Follow directions, plan your programs carefully, and complete the activities for the Swing Ride.

Objectives:

The students will demonstrate the ability to:

- ☑ Use logical thinking skills to program the Swing Ride to effectively use a buzzer, motor and LED to design an exciting ride. ***(Science and Technology)***
- ☑ Design programs for the Swing Ride that meet stated needs. ***(Science and Technology)***
- ☑ Collect, organize, and display relevant data to answer questions. ***(Science, Engineering, and Mathematics)***
- ☑ Report on the concept of inertia and describe how it influences the operation of the Swing Ride. ***(Science)***
- ☑ Solve problems related to rotational motion. ***(Science and Mathematics)***

Have students open the Swing Ride SCE.

Requirements:

For this activity you are required to:

1. Make daily entries in your STEM Journal. ***(Teacher Note: Help students to realize the importance of keeping records and journaling. Inform students of the materials they must include in their STEM Journals.)***
2. List the K'NEXions Chart for all Challenge Activities your team completes. ***(Teacher Note: If you are using the simplified Program Presentation Sheet, the K'NEXions Chart will be at the top of that sheet. If not, a template page for K'NEXions Charts has been provided.)***
3. List and describe the steps in your programs. Keep a record of changes you made to programs as you improved them. ***(Teacher Note: The simplified Program Presentation Sheet will help students with limited writing skills to describe their program in a graphic as well as a written form. Students with better writing skills can list and describe their programs directly in their STEM Journals.)***
4. Include all calculations, charts, and graphs you prepare in your STEM Journal.

Construction:

Use the instructions to build the K'NEX Swing Ride model. ***(Technology and Engineering)***

Ensure that all of the electronic components have been connected to the K'NEX Control Box before you begin work.

(The K'NEXions Chart outlines the placement of the buzzer, motor, and LEDs for the Learning Tasks in this lesson. The students will find this information in graphic form in the building instructions.)

K'NEXions Chart

K'NEX Swing Ride

Output	Device
1	
2	
3	LED
4	BUZZER
A	MOTOR
B	

Learning Tasks:

Complete these learning tasks using both the Swing Ride SCE on the computer and the K'NEX Swing Ride model and Control Box.
(Teacher Note: Encourage students to complete these learning tasks using the Swing Ride SCE on the computer before they program the Control Box to operate the K'NEX model.)

Write programs to make the K'NEX Swing Ride complete the tasks below.

1. * **Write a program for the Control Box to make the Swing Ride change direction three times. Allow the Control Box to repeat your program several times.**
   (Science and Technology)
2. * **Write a program for the Control Box to make the model:**
   a. Change direction three times and spin for 10 seconds in each direction,
   b. Stop for five seconds between direction changes.
   c. Repeat your program several times.
   (Science, Technology, and Mathematics)
3. * * **Write a program for the Control Box to add the LED and Buzzer to improve the safety of the ride for the riders and observers. Your team may decide how the ride will operate. Allow the Control Box to repeat your program several times.**
   (Science, Technology, and Engineering)

Challenge Activities:

Keep daily notes in your STEM Journal and include all of the programs you write.
(Teacher Note: Remind students that the output devices may need to be plugged into different locations on the Control Box for Challenge Activities.)

1. ** **Write a single program for the Control Box so:**
   a. The LED shines red when the ride is moving clockwise.
   b. The LED shines green when the ride is moving counterclockwise.
   c. Allow the Control Box to repeat your program several times.
   (Hint: you may need to plug the LED into a different location on the Control Box and remove the buzzer.)
   (Science and Technology)
2. * **Determine the speed of the K'NEX Swing Ride in revolutions per minute (rpm). In other words, how many times does the ride spin in one minute?**
   (Science and Mathematics)
3. ** **Find the average speed of the K'NEX Swing Ride in revolutions per minute (rpm) for a total of four (4), one-minute trials.**
   a. Collect the data and design a data chart to display the data.
   b. Find the average of the four (4) sets of data.
   c. Show all calculations in your STEM Journal.
   d. Be prepared to explain your experimental strategy and to demonstrate how you arrived at your answer.
   (Note: You may place a masking tape flag on one seat of the ride to make counting easier.) (Science and Mathematics)
4. * **Operate the ride for several minutes as you observe the motion of the seats. Start and stop the ride several times:**
   a. What do you observe about the seats when the ride speeds up?
   b. What do you observe about the seats as the ride moves at a constant speed?
   c. What do you observe about the seats when the ride slows?
   d. Provide one or more explanations for what you observed.
   (Science, Technology, Engineering and Mathematics)

