Question 1: Methods and Control Structures — 9 points

Canonical solution

a. **4 points**

```
public int walkDogs(int hour)
{
   int dogsToWalk = company.numAvailableDogs(hour);

   if (dogsToWalk > maxDogs)
   {
      dogsToWalk = maxDogs;
   }

   company.updateDogs(hour, dogsToWalk);
   return dogsToWalk;
}
```

b. **5 points**

```
public int dogWalkShift(int startHour, int endHour)
{
   int totalPay = 0;

   for (int hour = startHour; hour <= endHour; hour++)
   {
      int dogs = walkDogs(hour);
      int hourPay = 5 * dogs;
      if (dogs == maxDogs || (hour >= 9 && hour <= 17))
      {
         hourPay += 3;
      }
      totalPay += hourPay;
   }
   return totalPay;
}
```

a. `walkDogs`

	Scoring Criteria	Decision Rules	
1	Calls `DogWalkCompany` method(s) on `company`	Responses **can** still earn the point even if they • fail to save or use the returned value • call `numAvailableDogs` more than once • only call one of the methods Responses **will not** earn the point if they • use the incorrect parameter types • call either `numAvailableDogs` or `updateDogs` on nothing or on something other than `company`	**1 point**
2	Compares available dogs and `maxDogs` to determine number of dogs to walk	Responses **can** still earn the point even if they • call `numAvailableDogs` incorrectly • calculate an incorrect number of dogs that were walked	**1 point**
3	Calls `numAvailableDogs` with `hour` and `updateDogs` with `hour` and correct number of dogs to walk (*algorithm*)	Responses **can** still earn the point even if they • call either method on nothing or on something other than `company` Responses **will not** earn the point if they • calculate an incorrect number of dogs that were walked	**1 point**
4	Returns calculated value	Responses **can** still earn the point even if they • calculate an incorrect number of dogs that were walked • call `numAvailableDogs` multiple times Responses **will not** earn the point if they • return something other than an `int` • fail to return a value in some cases • print a value in addition to or instead of returning it	**1 point**

b. `dogWalkShift`

	Scoring Criteria	Decision Rules	
5	Loops from `startHour` to `endHour`, inclusive	Responses **can** still earn the point even if they • return from the loop early, as long as bounds would otherwise be correct	**1 point**
6	Calls `walkDogs` with `int` parameter (*in the context of a loop*)	Responses **can** still earn the point even if they • fail to save or use the returned value Responses **will not** earn the point if they • use an incorrect parameter type on any call to `walkDogs` • call the method on the class or on an object other than `this` (use of `this` is optional)	**1 point**
7	Calculates base pay for an hour	Responses **can** still earn the point even if they • fail to include the calculation in the loop • call `walkDogs` incorrectly	**1 point**
8	Calculates possible bonus for an hour's pay	Responses **can** still earn the point even if they • call `walkDogs` multiple times inside the loop • fail to include the calculation in the loop Responses **will not** earn the point if they • count the bonus twice when both conditions are true • count the bonus only when both conditions are true • count the bonus when it has not been earned • calculate bonus incorrectly	**1 point**
9	Accumulates total pay (*algorithm*)	Responses **can** still earn the point even if they • calculate base pay or bonus incorrectly • fail to return total pay (*return not assessed in this part*) Responses **will not** earn the point if they • fail to initialize variable used for total pay • call `walkDogs` multiple times inside the loop • do not accumulate base and bonus in the context of a loop • return from the loop early	**1 point**
	Question-specific penalties		
	None		

Applying the Scoring Criteria

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1-Point Penalty

v) Array/collection access confusion (`[] get`)
w) Extraneous code that causes side-effect (e.g., printing to output, incorrect precondition check)
x) Local variables used but none declared
y) Destruction of persistent data (e.g., changing value referenced by parameter)
z) Void method or constructor that returns a value

No Penalty

- Extraneous code with no side-effect (e.g., valid precondition check, no-op)
- Spelling/case discrepancies where there is no ambiguity*
- Local variable not declared provided other variables are declared in some part
- `private` or `public` qualifier on a local variable
- Missing `public` qualifier on class or constructor header
- Keyword used as an identifier
- Common mathematical symbols used for operators (× • ÷ ≤ ≥ <> ≠)
- `[]` vs. `()` vs. `<>`
- `=` instead of `==` and vice versa
- `length/size` confusion for array, `String`, `List`, or `ArrayList`; with or without `( )`
- Extraneous `[]` when referencing entire array
- `[i,j]` instead of `[i][j]`
- Extraneous size in array declaration, e.g., `int[size] nums = new int[size];`
- Missing `;` where structure clearly conveys intent
- Missing `{ }` where indentation clearly conveys intent
- Missing `( )` on parameter-less method or constructor invocations
- Missing `( )` around `if` or `while` conditions

Spelling and case discrepancies for identifiers fall under the "No Penalty" category only if the correction can be **unambiguously inferred from context, for example, "ArayList" instead of "ArrayList". As a counterexample, note that if the code declares `"int G=99, g=0;"`, then uses `"while (G < 10)"` instead of `"while (g < 10)"`, the context does **not** allow for the reader to assume the use of the lower case variable.*

2025 Digital Decision Rules

- Some non-ASCII characters are not printing correctly in ONE, particularly extended punctuation. Certain kinds of double-quotes may display as â□□; a character that displays as ï¼□ may be a parenthesis, comma, or semicolon (or other punctuation). If the badly displayed character makes sense as one of those, evaluate the response accordingly.
- If there are missing closed-double-quotes or closed-parentheses, assume they are at the end of the line where they opened, immediately before the semicolon or curly bracket (if any).
- Assume an open/left curly bracket `{` immediately after any method header or class header that does not already have one.
- Assume an appropriate amount of closing brackets before any method header to close all open brackets from the previous method or constructor.
- If there are missing curly brackets, clear indentation can "convey intent". Evaluate the response accordingly.
- Inside a method with left-justified code, indentation cannot "convey intent", so missing curly brackets cannot be assumed. Without bracketing or indentation, only the first line of a `while / if / for` is controlled by the statement; with open curly bracket and no indentation cues, the entire remainder of the method is "inside" the statement.

