

Please note: Some multiple-choice questions previously included in this practice exam have been removed because the content of the questions is no longer within the scope of the 2020 AP course. Other questions in this former practice exam may no longer perfectly align with the 2020 AP exam. Even though these questions do not fully represent the 2020 exam, teachers indicate that imperfectly aligned questions still provide instructional value. Teachers can consult the Question Bank to determine the degree to which these questions align to the 2020 exam.

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AP[®] Computer Science A Exam

Regularly Scheduled Exam Date: Thursday morning, May 7, 2015

Late-Testing Exam Date: Thursday morning, May 21, 2015

Section I Total Time: 1 hr. 15 min. Section II Total Time: 1 hr. 45 min.

Section I **Total Time:** 1 hour 15 minutes

Number of Questions: 40*

Percent of Total Score: 50%

Writing Instrument: Pencil required

**The number of questions may vary slightly depending on the form of the exam.*

Section II **Total Time:** 1 hour 45 minutes

Number of Questions: 4

Percent of Total Score: 50%

Writing Instrument: Pencil required

Note: The language used on the exam will be Java. The Java Quick Reference is included in the exam booklets.

What Proctors Need to Bring to This Exam

- Exam packets
- Answer sheets
- AP Student Packs
- 2014-15 AP Coordinator's Manual
- This book — *AP Exam Instructions*
- AP Exam Seating Chart template(s)
- School Code and Home-School/Self-Study Codes
- Pencil sharpener
- Container for students' electronic devices (if needed)
- Extra No. 2 pencils with erasers
- Extra pens with black or dark blue ink
- Extra paper
- Stapler
- Watch
- Signs for the door to the testing room
 - “Exam in Progress”
 - “Cell phones are prohibited in the testing room”

SECTION I: Multiple Choice

- **Do not begin the exam instructions below until you have completed the appropriate**
- **General Instructions for your group.**

Make sure you begin the exam at the designated time. Remember: You must complete a seating chart for this exam. See pages 279–280 for a seating chart template and instructions. See the 2014-15 AP Coordinator's Manual for exam seating requirements (pages 48–50, 88).

If you are giving the regularly scheduled exam, say:

It is Thursday morning, May 7, and you will be taking the AP Computer Science A Exam.

If you are giving the alternate exam for late testing, say:

It is Thursday morning, May 21, and you will be taking the AP Computer Science A Exam.

In a moment, you will open the packet that contains your exam materials. By opening this packet, you agree to all of the AP Program’s policies and procedures outlined in the *2014-15 Bulletin for AP Students and Parents*. You may now remove the shrinkwrap from your exam packet and take out the Section I booklet, but do not open the booklet or the shrinkwrapped Section II materials. Put the white seals aside. . . .

Carefully remove the AP Exam label found near the top left of your exam booklet cover. Now place it on page 1 of your answer sheet on the light blue box near the top right-hand corner that reads “AP Exam Label.”

If students accidentally place the exam label in the space for the number label or vice versa, advise them to leave the labels in place. They should not try to remove the label; their exam will be processed correctly.

Read the statements on the front cover of Section I and look up when you have finished. . . .

Sign your name and write today’s date. Look up when you have finished. . . .

Now print your full legal name where indicated. Are there any questions? . . .

Turn to the back cover and read it completely. Look up when you have finished. . . .

Are there any questions? . . .

You will now take the multiple-choice portion of the exam. You should have in front of you the multiple-choice booklet and your answer sheet. You may never discuss these specific multiple-choice questions at any time in any form with anyone, including your teacher and other students. If you disclose these questions through any means, your AP Exam score will be canceled. . . .

You must complete the answer sheet using a No. 2 pencil only. Mark all of your responses beginning on page 2 of your answer sheet, one response per question. Completely fill in the circles. If you need to erase, do so carefully and completely. No credit will be given for anything written in the exam booklet. Scratch paper is not allowed, but you may use the margins or any blank space in the exam booklet for scratch work. Are there any questions? . . .

The Java Quick Reference is located at the back of the booklet. You have 1 hour and 15 minutes for Section I. Open your Section I booklet and begin.



