



# CodeHS

AP Computer Science Principles: Cybersecurity in JavaScript Course Syllabus  
One Year for High School, 135 Hours

## Introduction

AP Computer Science Principles is the newest AP® course from the College Board. This course introduces students to the foundational concepts of computer science and explores the impact computing and technology have on our society.

With a unique focus on creative problem solving and real-world applications, the CodeHS AP Computer Science Principles course gives students the opportunity to explore several important topics of computing using their own ideas and creativity, use the power of computing to create artifacts of personal value, and develop an interest in computer science that will foster further endeavors in the field.

## Course Overview

**Prerequisites:** There are no official prerequisites for the CodeHS AP Computer Science Principles course. This course is meant to be a first-time introduction to computer science and does not require students to come in with any computer programming experience. However, we recommend that students take our Introduction to Computer Science prior to our AP courses (more info at [codehs.com/library](https://codehs.com/library)). Students who have completed our Intro to CS course will be able to apply knowledge of concepts covered in the Intro course to the more advanced setting of the AP courses. We also recommend that students complete a first-year high school algebra course prior to taking this course. Students should be comfortable with functions and function notation such as  $f(x) = x + 2$  as well as using a Cartesian  $(x, y)$  coordinate system to represent points in a plane.

### Overarching Goals:

- Increase and diversify participation in computer science
- Students, regardless of prior experience in computing, will develop confidence using computer science as a tool to express themselves and solve problems, and this confidence will prepare them for success in future endeavors in the field of computer science
- Students will understand the core principles of computing, a field which has and continues to change the world
- Students will be able to develop computational artifacts to solve problems, communicate ideas, and express their own creativity
- Students will be able to collaborate with others to solve problems and develop computational artifacts

- Students will be able to explain the impact computing has on society, economy, and culture
- Students will be able to analyze existing artifacts, identify and correct errors, and explain how the artifact functions
- Students will be able to explain how data, information, or knowledge is represented for computational use
- Students will be able to explain how abstractions are used in computation and modeling
- Students will learn to be informed and responsible users of technology

**Learning Environment:** The course utilizes a blended classroom approach. The content is a mix of web-based and physical activities. Students will write and run code in the browser, create digital artifacts, and engage in in-person collaborative exercises with classmates all with a focus of Cybersecurity. Teachers utilize tools and resources provided by CodeHS to leverage time in the classroom and give focused 1-on-1 attention to students. Each unit of the course is broken down into lessons. Lessons consist of video tutorials, short quizzes, example programs to explore, written programming exercises, free response exercises, collaborative creation projects, and research projects.

**Programming Environment:** Students write and run programs in the browser using the CodeHS editor. Students will be able to write both text-based and block-based JavaScript programs, and students will use Processing.js to create graphical programs. Students gain programming experience early on in the course that will enable them to explore the rest of the course topics through computational thinking practices.

**Course Resources:** Access to a computer and high-speed internet is required. There is also an online textbook available for many modules and topics which can be accessed through the lesson plans or at <https://codehs.gitbooks.io/introcs/content/>

**Quizzes:** At the end of most units, students take a summative multiple choice unit quiz in the style of the AP Exam that assesses their knowledge of the concepts covered in the unit. The course also provides an AP Test Practice unit with a cumulative AP Practice Multiple Choice Test.

## Course Objectives

This course is based directly on the College Board AP Computer Science Principles Framework. We recommend reading the curriculum framework [here](#) for context. The main course objectives are summarized below in the six computational thinking practices and five big ideas for the course.

### Computational Thinking Practices:

The six computational thinking practices represent important aspects of the work that computer scientists engage in, and are denoted here by P1 through P6:

- **Practice 1: Computational Solution Design**
  - *Design and evaluate computational solutions for a purpose.*

- **Practice P2: Algorithms and Program Development**
  - *Develop and implement algorithms.*
- **Practice P3: Abstraction in Program Development**
  - *Develop programs that incorporate abstractions.*
- **Practice P4: Code Analysis**
  - *Evaluate and test algorithms and programs.*
- **Practice P5: Computing Innovations**
  - *Investigate computing innovations.*
- **Practice P6: Responsible Computing**
  - *Contribute to an inclusive, safe, collaborative, and ethical computing culture.*

### **Big Ideas:**

The five big ideas of the course encompass foundational ideas in the field of computer science, and are denoted here by B1 through B5:

- **Big Idea 1: Creative Development (CRD)**

*When developing computing innovations, developers can use a formal, iterative design process or experimentation. While using either approach, developers will encounter phases of investigating and reflecting, designing, prototyping, and testing. Additionally, collaboration is an important tool to use at any phase of development because considering multiple perspectives allows for improvement of innovations.*
- **Big Idea 2: Data (DAT)**

*Data is central to computing innovations because it communicates initial conditions to programs and represents new knowledge. Computers consume data, transform data, and produce new data, allowing users to create new information or knowledge to solve problems through the interpretation of this data. Computers store data digitally, which means that the data must be manipulated in order to be presented in a useful way to the user.*
- **Big Idea 3: Algorithms and Programming (AAP)**

*Programmers integrate algorithms and abstraction to create programs for creative purposes and to solve problems. Using multiple program statements in a specified order, making decisions, and repeating the same process multiple times are the building blocks of programs. Incorporating elements of abstraction, by breaking problems down into interacting pieces, each with their own purpose, makes writing complex programs easier. Programmers need to think algorithmically and use abstraction to define and interpret processes that are used in a program.*
- **Big Idea 4: Computing Systems and Networks (CSN)**