No Penalty

- `:` instead of `;` and vice versa
- `,` instead of `;` and vice versa

Question 1: Methods and Control Structures — 9 points

Canonical solution

(a) — **4 points**

```
public int getScore()
{
   int score = 0;

   if (levelOne.goalReached())
   {
      score = levelOne.getPoints();

      if (levelTwo.goalReached())
      {
         score += levelTwo.getPoints();

         if (levelThree.goalReached())
         {
            score += levelThree.getPoints();
         }
      }
   }

   if (isBonus())
   {
      score *= 3;
   }

   return score;
}
```

(b) — **5 points**

```
public int playManyTimes(int num)
{
   int max = 0;

   for (int i = 0; i < num; i++)
   {
      play();
      int score = getScore();
      if (score > max)
      {
         max = score;
      }
   }

   return max;
}
```

(a) `getScore`

	Scoring Criteria	Decision Rules	
1	Calls `getPoints`, `goalReached`, and `isBonus`	Responses **will not** earn the point if they • fail to call `getPoints` or `goalReached` on a `Level` object • call `isBonus` on an object other than `this` (use of `this` is optional) • include parameters	**1 point**
2	Determines if points are earned based on `goalReached` return values	Responses **can** still earn the point even if they • calculate the score total incorrectly • call `goalReached` incorrectly • fail to distinguish all cases correctly Responses **will not** earn the point if they • fail to use a nested `if` statement or equivalent	**1 point**
3	Guards update of score for bonus game based on `isBonus` return value	Responses **can** still earn the point even if they • triple the calculated score incorrectly • update the score with something other than tripling • call `isBonus` incorrectly Responses **will not** earn the point if they • use the `isBonus` return value incorrectly	**1 point**
4	Initializes and accumulates appropriate score (*algorithm*)	Responses **can** still earn the point even if they • call methods incorrectly, as long as method calls are attempted • fail to return the score (*return is not assessed*) Responses **will not** earn the point if they • calculate the score total incorrectly • triple the calculated score incorrectly	**1 point**
		Total for part (a)	**4 points**

(b) `playManyTimes`

	Scoring Criteria	Decision Rules	
5	Loops `num` times	Responses **can** still earn the point even if they • return early	**1 point**
6	Calls `play` and `getScore`	Responses **will not** earn the point if they • call either method on an object other than `this` (use of `this` is optional) • include parameters	**1 point**
7	Compares a score to an identified max or to another score	Responses **can** still earn the point even if they • make the comparison outside the loop • call `getScore` incorrectly • fail to call `play` between calls to `getScore`	**1 point**
8	Identifies the maximum score (*algorithm*)	Responses **will not** earn the point if they • fail to initialize the result variable • compare a score to an identified max or to another score outside the loop • fail to call `play` exactly once each time through the loop	**1 point**
9	Returns identified maximum score	Responses **can** still earn the point even if they • calculate the maximum score incorrectly Responses **will not** earn the point if they • assign a value to the identified maximum score without any loop or logic to find the maximum	**1 point**
		Total for part (b)	**5 points**

Question-specific penalties
None

Total for question 1 **9 points**

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2019

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Scoring Guidelines

2019 SCORING GUIDELINES

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2019 SCORING GUIDELINES

Question 1: Calendar

Part (a)	`numberOfLeapYears`	**5 points**

Intent: *Return the number of leap years in a range*

+1 Initializes a numeric variable

+1 Loops through each necessary year in the range

+1 Calls `isLeapYear` on some valid year in the range

+1 Updates count based on result of calling `isLeapYear`

+1 Returns count of leap years

Part (b)	`dayOfWeek`	**4 points**

Intent: *Return an integer representing the day of the week for a given date*

+1 Calls `firstDayOfYear`

+1 Calls `dayOfYear`

+1 Calculates the value representing the day of the week

+1 Returns the calculated value

Question-Specific Penalties

-1 (t) Static methods called with `this`.

2019 SCORING GUIDELINES

Question 1: Scoring Notes

Part (a) `numberOfLeapYears`			**5 points**
Points	Rubric Criteria	Responses earn the point even if they...	Responses will not earn the point if they...
+1	Initializes a numeric variable		• use the variable for loop control only
+1	Loops through each necessary year in the range		• consider years outside the range
+1	Calls `isLeapYear` on some valid year in the range	• do not use a loop	
+1	Updates count based on result of calling `isLeapYear`	• do not use a loop • do not initialize the counter	• use result as a non-`boolean`
+1	Returns count of leap years	• loop from `year1` to `year2` incorrectly • do not initialize the counter	• do not use a loop • update or initialize the counter incorrectly • return early inside the loop
Part (b) `dayOfWeek`			**4 points**
Points	Rubric Criteria	Responses earn the point even if they...	Responses will not earn the point if they...
+1	Calls `firstDayOfYear`		• do not use the given year
+1	Calls `dayOfYear`		• have arguments out of order
+1	Calculates the value representing the day of the week		• make any error in the calculation
+1	Returns the calculated value	• return the value from calling `firstDayOfYear` or `dayOfYear`	• return a constant value

2019 SCORING GUIDELINES

Question 1: Calendar

Part (a)

```
public static int numberOfLeapYears(int year1, int year2)
{
   int count = 0;
   for (int y = year1; y <= year2; y++)
   {
      if (isLeapYear(y))
      {
         count++;
      }
   }
   return count;
}
```

Part (b)

```
public static int dayOfWeek(int month, int day, int year)
{
   int startDay = firstDayOfYear(year);
   int nthDay = dayOfYear(month, day, year);
   int returnDay = (startDay + nthDay - 1) % 7;
   return returnDay;
}
```

These canonical solutions serve an expository role, depicting general approaches to solution. Each reflects only one instance from the infinite set of valid solutions. The solutions are presented in a coding style chosen to enhance readability and facilitate understanding.

