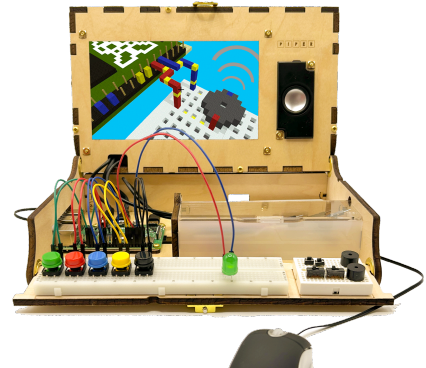# PIPER

PLAYBOOK
PIPER COMPUTER KIT V4

WELCOME TO THE PIPER COMPUTER KIT V4 PLAYBOOK

This playbook is designed to guide you through a series of carefully curated computer science enrichment projects. Students can build the Piper computer individually or in small groups, following the project guides with facilitators/teachers to check in on this exciting journey.

The Piper Computer Kit is standards aligned and will build basic skills and confidence in students through STEAM problem solving, engineering design, and develop computational thinking. Core to educator use is our Piper Premium Curriculum which all the playlists that follow will align to and will support pedagogy and content.

No experience is required for the teacher or student! We pride ourselves in delivering access, equity and inclusion in our instructional programs.

Grades 3-8

Total: 15 hours

NUTS AND BOLTS

PROGRAM COMPONENTS

- Playbook that customizes curriculum into an engaging expanded learning experience
- Training / professional development from Piper
- Self reported efficacy tool to measure student growth and engagement
- Supports diversity, equity, and inclusion; program is suitable for English Language Learners, Special Education, and Gifted/Talented students

INSTRUCTIONAL COMPONENTS

- Full Inquiry based curriculum with summary Playbook
- Aligns to state and international learning standards (NGSS, ISTE, CSTA, CSK12)
- Promotes the Five Strategies for Collaborative Learning
    1. Promote Team Building Exercises
    2. Allow for Flexibility
    3. Leverage Different Technologies
    4. Equalize Labor with Group Roles
    5. Assess Before and After Collaboration

RESOURCES AND SUPPORT

- Piper project guides with student/parent friendly tutorials and troubleshooting tips at www.playpiper.com
- Customer support at hi@playpiper.com

VIDEO OVERVIEWS FROM OUR FOUNDER, SHREE

| FULL PLAYLIST | OVERVIEW | CURRICULUM |
| PHASE 1 | PHASE 2 | PHASE 3 | PHASE 4/5 | CONCLUSION |
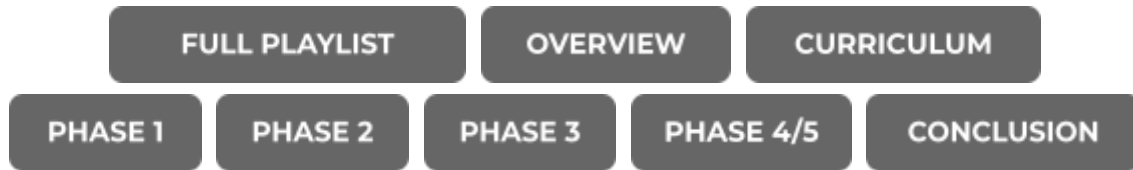
Note: These videos include images of the Piper Computer Kit V3.

PIPER LEARNING EXPERIENCE OVERVIEW - THE 5 PHASES

Estimated time for each phase is 3 hours, so if you have a 5-day program running 3 hours each day then estimate each day will be one phase. If you are running a 15-day program with one hour a day for Piper programs, in general every 3 days will be focused on one phase.

PHASE 1
BUILD A COMPUTER
Build the wooden pieces using the engineering blueprint and connect components of a working computer.

PHASE 2
DISCOVER ELECTRONICS
While playing Minecraft:Pi Edition levels of Piper StoryMode, learn electronic principles including circuits, inputs, outputs, breadboard, wiring, buttons, switches, buzzer and LEDs.

PHASE 3
LEARN TO CODE
Use our Google Blockly-based, drag-and-drop PiperCode platform to learn computer science principles including loops, sequences, and events, using visual programming blocks.

PHASE 4
EXPLORE WITH ART AND SENSORS
Extend the student experience with hardware sensors and projects designed to translate sensory experiences like music and color perceptions to computational inputs and outputs.