Note Start Time here _____. Note Stop Time here _____. Check that students are marking their answers in pencil on their answer sheets, and that they are not looking at their shrinkwrapped Section II booklets. After 1 hour and 5 minutes, say:

There are 10 minutes remaining.

After 10 minutes, say:

Stop working. Close your exam booklet and put your answer sheet on your desk, face up. Make sure you have your AP number label and an AP Exam label on page 1 of your answer sheet. Sit quietly while I collect your answer sheets.

Collect an answer sheet from each student. Check that each answer sheet has an AP number label and an AP Exam label. After all answer sheets have been collected, say:

Now you must seal your exam booklet using the white seals you set aside earlier. Remove the white seals from the backing and press one on each area of your exam booklet cover marked “PLACE SEAL HERE.” Fold each seal over the back cover. When you have finished, place the booklet on your desk, face up. . . .

I will now collect your Section I booklet.

Collect a Section I booklet from each student. Check that each student has signed the front cover of the sealed Section I booklet.

There is a 10-minute break between Sections I and II. When all Section I materials have been collected and accounted for and you are ready for the break, say:

Please listen carefully to these instructions before we take a 10-minute break. All items you placed under your chair at the beginning of this exam must stay there, and you are not permitted to open or access them in any way. Leave your shrinkwrapped Section II packet on your desk during the break. You are not allowed to consult teachers, other students, or textbooks during the break. You may not make phone calls, send text messages, check email, use a social networking site, or access any electronic or communication device. Remember, you may never discuss the multiple-choice questions at any time in any form with anyone, including your teacher and other students. If you disclose these questions through any means, your AP Exam score will be canceled. Are there any questions? . . .



You may begin your break. Testing will resume at _____.

SECTION II: Free Response

After the break, say:

May I have everyone’s attention? Place your Student Pack on your desk. . . .

You may now remove the shrinkwrap from the Section II packet, but do not open the exam booklet until you are told to do so. . . .

Read the bulleted statements on the front cover of the exam booklet. Look up when you have finished. . . .

Now place an AP number label on the shaded box. If you don’t have any AP number labels, write your AP number in the box. Look up when you have finished. . . .

Read the last statement. . . .

Using your pen, print the first, middle and last initials of your legal name in the boxes and print today’s date where indicated. This constitutes your signature and your agreement to the statements on the front cover. . . .

76	(A)	(B)	(C)	(D)	(E)
77	(A)	(B)	(C)	(D)	(E)
78	(A)	(B)	(C)	(D)	(E)
79	(A)	(B)	(C)	(D)	(E)
80	(A)	(B)	(C)	(D)	(E)
81	(A)	(B)	(C)	(D)	(E)
82	(A)	(B)	(C)	(D)	(E)
83	(A)	(B)	(C)	(D)	(E)
84	(A)	(B)	(C)	(D)	(E)
85	(A)	(B)	(C)	(D)	(E)
86	(A)	(B)	(C)	(D)	(E)
87	(A)	(B)	(C)	(D)	(E)
88	(A)	(B)	(C)	(D)	(E)
89	(A)	(B)	(C)	(D)	(E)
90	(A)	(B)	(C)	(D)	(E)

91	A	B	C	D	E
92	A	B	C	D	E
93	A	B	C	D	E
94	A	B	C	D	E
95	A	B	C	D	E
96	A	B	C	D	E
97	A	B	C	D	E
98	A	B	C	D	E
99	A	B	C	D	E
100	A	B	C	D	E
101	A	B	C	D	E
102	A	B	C	D	E
103	A	B	C	D	E
104	A	B	C	D	E
105	A	B	C	D	E

106	(A)	(B)	(C)	(D)	(E)
107	(A)	(B)	(C)	(D)	(E)
108	(A)	(B)	(C)	(D)	(E)
109	(A)	(B)	(C)	(D)	(E)
110	(A)	(B)	(C)	(D)	(E)
111	(A)	(B)	(C)	(D)	(E)
112	(A)	(B)	(C)	(D)	(E)
113	(A)	(B)	(C)	(D)	(E)
114	(A)	(B)	(C)	(D)	(E)
115	(A)	(B)	(C)	(D)	(E)
116	(A)	(B)	(C)	(D)	(E)
117	(A)	(B)	(C)	(D)	(E)
118	(A)	(B)	(C)	(D)	(E)
119	(A)	(B)	(C)	(D)	(E)
120	(A)	(B)	(C)	(D)	(E)

