

# Computer Mathematics

**Data Representation and Storage**

**DRS.1** The student will represent data and convert data between different number systems. [CM.DRS.1](#)

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**DRS.2** The student will differentiate between variable data types based upon their characteristics. [CM.DRS.2](#)

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**DRS.3** The student will represent data using appropriate data structures. [CM.DRS.3](#)

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**Represent data in different number systems, including binary, decimal, and hexadecimal.** [CM.DRS.1.A](#)

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**a** Represent data in different number systems, including binary, decimal, and hexadecimal. [CM.DRS.1.A](#)

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**Convert data between number systems (e.g., binary to decimal, decimal to hexadecimal).** [CM.DRS.1.B](#)

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**b** Convert data between number systems (e.g., binary to decimal, decimal to hexadecimal). [CM.DRS.1.B](#)

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**Describe the characteristics of different variable data types, including** [CM.DRS.2.A](#)

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**a** Describe the characteristics of different variable data types, including [CM.DRS.2.A](#)

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**Boolean;** [CM.DRS.2.A.I](#)

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**i** Boolean; [CM.DRS.2.A.I](#)

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**character;** [CM.DRS.2.A.II](#)

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**ii** character; [CM.DRS.2.A.II](#)

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**integer;** [CM.DRS.2.A.III](#)

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**iii** integer; [CM.DRS.2.A.III](#)

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**decimal (double/float); and** [CM.DRS.2.A.IV](#)

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**iv** decimal (double/float); and [CM.DRS.2.A.IV](#)

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**string.** [CM.DRS.2.A.V](#)

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**v** string. [CM.DRS.2.A.V](#)

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**Differentiate between variable data types to determine the data type needed based upon intended use (e.g., character versus string, integer versus double/float).** [CM.DRS.2.B](#)

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**b Differentiate between variable data types to determine the data type needed based upon intended use (e.g., character versus string, integer versus double/float).** [CM.DRS.2.B](#)

**Given a specific task or problem, determine the appropriate data structure (e.g., lists, arrays, objects) to represent data.** [CM.DRS.3.A](#)

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**a Given a specific task or problem, determine the appropriate data structure (e.g., lists, arrays, objects) to represent data.** [CM.DRS.3.A](#)

**Perform tasks related to lists or arrays (one-dimensional or two-dimensional), including** [CM.DRS.3.B](#)

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**b Perform tasks related to lists or arrays (one-dimensional or two-dimensional), including** [CM.DRS.3.B](#)

**declare a list or array (one-dimensional or two-dimensional);** [CM.DRS.3.B.I](#)

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**i declare a list or array (one-dimensional or two-dimensional);** [CM.DRS.3.B.I](#)

**choose an appropriate data type for a list or an array; and** [CM.DRS.3.B.II](#)

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**ii choose an appropriate data type for a list or an array; and** [CM.DRS.3.B.II](#)

**fill the list or array with data.** [CM.DRS.3.B.III](#)

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**iii fill the list or array with data.** [CM.DRS.3.B.III](#)

**Access and manipulate a particular element of a list or an array.** [CM.DRS.3.C](#)

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**c Access and manipulate a particular element of a list or an array.** [CM.DRS.3.C](#)

**Implement predefined objects to consolidate related information of different data types.** [CM.DRS.3.D](#)

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**d Implement predefined objects to consolidate related information of different data types.** [CM.DRS.3.D](#)

## Components of Programming

**CP.1** The student will design a step-by-step plan to perform a task or solve a problem, including those arising from mathematical or interdisciplinary contexts. [CM.CP.1](#)

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**CP.2** The student will construct Boolean expressions and implement conditional statements. [CM.CP.2](#)

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**CP.3** The student will perform iteration with loops. [CM.CP.3](#)

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**CP.4** The student will write and implement the output phase of a computer program. [CM.CP.4](#)

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**CP.5** The student will write and implement the input phase of a computer program. [CM.CP.5](#)

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**CP.6** The student will implement library functions. [CM.CP.6](#)

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**CP.7** The student will write and implement user-defined functions. [CM.CP.7](#)

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**CP.8** The student will implement pre-defined algorithms, including search routines and sort routines. [CM.CP.8](#)

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Design a step-by-step plan to perform a task or solve a problem using a flowchart or pseudocode that outlines the subtasks needed. [CM.CP.1.A](#)

