

Beijing National Day School  
Department of Mathematics & Computer Science

AP Computer Science A  
Semester 1 Exam

English Name: \_\_\_\_\_

Pinyin Name: \_\_\_\_\_

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**Exam Record**

Multiple Choice \_\_\_\_\_ / 20 pts

Free Response \_\_\_\_\_ / 18 pts

Practical Coding \_\_\_\_\_ / 2 pts

Total: \_\_\_\_\_ / 40 pts

Grade: \_\_\_\_\_

**Section I: Multiple Choice** (20 points)

- Number of questions: 20. Percent of total grade: 50%.
- Determine the answer to each of the following questions, using the available space for any necessary scratchwork.
- Decide which is the best of the choices given, and select the correct answer by filling in the corresponding bubble on the separate answer sheet.
- Assume that the classes in the **Java Quick Reference** have been imported where needed.
- Assume that variables and methods are declared within the context of an enclosing class.

(1<sup>pt</sup>) 1. Consider the following class declaration.

```
public class Person
{
    private String myName;
    private int myYearOfBirth;

    public Person(String name, int yearOfBirth)
    {
        myName = name;
        myYearOfBirth = yearOfBirth;
    }

    public String getName()
    { return myName; }

    public void setName(String name)
    { myName = name; }
}
```

1 pt
------

Assume that the following declaration has been made.

```
Person student = new Person("Thomas", 1995);
```

Which of the following statements is the most appropriate for changing the name of **student** from "Thomas" to "Tom"?

- A student = new Person("Tom", 1995);
- B student.myName = "Tom";
- C student.getName("Tom")
- D student.setName("Tom");
- E Person.setName("Tom");

- (1<sup>pt</sup>) 2. What is printed when the following code segment executes, and we have  $x = 4$  and  $y = 3$ ?

```
if (!(x < 3 || y > 2))
    System.out.println("first case");
else
    System.out.println("second case");
```

1 pt

- A first case
- B second case
- C first case second case
- D Nothing is printed out.
- E It will give a run-time error.

- (1<sup>pt</sup>) 3. Consider the following method:

```
public static String scramble(String word, int howFar)
{
    return word.substring(howFar+1,word.length()) + word.substring(0,howFar);
}
```

1 pt

What value is returned as a result of the call `scramble("compiler", 3)`?

- A "compiler"
- B "pilercom"
- C "ilercom"
- D "ilercomp"
- E No value is returned because an `IndexOutOfBoundsException` will be thrown.

- (1<sup>pt</sup>) 4. Consider the following method:

```
public String mystery(String input)
{
    String output = "";
    for (int k = 1; k < input.length(); k = k+2)
    {
        output += input.substring(k, k+1);
    }
    return output;
}
```

1 pt

What value is returned as a result of the call `mystery("computer")`?

- A "computer"
- B "cmue"
- C "optr"
- D "ompute"
- E Nothing is returned because an `IndexOutOfBoundsException` is thrown.

- (1<sup>pt</sup>) 5. How many asterisk characters(\*) are printed to the display, when the following code segment is executed?

1 pt

```
for (int i = 0; i < 5; i++)
{
    for (int j = 0; j < 5; j++)
    {
        System.out.println("*");
    }
}
```

- A 10
- B 5
- C 25
- D 50
- E 30

- (1<sup>pt</sup>) 6. What does the following code segment print to the display?

1 pt

```
for (int k = 0; k < 20; k += 2)
{
    if (k % 3 == 1)
        System.out.println(k + " ");
}
```

- A 4 16
- B 4 10 16
- C 0 6 12 18
- D 0 1 4 7 10 13 16 19
- E 10 16 18

- (1<sup>pt</sup>) 7. Given the following values of `nums` and the method `doubleLast`, what will the array `nums` contain after you execute `doubleLast()` ?

1 pt

```
private int[] nums = {-10, -5, 1, 4, 8, 30};

public void doubleLast()
{
    for (int i = nums.length/2; i < nums.length; i++)
    {
        nums[i] = nums[i] * 2;
    }
}
```

- A {-20, -10, 2, 8, 16, 60}
- B {-20, -10, 2, 4, 8, 30}
- C {-10, -5, 1, 8, 16, 60}
- D {-10, -5, 1, 4, 8, 30}
- E {4, 8, 30, -10, -5, 1}

(1<sup>pt</sup>) 8. Given the following code segment, what is the value of `sum` after this code executes?

```
int[] [] matrix = {{1,1,2,2}, {1,2,2,4}, {1,2,3,4}, {1,4,1,2}};

int sum = 0;
int col = matrix[0].length - 2;
for (int row = 0; row < 4; row++)
{
    sum = sum + matrix[row][col];
}
```