PHASE 5
INVENT WITH LEARNED SKILLS
While deconstructing the Piper Computer Kit, reflect on learned skills and apply them in our Piper Make-a-Thon to invent technology solutions to the problems you experience in the world around you.

BUILD A COMPUTER

🕐 1-3 hours | 6 Exploration Challenges

OBJECTIVES: Build the wooden pieces and connect components of a working computer.

CAREER CONNECTIONS:
Click each of the careers to learn more about how the skills you will learn can be used.

Information Technology Project Manager Avg Salary: $95,270	Construction Manager Avg. Salary: $98,890	Architect Avg. Salary: $80,180	Computer Hardware Engineer Avg. Salary: $128,170

STANDARDS:
★ **CA 3-5.CS.1** Describe how computing devices connect to other components to form a system. (P7.2)
★ **3-5.AP.18** Perform different roles when collaborating with peers during the design, implementation, and review stages of program development.

VOCABULARY:
Engineer - A person trained to design and build machines and structures
Blueprint - A design plan or other technical drawing
Single-board Computer - A complete computer built on a single circuit board
Computer - A digital electronic machine that can be programmed to carry out sequences of arithmetic or logical operations automatically
Collaboration - Working with someone to produce or create something
Input Device - A hardware device that sends data to a computer, allowing interaction and control
Output Device - A piece of hardware which converts information into a human-perceptible form

PHASE 1 INTRODUCTION   ⏱ 15 min

We will be building a computer from scratch in this phase. Once the build is complete, our custom educational Minecraft: Pi Edition games will guide you through building and learning about electronics.

PRE-SURVEY
Hand out the pre-survey and make sure first name, last initial, teacher name and grade are filled out at the top. You will use this to track learning.

PRE-SURVEY   **OPENING ANIMATION VIDEO**

⚠ **Prep Tip:** Charge batteries prior to use.

PHASE 1 EXPLORATION ACTIVITIES   ⏱ 2-3 hrs

CHALLENGE 1
DRAW A COMPUTER
Ask students: "What components make up a computer? Draw what you think is inside of a computer." Use the worksheet to draw a computer and label its parts and pieces.

WORKSHEET

CHALLENGE 2
BUILD USING THE BLUEPRINT
Begin the process of building the computer. Have students open the box and take out the blueprint.

BLUEPRINT   **FAST BUILD VIDEO**

CHALLENGE 3
SHARE SUCCESS AND FAILURE
Intermittently stop the class and have one of the students or teams present how they succeeded with a task after several failures.

CHALLENGE 4
TROUBLESHOOTING
Continue building the computer with steps 3 and 4. Practice "ask 3 before me" and do your best not to answer your students directly.

CHALLENGE 5
COMPUTATIONAL THINKING
As you continue the build, break down problems into smaller, manageable tasks. Ask: "How do the mouse and screen connect with the Raspberry Pi to form a system?"
🛠 **Essential Skill:** Interpreting Engineering Schematics

CHALLENGE 6
COMPLETE THE BUILD
Complete your Piper Computer Kit build. Please note that wiring happens in Phase 2 where the instructions are in the Minecraft game.
🛠 **Essential Skill:** Difference between input and output