*Computer systems and networks are used to transfer data. One of the largest and most commonly used networks is the Internet. Through a series of protocols, the Internet can be used to send and receive information and ideas throughout the world. Transferring and processing information can be slow when done on a single computer but leveraging multiple computers to do the work at the same time can significantly shorten the time it takes to complete tasks or solve problems.*

- **Big Idea 5: Impact of Computing (IOC)**

*Computers and computing have revolutionized our lives. To use computing safely and responsibly, we need to be aware of privacy, security, and ethical issues. As programmers, we need to understand how our programs will be used and be responsible for the consequences. As computer users, we need to understand how to protect ourselves and our privacy when using a computer.*

### **The AP Create Performance Task:**

The through course assessment is a performance task designed to gather evidence of student proficiency in the learning objectives. The AP Create Performance Tasks (PT) is an in-class assessment, administered by the teacher, that allows students to exemplify their learning through an authentic, “real-world” creation. In the Create Performance Task, students will design and implement a program to solve a problem, enable innovation, explore personal interest, or express creativity. Their development process should include exploration, investigation, reflection, design, implementation, and testing your program.

Students will gain the experience necessary to complete the Create Performance Task in class. Each unit comes with practice PTs in which students will research topics in computing, and create their own digital artifacts. Sufficient time is set aside in the course for students to prepare for and complete the Create Performance Task.

### **The AP Exam:**

The AP Computer Science Principles end-of-course exam has consistent question types and weighting every year, so you and your students know what to expect on exam day.

#### **Section I: End-of-Course Multiple-Choice Exam**

70 multiple-choice questions | 120 minutes | 70% of score | 4 answer options

- 57 single-select multiple-choice
- 5 single-select with reading passage about a computing innovation
- 8 multiple-select multiple-choice: select 2 answers

#### **Section II: Create Performance Task: Written Responses**

30% of score

- Create Performance Task program code, video, and student-authored Personalized Project Reference | 9 hours in-class
- 4 written response prompts | 60 minutes end-of-course exam

The second section of the AP Computer Science Principles Exam consists of a through-course Create Performance Task where students will develop a computer program of their choice and an end-of-course written response section where students demonstrate their understanding of their personal Create Performance Task by answering four prompts. Students will be provided 9 hours of in-class time to complete their program, video, and develop a Personalized Project Reference.

## Course Breakdown

### Unit 1: Introduction to Programming with Karel the Dog (3 weeks, 15 hours)

This course begins with a strong focus on programming in order to allow students to create computational artifacts early on in the course. Students will be able to use their knowledge of programming to explore future topics in the course.

We use Karel, a dog that only knows how to move, turn left, and place tennis balls in his world, to show students what it means to program, and allow students to focus on computational problem-solving. Students will learn about the need for programming languages, the uses of programs, how to write programs to solve computational problems, how to design algorithms, how to analyze and compare potential solutions to programming problems, and learn the value and challenges involved in collaborating with others to solve programming problems. Students will use the grid coloring functionality of Karel to create a digital painting.

Subsection	EKs	Lessons / Topics
<b>Abstraction</b>  <u>Lessons:</u> <i>Abstraction</i>	AAP-3.B.1    AAP-3.B.7 AAP-3.B.2    CRD-2.G.1 AAP-3.B.3    DAT-1.A.2 AAP-3.B.4    DAT-1.A.5 AAP-3.B.6	Procedural Abstraction Modularity Program Reuse Digital Data (Bits) Reducing Complexity
<b>Programming Style</b>  <u>Lessons:</u> <i>Intro to Programming</i> <i>Super Karel</i> <i>Ultra Karel</i> <i>Top-Down Design</i> <i>Commenting Your Code</i>	CRD-2.G.1    CRD-2.B.5 CRD-2.G.2    AAP-3.D.1 AAP-2.M.1    AAP-3.D.2 AAP-2.M.3    AAP-3.D.3 CRD-2.B.1    AAP-3.D.4 CRD-2.B.2    AAP-3.D.5	Program Documentation Using Existing Code and Libraries APIs Commenting Code
<b>Control Structures</b>  <u>Lessons:</u> <i>If/Else Statements</i> <i>For Loops</i> <i>While Loops in Karel</i>	AAP-2.G.1 AAP-2.J.1 AAP-2.K.1	If/Else Statements (Selection) For Loops and While Loops (Iteration)
<b>Debugging Strategies</b>  <u>Lessons:</u> <i>Functions in Karel</i>	CRD-2.I.1 CRD-2.I.2 CRD-2.I.3 CRD-2.I.5	Logic Errors Syntax Errors Run-Time Error Testing

<i>Debugging Strategies</i>			
<b>Designing Algorithms</b>  <u>Lessons:</u> <i>Karel Algorithms</i>	AAP-2.A.4 AAP-2.B.1 AAP-2.B.2 AAP-2.B.6 AAP-2.B.7	AAP-2.M.2 AAP-4.A.2 AAP-4.A.4 AAP-4.A.5 AAP-4.A.6	Sequencing, Selection, Iteration Clarity and Readability Using Existing Algorithms Optimization and Efficiency

**Example Activities and Big Idea/Computational Thinking Practice**

*The Two Towers:* In this program, students have Karel build two towers of tennis balls. Each tower should be 3 tennis balls high. In the end, Karel should end up on top of the second tower, facing East. Students need to write at least 3 functions in order to solve this problem. This activity requires students to design and create functions for repeated processes within their program. Students need to consider top-down design and decomposition through the following questions:

- How can you break this problem down into smaller problems?
- What is a subtask that Karel needs to do more than once in this problem?