2019 SCORING GUIDELINES

Question 2: Step Tracker

Class: `StepTracker`	**9 points**

Intent: *Define implementation of a class to record fitness data*

+1 Declares all appropriate `private` instance variables

+2 Constructor

- **+1** Declares header: `public StepTracker(int ___)`
- **+1** Uses parameter and appropriate values to initialize instance variables

+3 `addDailySteps` method

- **+1** Declares header: `public void addDailySteps(int ___)`
- **+1** Identifies active days and increments count
- **+1** Updates other instance variables appropriately

+1 `activeDays` method

- **+1** Declares and implements `public int activeDays()`

+2 `averageSteps` method

- **+1** Declares header: `public double averageSteps()`
- **+1** Returns calculated `double` average number of steps

2019 SCORING GUIDELINES

Question 2: Scoring Notes

Class `StepTracker`			**9 points**
Points	Rubric Criteria	Responses earn the point even if they...	Responses will not earn the point if they...
+1	Declares all appropriate `private` instance variables		• omit keyword `private` • declare variables outside the class
+2	Constructor		
+1	Declares header: `public StepTracker(int ___)`	• omit keyword `public`	• declare method `private`
+1	Uses parameter and appropriate values to initialize instance variables	• initialize primitive instance variables to default values when declared	• fail to use the parameter to initialize some instance variable • fail to declare instance variables • initialize local variables instead of instance variables • assign variables to parameters
+3	`addDailySteps` method		
+1	Declares header: `public void addDailySteps(int ___)`	• omit keyword `public`	• declare method `private`
+1	Identifies active days and increments count	• put valid comparison erroneously in some other method	• fail to use the parameter as part of the comparison • fail to increment a count of active days • fail to increment an instance variable • compare parameter to some numeric constant
+1	Updates other instance variables appropriately		• update another instance variable only on active days • update another instance variable inappropriately • fail to update appropriate instance variable • update a local variable
+1	`activeDays` method		
+1	Declares and implements `public int activeDays()`	• return appropriate count of active days where the instance variables were updated improperly in `addDailySteps` or `activeDays`	• declare method `private` • return value that is not the number of active days • fail to return a value

2019 SCORING GUIDELINES

Question 2: Scoring Notes (continued)

Points	Rubric Criteria	Responses earn the point even if they...	Responses will not earn the point if they...
+2	`averageSteps` method		
+1	Declares header: `public double averageSteps()`	• omit keyword `public`	• declare method `private`
+1	Returns calculated `double` average number of steps	• maintain instance variables improperly but calculate appropriate average • fail to handle the special case where no days are tracked	• use integer division • calculate something other than steps divided by days • fail to return

2019 SCORING GUIDELINES

Question 2: Step Tracker

```
public class StepTracker
{
   private int minSteps;
   private int totalSteps;
   private int numDays;
   private int numActiveDays;

   public StepTracker(int threshold)
   {
      minSteps = threshold;
      totalSteps = 0;
      numDays = 0;
      numActiveDays = 0;
   }

   public void addDailySteps(int steps)
   {
      totalSteps += steps;
      numDays++;
      if (steps >= minSteps)
      {
         numActiveDays++;
      }
   }

   public int activeDays()
   {
      return numActiveDays;
   }

   public double averageSteps()
   {
      if (numDays == 0)
      {
         return 0.0;
      }
      else
      {
         return (double) totalSteps / numDays;
      }
   }
}
```

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2019 SCORING GUIDELINES

Question 3: Delimiters

Part (a)	`getDelimitersList`	**4 points**

Intent: *Store delimiters from an array in an* `ArrayList`

+1 Creates `ArrayList<String>`

+1 Accesses all elements in array `tokens` (*no bounds errors*)

+1 Compares strings in `tokens` with both instance variables (*must be in the context of a loop*)

+1 Adds delimiters into `ArrayList` in original order

Part (b)	`isBalanced`	**5 points**

Intent: *Determine whether open and close delimiters in an* `ArrayList` *are balanced*

+1 Initializes accumulator(s)

+1 Accesses all elements in `ArrayList delimiters` (*no bounds errors*)

+1 Compares strings in `delimiters` with instance variables and updates accumulator(s) accordingly

+1 Identifies and returns appropriate `boolean` value to implement one rule

+1 Identifies and returns appropriate `boolean` values for all cases

2019 SCORING GUIDELINES

Question 3: Scoring Notes

Part (a) `getDelimitersList`			**4 points**
Points	Rubric Criteria	Responses earn the point even if they...	Responses will not earn the point if they...
+1	Creates `ArrayList<String>`	• omit `<String>`	• omit the keyword `new`
+1	Accesses all elements in array `tokens` (*no bounds errors*)	• return incorrectly inside the loop	• treat `tokens` as a single string • access elements of `tokens` as if from an `ArrayList` (e.g., `tokens.get(i)`)
+1	Compares strings in `tokens` with both instance variables (*must be in the context of a loop*)	• access elements of `tokens` as if from an `ArrayList` (e.g., `tokens.get(i)`)	• use `==` for string comparison • treat `tokens` as a single string
+1	Adds delimiters into `ArrayList` in original order	• add a delimiter by accessing `tokens` incorrectly (e.g., `tokens.get(i)`)	• add a token that is not a delimiter • do not maintain the original delimiter order
Part (b) `isBalanced`			**5 points**
Points	Rubric Criteria	Responses earn the point even if they...	Responses will not earn the point if they...
+1	Initializes accumulator(s)	• initialize inside the loop	• initialize an accumulator variable but don't update it
+1	Accesses all elements in `ArrayList delimiters` (*no bounds errors*)	• return incorrectly inside the loop	• access elements of `delimiters` as if from an array (e.g., `delimiters[i]`)
+1	Compares strings in `delimiters` with instance variables and updates accumulator(s) accordingly	• access elements of `delimiters` as if from an array (e.g., `delimiters[i]`)	• use `==` for string comparison • adjust an accumulator without a guarding condition
+1	Identifies and returns appropriate `boolean` value to implement one rule	• check for more closing delimiters (inside a loop) and return `false` • return `true` if the number of open and close delimiters is the same, and `false` otherwise (after a loop)	
+1	Identifies and returns appropriate `boolean` values for all cases	• have correct logic with the exception of a loop bounds error, accessing elements as if from an array, or using `==` for string comparison	• initialize accumulator inside a loop • fail to check for more closing delimiters inside a loop