5. ** Research the word inertia.

a. Describe how this model overcomes inertia in paragraph form.

b. How is the concept of inertia demonstrated by this model?
(Science, Technology, Engineering and Mathematics)

6. ** The seats on the K'NEX Swing Ride are attached to the ride with long gray Rods. Remove the gray Rods and replace them with yellow Rods.

a. Find the average speed of the modified K'NEX Swing Ride in revolutions per minute (rpm) for a total of four (4), one-minute trials.

b. Compare your findings with the results you calculated for the original K'NEX Swing Ride.

c. Explain any differences you find in paragraph form.
(Science, Technology, Engineering and Mathematics)

7. * Refer to the building instructions for the K'NEX Swing Ride and the Cost per Piece Chart provided by your teacher. Determine the cost of the materials that are used to build the ride.

a. Make a data chart for this activity in your STEM Journal and include all of your calculations

b. Place your answer on the board in the spot indicated by your teacher.
(Teacher Note: Set aside space on the white board or chalk board for each team to list their cost of materials so that the costs are visible to the entire class.).

c. How do your results compare with other groups who have completed the challenge? If answers vary, devise and implement a plan to check your work.
(Teacher Note: Provide time for the teams to compare their answers and to correct any differences. The Cost Per Piece Chart has been provided in an editable format allowing you to assign costs to the K'NEX Pieces that are appropriate for the students you are working with.
(Science, Engineering, and Mathematics)

8. ** Complete the activity above using a spreadsheet program to organize the data, compute the costs, and calculate the total cost of the materials used to build the K'NEX Swing Ride.
(Science, Technology, Engineering, and Mathematics)

Lesson 4 Spinning Carpet Ride

Objectives:

The students will demonstrate the ability to:

- ☑ Program the K'NEX Spinning Carpet model to add excitement and safety for the riders. ***(Science, Technology, Engineering, and Mathematics)***
- ☑ Design a system and an actual safety device to remove riders from the ride in the event of a failure. ***(Technology and Engineering)***
- ☑ Analyze a group of gears to determine whether a machine is geared up or geared down and to find the gear ratio of the gear system. ***(Science, Technology, Engineering and Mathematics)***
- ☑ Rebuild the K'NEX Spinning Carpet Ride with a new gear ratio and analyze the impact of the change to the system. ***(Science, Technology, Engineering, and Mathematics)***

Have students open the K'NEX Spinning Carpet Ride SCE.

Context:

The amusement park is taking shape and it is time to plan, construct and operate a new ride. The Spinning Carpet Ride will be great fun for all of the park visitors. Your team has proven you are ready for the challenge.

Requirements:

For this activity you are required to:

1. Make daily entries in your STEM Journal. ***(Teacher Note: Help students to realize the importance of keeping records and journaling. Inform students of the materials they must include in their STEM Journals.)***
2. List the K'NEXions Chart for all Challenge Activities your team completes. ***(Teacher Note: If you are using the simplified Program Presentation Sheet, the K'NEXions Chart will be at the top of that sheet. If not, a template page for K'NEXions Charts has been provided.)***
3. List and describe the steps in your programs. Keep a record of changes you made to programs as you improved them. ***(Teacher Note: The simplified Program Presentation Sheet will help students with limited writing skills to describe their program in a graphic as well as a written form. Students with better writing skills can list and describe their programs directly in their STEM Journals.)***
4. Include all calculations, charts, and graphs you prepare in your STEM Journal.

Construction:

Use the instructions to build the K'NEX Spinning Carpet Ride model. ***(Science, Technology, and Engineering)***

Ensure that all of the electronic components have been plugged into the K'NEX Control Box before you begin work.