1 pt

- A 4
- B 6
- C 8
- D 9
- E 12

(1<sup>pt</sup>) 9. Consider the following method.

```
public static int mystery(int[] arr)
{
    int total = 0;
    for (int i = 0; i < arr.length; i = i + 2)
    {
        total = total + arr[i];
    }
    return total;
}
```

1 pt

Assume that the array `nums` has been declared and initialized as follows:

```
int[] nums = {3, 6, 1, 0, 1, 4, 2};
```

What value will be returned as a result of the call `mystery(nums)`?

- A 10
- B 17
- C 5
- D 6
- E 7

(1<sup>pt</sup>) 10. Consider the following code segment.

```
int x = 7;
int y = 3;

if ((x < 10) && (y < 0))
{
    System.out.println("Value is: " + x * y);
}
else
{
    System.out.println("Value is: " + x / y);
}
```

1 pt

What is printed as a result of executing the code segment?

- A Value is: 2.3333333
- B Value is: 2
- C Value is: 21
- D Value is: 1
- E Value is: 0

(1<sup>pt</sup>) 11. Consider the following method.

```
public static int mystery(int num)
{
    int result = 0;
    for (int i = 1; i <= num; i = i + 2)
    {
        result += i;
    }
    return result;
}
```

1 pt

Which of the following choices best describes the value returned from a call to `mystery`?

- A `num`
- B The sum of all even integers between 1 and `num`, inclusive.
- C The sum of all odd integers between 1 and `num`, inclusive.
- D The sum of all integers between 1 and `num`, inclusive.
- E No value is returned, because of an infinite loop.

(1<sup>pt</sup>) 12. Consider the following method:

```
public static double mystery(int[] arr)
{
    double result = 0;
    for (int i = 0; i < arr.length; i++)
    {
        result = result + arr[i];
    }
    return result / arr.length;
}
```

1 pt

What will be printed as a result of executing the following code segment?

```
int[] nums = {10, 30, 30, 60};
System.out.println(mystery(nums));
```

- A 17.5
- B 30.0
- C 130
- D 32
- E 32.5

(1<sup>pt</sup>) 13. Consider the following code segment:

```
for (int k = 1; k <= 100; k++)
{
    if (k % 4 == 0)
    {
        System.out.println(k);
    }
}
```

1 pt

Which of the following code segments will produce the same output as the code segment above?

- A for (int k = 1; k <= 25; k++)  
  {System.out.println(k);}
- B for (int k = 1; k <= 100; k = k+4)  
  {System.out.println(k);}
- C for (int k = 1; k <= 100; k++)  
  {System.out.println(k % 4);}
- D for (int k = 4; k <= 25; k = 4\*k)  
  {System.out.println(k);}
- E for (int k = 4; k <= 100; k = k+4)  
  {System.out.println(k);}

(1<sup>pt</sup>) 14. Consider the following code segment:

```
ArrayList<String> students = new ArrayList<String>();
students.add("Alex");
students.add("Bob");
students.add("Carl");

for (int k = 0; k < students.size(); k++)
{
    System.out.print(students.set(k, "Alex") + " ");
}
System.out.println();

for (String name : students)
{
    System.out.print(name + " ");
}
```

1 pt

What will be printed as a result of executing this code segment?

A Alex Alex Alex  
Alex Alex Alex

B Alex Alex Alex  
Alex Bob Carl

C Alex Bob Carl  
Alex Alex Alex

D Alex Bob Carl  
Alex Bob Carl

E Nothing will be printed, because the first `print` statement will cause a runtime error to be thrown.

(1<sup>pt</sup>) 15. Consider the following method.

```
public int compute(int n, int k)
{
    int answer = 1;
    for (int i = 1; i <= k; i++)
        answer *= n;
    return answer;
}
```

1 pt

Which of the following represents the value returned as a result of the call `compute(n, k)`?

A  $n^k$

B  $2^k$

C  $k^n$

D  $n*k$

E  $n!$

(1<sup>pt</sup>) 16. Consider the following code segment.

```
int[] oldArray = {1, 2, 3, 4, 5, 6, 7, 8, 9};
int[][] newArray = new int[3][3];

int row = 0;
int col = 0;
for (int value : oldArray)
{
    newArray[row][col] = value;
    row++;
    if (row % 3 == 0)
    {
        col++;
        row = 0;
    }
}

System.out.println(newArray[0][1]);
```

1 pt

What is printed as a result of executing the code segment?