2019 SCORING GUIDELINES

Question 3: Delimiters

Part (a)

```
public ArrayList<String> getDelimitersList(String[] tokens)
{
   ArrayList<String> d = new ArrayList<String>();
   for (String str : tokens)
   {
      if (str.equals(openDel) || str.equals(closeDel))
      {
         d.add(str);
      }
   }
   return d;
}
```

Part (b)

```
public boolean isBalanced(ArrayList<String> delimiters)
{
   int openCount = 0;
   int closeCount = 0;

   for (String str : delimiters)
   {
      if (str.equals(openDel))
      {
         openCount++;
      }
      else
      {
         closeCount++;
      }

      if (closeCount > openCount)
      {
         return false;
      }
   }

   if (openCount == closeCount)
   {
      return true;
   }
   else
   {
      return false;
   }
}
```

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2019 SCORING GUIDELINES

Question 4: Light Board

Part (a)	`LightBoard`	**4 points**

Intent: *Define implementation of a constructor that initializes a 2D array of lights*

+1 Creates a `new boolean[numRows][numCols]` and assigns to instance variable `lights`

+1 Accesses all elements in the created 2D array (*no bounds errors*)

+1 Computes the 40% probability

+1 Sets all values of 2D array based on computed probability

Part (b)	`evaluateLight`	**5 points**

Intent: *Evaluate the status of a light in a 2D array of lights*

+1 Accesses an element of `lights` as a `boolean` value in an expression

+1 Traverses specified `col` of a 2D array (*no bounds errors*)

+1 Counts the number of `true` values in the traversal

+1 Performs an even calculation and a multiple of three calculation

+1 Returns `true` or `false` according to all three rules

Question-Specific Penalties

-1 (z) Constructor returns a value

-1 (y) Destruction of persistent data

2019 SCORING GUIDELINES

Question 4: Scoring Notes

Part (a) `LightBoard`			**4 points**
Points	Rubric Criteria	Responses earn the point even if they...	Responses will not earn the point if they...
+1	Creates a `new boolean[numRows][numCols]` and assigns to instance variable `lights`		• initialize a local variable that is never assigned to `lights` • omit the keyword `new` • use a type other than `boolean`
+1	Accesses all elements in the created 2D array (*no bounds errors*)	• fail to create `lights` but assume `lights[numRows][numCols]`	
+1	Computes the 40% probability	• use `Math.random() <= .4`	• incorrectly cast to `int`
+1	Sets all values of 2D array based on computed probability	• only assign `true` values	• compute a single probability but use it multiple times • reverse the sense of the comparison when assigning
Part (b) `evaluateLight`			**5 points**
Points	Rubric Criteria	Responses earn the point even if they...	Responses will not earn the point if they...
+1	Accesses an element of `lights` as a `boolean` value in an expression		• access `lights` as a type other than `boolean`
+1	Traverses specified `col` of a 2D array (*no bounds errors*)		
+1	Counts the number of `true` values in the traversal	• access too many or too few items in a single column • access a single row instead of a single column	• count an item more than once
+1	Performs an even calculation and a multiple of three calculation		• use `/` instead of `%`
+1	Returns `true` or `false` according to all three rules	• have an incorrect column count but use the correct logic	• fail to return a value in some case • implement counting loop more than once with one loop that is incorrect

2019 SCORING GUIDELINES

Question 4: Light Board

Part (a)

```
public LightBoard(int numRows, int numCols)
{
   lights = new boolean[numRows][numCols];

   for (int r = 0; r < numRows; r++)
   {
      for (int c = 0; c < numCols; c++)
      {
         double rnd = Math.random();
         lights[r][c] = rnd < 0.4;
      }
   }
}
```

Part (b)

```
public boolean evaluateLight(int row, int col)
{
   int numOn = 0;

   for (int r = 0; r < lights.length; r++)
   {
      if (lights[r][col])
      {
         numOn++;
      }
   }

   if (lights[row][col] && numOn % 2 == 0)
   {
      return false;
   }
   if (!lights[row][col] && numOn % 3 == 0)
   {
      return true;
   }
   return lights[row][col];
}
```

These canonical solutions serve an expository role, depicting general approaches to solution. Each reflects only one instance from the infinite set of valid solutions. The solutions are presented in a coding style chosen to enhance readability and facilitate understanding.

2018

AP CollegeBoard

AP Computer Science A

Scoring Guidelines

AP® COMPUTER SCIENCE A
2018 SCORING GUIDELINES

Apply the question assessment rubric first, which always takes precedence. Penalty points can only be deducted in a part of the question that has earned credit via the question rubric. No part of a question (a, b, c) may have a negative point total. A given penalty can be assessed only once for a question, even if it occurs multiple times or in multiple parts of that question. A maximum of 3 penalty points may be assessed per question.

1-Point Penalty

- v) Array/collection access confusion (`[] get`)
- w) Extraneous code that causes side-effect (e.g., printing to output, incorrect precondition check)
- x) Local variables used but none declared
- y) Destruction of persistent data (e.g., changing value referenced by parameter)
- z) Void method or constructor that returns a value

No Penalty

- Extraneous code with no side-effect (e.g., valid precondition check, no-op)
- Spelling/case discrepancies where there is no ambiguity*
- Local variable not declared provided other variables are declared in some part
- `private` or `public` qualifier on a local variable
- Missing `public` qualifier on class or constructor header
- Keyword used as an identifier
- Common mathematical symbols used for operators (× • ÷ ≤ ≥ <> ≠)
- `[]` vs. `()` vs. `<>`
- `=` instead of `==` and vice versa
- `length`/`size` confusion for array, String, List, or ArrayList; with or without ( )
- Extraneous `[]` when referencing entire array
- `[i,j]` instead of `[i][j]`
- Extraneous size in array declaration, e.g., `int[size] nums = new int[size];`
- Missing ; where structure clearly conveys intent
- Missing { } where indentation clearly conveys intent
- Missing ( ) on parameter-less method or constructor invocations
- Missing ( ) around `if` or `while` conditions