(The K'NEXions Chart outlines the placement of the buzzer, motor, and LEDs for the Learning Tasks in this lesson. The students will find this information in graphic form in the building instructions.)

K'NEXions Chart

K'NEX Spinning Carpet Ride

Output	Device
1	
2	
3	LED
4	BUZZER
A	MOTOR
B	

Learning Tasks:

Complete these learning tasks using both the Spinning Carpet Ride SCE on the computer and the K'NEX Spinning Carpet Ride model and Control Box.
(***Teacher Note: Encourage students to complete these learning tasks using the K'NEX Spinning Carpet Ride SCE on the computer before they program the Control Box to operate the model.)***

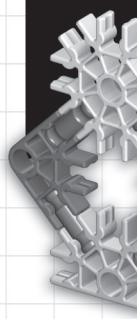
Write programs that will enable the Spinning Carpet Ride to:

1. * **Change direction three times.**
   - The ride must spin for 10 seconds in each direction.
   - Allow the Control Box to repeat your program several times.
     (Science and Technology)
2. * **Change directions several times and stop after each change of direction to keep the ride safer.**
   - The ride must spin for 10 seconds in each direction.
   - The ride must stop for five seconds between each direction change.
   - Allow the Control Box to repeat your program several times.
     (Science, Technology, and Engineering)
3. * **Change direction several times and shine a red LED whenever the ride is about to start spinning.**
   - Plan a ride for the Spinning Carpet that everyone will enjoy.
   - Shine the LED red for 3 seconds before the ride starts spinning.
   - Allow the Control Box to repeat your program several times.
     (Science and Technology)
4. * **Operate with sound.**
   - Plan a ride with lots of sound and shining LEDs.
   - Sound the buzzer for two seconds any time the ride is about to stop.
   - Allow the Control Box to repeat your program several times.
     (Science and Technology)

Challenge Activities:

Keep daily notes in your STEM Journal and include all of the programs you write.
(Teacher Note: Remind students that the output devices may need to be plugged into different locations on the Discover Control Box for Challenge Activities.)

1. * **Write a program for the Control Box that includes these actions:**
   - The LED shines red when the ride is moving clockwise,
   - The LED shines green when the ride is moving in a counterclockwise direction.
   - Allow the Control Box to repeat your program several times.
     (Science and Technology)
2. * **Write a program for the ride that flashes the LED red and green at different times when the ride is moving.**
     (Science and Technology)
3. * **Refer to the building instructions for the K'NEX Spinning Carpet Ride and the Cost per Piece Chart provided by your teacher. Determine the cost of the materials that are used to build the ride.**
   - Make a data chart for this activity in your STEM Journal and include all of your calculations
   - Place your answer on the board in the spot indicated by your teacher.
     (Teacher Note: Set aside space on the white board or chalk board for each team to list their cost of materials so that the costs are visible to the entire class.).



- How do your results compare with other groups who have completed the challenge? If answers vary, devise and implement a plan to check your work.
  (Teacher Note: Provide time for the teams to compare their answers and to correct any differences. The Cost Per Piece Chart has been provided in an editable format allowing you to assign costs to the K'NEX Pieces that are appropriate for the students you are working with.
  (Science, Engineering, and Mathematics)

4. ** Complete the activity above using a spreadsheet program to organize the data, compute the costs, and calculate the total cost of the materials used to build the K'NEX Spinning Carpet Ride.
(Science, Technology, Engineering, and Mathematics)

5. * Determine the speed of the K'NEX Spinning Carpet Ride in revolutions per minute (rpm). In other words, how many times does the ride spin in one minute? (Note: You may place a masking tape flag on one seat of the ride to make counting easier.)
(Science and Mathematics)

6. ** Find the average speed of the K'NEX Spinning Carpet Ride in revolutions per minute (rpm) for a total of four (4), one-minute trials.

a. Collect the data and design a data chart to display the data.

b. Find the average speed for the four (4) trials.

c. Show all calculations in your STEM Journal.