121

		/	/	/	
—	•	•	•	•	•
1	0	0	0	0	0
2	1	1	1	1	1
3	2	2	2	2	2
4	3	3	3	3	3
5	4	4	4	4	4
6	5	5	5	5	5
7	6	6	6	6	6
8	7	7	7	7	7
9	8	8	8	8	8

122

—	•	•	•	•	•
	1	0	0	0	0
	2	1	0	1	1
	3	2	2	2	2
	4	3	3	3	3
	5	4	4	4	4
	6	5	5	5	5
	7	6	6	6	6
	8	7	7	7	7
	9	8	8	8	8
	9	9	9	9	9

123

—	•	•	•	•	•
	1	0	0	0	0
	2	1	2	1	2
	3	2	3	2	3
	4	3	4	3	4
	5	4	5	4	5
	6	5	6	5	6
	7	6	7	6	7
	8	7	8	7	8
	9	8	9	8	9

124

-
1	0	0	0	0	0
2	1	1	1	1	1
3	2	2	2	2	2
4	3	3	3	3	3
5	4	4	4	4	4
6	5	5	5	5	5
7	6	6	6	6	6
8	7	7	7	7	7
9	8	8	8	8	8

125

○	○	/	/	/	○
		0	0	0	0
	1	1	1	1	1
	2	2	2	2	2
	3	3	3	3	3
	4	4	4	4	4
	5	5	5	5	5
	6	6	6	6	6
	7	7	7	7	7
	8	8	8	8	8
	9	9	9	9	9

126

○	○	/	/	/	○
		0	0	0	0
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6
7	7	7	7	7	7
8	8	8	8	8	8
9	9	9	9	9	9

131 (A) (B) (C) (D)

132 (A) (B) (C) (D)

133 (A) (B) (C) (D)

134 (A) (B) (C) (D)

135 (A) (B) (C) (D)

136 (A) (B) (C) (D)

137 (A) (B) (C) (D)

138 (A) (B) (C) (D)

139 (A) (B) (C) (D)

140 (A) (B) (C) (D)

141 (A) (B) (C) (D)

142 (A) (B) (C) (D)

[illegible]

DO NOT WRITE IN THIS AREA

AP[®] Computer Science A Exam

SECTION I: Multiple Choice

2015

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO.

At a Glance

Total Time

1 hour, 15 minutes

Number of Questions

40

Percent of Total Score

50%

Writing Instrument

Pencil required

Electronic Device

None allowed

Instructions

The Java Quick Reference is located at the back of this booklet.

Section I of this exam contains 40 multiple-choice questions. Fill in only the circles for numbers 1 through 40 on your answer sheet.

Indicate all of your answers to the multiple-choice questions on the answer sheet. No credit will be given for anything written in this exam booklet, but you may use the booklet for notes or scratch work. After you have decided which of the suggested answers is best, completely fill in the corresponding circle on the answer sheet. Give only one answer to each question. If you change an answer, be sure that the previous mark is erased completely. Here is a sample question and answer.

Sample Question Sample Answer

Chicago is a (A) ● (C) (D) (E)
(A) state
(B) city
(C) country
(D) continent
(E) village

Use your time effectively, working as quickly as you can without losing accuracy. Do not spend too much time on any one question. Go on to other questions and come back to the ones you have not answered if you have time. It is not expected that everyone will know the answers to all of the multiple-choice questions.

Your total score on the multiple-choice section is based only on the number of questions answered correctly. Points are not deducted for incorrect answers or unanswered questions.

