Lift-Off – TEKS Fundamentals of Computer Science Curriculum

The curriculum for Fundamentals of Computer Science consists of programming CodeX projects using a peripherals kit and completing lessons in computer science topics. The CodeX is a specialized micro:bit with integrated speaker, accelerometer, LEDs, display screen and several buttons for input. Using a physical device for coding dramatically increases engagement and interest over traditional computer science instructional methods that focus on math problems or manipulating on-screen elements. The peripherals kit offers even more physical devices to interact with while programming in Python and learning about computer science.

Our educational program creates real-world learning experiences for students. This is achieved through the use of:

- Step by step guided lessons in CodeSpace
- Open-ended physical hardware, used to implement meaningful projects
- Open-ended software, integrating development tools with instructional content, with the possibility of students to directly apply the tools well beyond the scope of what is covered in the curriculum
- Python, the fastest growing major programming language used in Industry
- An integrated learning environment that includes instructions, a source code editor with syntax highlighting and intelligent code completion, a built-in debugger and REPL.

All standards are met by completing the missions and lessons. The amount of time needed to complete the curriculum is flexible; it can be used once or twice a week up to an entire semester (or more).

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Beginning of Course

Lesson	Outline of lesson	Standards
Pre-Mission *5-7 class periods*	**Intro to Computer Science, CodeBot and CodeSpace** The project allows for time to get to know your students, build a foundation of computer science basics, and review previous CS concepts and programming techniques. Students may benefit from reviewing the foundations of computational thinking. Discuss algorithms, variables and constants, functions, loops and conditional statements. Go over debugging strategies. Review basics of Python coding, like indenting, use of capitalization, importing libraries, etc.	(5) C, E (6) A, B, E

Course Coding Projects

Mission	Outline of lesson	Standards
Mission 1 *(approx. 30-60 min)*	**Welcome to Lift-off with CodeX** Students will receive the Mission Briefing about their trip to outer space. They explore the different peripherals in their kit, and connect their first peripheral - the red LED light. No final project (short lesson)	(4) C (5) E (6) A, B, E
Mission 2 *(approx. 45-75 min)*	**Lift-Off** This mission is all about getting the rocket ship off the ground. Students will create a power switch for the engines, a countdown sequence for personnel and a launch button for Mission Control. Ideally students will refresh their Python knowledge as they get the mission to Mars underway. Final Project: Students complete an extension or cross-curricular project	(1) C, D, E (2) B (3) B, C (4) C, D, E, F, H, I, J, L (5) E (6) A, B, E
Mission 3 *(approx. 45-75 min)*	**Conserve Energy** Mars is a hike! In this lesson, students work with three different peripherals to detect motion, simulate a light source, and control the activation and brightness of the lights after motion has been detected. This project combines digital and analog sensors. Final Project: Students complete an extension or cross-curricular project	(1) C, D, E (2) B (3) B, C (4) C, D, E, F, G, H, I, J, L (5) E (6) A, B, E
Mission 4 *(approx. 45-75 min)*	**Hatch Lock** Now that the crew has a way to conserve energy on the way to Mars, they need to make sure they can successfully dock with a supporting craft that was launched ahead of the mission. With 8 locks that need to be successfully engaged, this project supports mathematical conversations about failure rates along with the percentages and statistics related to them.	(1) C, D, E (2) B, D (3) B, C (4) C, D, E, F, G, H, I, J, K, L (5) E (6) A, B, E