**[Big Idea AAP][Computational Thinking Practice 1]**

**Unit 2: Practice PT: Pair-Programming Paint (3 days, 3 hours)**

Students will use the grid coloring functionality of Karel to create a digital image. They will then embed this Karel program into their personal website portfolio.

<b>Subsection</b>	<b>EKs</b>	<b>Lessons / Topics</b>
<b>Collaboration and Communication</b>	CRD-1.A.3 CRD-1.A.4 CRD-1.B.2 CRD-1.C.1 CRD-2.F.5 CRD-2.F.6	CRD-2.F.7 CRD-2.G.1 CRD-2.G.3 CRD-2.G.4 CRD-2.G.5 CRD-2.H.1 CRD-2.H.2
		Collaboration Diverse Perspectives Bias Avoidance Pair-Programming Design and Planning Program Documentation Acknowledgement of Reused Code

**Example Activity and Big Idea/Computational Thinking Practice**

*Create Your Own UltraKarel Image:* Following the milestones and the pseudocode plan that students have laid out, students use pair-programming to write the code for their final project. They then test their code along the way to make sure they have solved each milestone. This activity allows students to develop something completely unique with their programming skills and implement a successful algorithm of their own design.

Students then reflect upon and answer the following questions:

1. Identify the programming language and purpose of your program.

2. Describe the incremental and iterative development process of your program. How did you divide the program into smaller tasks and make a plan to complete them all?
3. Describe the difficulties and/or opportunities you encountered and how they were resolved or incorporated.
4. Identify an algorithm that is fundamental for your program to achieve its intended purpose and includes two or more additional algorithms.
5. Describe how each algorithm within your selected algorithm functions independently, as well as in combination with others, to form a new algorithm that helps to achieve the intended purpose of the program.
6. Identify an abstraction you developed, and explain how your abstraction helped manage the complexity of your program.

**[Big Idea CRD][Computational Thinking Practice 2]**

### Unit 3: Programming with JavaScript (2 weeks, 10 hours)

This unit introduces students to the basics of JavaScript, including variables, user input, control structures, functions with parameters and return values, and basic graphics, how to send messages to objects.

Subsection	EKs	Lessons / Topics
<b>Programming Languages</b>  <u>Lessons:</u> <i>What is Code?</i> <i>Uses of Programs</i>	AAP-2.A.2 AAP-2.A.3 CRD-1.A.1 CRD-1.A.2 CRD-2.B.1	What is Programming? Pseudocode Programming Languages Computing Innovations
<b>Variables</b>  <u>Lessons:</u> <i>Variables</i>	AAP-1.A.1    AAP-1.B.2 AAP-1.A.2    AAP-1.B.3 AAP-1.A.3    DAT-1.A.1 AAP-1.A.4 AAP-1.B.1	Variable Names Assignment Operators Data Types Variables as Abstractions
<b>Arithmetic Expressions</b>  <u>Lessons:</u> <i>Basic Math in JavaScript</i>	CRD-2.B.4    AAP-2.B.3 CRD-2.I.5    AAP-2.B.4 CRD-2.J.1    AAP-2.B.5 CRD-2.J.2    AAP-2.C.1 CRD-2.J.3    AAP-2.C.2 AAP-2.A.1    AAP-2.C.3 AAP-2.A.2    AAP-2.C.4	Program Behavior Testing using Inputs Arithmetic Expressions Order of Operations Modulus String Concatenation

	AAP-2.A.3 AAP-2.A.4	AAP-2.D.1 AAP-2.D.2	
<b>User Input</b>  <u>Lessons:</u> <i>User Input</i> <i>Mouse Events: Mouse Clicked</i> <i>Key Events</i>	AAP-1.C.4 AAP-3.A.6 AAP-3.A.9 CRD-2.C.2 CRD-2.C.3	CRD-2.C.5 CRD-2.C.6 CRD-2.D.2	Strings User Input Program Output Events Mouse and Key Events
<p><b>Example Activity and Big Idea/Computational Thinking Practice</b></p> <p><i>Computing Innovations</i> (as part of <i>Uses of Programs</i> lesson): In this activity, students perform an online search for examples of computing innovations that have had an impact on society, economy, or culture. The computing innovations must consume, produce, and/or transform data. A computing innovation can be a physical object like a self-driving car, non-physical software like a picture editing software, or a non-physical concept like e-commerce.</p> <p>Students</p> <ul style="list-style-type: none"> <li>• practice searching and evaluating sources relevant to computing innovations</li> <li>• write the definition of <i>computing innovation</i> in their own words</li> <li>• list 5 items that ARE computing innovations and 5 items that are NOT computing innovations. For each one, explain the reason why it is or is not a computing innovation</li> <li>• identify the data used in at least one computing innovation and explain how the data is consumed, produced, or transformed by the given computing innovation. [<b>Computing Innovation 1, Prompt B</b>][<b>Big Idea IOC</b>][<b>Computational Thinking Practice 5</b>]</li> </ul>			

#### Unit 4: JavaScript Control Structures (2 weeks, 10 hours)

In this unit, students learn how to use booleans and logical operators with control structures to make more advanced programs in JavaScript.