Form O
Form Code 4LBP

31

COMPUTER SCIENCE A
SECTION I

Time—1 hour and 15 minutes

Number of questions—40

Percent of total score—50

Directions: Determine the answer to each of the following questions or incomplete statements, using the available space for any necessary scratch work. Then decide which is the best of the choices given and fill in the corresponding circle on the answer sheet. No credit will be given for anything written in the examination booklet. Do not spend too much time on any one problem.

Notes:

- Assume that the classes listed in the Java Quick Reference have been imported where appropriate.
- Assume that declarations of variables and methods appear within the context of an enclosing class.
- Assume that method calls that are not prefixed with an object or class name and are not shown within a complete class definition appear within the context of an enclosing class.
- 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.

1. Consider the following incomplete method, which is intended to return the number of integers that evenly divide the integer `inputVal`. Assume that `inputVal` is greater than 0.

```
public static int numDivisors(int inputVal)
{
    int count = 0;
    for (int k = 1; k <= inputVal; k++)
    {
        if ( /* condition */ )
        {
            count++;
        }
    }
    return count;
}
```

Which of the following can be used to replace `/* condition */` so that `numDivisors` will work as intended?

- (A) `inputVal % k == 0`
- (B) `k % inputVal == 0`
- (C) `inputVal % k != 0`
- (D) `inputVal / k == 0`
- (E) `k / inputVal > 0`

2. Consider the following code segment.

```
for (int r = 3; r > 0; r--)
{
    int c;

    for (c = 1; c < r; c++)
    {
        System.out.print("-");
    }
    for (c = r ; c <= 3; c++)
    {
        System.out.print("*");
    }

    System.out.println();
}
```

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

(A) --*
_**

(B) *--
**_

(C) ***
_**
--*

(D) ***
**_
*--

(E) --*

--*

3. Consider the following two classes.

```
public class A
{
    public void show()
    {
        System.out.print("A");
    }
}
```

```
public class B extends A
{
    public void show()
    {
        System.out.print("B");
    }
}
```

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

```
A obj = new B();
obj.show();
```

- (A) A
- (B) B
- (C) AB
- (D) BA
- (E) The code results in a runtime error.

4. Consider the following instance variable and method.

```
private int[] arr;

/** Precondition: arr.length > 0
 *  @return the largest value in array arr
 */
public int findMax()
{
    int maxVal = 0;

    for (int val : arr)
    {
        if (val > maxVal)
        {
            maxVal = val;
        }
    }

    return maxVal;
}
```

Method `findMax` is intended to return the largest value in the array `arr`. Which of the following best describes the conditions under which the method `findMax` will not work as intended?

- (A) The largest value in `arr` occurs only once and is in `arr[0]`.
- (B) The largest value in `arr` occurs only once and is in `arr[arr.length - 1]`.
- (C) The largest value in `arr` is negative.
- (D) The largest value in `arr` is zero.
- (E) The largest value in `arr` occurs more than once.

5. Assume that `x` and `y` are `boolean` variables and have been properly initialized.

`(x || y) && x`

Which of the following always evaluates to the same value as the expression above?

- (A) `x`
- (B) `y`
- (C) `x && y`
- (D) `x || y`
- (E) `x != y`

-
6. Consider the following method, which is intended to return `true` if at least one of the three strings `s1`, `s2`, or `s3` contains the substring "art". Otherwise, the method should return `false`.

```
public static boolean containsArt(String s1, String s2, String s3)
{
    String all = s1 + s2 + s3;

    return (all.indexOf("art") != -1);
}
```

Which of the following method calls demonstrates that the method does not work as intended?

- (A) `containsArt("rattrap", "similar", "today")`
- (B) `containsArt("start", "article", "Bart")`
- (C) `containsArt("harm", "chortle", "crowbar")`
- (D) `containsArt("matriculate", "carat", "arbitrary")`
- (E) `containsArt("darkroom", "cartoon", "articulate")`

7. Consider the following code segment.

```
for (int outer = 1; outer <= 6; outer++)
{
    for (int inner = outer; inner <= 6; inner++)
    {
        if (inner % 2 == 0)
        {
            System.out.print(inner + "  ");
        }
    }
    System.out.println();
}
```

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

(A) 2 4 6
4 6
6

(B) 2 4 6
2 4 6
2 4 6

(C) 2 4 6
2 4 6
4 6
4 6
6
6

(D) 2 4 6
2 4 6
2 4 6
2 4 6
2 4 6
2 4 6

(E) 2 4
2 4
4
4

8. Consider the following method.

```
public static int[] operation(int[][] matrix, int r, int c)
{
    int[] result = new int[matrix.length];

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

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

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

int[] arr = operation(mat, 1, 2);
```

Which of the following represents the contents of `arr` as a result of executing the code segment?