	Students will generate random numbers to simulate the hatch locks. Final Project: Students complete an extension or cross-curricular project	
Mission 5 *(approx. 60-90 min)*	**Alert System** Being on another planet can get lonely sometimes. With no neighbors to check on the crew, they'll need a good alarm system. In this project students will consider the technical dangers a crew can encounter on the ship. Students will convert raw data to Celsuis and use an averaging calculation. Final Project: Students complete an extension or cross-curricular project	(1) C, D, E (2) B, D (3) B, C (4) C, D, E, F, G, H, I, J, L (5) E (6) A, B, E
Mission 6 *(approx. 30-60 min)*	**Life Support** It doesn't matter how safe the crew is if they can't breathe. Ensuring consistent air quality is key to the success of this mission. Students will be using a servo to make sure the air circulates throughout the spacecraft. Final Project: Students complete an extension or cross-curricular project	(1) C, D, E (2) B (3) B, C (4) C, D, E, F, G, H, I, J, L (5) E (6) A, B, E
Mission 7 *(approx. 45-75 min)*	**Solar Tracking** For this project the crew needs a way to generate energy from the sun. Learners will use a light sensor to determine when to rotate the solar panels to follow the path of the sun. Final Project: Students complete an extension or cross-curricular project	(1) C, D, E (2) B (3) B, C (4) C, D, E, F, G, H, I, J, L (5) E (6) A, B, E
Mission 8 *(approx. 45-75 min)*	**Prepare Lander** To land safely on Mars, a complete ground sensing system will be constructed using several peripherals. The object sensor will be used to detect the nearing of the surface, the NeoPixel ring will be used to alert the crew, and the microswitch will be used to indicate the surface contact. Also, the servo will be used to simulate landing gear. Final Project: Students complete an extension or cross-curricular project	(1) C, D, E (2) B, D (3) B, C (4) C, D, E, F, G, H, I, J, L (5) E (6) A, B, E
Mission 9 *(approx. 30-60 min)*	**Automatic Garden** The crew wants to automate the growing of their food after they land on Mars. Students will construct a system to sense soil moisture levels and then automatically water the garden. Students will use a relay and water pump to complete the task. Final Project: Students complete an extension or cross-curricular project	(1) C, D, E (2) B (3) B, C (4) C, D, E, F, H, I, J, L (5) E (6) A, B, E
Mission 10 *(approx. 60-90 min)*	**Exploring the Surface** Now that your Mars habitat is set up, it's time to fire up the Martian Rover to explore the surface. But all around the landing zone, there are large boulders that could damage the Rover. During this mission students use salvaged parts and a breadboard to build an "Obstacle Detection and Navigation" system for the rover. Final Project: Students complete an extension or cross-curricular project	(1) C, D, E (2) B, D (3) B, C (4) C, D, E, F, G, H, I, J, L (5) E (6) A, B, E

Final Coding Project *(approx. 60-90 min)*	**Final Coding Project** For the final project, students will come up with their own idea for the Mars mission, using several peripherals from the kit. The final project allows students to use their creativity to design, build and program their own project. Students will use the design process, create a flowchart, and resolve design challenges during the creation of their program. Students can use previous missions as a starting point for their project. This is an excellent opportunity to have students work in a team and develop collaboration and leadership skills. Final Project: Completed program ● Create a presentation and show to class or other identified audience ● Show program run in a video to include in presentation ● Optional -- create a web page for the final remix	(1) C, D, E, F, H (2) B (3) A, B, C (4) C, D, E, F, G, H, I, J, L (5) E (6) A, B, E

Additional Lessons

Lesson	Outline of lesson	Standards
Technology *5-10 class periods*	This project will teach students about important technology operations, concepts, systems, and operations as they apply to computer science. Basic computer components, such as storage and peripheral devices, will be studied. Students will learn about different operating systems and describe the differences between an application and an operating system. Students will also review system tools, including appropriate file management. Binary numbers will be practiced, allowing students to understand how data is represented in a computer system, convert between binary and decimal numbers, and count in binary. Students will have an opportunity to discuss and give examples of the impact of computing and computing-related advancements on society. **Final Project:** Create a project that summarizes their learning or extends their learning on a specific concept. Students will then publish their project, which could include print, monitor display, web pages, or video.	(3) C (4) B (5) E (6) A, B, C, D, E
Digital Citizenship *5-10 class periods*	This project will teach students about digital citizenship. Students explore and understand safety, legal, cultural, and societal issues relating to the use of technology and information. Privacy and copyright laws are discussed, and students learn to ethically find digital information and cite their sources. They look at acceptable use policies. They learn about keeping their information safe through strong passwords, virus detection and security. Students also analyze how electronic media can affect the reliability of information. Students will have an opportunity to discuss and give examples of the impact of computing and computing-related advancements on society. **Final Project:** Create a project that summarizes their learning or extends their learning on a specific concept. This can be a team project, allowing students to work on employability skills, like time management, leadership, planning, and communication. Students will then publish their project, which could include print, monitor display, web pages, or video.	(3) C (5) A, B, C, D, E, F

Computer Science Careers *5-10 class periods*	This project will enable students to identify various employment opportunities in the computer science field. Students will compare university computer science programs and examine the role of certifications, resumes and portfolios in the computer science profession. They will seek to identify job and internship opportunities in computer science and explore career opportunities. Students will also demonstrate an understanding of legal and ethical responsibilities in a computer science career. Students will have an opportunity to discuss and give examples of the impact of computing and computing-related advancements on society. **Final Project:** Create a project that summarizes their learning or extends their learning on a specific concept. This can be a team project, allowing students to work on employability skills, like time management, leadership, planning, and communication. Students will then publish their project, which could include print, monitor display, web pages, or video.	(1) A, B, G, I (2) A (3) C (4) E
Web Pages *15-25 class periods*	This project will allow students to use their creativity and innovation to develop products and generate new knowledge, understanding, and skills. The focus of the project will be to create web pages. They will use accepted design standards to make their web pages effective and user friendly. The project will include static and interactive pages. Students can include their computer science career research on the web pages. During the project students must use effective communication skills, solve problems and think critically, and demonstrate planning and time-management skills. Students will model ethical acquisition of digital information by citing sources using established methods. **Final Project:** Students will create and publish a website with multiple pages, including static and interactive pages, external objects, and an accepted design standard for fonts, colors and spacing.	(1) D, E, H (2) A, C, D (3) C (4) A (5) A, E
Final CS Project *5-15 class periods*	The final project can be determined by the teacher and the interests of the students. For example, students could: ● create an original program for the CodeX, then create a video of the CodeX running the code and embed the video on their web page ● Create a new feature or web page for their website ● Research a computer science topic not yet covered: ○ cyber security ○ how the internet works, or the internet of things ○ artificial intelligence or machine learning ○ digital data and compression ○ data science and representation ○ global impact of computing / future of computing ● Take apart and label the parts of a computer ● Create a presentation or lesson on a computer science topic and teach it to a group of students ● Create a newsletter or video about the class (recruiting tool!)	(1) C, D, E, F, H (3) C (4) C