Spelling and case discrepancies for identifiers fall under the "No Penalty" category only if the correction can be **unambiguously inferred from context, for example,* "ArayList" *instead of* "ArrayList". *As a counterexample, note that if the code declares* "`int G=99, g=0;`", *then uses* "`while (G < 10)`" *instead of* "`while (g < 10)`", *the context does **not** allow for the reader to assume the use of the lower case variable.*

AP® COMPUTER SCIENCE A
2018 SCORING GUIDELINES

Question 1: Frog Simulation

Part (a)	`simulate`	**5 points**

Intent: *Simulate the distance traveled by a hopping frog*

+1 Calls `hopDistance` and uses returned distance to adjust (or represent) the frog's position

+1 Initializes and accumulates the frog's position at most `maxHops` times (*must be in context of a loop*)

+1 Determines if a distance representing multiple hops is at least `goalDistance`

+1 Determines if a distance representing multiple hops is less than starting position

+1 Returns `true` if goal ever reached, `false` if goal never reached or position ever less than starting position

Part (b)	`runSimulations`	**4 points**

Intent: *Determine the proportion of successful frog hopping simulations*

+1 Calls `simulate` the specified number of times (*no bounds errors*)

+1 Initializes and accumulates a count of `true` results

+1 Calculates proportion of successful simulations using `double` arithmetic

+1 Returns calculated value

AP® COMPUTER SCIENCE A
2018 SCORING GUIDELINES

Question 1: Scoring Notes

Part (a) `simulate`			**5 points**
Points	Rubric Criteria	Responses earn the point if they...	Responses will not earn the point if they...
+1	Calls `hopDistance` and uses returned distance to adjust (or represent) the frog's position	• use `hopDistance()` as a position, like `hopDistance() < 0`	• only use `hopDistance()` as a count, like `hopDistance() < maxHops`
+1	Initializes and accumulates the frog's position at most `maxHops` times (*must be in context of a loop*)		• do not use a loop
+1	Determines if a distance representing multiple hops is at least `goalDistance`	• use some number of hops `*` `hopDistance()` as the frog's final position	
+1	Determines if a distance representing multiple hops is less than starting position		
+1	Returns `true` if goal ever reached, `false` if goal never reached or position ever less than starting position	• have checks for all three conditions and correct return logic based on those checks, even if a check did not earn a point	• do not check all three conditions • only check for `goalDistance` after the loop • only check for starting position after the loop
Part (b) `runSimulations`			**4 points**
Points	Rubric Criteria	Responses earn the point if they...	Responses will not earn the point if they...
+1	Calls `simulate` the specified number of times (*no bounds errors*)	• do not use the result of calling `simulate`	• do not use a loop
+1	Initializes and accumulates a count of `true` results		• initialize the count inside a loop • do not use a loop
+1	Calculates proportion of successful simulations using `double` arithmetic	• perform the correct calculation on an accumulated value, even if there was an error in the accumulation	• fail to divide by the parameter
+1	Returns calculated value		• calculate values using nonnumeric types • return a count of simulations

AP® COMPUTER SCIENCE A
2018 SCORING GUIDELINES

Question 1: Frog Simulation

Part (a)

```
public boolean simulate()
{
   int position = 0;

   for (int count = 0; count < maxHops; count++)
   {
      position += hopDistance();
      if (position >= goalDistance)
      {
         return true;
      }
      else if (position < 0)
      {
         return false;
      }
   }
   return false;
}
```

Part (b)

```
public double runSimulations(int num)
{
   int countSuccess = 0;

   for (int count = 0; count < num; count++)
   {
      if(simulate())
      {
         countSuccess++;
      }
   }
   return (double)countSuccess / num;
}
```

These canonical solutions serve an expository role, depicting general approaches to solution. Each reflects only one instance from the infinite set of valid solutions. The solutions are presented in a coding style chosen to enhance readability and facilitate understanding.

AP® COMPUTER SCIENCE A
2018 SCORING GUIDELINES

Question 2: Word Pair

Part (a)	`WordPairList`	**5 points**

Intent: *Form pairs of strings from an array and add to an* `ArrayList`

+1 Creates new `ArrayList` and assigns to `allPairs`

+1 Accesses all elements of `words` (*no bounds errors*)

+1 Constructs new `WordPair` using distinct elements of `words`

+1 Adds all necessary pairs of elements from word array to `allPairs`

+1 **On exit:** `allPairs` contains all necessary pairs and no unnecessary pairs

Part (b)	`numMatches`	**4 points**

Intent: *Count the number of pairs in an* `ArrayList` *that have the same value*

+1 Accesses all elements in `allPairs` (*no bounds errors*)

+1 Calls `getFirst` or `getSecond` on an element from list of pairs

+1 Compares first and second components of a pair in the list

+1 Counts number of matches of pair-like values

Question-Specific Penalties

-1 (z) Constructor returns a value

AP® COMPUTER SCIENCE A
2018 SCORING GUIDELINES

Question 2: Scoring Notes

Part (a) `WordPairList`			**5 points**
Points	Rubric Criteria	Responses earn the point if they...	Responses will not earn the point if they...
+1	Creates new `ArrayList` and assigns to `allPairs`	• `allPairs = new ArrayList();` • `allPairs = new ArrayList<>();` • `this.allPairs = ...`	• initialize a local variable that is never assigned to `allPairs`
+1	Accesses all elements of `words` (*no bounds errors*)		
+1	Constructs new `WordPair` using distinct elements of `words`		
+1	Adds all necessary pairs of elements from word array to `allPairs`	• have a loop bounds error • add unnecessary pairs	• improperly add to an `ArrayList`, e.g., `allPairs.get(i) = x;` • only add consecutive pairs `(words[i], words[i+1])`
+1	**On exit:** `allPairs` contains all necessary pairs and no unnecessary pairs	• improperly add to an `ArrayList`, e.g., `allPairs.get(i) = x;` • have a loop bounds error	• add pairs (i, i) or (i, j) where i > j
Part (b) `numMatches`			**4 points**
Points	Rubric Criteria	Responses earn the point if they...	Responses will not earn the point if they...
+1	Accesses all elements in `allPairs` (*no bounds errors*)		• access elements of `allPairs` as array elements (e.g., `allPairs[i]`)
+1	Calls `getFirst` or `getSecond` on an element from list of pairs		
+1	Compares first and second components of a pair in the list		• compare using ==
+1	Counts number of matches of pair-like values		• fail to initialize the counter

Return is not assessed in part (b).