- A 3
- B 4
- C 5
- D 7
- E 8

(1<sup>pt</sup>) 17. Consider the following method.

```
public void mystery(int[] data)
{
    for (int k = 0; k < data.length - 1; k++)
        data[k + 1] = data[k] + data[k + 1];
}
```

1 pt

The following code segment appears in another method in the same class.

```
int[] values = {5, 2, 1, 3, 8};
mystery(values);
for (int v : values)
    System.out.print(v + " ");
System.out.println();
```

What is printed as a result of executing the code segment?

- A 5 2 1 3 8
- B 5 7 3 4 11
- C 7 3 4 11 8
- D 5 7 8 11 19
- E Nothing is printed because an `ArrayIndexOutOfBoundsException` is thrown during the execution of method `mystery`.

(1<sup>pt</sup>) 18. Consider the following code segment.

```
int num = 6853;
int result = 0;

While (num > 0)
{
    result = result * 10 + num % 10;
    num /= 10;
}
System.out.println(result);
```

1 pt

What is printed as a result of executing the code segment?

- A 6
- B 3
- C 22
- D 3586
- E 6853

(1<sup>pt</sup>) 19. Consider the following code segment.

```
int x = 1;
while ( /* missing code */ )
{
    System.out.print(x + " ");
    x = x + 2;
}
```

1 pt

Consider the following possible replacements for `/* missing code */`.

- I.** `x < 6`
- II.** `x < 7`
- III.** `x != 6`

Which of the proposed replacements for `/* missing code */` will cause the code segment to print only the values 1 3 5?

- A **I** only
- B **II** only
- C **I** and **II** only
- D **I** and **III** only
- E **I**, **II**, and **III**

(1<sup>pt</sup>) 20. Consider the following method.

1 pt
------

```
// Precondition: arr.length > 0
public static int mystery(int[] arr)
{
    int index = 0;
    int count = 0;
    int m = -1;

    for (int outer = 0; outer < arr.length; outer++)
    {
        count = 0;
        for (int inner = outer + 1; inner < arr.length; inner++)
        {
            if (arr[outer] == arr[inner])
            {
                count++;
            }
        }

        if (count > m)
        {
            index = outer;
            m = count;
        }
    }
    return index;
}
```

Assume that `nums` has been declared and initialized as an array of integer values. Which of the following best describes the value returned by the call `mystery(nums)`?

- A An index of a value that occurs most often in `nums`
- B The maximum value that occurs in `nums`
- C An index of the maximum value that occurs in `nums`
- D The number of times that the maximum value occurs in `nums`
- E A value that occurs most often in `nums`

**Section II: Free Response** (18 points)

- Number of questions: 2. Percent of total grade: 45%.
- **SHOW ALL YOUR WORK. REMEMBER THAT PROGRAM SEGMENTS ARE TO BE WRITTEN IN JAVA.**
- Assume that the classes listed in the **Java Quick Reference** have been imported where appropriate.
- Unless otherwise noted in the question, assume that parameters in method calls are not `null` and that methods are called only when their preconditions are satisfied.
- In writing solutions for each question, you may use any of the accessible methods that are listed in classes defined in that question. Writing significant amounts of code that can be replaced by a call to one of these methods may not receive full credit.

**Question 1 begins on the next page.**

## StepTracker question(2019 AP Computer Science A Free Response)

- (9<sup>pts</sup>) 1. This question involves the implementation of a fitness tracking system that is represented by the `StepTracker` class. A `StepTracker` object is created with a parameter that defines the minimum number of steps that must be taken for a day to be considered **active**.

9 pts

The `StepTracker` class provides a constructor and the following methods.

- `addDailySteps`, which accumulates information about steps, in readings taken once per day.
- `activeDays`, which returns the number of active days.
- `averageSteps`, which returns the average number of steps per day, calculated by dividing the total number of steps taken by the number of days tracked.

The following table contains a sample code execution sequence and the corresponding results.