Subsection	EKs	Lessons / Topics
<b>Comparison Operators</b>  <u>Lessons:</u> <i>Booleans</i> <i>Comparison Operators</i>	AAP-2.E.1 AAP-2.E.2 AAP-2.F.1 AAP-2.F.2 AAP-2.F.3	AAP-2.F.4 AAP-2.F.5  Booleans Relational Operators Operands
<b>Selection</b>  <u>Lessons:</u> <i>If Statements</i> <i>Random Numbers</i> <i>Applying Conditionals</i>	AAP-2.G.1 AAP-2.H.1 AAP-2.H.2 AAP-2.H.3 AAP-2.I.1	AAP-2.I.2 AAP-2.L.3 AAP-2.L.4 AAP-3.E.2  Selection Conditional Statements Nested Conditionals Equivalent Boolean Statements Random Numbers Password Validation



<b>Iteration</b>  <u>Lessons:</u> <i>While Loops</i>	AAP-2.K.2    AAP-2.L.1 AAP-2.K.3    AAP-2.L.2 AAP-2.K.4    AAP-2.L.5 AAP-2.K.5	Iteration Loops Different but Equivalent Algorithms

**Example Activity and Big Idea/Computational Thinking Practice**

*Create a Password Prompt:* Students write a program that uses conditional statements to verify that a user entered password meets minimum criteria. If their password is too short it will reprompt once. Once it is long enough it will ask the user to verify the password. This activity requires that students use multiple program statements and nested if statements in a specific order to solve a problem.

**[Big Idea AAP][Computational Thinking Practice 2]**

**Unit 5: Functions and Parameters (2 weeks, 10 hours)**

In this unit, students learn to write reusable code with functions and parameters.

<b>Subsection</b>	<b>EKs</b>	<b>Lessons / Topics</b>
<b>Functions and Parameters</b>  <u>Lessons:</u> <i>Functions and Parameters 1</i> <i>Functions and Parameters 2</i> <i>Functions and Return Values 1</i> <i>Functions and Return Values 2</i>	CRD-2.C.6    AAP-3.A.3 CRD-2.D.2    AAP-3.A.4 CRD-2.B.3    AAP-3.B.5 CRD-2.C.4    AAP-3.C.1 AAP-3.A.1    AAP-3.C.2 AAP-3.A.2    AAP-2.M.2	User and Application Input Program Output Procedures Parameters Return Values Using Existing Algorithms

**Example Activity and Big Idea/Computational Thinking Practice**

*Pool Table:* Students write a program with a function that draws a pool ball. This function should take as parameters, the color, the number that should go on the pool ball, and the location of the center of the pool ball. Students need to consider the function abstractly as a means for taking specific data via the parameters and creating a unique graphical output based on those inputs.

**[Big Idea DAT][Computational Thinking Practice 3]**

**Unit 6: Practice PT: Tell a Story (3 days, 3 hours)**

In this project, students will write a JavaScript program that tells a graphical story

**Example Activity and Big Idea/Computational Thinking Practice**

*Tell a Story!* In this activity, students write a JavaScript program that tells a graphical story in at least 4 scenes. Following the milestones and the pseudocode plan that students have laid out

prior to this exercise, students write the code for their final project. Along the way, students are testing their code to identify errors in both their pseudocode algorithm and their program. At each milestone, students test their code to ensure that the functionality meets the expected results that were laid out in their plan. After completing the program, students are asked to reflect and explain how their program functions.

**[Big Idea CRD][Computational Thinking Practice 4]**

**Unit 7: Basic Data Structures (2 weeks, 10 hours)**

In this unit, students learn to write reusable code with functions and parameters.

<b>Subsection</b>	<b>EKs</b>	<b>Lessons / Topics</b>
<p><b>Basic Data Structures</b></p> <p><u>Lessons:</u> Intro to Lists/Arrays Indexing Into an Array Removing an Element</p>	<p>DAT-1.A.1 AAP-1.A.1 AAP-1.C.1 AAP-1.C.2 AAP-1.C.3 AAP-1.D.6 AAP-1.D.7 AAP-1.D.8 AAP-2.N.2 AAP-2.N.1</p>	<p>Data Values Lists and Elements Indices List Procedures</p>
<p><b>Data Abstractions</b></p> <p><u>Lessons:</u> Adding/Removing From Arrays Array Length and Looping</p>	<p>AAP-1.D.1 AAP-1.D.5 DAT-2.E.4 AAP-1.D.2 AAP-1.D.3 AAP-1.D.4 DAT-2.E.2 DAT-2.D.4 DAT-2.E.5</p>	<p>Data Abstraction Translating and Transforming Data Filtering and Cleaning Patterns</p>
<p><b>Traversing a List</b></p> <p><u>Lessons:</u> Array Length and Looping Iterating Over an Array Removing an Element</p>	<p>DAT-2.D.6    AAP-3.A.5 AAP-2.O.1    AAP-3.A.7 AAP-2.O.2    AAP-3.A.8 AAP-3.C.1    AAP-3.E.1 AAP-3.C.2 AAP-3.A.6 AAP-2.O.3</p>	<p>Extract and Modify Information Traversing a List Iteration Statements Usernames and Passwords</p>
<p><b>Algorithm Efficiency</b></p> <p><u>Lessons:</u> Array Length and Looping Finding an Element in a List</p>	<p>AAP-2.O.4    AAP-4.A.1 DAT-2.D.3    AAP-4.A.3 AAP-2.O.5    AAP-4.A.7 AAP-2.P.1    AAP-4.A.8 AAP-2.P.2    AAP-4.A.9</p>	<p>Using Existing Algorithms Search Tools Linear Search Binary Search Algorithm Efficiency</p>