AP® COMPUTER SCIENCE A
2018 SCORING GUIDELINES

Question 2: Word Pair

Part (a)

```
public WordPairList(String[] words)
{
   allPairs = new ArrayList<WordPair>();

   for (int i = 0; i < words.length-1; i++)
   {
      for (int j = i+1; j < words.length; j++)
      {
         allPairs.add(new WordPair(words[i], words[j]));
      }
   }
}
```

Part (b)

```
public int numMatches()
{
   int count = 0;

   for (WordPair pair: allPairs)
   {
      if (pair.getFirst().equals(pair.getSecond()))
      {
         count++;
      }
   }
   return count;
}
```

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AP® COMPUTER SCIENCE A
2018 SCORING GUIDELINES

Question 3: Code Word Checker

Class: `CodeWordChecker`	**9 points**

Intent: *Define implementation of a class to determine if a string meets a set of criteria*

+1 Declares header: `public class CodeWordChecker implements StringChecker`

+1 Declares all appropriate `private` instance variables

+3 Constructors

- **+1** Declares headers: `public CodeWordChecker(int __, int __, String __)` and `public CodeWordChecker(String __)`
- **+1** Uses all parameters to initialize instance variables in 3-parameter constructor
- **+1** Uses parameter and default values to initialize instance variables in 1-parameter constructor

+4 `isValid` method

- **+1** Declares header: `public boolean isValid(String __)`
- **+1** Checks for length between min and max inclusive
- **+1** Checks for unwanted string
- **+1** Returns `true` if length is between min and max and does not contain the unwanted string, `false` otherwise

2018 SCORING GUIDELINES

Question 3: Scoring Notes

Class `CodeWordChecker`			**9 points**
Points	Rubric Criteria	Responses earn the point if they...	Responses will not earn the point if they...
+1	Declares header: `public class CodeWordChecker implements StringChecker`	• omit keyword `public`	• declare class `private` • declare class `static`
+1	Declares all appropriate `private` instance variables		• declare variables as `static` • omit keyword `private` • declare variables outside the class
+3	Constructors		
+1	Declares headers: `public CodeWordChecker (int __, int __, String __)` and `public CodeWordChecker (String __)`	• omit keyword `public`	• declare method `static` • declare method `private`
+1	Uses all parameters to initialize instance variables in 3-parameter constructor		• fail to declare instance variables • initialize local variables instead of instance variables • assign variables to parameters
+1	Uses parameter and default values to initialize instance variables in 1-parameter constructor	• initialize instance variables to default values when declared	• fail to declare instance variables • initialize local variables instead of instance variables • assign variables to parameters
+4	`isValid` method		
+1	Declares header: `public boolean isValid (String __)`		• fail to declare method `public` • declare method `static`
+1	Checks for length between min and max inclusive		• fail to use instance variables • fail to declare the method header
+1	Checks for unwanted string		• fail to use instance variables • fail to declare the method header
+1	Returns `true` if length is between min and max and does not contain the unwanted string, `false` otherwise	• have incorrect checks for length and/or containment, but return the correct value based on those checks	• fail to declare the method header • fail to return in all cases • only check one substring location for containment

AP® COMPUTER SCIENCE A
2018 SCORING GUIDELINES

Question 3: Code Word Checker

```
public class CodeWordChecker implements StringChecker
{
   private int minLength;
   private int maxLength;
   private String notAllowed;

   public CodeWordChecker(int minLen, int maxLen, String symbol)
   {
      minLength = minLen;
      maxLength = maxLen;
      notAllowed = symbol;
   }

   public CodeWordChecker(String symbol)
   {
      minLength = 6;
      maxLength = 20;
      notAllowed = symbol;
   }

   public boolean isValid(String str)
   {
      return str.length() >= minLength && str.length() <= maxLength &&
             str.indexOf(notAllowed) == -1;
   }

}
```

These canonical solutions serve an expository role, depicting general approaches to solution. Each reflects only one instance from the infinite set of valid solutions. The solutions are presented in a coding style chosen to enhance readability and facilitate understanding.

AP® COMPUTER SCIENCE A
2018 SCORING GUIDELINES

Question 4: Latin Squares

Part (a)	`getColumn`	**4 points**

Intent: *Create a 1-D array that contains the values from one column of a 2-D array*

+1 Constructs a new `int` array of size `arr2D.length`

+1 Accesses all items in one column of `arr2D` (*no bounds errors*)

+1 Assigns one element from `arr2D` to the corresponding element in the new array

+1 **On exit:** The new array has all the elements from the specified column in `arr2D` in the correct order

Part (b)	`isLatin`	**5 points**

Intent: *Check conditions to determine if a square 2-D array is a Latin square*

+1 Calls `containsDuplicates` referencing a row or column of `square`

+1 Calls `hasAllValues` referencing two different rows, two different columns, or one row and one column

+1 Applies `hasAllValues` to all rows or all columns (*no bounds errors*)

+1 Calls `getColumn` to obtain a valid column from `square`

+1 Returns `true` if all three Latin square conditions are satisfied, `false` otherwise

Question-Specific Penalties

-1 (r) incorrect construction of a copy of a row

-1 (s) syntactically incorrect method call to any of `getColumn()`, `containsDuplicates()`, or `hasAllValues()`