Optional Projects – Extensions and Cross-curricular projects for each Mission

Mission	Suggestions for extensions and/or cross-curricular projects	Standards
Mission 1	**Extensions and Cross-curricular Projects** • Light up the CodeX pixel 0 to indicate where the peripheral is connected. • Use the A and B buttons of the CodeX to turn on/off the red LED. • Set up and write code for the white LED. Use the CodeX buttons to control the red and white LEDs. • **LANGUAGE ARTS:** Students write a first-person essay about the impact of technology. • **SCIENCE:** Students select one peripheral and research how it works or its uses in a science field. • **MATH:** Many peripherals are digital and only use the values True or False. Review binary numbers.	(1) C, D, E (2) B (3) B, C (4) B, C, D, E, F (6) A, B, E
Mission 2	**Extensions and Cross-curricular Projects** • Review and practice algorithms with your students and encourage them to see algorithms in their daily lives. • Review and practice the concept of abstraction and encourage them to see abstraction in their daily lives. • Display images of a rocket ship taking off during the lift_off phase. • Add the CodeX pixels as flashing lights during the countdown phase. Use random colors. • Each astronaut may need to indicate they are ready for lift-off. Use the CodeX buttons as inputs for the astronauts to push in sequence to indicate they are ready. • **LANGUAGE ARTS:** Have students write about a time they prepared to leave for somewhere. Or discuss the theme of transitioning with a current book assignment. • **SCIENCE:** Discuss gravity or Newton's Laws and how they relate to the mission to Mars. –OR– include a lesson on space. • **MATH:** Create a chart of the distance traveled by the ship. –OR– Draw a rocket ship trajectory and then find the equation of the line.	(1) C, D, E, F, H (2) B (3) A, B, C (4) C, D, E, F, H, I, J, K, L (6) A, B, E
Mission 3	**Extensions and Cross-curricular Projects** • Use the CodeX to add an indicator in energy-saving mode and energy-wasting mode. Example: sound, pixels, display, etc. • The CodeX also has a built-in light sensor. Use another motion detector to control the other sensor. • **Cross-Curricular:** Talk about a road trip and how they would plan. They can use a map as a geography lesson, calculate distance using the scale of a map, and work on a plan for how much money they will need, how often they will stop, gas mileage, etc. Then have them find the distance to Mars. Have them consider how their plans might change if they knew they were going that far, and how long it will take. Consider conserving energy. Additional **SCIENCE** ideas: • Distance, rate & time • Conserving energy • Artificial vs natural light	(1) C, D, E, F, H (2) B (3) A, B, C (4) C, D, E, F, G, H, I, J, L (6) A, B, E

Mission 4	**Extensions and Cross-curricular Projects** ● Include the disco ball with the hatch lock project. ● Use buttons on the CodeX to control the disco ball speed (speed up, slow down). ● Add a signal when all 8 hatch locks are successful (sound, image, CodeX pixels, etc.). ● **LANGUAGE ARTS:** Have students write about a personal experience where something failed. ● **SCIENCE:** Discuss RGB in the context of light. Have a lesson on the science of pixels. ● **MATH:** Explore rates (like failure rates) and construct the algorithm for calculating them.	(1) C, D, E, F, H (2) B, D (3) A, B, C (4) C, D, E, F, G, H, I, J, K, L (6) A, B, E