	AAP-2.P.3	Heuristics
<b>Simulation</b>  <u>Lessons:</u> <i>Simulation</i>	AAP-3.F.1 AAP-3.F.2 AAP-3.F.3 AAP-3.F.4 AAP-3.F.5 AAP-3.F.6 AAP-3.F.7 AAP-3.F.8	Simulations as Abstractions Bias in Simulations Random Number Generators
<b>Example Activity and Big Idea/Computational Thinking Practice</b> <i>Draw a Barcode:</i> Students write a program to draw a barcode on the screen given an array that represents the data in the barcode. The array will contain a boolean in it, and if the boolean is `true`, the program will need to draw a vertical line in that position that runs from the top to the bottom of the screen. If not, the program will not draw a line. This program development requires students to use data generated from their bit array and loops and conditionals to determine where lines are drawn and where they are not drawn. <b>[Big Idea DAT][Computational Thinking Practice 2]</b>		

### Unit 8: Digital Information (3 weeks, 15 hours)

In this unit, students will learn about the various ways we represent information digitally. Topics covered include number systems, encoding data, programmatically creating pixel images, comparing data encodings, compressing and encrypting data. Students will work in pairs to develop their own data encryption algorithms and attempt to crack the encryptions of their peers.

Subsection	EKs	Lessons / Topics
<b>Number Systems</b>  <u>Lessons:</u> <i>Intro to Digital Information</i> <i>Number Systems</i>	CRD-2.C.1    DAT-1.A.7 CRD-2.D.1    DAT-1.B.1 CRD-2.J.2    DAT-1.B.2 CRD-2.J.3    DAT-1.B.3 CRD-2.I.4    DAT-1.C.1 DAT-1.A.2    DAT-1.C.2 DAT-1.A.3    DAT-1.C.3 DAT-1.A.4    DAT-1.C.4 DAT-1.A.5    DAT-1.C.5 DAT-1.A.6	Computing Devices Abstraction Program Input and Output Bits and Bytes Overflow Errors Range of Value Limits Binary and Decimal Systems
<b>Data Compression</b>  <u>Lessons:</u> <i>Data Compression</i> <i>Lossy Compression</i>	DAT-1.A.8    DAT-1.D.4 DAT-1.A.9    DAT-1.D.5 DAT-1.A.10    DAT-1.D.6 DAT-1.D.1    DAT-1.D.7 DAT-1.D.2    DAT-1.D.8 DAT-1.D.3	Lossless Data Lossy Data Digital and Analog Data

<p><b>Steganography</b></p> <p><u>Lessons:</u>  <i>Introduction to Steganography</i>  <i>Ethics of Steganography</i></p>	<p>IOC-1.F.2  IOC-1.F.8  IOC-1.F.9  IOC-1.F.11</p>	<p>What is Steganography  Hiding and Extracting Messages  Government Surveillance</p>
<p><b>Example Activity and Big Idea/Computational Thinking Practice</b></p> <p><i>Ethics of Steganography:</i> Students will explore the impact that computing has on privacy and surveillance by researching different ethical issues around personal and government tracking. Students will answer questions as to how technology has made it easier for companies and the government to track criminal behavior as well as discuss the ethical impact of this type of tracking.</p> <p><b>[Big Idea IOC][Computational Thinking Practice 6]</b></p>		

**Unit 9: Practice PT: Steganography (3 days, 3 hours)**

In this project, students will be implementing a form of cryptography known as Steganography. Students can choose this practice PT or the following.

<p><b>Example Activity and Big Idea/Computational Thinking Practice</b></p> <p><i>Secret Image: Steganography-</i> Students use a form of cryptography called steganography to hide a secret image inside of a cover image. They need to develop two functions that create filters, with one encoding and the other decoding. They are required to use a solid degree of abstraction since several functions will be required for each part of the encoding and decoding process. This also continues their consideration and discussions of privacy issues in computing.</p> <p><b>[Big Idea IOC][Computational Thinking Practice 3]</b></p>
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**Unit 10: Encryption (1 weeks, 5 hours)**

In this unit, students will learn about the various ways we encrypt information. Topics covered include encoding and decrypting Caesar and Vigenere ciphers, and understanding symmetric and public key encryption.

<b>Subsection</b>	<b>EKs</b>	<b>Lessons / Topics</b>
<p><b>Encryption</b></p> <p><u>Lessons:</u>  <i>Caesar</i>  <i>Vigenere</i></p>	<p>CRD-1.A.3  AAP-2.D.1  AAP-2.H.1  AAP-3.E.2</p>	<p>Introduction to Caesar  Decrypting and Breaking Caesar  Vigenere Cipher</p>

<p><b>Symmetric and Public Key Encryption</b></p> <p><u>Lessons:</u>  <i>Diffie-Hellman</i>  <i>RSA Encryption</i></p>	<p>AAP-4.B.1  AAP-4.B.2  AAP-4.B.3  IOC-2.B.1  IOC-2.B.5</p>	<p>Diffie-Hellman Key Exchange  Public Key Programming  RSA Encryption  RSA Example</p>
<p><b>Example Activity and Big Idea/Computational Thinking Practice</b></p> <p><i>Break Caesar's Cipher:</i> Students explore the concept of ciphers and how to write code that can encode and decode ciphers such as a Caesar Cipher. Before moving into more complex ciphers, students explore how a computer can easily break a Caesar Cipher. Students are given an encrypted passage and a tool that can shift letters. They then explore different shifts until the phrase becomes legible. In this process, students can see how there are a limited number of shifts that can be applied and through brute strength, the encrypted message can be broken fairly quickly.</p> <p><b>[Big Idea IOC][Computational Thinking Practice 2]</b></p>		

**Unit 11: Practice PT: Create Your Own Image Filter (3 days, 3 hours)**

In this project, students pair up with a partner to develop a novel image filter that can be applied to any digital image of their choosing. They will describe their image filter, and their development process, and embed their image filter along with its description on their personal portfolio website. Students can choose this practice PT or the previous.