d. Be prepared to explain your experimental strategy and to demonstrate how you arrived at your answer.

e. (Note: You may place a masking tape flag on one seat of the ride to make counting easier.)
(Science and Mathematics)

7. ** Design and build a device to safely unload the passenger car of the K'NEX Spinning Carpet Ride in the event the car does not stop at the bottom of its path. Use additional K'NEX parts if necessary.
(Technology and Engineering)

8. ** Write a program for the ride that:

a. Spins the ride for 10 seconds and stops the car when it is at the bottom of its path for five seconds.

b. Allow the Control Box to repeat your program until the car stops again at the bottom of its path.

c. How many times did the program have to loop to bring the car back to the bottom? Why?
(Science, Technology, Engineering, and Mathematics)

9. ** Two gears help operate the K'NEX Spinning Carpet Ride. Gears are wheel and axle simple machines. Research gears to determine whether the gears on the Spinning Carpet Ride speed up the ride or slow it down.

a. What is the gear ratio of the ride?

b. Is the K'NEX Spinning Carpet Ride geared up or geared down?

c. In an earlier Challenge Activity you found the speed of the ride with its original gears. Switch the gears on the ride so that the large gear drives the small gear and find the average speed again.

d. Is the speed of the Spinning Carpet Ride faster with the new gear arrangement?

e. Did the results you found by experimenting agree with what you discovered in your research?
(Science, Technology, Engineering, and Mathematics)

10. ** Examine the K'NEX Spinning Carpet Ride. There are four Hubs and Tires on one end of the arm that supports the passenger car. Why are there four Hubs and Tires included on this ride? Support your explanation with information you gather from research.
(Science, Technology, Engineering, and Mathematics)

Lesson 5 Double Ferris Wheel

Objectives:

The students will demonstrate the ability to:

- ☑ Design and implement looped, linear programs to operate the K'NEX Double Ferris Wheel.
  (Science and Technology)
- ☑ Solve mathematical problems to find the cost of materials to build the K'NEX Double Ferris Wheel.
  (Engineering and Mathematics)
- ☑ Explore the rotational motion of the ride to determine its speed.
  (Science and Mathematics)
- ☑ Complete speed comparisons of the various rides in this set to determine the fastest and slowest.
  (Science and Mathematics)

Have students open the K'NEX Double Ferris Wheel SCE.

Context:

The Ferris Wheel is found at almost every amusement park. Your amusement park will be the first in the country to have a double Ferris Wheel. Your team will be writing a series of programs to show the capabilities of your one-of-a-kind Ferris Wheel and to demonstrate how the programs loop to make the your Double Ferris Wheel the best ride at the amusement park!

Requirements:

For this activity you are required to:

1. Make daily entries in your STEM Journal.
   (Teacher Note: Help students to realize the importance of keeping records and journaling. Inform students of the materials they must include in their STEM Journals.)
2. List the K'NEXions Chart for all Challenge Activities your team completes.
   (Teacher Note: If you are using the simplified Program Presentation Sheet, the K'NEXions Chart will be at the top of that sheet. If not, a template page for K'NEXions Charts has been provided.)
3. List and describe the steps in your programs. Keep a record of changes you made to programs as you improved them.
   (Teacher Note: The simplified Program Presentation Sheet will help students with limited writing skills to describe their program in a graphic as well as a written form. Students with better writing skills can list and describe their programs directly in their STEM Journals.)
4. Include all calculations, charts, and graphs you prepare in your STEM Journal.

Construction:

Use the instructions to build the K'NEX Double Ferris Wheel model.
(Technology and Engineering)

Ensure that all of the electronic components have been plugged into the K'NEX Control Box before you begin work.

(The K'NEXions Chart outlines the placement of the buzzer, motors, and LEDs for the Learning Tasks in this lesson. The students will find this information in graphic form in the building instructions.)

K'NEXions Chart

K'NEX Double Ferris Wheel

Output	Device
1	MOTOR
2	MOTOR
3	LED
4	BUZZER
A	
B	

Learning Tasks:

Complete these learning tasks using both the Double Ferris Wheel SCE on the computer and the K'NEX Double Ferris Wheel model Control Box.
(Teacher Note: Encourage students to complete these learning tasks using the K'NEX Double Ferris Wheel SCE on the computer before they program the Control Box to operate the model.)