PHASE 1 CLOSING   ⏱ 30 min

Ask the following questions to guide discussion:
- What computing devices did you connect to form your Piper Computer Kit? **(CA 3-5.CS.1)**
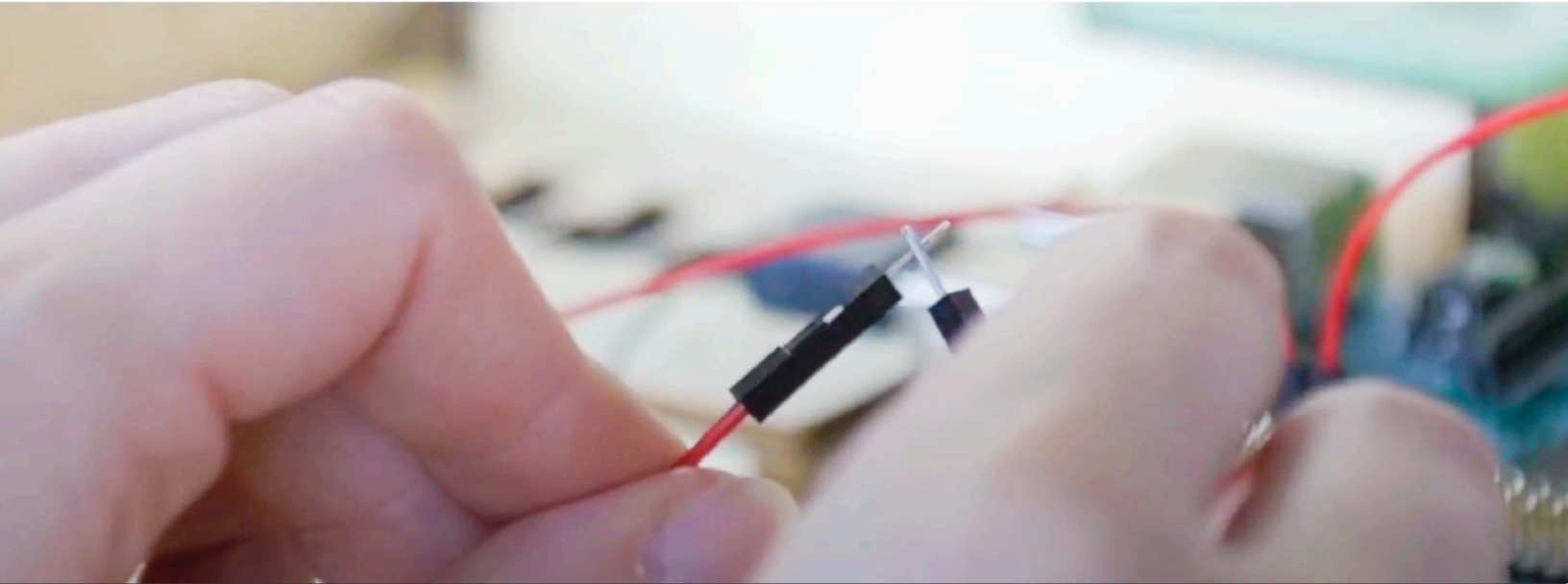- How did you decide who did what in your teams during the build? **(3-5.AP.18)**

SLIDE PRESENTATION   **ELEMENTARY KAHOOT!**   **MIDDLE SCHOOL KAHOOT!**

DISCOVER ELECTRONICS

🕐 2-4 hours | 10 Exploration Challenges

OBJECTIVES: While completing levels of StoryMode, learn electronic principles including circuits, inputs, outputs, breadboard, wiring, buttons, switches, buzzer and LEDs.

CAREER CONNECTIONS:
Click each of the careers to learn more about how the skills you will learn can be used.

Computer Hardware Engineer Avg. Salary: $128,170	Environmental Engineer Avg. Salary: $96,820	Electrician Avg. Salary: $60,040	Aerospace Engineer Avg. Salary: $122,270

STANDARDS:
★ **3-5.CS.3** Determine potential solutions to solve simple hardware and software problems using common troubleshooting strategies. (P6.2)
★ **6-8.CS.3** Systematically apply troubleshooting strategies to identify and resolve hardware and software problems in computing systems. (P6.2)

VOCABULARY:
Circuit Board - A set of electrical connections made by thin lines of metal fixed onto a surface
Display - a device that shows a rendered electronic image made up of pixels
Circuit - A complete circular path that electricity flows through
Breadboard - A board for prototyping or building circuits on
Switch - An electrical component that can disconnect or connect the conducting path in an electrical circuit
Jumper Wire - A short wire used to complete an electric circuit

PHASE 2 INTRODUCTION   🕐 5 min

Discuss careers in technology that use electronics. Now that you have built the computer it's time to play Minecraft! We use the Raspberry Pi Edition of Minecraft (no login required). Any hardware that is used to play Minecraft, the students will build themselves.

PHASE 2 EXPLORATION ACTIVITIES   🕐 2-3 hrs

CHALLENGE 1   🕐 30 min
STORYMODE: MARS
In this level, you will learn about electrical currents, conductivity and circuits which will be the basis for the rest of your missions going forward. Students will touch two wires together to make their character move, then connect the wires to a button.

🛠️**Essential Skill:** Completing Circuits, Breadboarding

[PROJECT GUIDE]

CHALLENGE 2   🕐 10 min
STORYMODE: CHEESETEROID
Help Piperbot and Pip save the planet from a Cheeseteroid (an asteroid made out of cheese that is)!! This project is more for fun, students build a jump button and navigate a 3D maze.