AP® COMPUTER SCIENCE A
2018 SCORING GUIDELINES

Question 4: Scoring Notes

Part (a) `getColumn`			**4 points**
Points	Rubric Criteria	Responses earn the point if they...	Responses will not earn the point if they...
+1	Constructs a new `int` array of size `arr2D.length`		• only create an `ArrayList`
+1	Accesses all items in one column of `arr2D` (*no bounds errors*)	• declare the new array of an incorrect size and use that size as the number of loop iterations	• switch row and column indices
+1	Assigns one element from `arr2D` to the corresponding element in the new array		• use `ArrayList` methods to add to array
+1	**On exit:** The new array has all the elements from the specified column in `arr2D` in the correct order		• switch row and column indices • do not use an index when assigning values to the array
Part (b) `isLatin`			**5 points**
Points	Rubric Criteria	Responses earn the point if they...	Responses will not earn the point if they...
+1	Calls `containsDuplicates` referencing a row or column of `square`	• reference any row or column of `square`, even if the syntax of the reference is incorrect	
+1	Calls `hasAllValues` referencing two different rows, two different columns, or one row and one column	• reference any two distinct rows, two distinct columns, or a row and column of `square`, even if the syntax of the reference is incorrect	
+1	Applies `hasAllValues` to all rows or all columns (*no bounds errors*)		• only reference one array in the call to `hasAllValues`
+1	Calls `getColumn` to obtain a valid column from `square`		• reverse parameters
+1	Returns `true` if all three Latin square conditions are satisfied, `false` otherwise	• test the three sets of conditions and return the correct value	

Return is not assessed in Part (a).

AP® COMPUTER SCIENCE A
2018 SCORING GUIDELINES

Question 4: Latin Squares

Part (a)

```
public static int[] getColumn(int[][] arr2D, int c)
{
   int[] result = new int[arr2D.length];

   for (int r = 0; r < arr2D.length; r++)
   {
      result[r] = arr2D[r][c];
   }
   return result;
}
```

Part (b)

```
public static boolean isLatin(int[][] square)
{
   if (containsDuplicates(square[0]))
   {
      return false;
   }

   for (int r = 1; r < square.length; r++)
   {
      if (!hasAllValues(square[0], square[r]))
      {
         return false;
      }
   }

   for (int c = 0; c < square[0].length; c++)
   {
      if (!hasAllValues(square[0], getColumn(square, c)))
      {
         return false;
      }
   }

   return true;
}
```

These canonical solutions serve an expository role, depicting general approaches to solution. Each reflects only one instance from the infinite set of valid solutions. The solutions are presented in a coding style chosen to enhance readability and facilitate understanding.

AP® Computer Science A 2016 Scoring Guidelines

2016 GENERAL SCORING GUIDELINES

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1-Point Penalty

v) Array/collection access confusion (`[] get`)

w) Extraneous code that causes side-effect (e.g., writing to output, failure to compile)

x) Local variables used but none declared

y) Destruction of persistent data (e.g., changing value referenced by parameter)

z) Void method or constructor that returns a value

No Penalty

- Extraneous code with no side-effect (e.g., precondition check, no-op)
- Spelling/case discrepancies where there is no ambiguity*
- Local variable not declared provided other variables are declared in some part
- `private` or `public` qualifier on a local variable
- Missing `public` qualifier on class or constructor header
- Keyword used as an identifier
- Common mathematical symbols used for operators (× • ÷ ≤ ≥ <> ≠)
- `[]` vs. `()` vs. `<>`
- = instead of == and vice versa
- `length`/`size` confusion for array, String, List, or ArrayList; with or without ( )
- Extraneous `[]` when referencing entire array
- `[i,j]` instead of `[i][j]`
- Extraneous size in array declaration, e.g., `int[size] nums = new int[size];`
- Missing ; where structure clearly conveys intent
- Missing { } where indentation clearly conveys intent
- Missing ( ) on parameter-less method or constructor invocations
- Missing ( ) around `if` or `while` conditions

Spelling and case discrepancies for identifiers fall under the "No Penalty" category only if the correction can be **unambiguously inferred from context. For example,* "ArayList" *instead of* "ArrayList". *As a counter example, note that if the code declares* "Bug bug;"*, then uses* "Bug.move()" *instead of* "bug.move()"*, the context does **not** allow for the reader to assume the object instead of the class.*

2016 SCORING GUIDELINES

Question 1: Random String Chooser

Part (a)	`RandomStringChooser`	**7 points**

Intent: *Define implementation of class to choose a random string*

+1 Uses correct class, constructor, and method headers

+1 Declares appropriate `private` instance variable(s)

+1 Initializes all instance variable(s) (*point lost if parameter not used in any initialization*)

+4 Implements `getNext`

- **+1** Generates a random number in the proper range (*point lost for improper or missing cast*)
- **+1** Chooses a string from instance variable using generated random number
- **+1** Updates state appropriately (*point lost if constructor parameter is altered*)
- **+1** Returns chosen string or `"NONE"` as appropriate

Part (b)	`RandomLetterChooser`	**2 points**

Intent: *Define implementation of a constructor of a class that extends* `RandomStringChooser`

+1 `getSingleLetters(str)`

+1 `super(getSingleLetters(str));` (*point lost if not first statement in constructor*)

2016 CANONICAL SOLUTIONS

Question 1: Random String Chooser

Part (a):

```
public class RandomStringChooser
{
    private List<String> words;

    public RandomStringChooser(String[] wordArray)
    {
       words = new ArrayList<String>();

       for (String singleWord : wordArray)
       {
            words.add(singleWord);
       }
    }

    public String getNext()
    {
       if (words.size() > 0)
       {
            return words.remove((int)(Math.random() * words.size()));
       }
       return "NONE";
    }
}
```

Part (b):

```
    public RandomLetterChooser(String str)
    {
         super(getSingleLetters(str));
    }
```

2016 SCORING GUIDELINES

Question 2: Log Messages

Part (a) `LogMessage` constructor **2 points**

Intent: *Initialize instance variables using passed parameter*

+1 Locates colon

+1 Initializes instance variables with correct parts of the parameter

Part (b) `containsWord` **2 points**

Intent: *Determine whether description properly contains a keyword*

+1 Identifies at least one properly-contained occurrence of `keyword` in `description`

+1 Returns `true` if and only if `description` properly contains `keyword`
Returns `false` otherwise (*no bounds errors*)