<p><b>Example Activity and Big Idea/Computational Thinking Practice</b></p> <p><i>Create an Image Filter:</i> In this activity, students work with a partner to develop functions for creating unique image filters. They share their creative solutions designs with others and incorporate feedback for improvement.</p> <p><b>[Big Idea CRD][Computational Thinking Practice 1]</b></p>
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**Unit 12: The Internet (2 weeks, 10 hours)**

This unit explores the structure and design of the internet, and how this design affects the reliability of network communication, the security of data, and personal privacy. Students will learn about the protocols and algorithms used on the internet and the importance of cybersecurity. Students will choose an innovation that was enabled by the Internet and explore the positive and negative impacts of their innovation on society, economy, and culture. Students will develop a computational artifact that illustrates, represents, or explains the innovation's purpose, its function, or its effect.

Subsection	EKs	Lessons / Topics
<p><b>Internet Hardware and Addresses</b></p> <p><u>Lessons:</u>  <i>Welcome to the Internet</i>  <i>Internet Hardware</i>  <i>Internet Addresses</i></p>	<p>CSN-1.A.1    CSN-1.A.8  CSN-1.A.2    CSN-1.B.3  CSN-1.A.3    CSN-1.B.4  CSN-1.A.4  CSN-1.A.7</p>	<p>Protocols  Computing Devices  Computer Networks  Bandwidth</p>
<p><b>Routing</b></p> <p><u>Lessons:</u>  <i>Routing</i></p>	<p>CSN-1.A.5    CSN-1.E.2  CSN-1.A.6    CSN-1.E.3  CSN-1.B.5    CSN-1.E.4  CSN-1.B.6    CSN-1.E.5  CSN-1.B.7    CSN-1.E.6  CSN-1.E.1    CSN-1.E.7</p>	<p>Routing  Scalability  Fault-Tolerance  Redundancy</p>
<p><b>Packets and Protocols</b></p> <p><u>Lessons:</u>  <i>Packets and Protocols</i></p>	<p>CSN-1.B.1    CSN-1.D.1  CSN-1.B.2    CSN-1.D.2  CSN-1.C.1    CSN-1.D.3  CSN-1.C.2    DAT-2.B.1  CSN-1.C.3    DAT-2.B.3  CSN-1.C.4    DAT-2.B.5</p>	<p>Datastreams  Packets  IP, TCP, UDP  HTTP  Metadata</p>
<p><b>Computing Systems</b></p> <p><u>Lessons:</u>  <i>Sequential, Parallel &amp; Distributed</i></p>	<p>DAT-2.C.7    CSN-2.A.6  DAT-2.C.8    CSN-2.A.7  CSN-2.A.1    CSN-2.B.1  CSN-2.A.2    CSN-2.B.2  CSN-2.A.3    CSN-2.B.3  CSN-2.A.4    CSN-2.B.4  CSN-2.A.5    CSN-2.B.5</p>	<p>Parallel Systems  Scalability of Systems  Sequential Computing  Parallel Computing  Distributed Computing  Efficiency of Solutions  Speedup</p>
<p><b>Impact of the Internet</b></p> <p><u>Lessons:</u>  <i>The Impact of the Internet</i>  <i>Creative Credit and Copyright</i></p>	<p>IOC-1.A.1    IOC-1.E.2  IOC-1.A.3    IOC-1.E.3  IOC-1.A.4    IOC-1.E.4  IOC-1.A.5    IOC-1.E.5  IOC-1.B.1    IOC-1.E.6  IOC-1.B.2    IOC-1.F.1  IOC-1.B.3    IOC-1.F.2  IOC-1.B.4    IOC-1.F.3  IOC-1.B.5    IOC-1.F.4  IOC-1.B.6    IOC-1.F.5  IOC-1.C.1    IOC-1.F.6  IOC-1.C.2    IOC-1.F.7  IOC-1.C.3    IOC-1.F.9  IOC-1.C.4    IOC-1.F.10  IOC-1.C.5    IOC-1.F.11  IOC-1.E.1</p>	<p>Computing Innovations  Unintended Effects  Impact on Society  Rapid Sharing  Digital Divide  Citizen Science  Crowdsourcing  Creative Credit and Copyright</p>

### Example Activity and Big Idea/Computational Thinking Practice

*Reflection: Unintended Effects* - Students consider the WWW, targeted advertising and machine learning and data mining as examples of computing innovations. They also learn that responsible programmers try to consider the unintended ways their computing innovations can be used and the potential beneficial and harmful effects of these new uses although it may not be possible for a programmer to consider all the ways a computing innovation can be used.

They then consider *Pokemon Go* (from the previous video) or research another innovation that had unintended effects. Students answer in their reflections:

1. What were the intended effects and what were the unintended effects?
2. Explain beneficial and harmful effects of at least one other computing innovation on society, economy, or culture.

### [Computing Innovation 2, Prompt A][Big Idea IOC][Computational Thinking Practice 5]

*Packets and Protocols: The Story of the Internet* - In their own words, students tell the story of downloading an image from a website on the internet. They tell the story step by step of how their computer finds the relevant server, requests information from the server, and receives it. Students are required to include distinctions between the internet and the World Wide Web, such as:

- The World Wide Web is a system of linked pages, programs, and files.
- HTTP is a protocol used by the World Wide Web.
- The World Wide Web uses the Internet.