Write programs that enable the Double Ferris Wheel Ride complete these tasks.

1. * **Write a program for the Double Ferris Wheel Ride that includes the following:**
   - The buzzer sounds when the ride is about to begin.
   - The two wheels should both spin in the same direction for some time.
   - The LED should flash while the wheels are turning.
   - Allow the Control Box to repeat your program several times.
     (Science and Technology)

2. * **Write a program that:**
   - Spins the Ferris wheels one at a time.
   - Includes the LED and Buzzer.
   - Allow the Control Box to repeat your program several times.
     (Science and Technology)

Challenge Activities:

Keep daily notes in your STEM Journal and include all of the programs you write.
(Teacher Note: Remind students that the output devices may need to be plugged into different locations on the Discover Control Box for Challenge Activities.)

1. * **Write a program so that the following actions can be completed. You must remove the LED and buzzer from the Control Box and place the motors' plugs into the Output A and B positions on the Control Box.**
   - Spin both wheels in the same direction for five (5) seconds,
   - Change the direction of both wheels for five (5) seconds,
   - Spin both wheels in opposite directions for five (5) seconds.
   - Allow the Control Box to repeat your program several times.
     (Science, Technology, and Mathematics)

2. * **Write a program for the K'NEX Double Ferris Wheel that will make it fun and exciting.**
   - Use both of the motors, the buzzer and the LED in your program.
   - Demonstrate how your ride allows riders time to exit the ride when it is over.
   - Allow the Control Box to repeat your program several times.

3. ** **Find how many riders can ride the K'NEX Double Ferris Wheel Ride in one day.**
   - If the ride lasts for a total of 5 minutes and it takes 7 minutes to load and unload passengers, how many rides can take place in one hour?
   - How many rides can take place in a full day at the amusement park if the park opens at 11:00 am and closes at 9:00 pm?
   - If the ride can hold a total of eight riders when it is full, how many riders could ride in one day?
     (Note: Save this information and calculations in your STEM Journal for later activities.)
     (Science, Engineering and Mathematics)

4. * **Determine the speed of the K'NEX Double Ferris Wheel Ride in revolutions per minute (rpm). In other words, how many times does the ride spin in one minute?**
   (Note: You may place a masking tape flag on one seat of the ride to make counting easier.)
   (Science and Mathematics)

5. **** Find the average speed of the K'NEX Double Ferris Wheel in revolutions per minute (rpm) for a total of four (4), one-minute trials.**

   - Collect the data and design a data chart to display the data.
   - Compute the average speed of the four (4) trials.
   - Show all calculations in your STEM Journal.
   - Be prepared to explain your experimental strategy and to demonstrate how you arrived at your answer.
   - Previously, you gathered similar information for the K'NEX Swing Ride and the K'NEX Spinning Carpet Ride.
   - Compare the performance of each ride and list the fastest of the rides, the slowest of the rides.
   - What feature(s) of the fastest ride made it the fastest?
   - What feature(s) of the slowest ride made it the slowest?
     (Science, Technology, Engineering and Mathematics)

6. *** Refer to the building instructions for the K'NEX Double Ferris Wheel and the Cost per Piece Chart provided by your teacher. Find the cost of the materials that are used to build the ride.**

   a. Make a data chart for this activity in your STEM Journal and include all of your calculations

   b. Place your answer on the board in the spot indicated by your teacher.
   (Teacher Note: Set aside space on the white board or chalk board for each team to list their cost of materials so that the costs are visible to the entire class.).

   c. How do your results compare with other groups who have completed the challenge? If answers vary, devise and implement a plan to check your work.
   (Teacher Note: Provide time for the teams to compare their answers and to correct any differences. The Cost Per Piece Chart has been provided in an editable format allowing you to assign costs to the K'NEX Pieces that are appropriate for the students you are working with.)
   (Science and Mathematics)