[PROJECT GUIDE]

CHALLENGE 3   🕐 15 min
STORYMODE: TREASURE HUNT
You will build upon your knowledge of currents and circuits. After connecting the wires to the light, an electric current flows from the Raspberry Pi through the Light Emitting Diode (LED), which sends a virtual message (OUTPUT) to the player.

🛠️**Essential Skill:** Cathodes/Anodes, Directionality of Current

[PROJECT GUIDE]

TAKE SOME NOTES   🕐 10 min

This is a good time to break away from the Piper Computer and reflect on what has been learned so far. Use the Graphic Organizers of the Premium Curriculum to guide this note-taking.

CHALLENGE 4   🕐 15 min
STORYMODE: CHAIN REACTION
Learn about different switches. Use examples of a button (momentary switch) or a fixed switch. When you turn the light on in a room, is that a momentary or fixed switch?

🛠️**Essential Skill:** Current-Controlling Switches

[PROJECT GUIDE]

STORYMODE: BOT BUILDER
This project brings the A into STEAM. Design your own skin for PiperBot that you may use throughout the remaining projects.

⏱ 10 min

PROJECT GUIDE

CHALLENGE 6
STORYMODE: POWER PLANT
This is a review of buttons and switches. The concept of hydroelectric power generation can be touched upon (NGSS Secondary school concept).

⏱ 20 min

PROJECT GUIDE

CHALLENGE 7
STORYMODE: RAINBOW BRIDGE
This is a review of outputs. A new type of output is introduced with a Piezo buzzer.

⏱ 15 min

PROJECT GUIDE

CHALLENGE 8
STORYMODE: BREADBOARD BLUFFS
This is a deep dive into breadboards and how they work. The Minecraft game has the students actually go inside a breadboard and make repairs.

⏱ 15 min

PROJECT GUIDE

CHALLENGE 9
STORYMODE: FUNKY FUNGI
This one is more for fun. It is challenging and the students will learn how to fly. Have your Minecraft experts help others!