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**a** Design a step-by-step plan to perform a task or solve a problem using a flowchart or pseudocode that outlines the subtasks needed. [CM.CP.1.A](#)

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Define the variables needed to perform a task or solve a problem. [CM.CP.1.B](#)

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**b** Define the variables needed to perform a task or solve a problem. [CM.CP.1.B](#)

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Define the constraints of a task or problem (e.g., pre-conditions, post-conditions) to determine the desired input and output. [CM.CP.1.C](#)

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**c** Define the constraints of a task or problem (e.g., pre-conditions, post-conditions) to determine the desired input and output. [CM.CP.1.C](#)

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Write and implement Boolean expressions using logical and relational operators (e.g., !, &&, ||, ==, <, >, >=, <=, !=). [CM.CP.2.A](#)

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**a** Write and implement Boolean expressions using logical and relational operators (e.g., !, &&, ||, ==, <, >, >=, <=, !=). [CM.CP.2.A](#)

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**Write and implement “if” conditional statements.** [CM.CP.2.B](#)

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**b Write and implement “if” conditional statements.** [CM.CP.2.B](#)

**Write and implement “if/else” conditional statements.** [CM.CP.2.C](#)

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**c Write and implement “if/else” conditional statements.** [CM.CP.2.C](#)

**Write and implement compound conditional statements (e.g., nested conditionals, chained conditional statements).** [CM.CP.2.D](#)

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**d Write and implement compound conditional statements (e.g., nested conditionals, chained conditional statements).** [CM.CP.2.D](#)

**Determine which parts of an algorithm are executed based on a condition being true or false.** [CM.CP.2.E](#)

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**e Determine which parts of an algorithm are executed based on a condition being true or false.** [CM.CP.2.E](#)

**Write and implement “while” and “for” loops.** [CM.CP.3.A](#)

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**a Write and implement “while” and “for” loops.** [CM.CP.3.A](#)

**Differentiate between loops that run a fixed number of times and loops that run an indefinite number of times (e.g., stopping dependent on variable conditions).** [CM.CP.3.B](#)

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**b Differentiate between loops that run a fixed number of times and loops that run an indefinite number of times (e.g., stopping dependent on variable conditions).** [CM.CP.3.B](#)

**Identify conditions that cause infinite loops.** [CM.CP.3.C](#)

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**c Identify conditions that cause infinite loops.** [CM.CP.3.C](#)

**Determine the outcome of code segments that include loops.** [CM.CP.3.D](#)

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**d Determine the outcome of code segments that include loops.** [CM.CP.3.D](#)

**Write and implement the output phase of a computer program, which may include:** [CM.CP.4.A](#)

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**a Write and implement the output phase of a computer program, which may include:** [CM.CP.4.A](#)

formatting output in text-based environments; [CM.CP.4.A.I](#)

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**i** formatting output in text-based environments; [CM.CP.4.A.I](#)

displaying output through a graphical user interface; and [CM.CP.4.A.II](#)

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**ii** displaying output through a graphical user interface; and [CM.CP.4.A.II](#)

sending output to a physical device (e.g., speakers, robots, LED lights). [CM.CP.4.A.III](#)

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**iii** sending output to a physical device (e.g., speakers, robots, LED lights). [CM.CP.4.A.III](#)

Write output to a file. [CM.CP.4.B](#)

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**b** Write output to a file. [CM.CP.4.B](#)

Write and implement input statements to store user given values into a program. [CM.CP.5.A](#)

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**a** Write and implement input statements to store user given values into a program. [CM.CP.5.A](#)

Validate input data using exception coding (e.g., using a “while” loop to control valid input by a user). [CM.CP.5.B](#)

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**b** Validate input data using exception coding (e.g., using a “while” loop to control valid input by a user). [CM.CP.5.B](#)

Determine what output a program will produce given a specific input. [CM.CP.5.C](#)

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**c** Determine what output a program will produce given a specific input. [CM.CP.5.C](#)

Implement library functions to process data. [CM.CP.6.A](#)

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**a** Implement library functions to process data. [CM.CP.6.A](#)

Implement library functions to perform mathematical operations (e.g., random, absolute value, square root, power). [CM.CP.6.B](#)

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**b** Implement library functions to perform mathematical operations (e.g., random, absolute value, square root, power). [CM.CP.6.B](#)

**Implement void library functions and return library functions.** [CM.CP.6.C](#)

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**c Implement void library functions and return library functions.** [CM.CP.6.C](#)