### [Big Idea CSN][Computational Thinking Practice 5]

## Unit 13: Cybersecurity (2 weeks, 10 hours)

In this unit, students will learn about the various ways we encrypt information. Topics covered include encoding and decrypting Caesar and Vigenere ciphers, and understanding symmetric and public key encryption.

Subsection	EKs	Lessons / Topics
<b>Information Security</b>  <u>Lessons:</u> <i>CIA Triad</i> <i>Personal security</i>	IOC-1.F.8 IOC-2.A.1    IOC-2.B.6 IOC-2.A.7    IOC-2.B.7 IOC-2.A.8    IOC-2.B.9 IOC-2.A.9    IOC-2.B.10 IOC-2.A.11    IOC-2.B.11 IOC-2.A.12 IOC-2.A.13 IOC-2.A.15 IOC-2.B.1	Phishing Attacks Password Authentication Password Strength Multi Factor Authentication

	IOC-2.B.2 IOC-2.B.3 IOC-2.B.4	
<b>Network Security</b>  <u>Lessons:</u> <i>OSI Model</i> <i>Network Attacks</i>	IOC-2.A.4 IOC-2.B.8 IOC-2.B.5 IOC-2.B.9 IOC-2.B.10	Introduction to Networking Introduction to the OSI Model Network Attacks
<b>Risk</b>  <u>Lessons:</u> <i>Cybersecurity Risk Model</i>	IOC-2.C.1    IOC-2.C.5 IOC-2.C.2    IOC-2.C.6 IOC-2.C.3    IOC-2.C.7 IOC-2.C.4	Basic Cybersecurity Risk Assessing Vulnerabilities Security Controls
<p><b>Example Activity and Big Idea/Computational Thinking Practice</b>  <i>Phishing Simulator and Reflection:</i> Students will explore several situations that are designed to look like possible phishing situations. In each, students decide if the situation is legitimate or phishing and then receive feedback as to their choice. After the exercise, they then have a chance to reflect on common characteristics.  <b>[Big Idea IOC][Computational Thinking Practice 6]</b></p>		

**Unit 14: Practice PT: Cyber Ethics (3 days, 3 hours)**

In this project, students will choose one of four articles on cyber ethics and write a position paper. Based on that article, they will provide an arguable opinion about who is responsible and why, and how the culpable party(ies) should be held accountable in the future so that other cities and their citizens do not suffer the same harms.

<p><b>Example Activity and Big Idea/Computational Thinking Practice</b>  <i>Develop Your Position:</i> In this activity, students focus on developing their position. They are asked to pick the best 3 or 4 points from an earlier activity where they listed the Pros and Cons for their article.</p> <p>For each point, students are then asked to write a well constructed paragraph that contains the following:</p> <ul style="list-style-type: none"> <li>• A general statement of the position</li> <li>• An elaboration that references documents and source data</li> <li>• Past experiences and authoritative testimony</li> <li>• Conclusion restating the position</li> </ul> <p><b>[Computing Innovation 3, Prompt C][Big Idea IOC][Computational Thinking Practice 5]</b></p>
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**Unit 15: Data (1 week, 5 hours)**



In this unit, students will explore using computational tools to store massive amounts of data, manipulate and visualize data, find patterns in data, and draw conclusions from data. Students will consider how the modern wealth of data collection has impacted society in positive and negative ways. Students will work in teams to investigate a question of personal interest and use public data to present a data-driven insight to their peers. They will develop visualizations to communicate their findings.

<b>Subsection</b>	<b>EKs</b>	<b>Lessons / Topics</b>
<p><b>Visualizing and Interpreting Data</b></p> <p><u>Lessons:</u>  <i>Getting Started with Data</i>  <i>Visualizing and Interpreting Data</i></p>	DAT-2.A.1    DAT-2.D.5 DAT-2.A.2    DAT-2.D.6 DAT-2.C.1    DAT-2.E.1 DAT-2.D.1    DAT-2.E.2 DAT-2.D.2    DAT-2.E.3 DAT-2.D.3    DAT-2.E.5 DAT-2.D.4	Filtering and Cleaning Data Patterns and Trends Search Tools Tables, Diagrams and Displays Interactive Visualizations Combining Data Sources
<p><b>Collecting Data and Data Limitations</b></p> <p><u>Lessons:</u>  <i>Data Collection and Limitations</i></p>	DAT-2.A.3    DAT-2.C.2 DAT-2.A.4    DAT-2.C.3 DAT-2.B.1    DAT-2.C.4 DAT-2.B.2    DAT-2.C.5 DAT-2.B.3    DAT-2.C.6 DAT-2.B.4    DAT-2.D.6 DAT-2.B.5    CRD-2.F.3	Metadata Correlation Using a Variety of Sources Incomplete or Invalid Data Bias Surveys, Testing, Interviews
<p><b>Personal Data Vulnerabilities</b></p> <p><u>Lessons:</u>  <i>Unintended Data Sharing</i>  <i>Metadata and Data Collection</i></p>		Personal Data Vulnerabilities What Can you Learn Cleaning Up Social Media Information Data Exchange What Can You Learn From an Image Online Privacy
<p><b>Example Activity and Big Idea/Computational Thinking Practice</b></p> <p><i>Importance of Metadata:</i> Students consider how metadata can increase the effective use of data or data sets by providing additional information. They consider the importance of metadata and reflect on why metadata is important for a data set, how metadata help in finding specific data, and what metadata should reveal about the data.</p> <p><b>[Big Idea DAT][Computational Thinking Practice 5]</b></p>		

**Unit 16: Practice PT: Present a Data-Driven Insight (3 days, 3 hours)**

In this project, students will work with a partner to answer a question of personal interest using a publicly available data set. Students will need to produce data visualizations and explain how these visualizations led to their conclusions. They will develop a computational artifact that illustrates, represents, or explains their findings, communicate their findings to their classmates.