⏱ 15 min

PROJECT GUIDE

CHALLENGE 10
STORYMODE: RETURN TO CHEESETEROID
See

⏱ 20 min

PROJECT GUIDE

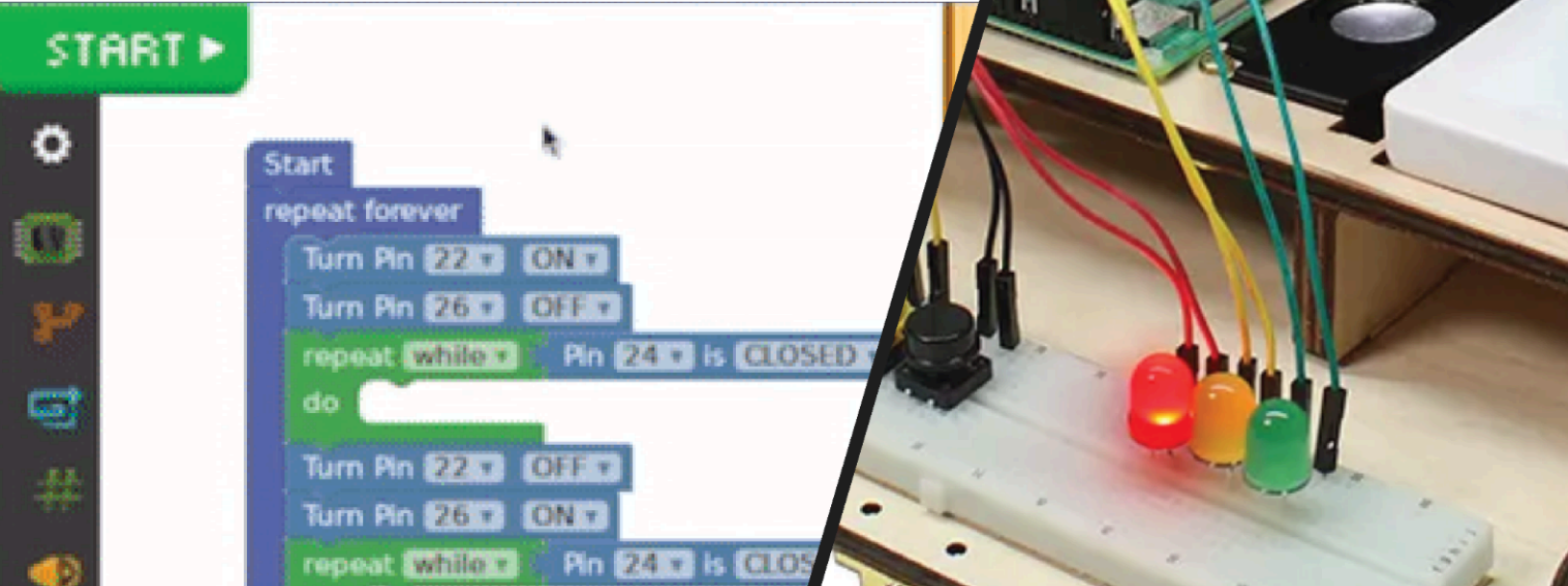## PHASE 2 CLOSING   ⏱ 30 min

Ask the following questions to guide discussion:
- Did you have a circuit that didn't work at first? Did you connect your hardware incorrectly? How did you figure out where the error was? **(3-5.CS.3)**
- How did you correct the errors you figured out? **(6-8.CS.3)**

ELEMENTARY KAHOOT!   **MIDDLE SCHOOL KAHOOT!**

LEARN TO CODE

🕐 2-6 hours | 11 Exploration Challenges

OBJECTIVES: Write code and learn computer science principles including loops, sequences, and events, using visual programming blocks.

CAREER CONNECTIONS:
Click each of the careers to learn more about how the skills you will learn can be used.

Data Scientist	Graphic Designer	Web Developer	Video Game Designer
Avg. Salary: $131,490	Avg. Salary: $50,710	Avg. Salary: $77,030	Avg. Salary: $79,890

STANDARDS:
- ★ **CA 3-5.CS.2** Demonstrate how computer hardware and software work together as a system to accomplish tasks. (P4.4)
- ★ **3-5.AP.13** Decompose problems into smaller, manageable tasks which may themselves be decomposed. (P3.2)

VOCABULARY:
Software - The programs and other operating information used by a computer.
Programming - The process or activity of writing computer programs.
Python - A high-level, general-purpose programming language.
Logic - A set of principles that delineates how elements should be arranged so a computer can perform specific tasks.
Loops - Running the same sequence multiple times
Variables - A program storage location for information that is given a name
Event - One thing causing another thing to happen
Conditional - A program component for making decisions if a circumstance is true or false

PHASE 3 INTRODUCTION   🕐 25 min

Discuss careers in technology that utilize hardware programming. Hardware programming is everywhere, from motion sensing lights to how we can grow mini-tumors in a lab. Can you think of where you used hardware programmed in a certain way even this morning?

RUBY THE ROBOT   🕐 20 min

With your students, do the following exercise to illustrate sequences of events to accomplish a task.
- Assign your classroom into pairs.
- In their pairs, assign one learner to be **"Pip The Programmer"** and one to be **"Piperbot".**
- Assign each pair a daily task (like brushing teeth)
- Tell **Pip The Programmer** to explain to their partner, **Piperbot**, how to perform the steps needed to complete the assigned task using words only (no non-verbal motions like hand movements)!
- Switch pairs, so that the other partner does the explaining.
- Have a few students share as you act out their directions without knowing the task. D**iscuss the importance of simple, clear instructions and sequences of instructions.**

PHASE 3 EXPLORATION ACTIVITIES   🕐 2-3 hrs

CHALLENGE 1   🕐 15-30 min
PIPERCODE: BLINK
Build a simple circuit and program an LED to blink.
🛠**Essential Skill:** Loops, Running a Program

PROJECT GUIDE

CHALLENGE 2   🕐 15-30 min
PIPERCODE: STOPLIGHT
Program loops and sequences through program design and simulation.
🛠**Essential Skill:** Sequence

PROJECT GUIDE

CHALLENGE 3   🕐 15-30 min
PIPERCODE: LIGHT SHOW
Events (with inputs/outputs) Program events and test & debug
🛠**Essential Skill:** Conditional, Events

PROJECT GUIDE

CHALLENGE 4   🕐 15-30 min
PIPERCODE: FROG FRENZY
Light and Sound Inventions-Game Design Practice programming loops; Sound as an output

PROJECT GUIDE

CHALLENGE 5
PIPERCODE: TALLY
🕐 15-30 min

Tally represents a significant step forward in programming complexity in that it involves skills related to variables, conditionals, debugging, and sounds in the same project

🛠️**Essential Skill:** Variables, Coding Mathematical Operations, Function

`PROJECT GUIDE`

CHALLENGE 6
PIPERCODE: SIREN
🕐 15-30 min

Learn how to use the columns of the breadboard to provide a ground connection to two LED lights with one wire.