**Implement overloaded library functions.** [CM.CP.6.D](#)

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**d Implement overloaded library functions.** [CM.CP.6.D](#)

**Write and implement a user-defined function to complete a task or sub-task.** [CM.CP.7.A](#)

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**a Write and implement a user-defined function to complete a task or sub-task.** [CM.CP.7.A](#)

**Write and implement void functions and return functions.** [CM.CP.7.B](#)

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**b Write and implement void functions and return functions.** [CM.CP.7.B](#)

**Write and implement functions that accept parameters.** [CM.CP.7.C](#)

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**c Write and implement functions that accept parameters.** [CM.CP.7.C](#)

**Differentiate between types of search routines.** [CM.CP.8.A](#)

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**a Differentiate between types of search routines.** [CM.CP.8.A](#)

**Differentiate between types of sort routines.** [CM.CP.8.B](#)

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**b Differentiate between types of sort routines.** [CM.CP.8.B](#)

**Implement pre-defined algorithms.** [CM.CP.8.C](#)

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**c Implement pre-defined algorithms.** [CM.CP.8.C](#)

**Implement a search routine on a one-dimensional list or an array, including sequential search and binary search.** [CM.CP.8.D](#)

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**d Implement a search routine on a one-dimensional list or an array, including sequential search and binary search.** [CM.CP.8.D](#)

**Implement a sort routine on a one-dimensional list or an array (e.g., selection**

**e Implement a sort routine on a one-dimensional list or an array (e.g., selection sort, insertion sort, merge sort).** [CM.CP.8.E](#)

sort, insertion sort, merge sort). [CM.CP.8.E](#)

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## Applications of Programming

**AP.1** The student will write and implement programs using sequencing, selection, and iteration to perform a specific task or solve a problem, including those arising from mathematical and interdisciplinary contexts. [CM.AP.1](#)

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**AP.2** The student will create documentation using written comments to annotate the intended purpose of the components of a user-created program. [CM.AP.2](#)

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**AP.3** The student will verify how programs access and process variables. [CM.AP.3](#)

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**AP.4** The student will translate a mathematical expression or statement into computer code. [CM.AP.4](#)

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**AP.5** The student will trace existing code to interpret the intended purpose. [CM.AP.5](#)

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Determine what components of programming are needed to implement a step-by-step plan to perform a specific task or solve a problem. [CM.AP.1.A](#)

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**a** Determine what components of programming are needed to implement a step-by-step plan to perform a specific task or solve a problem. [CM.AP.1.A](#)

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Write a computer program that includes sequencing, selection (conditionals), and iteration (loops). [CM.AP.1.B](#)

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**b** Write a computer program that includes sequencing, selection (conditionals), and iteration (loops). [CM.AP.1.B](#)

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Write and implement computer programs to solve mathematical problems using [CM.AP.1.C](#)

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**c** Write and implement computer programs to solve mathematical problems using [CM.AP.1.C](#)

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formulas and equations; [CM.AP.1.C.I](#)

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**i** formulas and equations; [CM.AP.1.C.I](#)

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functions; [CM.AP.1.C.II](#)

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**ii** functions; [CM.AP.1.C.II](#)

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probability and statistics; and [CM.AP.1.C.III](#)

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**iii** probability and statistics; and [CM.AP.1.C.III](#)

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**data-analysis.** [CM.AP.1.C.IV](#)

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**iv data-analysis.** [CM.AP.1.C.IV](#)

**Create documentation using written comments to:** [CM.AP.2.A](#)

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**a Create documentation using written comments to:** [CM.AP.2.A](#)

**describe the overall purpose of a program;** [CM.AP.2.A.I](#)

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**i describe the overall purpose of a program;** [CM.AP.2.A.I](#)

**align a previously created step-by-step plan to a written program;** [CM.AP.2.A.II](#)

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**ii align a previously created step-by-step plan to a written program;** [CM.AP.2.A.II](#)

**describe pre-conditions and post-conditions; and** [CM.AP.2.A.III](#)

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**iii describe pre-conditions and post-conditions; and** [CM.AP.2.A.III](#)

**improve the readability of a program.** [CM.AP.2.A.IV](#)

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**iv improve the readability of a program.** [CM.AP.2.A.IV](#)

**Verify that the variable types are aligned to the purpose of the algorithm.** [CM.AP.3.A](#)

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**a Verify that the variable types are aligned to the purpose of the algorithm.** [CM.AP.3.A](#)