7. **** Complete the activity above using a spreadsheet program to organize the data, compute the costs, and calculate the total cost of the materials used to build the K'NEX Double Ferris Wheel Ride.**
   (Science, Technology, and Mathematics)

Objectives:

The students will demonstrate the ability to:

- ☑ Order programming commands and extend programming patterns to operate models. ***(Science and Technology)***
- ☑ Design and produce a plot plan that optimizes the transport of park visitors from their cars to the park gateway. ***(Science, Technology, Engineering, and Mathematics)***
- ☑ Experiment to find how fast the K'NEX Tramcar moves. ***(Science and Mathematics)***
- ☑ Determine the time required to recoup the cost of materials for various park rides and systems using a mathematical simulation activity. ***(Science, Technology, Engineering, and Mathematics)***

Have students open the K'NEX Tramcar. SCE.

Materials:

To complete the Learning Tasks and Challenge Activities below students will need the following:

- ☑ Large sheets of drawing paper (one per team).
- ☑ A collection of colored pencils, crayons, or markers.
- ☑ Rulers
- ☑ Meter sticks or tapes

Context:

A tramcar is a vehicle that transports amusement park visitors from the parking lot to the park entrance and then back again at the end of the day. Tramcar drivers make the trip from the parking lot easy and an onboard speaker system provides the visitors with important information that will make their park visit a success. At the end of the day, tram riders are very tired and they are happy to have an easy way to get to their car.

Requirements:

For this activity you are required to:

1. Make daily entries in your STEM Journal. ***(Teacher Note: Help students to realize the importance of keeping records and journaling. Inform students of the materials they must include in their STEM Journals.)***
2. List the K'NEXions Chart for all Challenge Activities your team completes. ***(Teacher Note: If you are using the simplified Program Presentation Sheet, the K'NEXions Chart will be at the top of that sheet. If not, a template page for K'NEXions Charts has been provided.)***
3. List and describe the steps in your programs. Keep a record of changes you made to programs as you improved them. ***(Teacher Note: The simplified Program Presentation Sheet will help students with limited writing skills to describe their program in a graphic as well as a written form. Students with better writing skills can list and describe their programs directly in their STEM Journals.)***
4. Include all calculations, charts, and graphs you prepare in your STEM Journal.

Construction:

Use the instructions to build the K'NEX Tramcar model.
(Technology and Engineering)

Ensure that all of the electronic components have been plugged into the Control Box before you begin work.

(The K'NEXions Chart outlines the placement of the buzzer, motors, and LED for the Learning Tasks in this lesson. The students will find this information in graphic form in the building instructions.)

K'NEXions Chart

K'NEX Tramcar

Output	Device
1	
2	
3	LED
4	BUZZER
A	MOTOR
B	

Learning Tasks:

Complete these learning tasks using both the Tramcar SCE on the computer and the K'NEX Tramcar model and Control Box.
(Teacher Note: Encourage students to complete these learning tasks using the K'NEX Tramcar SCE on the computer before they program the Control Box to operate the model.)

Program the Tramcar to operate in a safe manner as it carries park visitors.

1. * **Write a program that uses the motor to move the Tramcar forward and backward to the extent that the wiring will allow. Allow the Control Box to loop the program several times.**
   (Science and Technology)

2. * **Write a single program that uses the motor, LED, and buzzer in the following ways:**
   - When the Tramcar moves forward, the LED flashes,
   - When the Tramcar reverses, the LED stops and the buzzer sounds.
   - Allow the Control Box to loop your program several times.

   (Science and Technology)

Challenge Activities:

Keep daily notes in your STEM Journal and include all of the programs you write.
(Teacher Note: Remind students that the output devices may need to be plugged into different locations on the Control Box for Challenge Activities.)

1. * **Write a program that stops the Tramcar twice in the parking lot to safely load passengers before it moves to the park.**
   - Sound the buzzer briefly when the Tramcar is about to stop.
   - Flash the LED as the Tramcar stops and keep it flashing until the Tramcar begins moving again.
   - Allow the Control Box to loop your program several times.