Mission 5	**Extensions and Cross-curricular Projects**
	● Change the raw temperature to Fahrenheit.
	● Use buttons on the CodeX to use either Celsius or Fahrenheit temperatures.
	● Find images that go with the different alerts and display them on the CodeX screen when the alarm is triggered.
	● Like a traffic light, add a "warning" period before the alarm is triggered, that alerts the crew to a potential danger before the actual threshold is reached.
	● Check for the sound reading two different ways. Below threshold could mean power failure and no electronics are working. Above threshold could mean an explosion. Give a different warning for each situation.
	● **LANGUAGE ARTS:** Have students write a poem about a topic from the lesson, or about their coding experience.
	● **SCIENCE:** Explore sound waves and sound in space.
	● **MATH:** Many applications from this lesson
	    ○ Make a chart of the sensor readings (temp and sound).
	    ○ Practice converting temperatures – Fahrenheit to Celsius, Celsius to Fahrenheit.
	    ○ The lesson uses EMA for the sound average. Compare and contrast other ways to find a weighted average.
	● **ART:** Students can draw (or use mixed-media) the interior of their own spacecraft. Discuss the use of color and/or perspective in their artwork.
		(1) C, D, E, F, H
		(2) B, D
		(3) A, B, C
		(4) C, D, E, F, G, H, I, J, L
		(6) A, B, E

Mission 6	**Extensions and Cross-curricular Projects** ● Have multiple speeds for the fan and cycle through the speeds, like a ceiling fan. ● Add a temperature sensor to speed up the fan when the temperature is getting warm. ● Use the computer's clock to set a timer for keeping the fan on. ● Use the motion detector to turn on the fan. ● Use the potentiometer to make the fan a variable speed. ● Use the CodeX NeoPixels or display screen to show additional information. ● Use the accelerometer to simulate the effects of movement on the air circulation system. Tilt the CodeX to represent changes in the spaceship's orientation, which could affect airflow and require adjustments.	(1) C, D, E, F, H (2) B (3) A, B, C (4) C, D, E, F, G, H, I, J, L (6) A, B, E

	• **SCIENCE:** Have a lesson on energy and/or DC motors. • **MATH:** Make your own chart of percents for the servo duty-cycle. Calculate and graph the actual numbers being used by the servo. Use a scale representation.	
Mission 7	**Extensions and Cross-curricular Projects** • Use a temperature sensor to make the solar panels accurately follow the sun by moving when a temperature is past a certain threshold. • Add more "states" to the finite-state machine. • Add buttons to manually control the servo position. • Add Neopixel and/or LEDs to indicate current position. Light up a certain # of LEDs to correspond to a position. • **SCIENCE:** Design a garden. What would you grow? How much light and moisture do the plants need? • **SCIENCE:** Have a lesson on solar energy. Compare and contrast solar energy to different types of energy. • **MATH:** The solar panels will generate energy for the craft. Look at graphs that show energy production and interpret the data.	(1) C, D, E, F, H (2) B (3) A, B, C (4) C, D, E, F, G, H, I, J, L (6) A, B, E
Mission 8	**Extensions and Cross-curricular Projects** • Add an alert sound when deploying landing gear. • Assign buttons to send communication to Mission Control for various stages of the landing process. For example, Button A could initiate descent, Button B could initiate the prepare phase, and Button D could send a landing message. • Make sure all crew members are strapped in and ready for landing. Use CodeX buttons for crew members to indicate their readiness. When all are ready, start the process. • **SCIENCE:** What is the gravity on Mars? What kind of energy is required to land on Mars? Compare gravity on Mars to gravity on Earth. • **MATH:** Consider different crafts that might land on Mars. Calculate the gravity pull for the different crafts. Create a chart on the various crafts. --OR-- interpret graphs that have already been created.	(1) C, D, E, F, H (2) B, D (3) A, B, C (4) C, D, E, F, G, H, I, J, L (6) A, B, E
Mission 9	**Extensions and Cross-curricular Projects** • Add neopixels and LEDs to indicate the status of the soil moisture. For instance, green could indicate optimal moisture, yellow could indicate that watering is needed soon, and red could indicate that watering is immediately needed. • Show the process of watering with a sequence of LED lights to simulate water flow. • Use the LCD screen to display real-time soil moisture levels. • **SCIENCE:** Have a lesson on fluids and their rates of flow. What would be the optimum size of pipe for the automatic garden? • **MATH:** Research the life cycles of plants. Make a graph of the daily or weekly growth of plants.	(1) C, D, E, F, H (2) B (3) A, B, C (4) C, D, E, F, G, H, I, J, L (6) A, B, E
Mission 10	**Extensions and Cross-curricular Projects** • Add a servo to simulate the wheels and adjust the speed of the servo depending on the distance to an object. For example, slow down the "wheels" when in the warning zone and stop the "wheels" when in the danger zone.	(1) C, D, E, F, G, H (2) B, D (3) A, B, C (4) C, D, E, F, G, H, I, J, L

	• Adjust the distance for warning and danger by using the CodeX buttons. • Use the CodeX display screen to show information. • **SCIENCE:** Have a lesson about sonar and how it works. • **SCIENCE:** Have a lesson about electrical resistance and ohms. • **MATH:** Calculate break distances for the varying speeds of the Rover. Create a graph of the data and extrapolate for distances not calculated.	(6) A, B, E