**Example Activity and Big Idea/Computational Thinking Practice**

*Present a Data-driven Insight:* Students consider how the amount of collected data impacts our lives in ways that require considerable study and reflection for us to fully understand them.

Students explore a question that can be answered by analyzing a dataset. They form a question and use visualization techniques to analyze the data to answer the question.

**[Big Idea DAT][Computational Thinking Practice 6]**

**Unit 17 & 18: Explore MCQ Practice and Create Performance Task (3 weeks, 15 hours)**

This time is set aside for students to prepare for the Explore MCQ and create their AP Create Performance Task. Students will be given the chance to review course content and practice the skills necessary to complete the Create Performance Task. The Create PT will be administered over 9 hours of class time.

<b>Subsection</b>	<b>EKs</b>	<b>Lessons / Topics</b>
<b>AP CSP Explore Task Practice</b>	IOC-2.A.2 IOC-2.A.10 IOC-2.A.3 IOC-2.A.14 IOC-2.A.4 IOC-1.F.11 IOC-2.A.5 CRD-1.A.1 IOC-2.A.6 CRD-1.A.2	Artifact Creation Computing Innovations Data Input and Output Data Privacy and Security
<b>Prepare for Create PT</b>	ALL	Review Course Content Incremental Development Documentation Debugging Collaborative Development
<b>Create PT</b>		9 hours of class time to conduct Create PT

**Example Activity and Big Idea/Computational Thinking Practice**

*Create Performance Task:* Students develop a program of their choice. Their development process includes iteratively designing, implementing, and testing their program. Students are strongly encouraged to work with another student in their class.

**[Big Idea AAP][Computational Thinking Practices 1-4]**

**Unit 19: Review for the AP Exam (1 week, 5 hours)**

This unit gives students a review of the topics covered in the course and provides practice solving AP Exam style multiple-choice questions.

<b>Subsection</b>	<b>Lessons / Topics</b>
<b>Prepare for Practice Exam</b>	Review course content What to expect on the exam
<b>Practice AP Exam</b>	Cumulative Final AP Review Multiple Choice Test

**Unit 20: Creative Development (Remainder of the school year, 2-4 weeks, 10-20 hours)**

In this unit, students will brainstorm their own final project, discuss their ideas with their peers, scope their project to fit within the time constraints of the class, plan out milestones for incremental development, and create their own final product from scratch. This project allows students to think creatively about the applications of the concepts covered in the course, and create something of personal value.

<b>Subsection</b>	<b>EKs</b>	<b>Lessons / Topics</b>
<b>Design Thinking</b>  <u>Lessons:</u> <i>Intro to Design Thinking</i>	CRD-1.A.4    CRD-2.E.4 CRD-1.A.5    CRD-2.F.1 CRD-1.A.6    CRD-2.F.2 CRD-2.A.1    CRD-2.F.5 CRD-2.A.2    CRD-2.F.6 CRD-2.E.1    CRD-2.F.7 CRD-2.E.2    IOC-1.A.2	Computing Innovations Development Process Program Specifications Design Phase Communication Collaboration
<b>Brainstorm, Prototype &amp; Test</b>  <u>Lessons:</u> <i>Prototype Test</i>	CRD-2.E.2    CRD-2.F.4 CRD-2.F.7    CRD-2.F.3 CRD-1.A.5    IOC-1.D.1 CRD-1.A.6    IOC-1.D.2 CRD-1.A.4    IOC-1.D.3 CRD-2.E.3    IOC-1.F.11	Development Process User Testing User Research Diverse Perspectives Iterative Development Human Biases Legal and Ethical Concerns
<b>Project Prep and Development</b>  <u>Lessons:</u> <i>Project Prep and Development</i>	CRD-1.B.1	Online Collaboration Tools

**Example Activity and Big Idea/Computational Thinking Practice**

*User Interface Scavenger Hunt:* Students search for 2 websites or apps, one with a good UI and one with a not-so-good UI. They learn to discriminate features of solid UI design in terms of accessibility and more before moving onto prototyping their creative project for the unit.

**[Big Idea CRD][Computational Thinking Practices 6]**

## AP Computer Science Principles 2020 Supplemental Materials

<b>Supplementary Units</b>	<b>Prerequisite/Recommended Unit(s)</b>	<b># of activities</b>
Extra Karel Practice	Intro to Programming	12
Extra Karel Puzzles	Intro to Programming	11
Karel Challenges	Intro to Programming	7
Web Development	After Pretest	79
Functions and Parameters Practice	Functions & Parameters	8
Extra Console Challenges - Prime Numbers	Javascript Control Structures	10
Animation and Games - Timers - Random Circles - Random Ghosts - Bouncing Ball - Mouse Events: Mouse Clicked - Mouse Events: Mouse Moved - Drawing Lines - Key Events - Crazy Ball Game	Functions & Parameters	51
Project: Breakout	Functions & Parameters	4
Data Structures Challenge Problems - Conway's Game of Life - Connect Four	Basic Data Structures	6
Visualizing Music	Basic Data Structures	9
Project: Tic Tac Toe	Basic Data Structures	4
Project: Helicopter	Basic Data Structures	24
More Basic Data Structures	Basic Data Structures	38