Statements and Expressions	Value Returned	Comment
<code>StepTracker tr = new StepTracker(10000);</code>		Days with at least 10,000 steps are considered active. Assume that the parameter is positive.
<code>tr.activeDays();</code>	0	No data have been recorded yet.
<code>tr.averageSteps();</code>	0.0	When no step data have been recorded, the <code>averageSteps</code> method returns 0.0
<code>tr.addDailySteps(9000);</code>		This is too few steps for the day to be considered active.
<code>tr.addDailySteps(5000);</code>		This is too few steps for the day to be considered active.
<code>tr.activeDays();</code>	0	No day had at least 10,000 steps.
<code>tr.averageSteps();</code>	7000.0	The average number of steps per day is (14000/2).
<code>tr.addDailySteps(13000);</code>		This represents an active day.
<code>tr.activeDays();</code>	1	Of the three days for which step data were entered, one day had at least 10,000 steps.
<code>tr.averageSteps();</code>	9000.0	The average number of steps per day is (27000/3).
<code>tr.addDailySteps(23000);</code>		This represents an active day.
<code>tr.addDailySteps(1111);</code>		This is too few steps for the day to be considered active.
<code>tr.activeDays();</code>	2	Of the five days for which step data were entered, two days had at least 10,000 steps.
<code>tr.averageSteps();</code>	10222.2	The average number of steps per day is (51111/5).

Write the complete `StepTracker` class, including the constructor and any required instance variables and methods. Your implementation must meet all specifications and conform to the example.

**Delimiters question(2019 AP Computer Science A Free Response)**

- (9<sup>pts</sup>) **2.** Many encoded strings contain **delimiters**. A delimiter is a non-empty string that acts as a boundary between different parts of a larger string.

9 pts

The delimiters involved in this question occur in pairs that must be **balanced**, with each pair having an open delimiter and a closed delimiter. There will be only one type of delimiter for each string. The following are examples of delimiters.

**Example 1**

Expressions in mathematics use open parentheses "(" and close parentheses ")" as delimiters. For each open parenthesis, there must be a matching close parenthesis.

$(x + y) * 5$  is a valid mathematical expression.

$(x + (y)$  is NOT a valid mathematical expression, because there are more open delimiters than close delimiters.

**Example 2**

HTML uses `<B>` and `</B>` as delimiters. For each open delimiter `<B>`, there must be a matching close delimiter `</B>`.

`<B> Make this text bold </B>` is valid HTML.

`<B> Make this text bold </UB>` is NOT valid HTML, because there is one open delimiter and no matching close delimiter.

In this question, you will write two methods in the following `Delimiters` class.

```
1 public class Delimiters
2 {
3     // The open and close delimiters.
4     private String openDel;
5     private String closeDel;
6
7     // Constructs a Delimiters object where open is the open delimiter and close
8     // is the close delimiter.
9     // Precondition: open and close are non-empty strings.
10    public Delimiters(String open, String close)
11    {
12        openDel = open;
13        closeDel = close;
14    }
15
16    // Returns an ArrayList of delimiters from the array tokens, as described in part (a).
17    public ArrayList<String> getDelimitersList(String[] tokens)
18    {
19        // to be implemented in part (a)
20    }
21
22    // Returns true if the delimiters are balanced, and false otherwise, as described
23    // in part (b).
24    // Precondition: delimiters contains only valid open and close delimiters.
25    public boolean isBalanced(ArrayList<String> delimiters)
26    {
27        // to be implemented in part (b)
28    }
29
30    // There may be instance variables, constructors, and methods that are not shown.
31 }
```

(a) A string containing text (and possibly delimiters) has been split into **tokens** and stored in the array `String[] tokens`. Each token is either an open delimiter, a close delimiter, or a substring that is not a delimiter.

You will write the method `getDelimitersList`, which returns an `ArrayList` containing all the open and close delimiters found in `tokens` in their original order.

The following examples show the contents of an `ArrayList` returned by `getDelimitersList` for different open and close delimiters, and different `tokens` arrays.

### Example 1

openDel: "("

closeDel: ")"

tokens: 

" ("	"x + y"	") "	" * 5 "
------	---------	------	---------

ArrayList  
of delimiters: 

" ("	") "
------	------

### Example 2

openDel: "<q>"

closeDel: "</q>"

tokens: 

"<q>"	"yy"	"</q>"	"zz"	"</q>"
-------	------	--------	------	--------

ArrayList  
of delimiters: 

"<q>"	"</q>"	"</q>"
-------	--------	--------

(a) (4pts) Complete method `getDelimitersList` below.

```
// Returns an ArrayList of delimiters from the array tokens, as described  
// in part (a).  
public ArrayList<String> getDelimitersList(String[] tokens)
```

(b) Write the method `isBalanced`, which returns `true` when the delimiters are balanced, and return `false` otherwise. The delimiters are balanced when both of the following conditions are satisfied; otherwise, they are not balanced.