**Verify that global variables are set to constant values before run time.** [CM.AP.3.B](#)

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**b Verify that global variables are set to constant values before run time.** [CM.AP.3.B](#)

**Differentiate between the scopes of variables (e.g., global scope versus local scope) and verify the intended use.** [CM.AP.3.C](#)

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**c Differentiate between the scopes of variables (e.g., global scope versus local scope) and verify the intended use.** [CM.AP.3.C](#)

**Declare, initialize, and assign variables to represent mathematical expressions or statements.** [CM.AP.4.A](#)

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**a Declare, initialize, and assign variables to represent mathematical expressions or statements.** [CM.AP.4.A](#)

**Implement order of operations, including logical and relational operators.** [CM.AP.4.B](#)

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**b Implement order of operations, including logical and relational operators.** [CM.AP.4.B](#)

**Translate a mathematical expression or statement into a programming statement(s).** [CM.AP.4.C](#)

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**c Translate a mathematical expression or statement into a programming statement(s).** [CM.AP.4.C](#)

**Trace existing code of an algorithm to** [CM.AP.5.A](#)

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**a Trace existing code of an algorithm to** [CM.AP.5.A](#)

**identify values at each stage of an algorithm; and** [CM.AP.5.A.I](#)

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**i identify values at each stage of an algorithm; and** [CM.AP.5.A.I](#)

**predict return values of functions given specific arguments.** [CM.AP.5.A.II](#)

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**ii predict return values of functions given specific arguments.** [CM.AP.5.A.II](#)

**Use tracing to describe the intended purpose of existing code for an algorithm.** [CM.AP.5.B](#)

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**b Use tracing to describe the intended purpose of existing code for an algorithm.** [CM.AP.5.B](#)

**Evaluation of Programming**

**EP.1 The student will test a program to match a sample output, using a set of data.** [CM.EP.1](#)

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**EP.2 The student will identify errors and debug a program using various techniques.** [CM.EP.2](#)

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**EP.3 The student will compare and contrast the efficiency of computer programs.** [CM.EP.3](#)

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**Produce a given output by entering a data set.** [CM.EP.1.A](#)

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**a Produce a given output by entering a data set.** [CM.EP.1.A](#)

**Test a program including boundary cases and inaccurate data types to verify the intended outcomes.** [CM.EP.1.B](#)

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**b Test a program including boundary cases and inaccurate data types to verify the intended outcomes.** [CM.EP.1.B](#)

**Differentiate among syntax errors, runtime errors, and logic errors.** [CM.EP.2.A](#)

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**a Differentiate among syntax errors, runtime errors, and logic errors.** [CM.EP.2.A](#)

**Debug a program using various techniques:** [CM.EP.2.B](#)

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**b Debug a program using various techniques:** [CM.EP.2.B](#)

**interpret syntax and runtime error messages;** [CM.EP.2.B.I](#)

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**i interpret syntax and runtime error messages;** [CM.EP.2.B.I](#)

**place controlled breaks;** [CM.EP.2.B.II](#)

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**ii place controlled breaks;** [CM.EP.2.B.II](#)

**output intermediate results;** [CM.EP.2.B.III](#)

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**iii output intermediate results;** [CM.EP.2.B.III](#)

**disable a section of code by converting it into a comment;** [CM.EP.2.B.IV](#)

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**iv disable a section of code by converting it into a comment;** [CM.EP.2.B.IV](#)

**trace code to identify logic errors; and** [CM.EP.2.B.V](#)

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**v trace code to identify logic errors; and** [CM.EP.2.B.V](#)

**use debugging tools available in the programming environment.** [CM.EP.2.B.VI](#)

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**vi use debugging tools available in the programming environment.** [CM.EP.2.B.VI](#)

**Compare and contrast the efficiency of computer programs in terms of** [CM.EP.3.A](#)

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**a Compare and contrast the efficiency of computer programs in terms of** [CM.EP.3.A](#)

**complexity of algorithms with the same intended outcomes;** [CM.EP.3.A.I](#)

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**i complexity of algorithms with the same intended outcomes;** [CM.EP.3.A.I](#)

**memory space used; and** [CM.EP.3.A.II](#)

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**ii memory space used; and** [CM.EP.3.A.II](#)

**run time.** [CM.EP.3.A.III](#)

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**iii run time.** [CM.EP.3.A.III](#)