   (Science and Technology)

2. ** **Design and create a diagram of the amusement park's parking lot and the tramcar roadway that leads up to the park's gateway. Draw the diagram as it would look from a helicopter high above the ground. Once your diagram has been accepted by the park owners, the contractors can begin work on the parking lot and roadway.**
   - Your group will take a large sheet of drawing paper to use for this activity.
   - Your diagram will show an aerial view of the parking lot, tramcar roadway, and the park gateway.

- Use colored pencils, crayons, or markers to color in the appropriate parts of the diagram.
- Add landscaping to your diagram along with any other details that you would expect to see as you approach an amusement park.
- Label your diagram.
- List your team members on the plot plan and place it on the wall as directed by your teacher.
  (Teacher Note: In advance of this activity, set aside wall or bulletin board space where teams can post their plot plans.)
  (Science, Technology, Engineering, and Mathematics)

3. * **Refer to the building instructions for the K'NEX Tramcar and the Cost per Piece Chart provided by your teacher. Determine the cost of the materials that are used to build the ride.**
   - Make a data chart for this activity in your STEM Journal and include all of your calculations
   - Place your answer on the board in the spot indicated by your teacher.
     (Teacher Note: Set aside space on the white board or chalk board for each team to list their cost of materials so that the costs are visible to the entire class.).
   - How do your results compare with other groups who have completed the challenge? If answers vary, devise and implement a plan to check your work.
     (Teacher Note: Provide time for the teams to compare their answers and to correct any differences. The Cost Per Piece Chart has been provided in an editable format allowing you to assign costs to the K'NEX Pieces that are appropriate for the students you are working with.
     (Science and Mathematics)

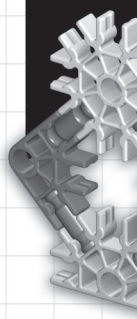
4. ** **Complete the activity above using a spreadsheet program to organize the data, compute the costs, and calculate the total cost of the materials used to build the K'NEX Tram.**
   (Science, Technology, and Mathematics)

5. * **Determine how far the Tramcar travels in five (5) seconds. Determine the materials you will need to complete the activity and request them from your teacher. Your design team must run three tests and find the average distance the Tramcar will travel in five (5) seconds. Prepare a data chart to show the results of each trial and show all of your calculations. Be prepared to explain the strategy you used to solve this challenge.**
   (Science, Technology, and Mathematics)

6. ** **Compare the cost of materials for the Swing Ride, Spinning Carpet Ride, Double Ferris Wheel Ride, and the Tramcar. Which of these was the most expensive to build? The costs of the Tramcar and Gateway are necessary expenses to keep visitors safe as they move back and forth from the parking lot and to welcome them to the park. The cost of these five items must be made up through the sale of tickets. Given the following information:**
   - Four people can ride the Swing Ride at one time.
   - Four people can ride the Spinning Carpet Ride at one time.
   - Eight people can ride the Double Ferris Wheel at one time.
   - The cost to ride each ride is $1.00.
   - The Swing Ride and the Spinning Carpet Ride run 50 times a day.
   - You found how many times a day the Double Ferris Wheel Ride runs in one of the Challenge Activities for that ride. Check your STEM Journal to find how many times the Double Ferris Wheel runs each day.

   How many days would it take to pay off the material costs of the different rides if the seats are completely full each time the rides are run?

   If each of the rides were to run for an additional 40 days, would they be able to make enough money to cover the cost of the K'NEX Tramcar and Gateway?
   (Science, Technology, Engineering and Mathematics)



K'NEXions Chart

Model: ______________________

Output	Device
1	
2	
3	
4	
A	
B	

Model: ______________________

Output	Device
1	
2	
3	
4	
A	
B	

Model: ______________________

Output	Device
1	
2	
3	
4	
A	
B	

Model: ______________________

Output	Device
1	
2	
3	
4	
A	
B	

Model: ______________________

Output	Device
1	
2	
3	
4	
A	
B	

Model: ______________________

Output	Device
1	
2	
3	
4	
A	
B	

Model: ______________________

Output	Device
1	
2	
3	
4	
A	
B	

Model: ______________________

Output	Device
1	
2	
3	
4	
A	
B	

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Program Presentation Sheet

As you prepare your program using the Control Box, you will make a copy of your program by filling in the two charts below following the instructions provided by your teacher.