1. When traversing the `ArrayList` from the first element to the last element, there is no point at which there are more close delimiters than open delimiters, at or before that point.
2. The total number of open delimiters is equal to the total number of close delimiters.

Consider a `Delimiters` object for which `openDel` is `"<sup>"` and `closeDel` is `"</sup>"`. The examples below show different `ArrayList` objects that could be returned by calls to `getDelimitersList` and the value that would be returned by a call to `isBalanced`.

### Example 1

The following example shows an `ArrayList` for which `isBalanced` returns `true`. As tokens are examined from first to last, the number of open delimiters is always greater than or equal to the number of close delimiters. After examining all tokens, there are an equal number of open and close delimiters.

"<sup>"	"<sup>"	"</sup>"	"<sup>"	"</sup>"	"</sup>"
---------	---------	----------	---------	----------	----------

### Example 2

The following example shows an `ArrayList` for which `isBalanced` returns `false`.

"<sup>"	"</sup>"	"</sup>"	"<sup>"
---------	----------	----------	---------

↑

When starting from the left, at this point, condition 1 is violated.

### Example 3

The following example shows an `ArrayList` for which `isBalanced` returns `false`.

"</sup>"
----------

↑

At this point, condition 1 is violated.

### Example 4

The following example shows an `ArrayList` for which `isBalanced` returns `false`, because the second condition is violated. After examining all tokens, there are not an equal number of open and close delimiters.

"<sup>"	"<sup>"	"</sup>"
---------	---------	----------

(b) (5 pts) Complete method `isBalanced` below.

```
// Returns true if the delimiters are balanced and false otherwise, as described  
// in part (b).  
// Precondition: delimiters contains only valid open and close delimiters.  
public boolean isBalanced(ArrayList<String> delimiters)
```

**Section III: Practical Coding** (2 points)

- Number of questions: 1. Percent of total grade: 5%.
- Solve the following practical coding question. Write your solution in the space provided.
- Show all of your work. Remember that all programming segments are to be written in the Java programming language.

**(2<sup>pts</sup>) 1. Background Theory: Rocket Science**

SpaceX is a private aerospace manufacturer and space transportation services company that was founded in 2002 by Elon Musk. One of its more successful projects was the Falcon launch vehicle, a rocket ship that has the unique ability to land in an upright stance.

2 pts

In order to launch the Falcon rocket ship into orbit, engineers must first determine the amount of fuel that is required, and this depends upon the rocket's **mass**. Let's say that the fuel equation is as follows: take the mass of the Falcon rocket, divide by three, discard the decimal component of that result, and then subtract two, to get your answer.

For example:

- Consider the case where the Falcon rocket has a mass of 23. Dividing this by 3 yields a result of 7.66666. Then, discard the decimal component to get 7. Subtracting 2 from this results in a final answer of 5.
- **Hint:** Use the `Math.floor(double num)` function to discard the decimal component of `num`.

**The Problem Scope**

Unfortunately, when it comes to rocket science, things aren't so simple. Fuel itself has a mass component, and thus, it also requires fuel to be launched into orbit. Luckily, we can use our previously mentioned equation for this: take the fuel's mass, divide by 3, discard the decimal component of the result, and subtract 2. However, that fuel **also** requires fuel, and **that** fuel requires fuel, and so on. Note that any mass that would require **negative fuel** should instead be treated as if it requires **zero fuel**.

So, for the mass of the Falcon rocket, calculate its required fuel and add it to the total. Then, treat the fuel amount that you just calculated as input mass, and repeat the process, continuing until a fuel requirement is zero or negative.

For example:

- At first, a Falcon rocket of mass 1969 requires 654 fuel. Then, this fuel requires 216 more fuel( $654/3 - 2$ ). 216 then requires 70 more fuel, which requires 21 more fuel, which requires 5 fuel, which requires no further fuel. So, the total fuel required for a Falcon rocket of mass 1969 is:  $654 + 216 + 70 + 21 + 5 = 966$ .

**Write your solution on the next page.**

**Specification**

Write a Java function that takes in a `double` value `mass` as a parameter, representing the mass of the Falcon rocket. Then, it calculates the amount of fuel required to launch the rocket into orbit, according to the previously mentioned requirements.

The function should return a `double`.

**Testing**

If the following statements are executed:

```
double result = rocketFuel(1969.0);  
System.out.println(result);
```

Then the output of your program should be: 966.0

```
public static double rocketFuel(double mass)  
{  
    // YOUR CODE HERE
```

**STOP**  
**END OF EXAM**

---