`PROJECT GUIDE`

CHALLENGE 7
PIPERCODE: CIRCUIT DESIGN
🕐 15-30 min

Learn about the positive and negative states of the GPIO pins and how to use them to design the architecture of a circuit.

`PROJECT GUIDE`

CHALLENGE 8
PIPERCODE: DEBUG
🕐 15-30 min

Learn to fix code that someone has written incorrectly.

🛠️**Essential Skill:** Print Commands

`PROJECT GUIDE`

CHALLENGE 9
PIPERCODE: RANDOMIZER
🕐 15-30 min

Program a probability tool that will randomly light an LED when a button is pressed.

`PROJECT GUIDE`

CHALLENGE 10
PIPERCODE: BEAT THE BUZZER
🕐 30-45 min

Learn to program functions / procedures, a key skill for programming. Other key skills in this project include timer, sequences and variables.

`PROJECT GUIDE`

CHALLENGE 11
PIPERCODE: EL PANGOLIN (SIMON)
🕐 30-90 min

Program with variables, conditionals, events, functions, random numbers, comparisons, data, lists, algorithms. Control inputs and outputs, debug and remix code.

🛠️**Essential Skill:** Lists

`PROJECT GUIDE`

PHASE 3 CLOSING
🕐 30 min

Ask the following questions to guide discussion:
- When thinking about blinking a light, what steps did you break down the action into? How did you represent those smaller, manageable tasks in code? **(3-5.AP.13)**
- What tasks did you complete with code you wrote and circuits you built? **(CA 3-5.CS.2)**

`ELEMENTARY KAHOOT!`   `MIDDLE SCHOOL KAHOOT!`

EXPLORE WITH ARTS AND SENSORS

🕐 2-3 hours | 12 Exploration Challenges | REQUIRED: Sensor Explorer

OBJECTIVES: Extend the student experience with hardware sensors and projects designed to translate sensory experiences like music and color perceptions to computational inputs and outputs.

CAREER CONNECTIONS:
Click each of the careers to learn more about how the skills you will learn can be used.

Civil Engineer	Fashion Designer	Advertising and Promotions Manager	Sound Engineer
Avg. Salary: $88,050	Avg. Salary: $77,450	Avg. Salary: $127,150	Avg. Salary: $60,500

STANDARDS:
- ★ **CA 3-5.CS.1** Describe how computing devices connect to other components to form a system. (P7.2)
- ★ **CA 3-5.CS.2** Demonstrate how computer hardware and software work together as a system to accomplish tasks. (P4.4)

VOCABULARY:
Invention - A unique or novel device, method, composition, idea or process
Smart Device - An electronic gadget that is able to connect, share and interact with users and other smart devices
Constraint - A limitation or restriction
User Interface - The means by which the user and a computer system interact, in particular the use of input devices and software
Prototype - The original model, a sample on which to base future designs
Sensor - A device which detects or measures a physical property and records, indicates, or otherwise responds to it.

PHASE 4 INTRODUCTION   ⏱ 10 min

Start with a discussion of where technology is used to mimic human functions (i.e., specifically think through the five senses). Ask questions like:
- **Touch:** How do you think your skin detects pressure? Is it similar to how your touchpad on your phone/tablet detects when you press down?
- **Sight:** How can the human eye detect color? Can we detect color with sensors?
- **Sound:** Think about your favorite song and deconstruct it. Are musical notes a kind of code?

PHASE 4 EXPLORATION ACTIVITIES   ⏱ 2 hrs

CHALLENGE 1   ⏱ 15-30 min
STORYMODE: CHAMELEON GIANT
Deepens science disciplinary knowledge associated with waveforms. Students will explore visible light, how light enters our atmosphere, and deepen their understanding of how color is detected in the human eye

🛠**Essential Skill:** Color as an Input

CHALLENGE 2   ⏱ 15-30 min
PIPERCODE: COLOR CODED
Learn about how waves are part of the universe and build on the use of the color sensor

🛠**Essential Skill:** Mapping Inputs

[PROJECT GUIDE]

CHALLENGE 3   ⏱ 15-30 min
STORYMODE: POST NO. 34 1/2
Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.