K'NEXions Chart

Model: _____

Output	Device
1	
2	
3	
4	
A	
B	

Program Chart

STEP	Button Number 1	2	3	4	Action	For *(Time)*
1	○	○	○	○		
2	○	○	○	○		
3	○	○	○	○		
4	○	○	○	○		
5	○	○	○	○		
6	○	○	○	○		
7	○	○	○	○		
8	○	○	○	○		
9	○	○	○	○		
10	○	○	○	○		
11	○	○	○	○		
12	○	○	○	○		
13	○	○	○	○		
14	○	○	○	○		
15	○	○	○	○		
16	○	○	○	○		
17	○	○	○	○		
18	○	○	○	○		
19	○	○	○	○		
20	○	○	○	○		
21	○	○	○	○		
22	○	○	○	○		
23	○	○	○	○		
24	○	○	○	○		
25	○	○	○	○		
26	○	○	○	○		

STEP	Button Number 1	2	3	4	Action	For *(Time)*
27	○	○	○	○		
28	○	○	○	○		
29	○	○	○	○		
30	○	○	○	○		
31	○	○	○	○		
32	○	○	○	○		
33	○	○	○	○		
34	○	○	○	○		
35	○	○	○	○		
36	○	○	○	○		
37	○	○	○	○		
38	○	○	○	○		
39	○	○	○	○		
40	○	○	○	○		
41	○	○	○	○		
42	○	○	○	○		
43	○	○	○	○		
44	○	○	○	○		
45	○	○	○	○		
46	○	○	○	○		
47	○	○	○	○		
48	○	○	○	○		
49	○	○	○	○		
50	○	○	○	○		
51	○	○	○	○		
52	○	○	○	○		
53	○	○	○	○		
54	○	○	○	○		
55	○	○	○	○		
56	○	○	○	○		
57	○	○	○	○		
58	○	○	○	○		
59	○	○	○	○		
60	○	○	○	○		
61	○	○	○	○		
62	○	○	○	○		
63	○	○	○	○		
64	○	○	○	○		

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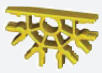
Cost Per Piece Chart

	ITEM	COST	QTY	TOTAL
ELECTRONIC COMPONENTS				
	LED	$_____	X ____ =	$
	BUZZER	$_____	X ____ =	$
	MOTOR	$_____	X ____ =	$
CONNECTORS				
	LIGHT GRAY	$_____	X ____ =	$
	RED	$_____	X ____ =	$
	GREEN	$_____	X ____ =	$
	BLUE	$_____	X ____ =	$
	TAN CLIP	$_____	X ____ =	$
	PURPLE	$_____	X ____ =	$
	ORANGE	$_____	X ____ =	$
	YELLOW	$_____	X ____ =	$
	WHITE	$_____	X ____ =	$
	DARK GRAY	$_____	X ____ =	$
	ROD/CONNECTOR - BLACK	$_____	X ____ =	$

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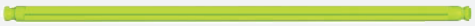
	ITEM	COST	QTY	TOTAL
RODS				
	GREEN	$_____	X ____ =	$
	WHITE	$_____	X ____ =	$
	BLUE	$_____	X ____ =	$
	LIGHT GRAY	$_____	X ____ =	$
	YELLOW	$_____	X ____ =	$
	RED	$_____	X ____ =	$
	YELLOW/GREEN FLEXIBLE	$_____	X ____ =	$
	TAN	$_____	X ____ =	$
GEARS, PULLEYS AND TRIM				
	SPACER - BLUE	$_____	X ____ =	$
	RED GEAR	$_____	X ____ =	$
	SPACER - SILVER	$_____	X ____ =	$
	BLUE GEAR	$_____	X ____ =	$
	TIRE	$_____	X ____ =	$
	PULLEY	$_____	X ____ =	$
	WIRE CONNECTOR - DRK GRAY	$_____	X ____ =	$

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