Part (c) `removeMessages` **5 points**

Intent: *Remove log messages containing keyword from system log list and return these messages in a new list*

+1 Accesses all items in `messageList` (*no bounds errors; point lost if no removal attempted*)

+1 Identifies keyword-containing entry using `containsWord`

+1 Adds all and only identified entries to new list (*point lost if original order not maintained*)

+1 Removes all identified entries from `messageList` (*point lost if* `messageList` *reordered)*

+1 Constructs and returns `new ArrayList<LogMessage>`

2016 CANONICAL SOLUTIONS

Question 2: Log Messages

Part (a):

```
public LogMessage(String message)
{
      int colon = message.indexOf(":");
      machineId = message.substring(0, colon);
      description = message.substring(colon + 1);
}
```

Part (b):

```
public boolean containsWord(String keyword)
{
   if (description.equals(keyword))
   {   return true;   }
   if (description.indexOf(keyword + " ") == 0)
   {   return true;   }
   if (description.indexOf(" " + keyword + " ") != -1)
   {   return true;   }
   if (description.length() > keyword.length())
   {
       if ((description.substring(description.length() -
                                  keyword.length() - 1).equals(
                                  " " + keyword)))
       {
          return true;
       }
   }
   return false;
}
```

Part (c):

```
public List<LogMessage> removeMessages(String keyword)
{
      List<LogMessage> removals = new ArrayList<LogMessage>();

      for (int i = 0; i < messageList.size(); i++)
      {
            if (messageList.get(i).containsWord(keyword))
            {
                  removals.add(messageList.remove(i));
                  i--;
            }
      }
      return removals;
}
```

2016 SCORING GUIDELINES

Question 3: Crossword

Part (a)	`toBeLabeled`	**3 points**

Intent: *Return a `boolean` value indicating whether a crossword grid square should be labeled with a positive number*

+1 Checks `blackSquares[r][c]`

+1 Checks for black square/border above and black square/border to the left (*no bounds errors*)

+1 Returns `true` if square should be labeled with positive number; returns `false` otherwise

Part (b)	`Crossword` constructor	**6 points**

Intent: *Initialize each square in a crossword puzzle grid to have a color `(boolean)` and an integer label*

+1 `puzzle = new Square[blackSquares.length][blackSquares[0].length];` (*or equivalent*)

+1 Accesses all locations in `puzzle` (*no bounds errors*)

+1 Calls `toBeLabeled` with appropriate parameters

+1 Creates and assigns new `Square` to location in `puzzle`

+1 Numbers identified squares consecutively, in row-major order, starting at 1

+1 On exit: All squares in `puzzle` have correct color and number (*minor errors covered in previous points ok*)

Question-Specific Penalties

-2 (p) Consistently uses incorrect name instead of `puzzle`

-1 (q) Uses *array*`[].length` instead of *array*`[`*num*`].length`

2016 CANONICAL SOLUTIONS

Question 3: Crossword

Part (a):

```
private boolean toBeLabeled(int r, int c, boolean[][] blackSquares)
{
      return (!(blackSquares[r][c]) &&
              (r == 0 || c == 0 || blackSquares[r - 1][c] ||
               blackSquares[r][c - 1]));
}
```

Part (b):

```
public Crossword(boolean[][] blackSquares)
{
      puzzle = new Square[blackSquares.length][blackSquares[0].length];
      int num = 1;

      for (int r = 0; r < blackSquares.length; r++)
      {
            for (int c = 0; c < blackSquares[0].length; c++)
            {
                  if (blackSquares[r][c])
                  {
                        puzzle[r][c] = new Square(true, 0);
                  }
                  else
                  {
                        if (toBeLabeled(r, c, blackSquares))
                        {
                              puzzle[r][c] = new Square(false, num);
                              num++;
                        }
                        else
                        {
                              puzzle[r][c] = new Square(false, 0);
                        }
                  }
            }
      }
}
```

2016 SCORING GUIDELINES

Question 4: String Formatter

Part (a)	`totalLetters`	**2 points**

Intent: *Calculate the total number of letters in a list of words*

+1 Accesses all strings in `wordList` and adds length of each to accumulated count (*no bounds errors*)

+1 Initializes and returns accumulated count

Part (b)	`basicGapWidth`	**2 points**

Intent: *Calculate the minimum number of spaces (basic gap width) to be placed between each word in the formatted string*

+1 Calls `totalLetters` correctly and uses result

+1 Returns correct calculated value

Part (c)	`format`	**5 points**

Intent: *Return a formatted string consisting of words from `wordList` separated by one or more spaces*

+1 Calls `basicGapWidth` and `leftoverSpaces` correctly and uses results

+1 Adds all strings in `wordList` to formatted string in original order (*no bounds errors*)

+1 Inserts *basicGapWidth* spaces between each pair of words in formatted string

+1 Inserts one space between first *leftoverSpaces* pairs of words in formatted string

+1 Initializes and returns formatted string (*no extra or deleted characters*)

2016 CANONICAL SOLUTIONS

Question 4: String Formatter

Part (a):

```
public static int totalLetters(List<String> wordList)
{
      int total = 0;

      for (String word : wordList)
      {
            total += word.length();
      }
      return total;
}
```

Part (b):

```
public static int basicGapWidth(List<String> wordList, int formattedLen)
{
      return (formattedLen – totalLetters(wordList)) / (wordList.size()-1);
}
```

Part (c):

```
public static String format(List<String> wordList, int formattedLen)
{
      String formatted = "";
      int gapWidth = basicGapWidth(wordList, formattedLen);
      int leftovers = leftoverSpaces(wordList, formattedLen);

      for (int w = 0; w < wordList.size() - 1; w++)
      {
            formatted = formatted + wordList.get(w);
            for (int i = 0; i < gapWidth; i++)
            {
                  formatted = formatted + " ";
            }
            if (leftovers > 0)
            {
                  formatted = formatted + " ";
                  leftovers--;
            }
      }
      formatted = formatted + wordList.get(wordList.size() - 1);

      return formatted;
}
```