[INTRO SLIDES]

Note: Additional resources are available when logged into the Premium Curriculum.

CHALLENGE 4   ⏱ 15-30 min
PIPERCODE: SECURITY ZONE
Deepen students' knowledge of an object's motion to provide evidence that a pattern can be used to predict future motion

🛠**Essential Skill:** Distance as an Input

[PROJECT GUIDE]

CHALLENGE 5   ⏱ 15-30 min
STORYMODE: TERRA-SENSE
Deepen understanding of the states of matter by examining in detail how the movements of particles affect phase change in matter.

[INTRO SLIDES]

Note: Additional resources are available when logged into the Premium Curriculum.

PIPERCODE: THER-MOOD-STAT

Deepen understanding of temperature, forms of energy, and quantitative/qualitative data

🛠️**Essential Skill:** Temperature as an Input

🕐 15-30 min

`PROJECT GUIDE`

PIPERCODE: CREATE A 5-BUTTON SYNTHESIZER

Make a five-button synth using PiperCode and the components in a Piper Computer Kit.

🕐 15-30 min

`PROJECT GUIDE`

PIPERCODE: ROCK OUT WITH BINARY HERO

Create your own version of Guitar Hero. Instead of arrows, we'll display which buttons should be pressed using 1's or 0's.

🕐 15-30 min

`PROJECT GUIDE`

STORYMODE: PIP HOP

Create and listen to your own music on Piper. Pip Hop is a music sequencer where students place blocks to create measures of music and the sequencer will play your custom song.

🕐 15-30 min

`PROJECT GUIDE`

STORYMODE: SNAKE TRAP

Build an input using your Raspberry Pi and breadboard. This game may be played over and over to improve your time/score.

🕐 15-30 min

`PROJECT GUIDE`

STORYMODE: DARK MAZE

Build an input using your Raspberry Pi and breadboard. This game may be played over and over to improve your time/score.

🕐 15-30 min

`PROJECT GUIDE`

STORYMODE: RING RACE

Build an input using your Raspberry Pi and breadboard. This game may be played over and over to improve your time/score.

🕐 30-60 min

`PROJECT GUIDE`

PHASE 4 CLOSING   🕐 30 min

Ask the following questions to guide discussion:
- What role did the sensor computing devices serve in your system? Inputs or outputs? What was the form of the data transmitted for each sensor? **(CA 3-5.CS.1)**
- What tasks did you complete with code you wrote and circuits you built? **(CA 3-5.CS.2)**

`PHASE 4 FINAL ASSESSMENT BANK`

INVENT WITH LEARNED SKILLS

🕑 3-4 hours | MAKE-A-THON

OBJECTIVES: While deconstructing the Piper Computer Kit, reflect on learned skills and apply them in our Piper Make-a-Thon to invent technology solutions to the problems you experience in the world around you.

CAREER CONNECTIONS:
Click each of the careers to learn more about how the skills you will learn can be used.

Economist Avg. Salary: $106,630	Pilot Avg. Salary: $202,180	Database Architect: Avg. Salary: $123,430	Physician Avg. Salary: $208,000

STANDARDS:
- ★ **6-8.AP.13** Decompose problems and subproblems into parts to facilitate the design, implementation, and review of programs. (P3.2)
- ★ **6-8.CS.2** Design a project that combines hardware and software components to collect and exchange data. (P5.1)

PHASE 5 INTRODUCTION   ⏲ 10 min

Take apart the Piper Computer Kit using the blueprint to check parts and inventory. Reflect on the build process and what your ideal computer looks like now.

PHASE 5 MAKE-A-THON   ⏲ 2 hrs

The goal of this event is to get students thinking about using what they have learned about engineering, coding, and design in the context of their own lives and communities. Use the following worksheet to guide this process:

> **MAKE-A-THON WORKSHEET**

STEP 1: IDENTIFYING COMMON PROBLEMS

As a class, brainstorm some problems that your students/community experience. Put some of these ideas on a whiteboard during this open brainstorming session and then select the top options. Good questions to ask to guide this process include:
- Can someone tell me the most frustrating part of your morning?
- Do you live in a special climate? Do you get fined if you use your sprinklers at any point?

STEP 2: FORMING TEAMS

Ask students to select the problem that they want to tackle and ask them to split into groups. Rearrange groups as necessary to facilitate diverse perspectives in each group.

STEP 3: INVENTING SOLUTIONS

Ask students to break down the problem first, into the steps that make it a problem. See the following example from a real student on a common problem she was facing! **Ask students to identify where an invention could intervene.**
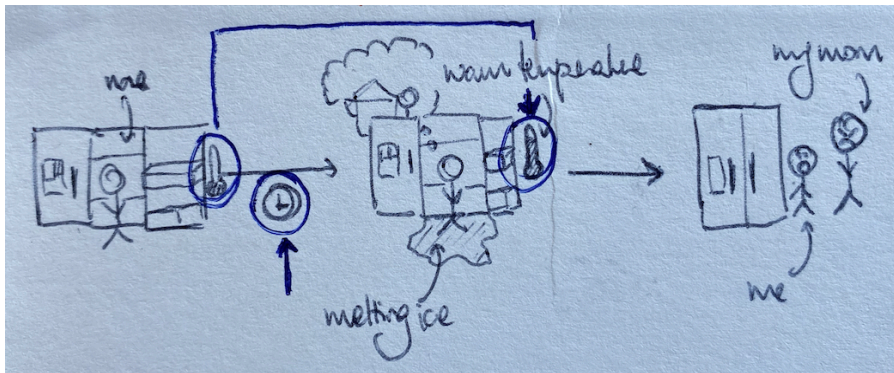
STEP 1	STEP 2	STEP 3
"I went to the fridge this morning to get a snack, and I opened it"	"I got distracted and stood there staring and ice started melting and the fridge warmed"	"I get yelled at by my mom because food got ruined"

Think about what changes happened between Step 1 and 2. This class discussed measuring:
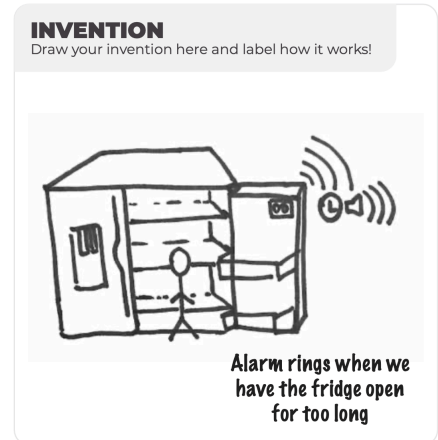> 📏 **TEMPERATURE** going up
> 📏 The amount of **TIME** the door is open

This group decided that they wanted to measure the **TIME** the door is open and set an alarm when the door was open for too long:

STEP 4: DETAILING THE CREATION
Ask students to draw out what the invention would look like. What pieces of technology would it use? What elements of coding would be helpful?
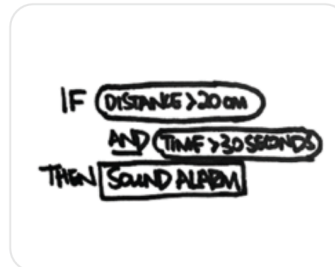
For this group, we asked – "How would you measure the fridge door being open? What piece of technology did we use before to measure distance? **What would you like the CONDITIONS to be to trigger the alarm?"**

INVENTION
Draw your invention here and label how it works!

Alarm rings when we have the fridge open for too long

What hardware does your invention use? *(Draw it!)*

ULTRASONIC RANGE FINDER

What elements of code would your invention use?

IF (DISTANCE > 20 CM) AND (TIME > 30 SECONDS) THEN SOUND ALARM

STEP 5: TELL US ABOUT YOUR BRILLIANT CREATIONS
Send us your best creation at hi@playpiper.com to be featured in our next newsletter!

PHASE 5 CLOSING   🕐 30 min

Ask the following questions to guide discussion:
- What was the most difficult part of decomposing the problem that your group chose? What was the subproblem that you were able to design your solution for? **(6-8.AP.13)**
- Do you feel confident about the hardware and software components you designed? Do you think they can gather the data and respond to the challenge? **(6-8.CS.2)**

Use the Piper Post-Survey and compare it to pre-surveys (matched by name from before) to understand how your Piper Computer Kit experience affected key learning outcomes.

PIPER POST-SURVEY

Follow us on social media **@startwithpiper** or **@start_with_piper on TikTok.**
Email us at hi@playpiper.com with any questions/concerns/recommendations.
Thank you for joining us inspiring the next generation of inventors!