- (A) {6, 4, 2, 4}
- (B) {1, 6, 3, 4}
- (C) {4, 3, 6, 1}
- (D) {4, 4, 2, 2}
- (E) {2, 2, 4, 4}

9. A pair of number cubes is used in a game of chance. Each number cube has six sides, numbered from 1 to 6, inclusive, and there is an equal probability for each of the numbers to appear on the top side (indicating the cube's value) when the number cube is rolled. The following incomplete statement appears in a program that computes the sum of the values produced by rolling two number cubes.

```
int sum = /* missing code */ ;
```

Which of the following replacements for `/* missing code */` would best simulate the value produced as a result of rolling two number cubes?

- (A) `2 * (int) (Math.random() * 6)`
- (B) `2 * (int) (Math.random() * 7)`
- (C) `(int) (Math.random() * 6) + (int) (Math.random() * 6)`
- (D) `(int) (Math.random() * 13)`
- (E) `2 + (int) (Math.random() * 6) + (int) (Math.random() * 6)`

10. Consider the following interface and class declarations.

```
public interface Student
{ /* implementation not shown */ }

public class Athlete
{ /* implementation not shown */ }

public class TennisPlayer extends Athlete implements Student
{ /* implementation not shown */ }
```

Assume that each class has a zero-parameter constructor. Which of the following is NOT a valid declaration?

- (A) `Student a = new TennisPlayer();`
- (B) `TennisPlayer b = new TennisPlayer();`
- (C) `Athlete c = new TennisPlayer();`
- (D) `Student d = new Athlete();`
- (E) `Athlete e = new Athlete();`

11. Consider the following method.

```
public static boolean mystery(String str)
{
    String temp = "";

    for (int k = str.length(); k > 0; k--)
    {
        temp = temp + str.substring(k - 1, k);
    }

    return temp.equals(str);
}
```

Which of the following calls to `mystery` will return `true`?

- (A) `mystery("no")`
- (B) `mystery("on")`
- (C) `mystery("nnoo")`
- (D) `mystery("nono")`
- (E) `mystery("noon")`

12. Assume that `x` and `y` are boolean variables and have been properly initialized.

`(x && y) && !(x || y)`

Which of the following best describes the result of evaluating the expression above?

- (A) true always
- (B) false always
- (C) true only when `x` is true and `y` is true
- (D) true only when `x` and `y` have the same value
- (E) true only when `x` and `y` have different values

13. Consider the following instance variable and method.

```
private int[] numbers;

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

Assume that `numbers` has been initialized with the following values.

{17, 34, 21, 42, 15, 69, 48, 25, 39}

Which of the following represents the order of the values in `numbers` as a result of the call `mystery(3)` ?

- (A) {17, 20, 21, 42, 45, 69, 48, 51, 39}
- (B) {17, 20, 23, 26, 29, 32, 35, 38, 41}
- (C) {17, 37, 21, 42, 18, 69, 48, 28, 39}
- (D) {20, 23, 21, 42, 45, 69, 51, 54, 39}
- (E) {20, 34, 21, 45, 15, 69, 51, 25, 39}

14. Consider the following method, `biggest`, which is intended to return the greatest of three integers. It does not always work as intended.

```
public static int biggest(int a, int b, int c)
{
    if ((a > b) && (a > c))
    {
        return a;
    }
    else if ((b > a) && (b > c))
    {
        return b;
    }
    else
    {
        return c;
    }
}
```

Which of the following best describes the error in the method?

- (A) `biggest` always returns the value of `a`.
- (B) `biggest` may not work correctly when `c` has the greatest value.
- (C) `biggest` may not work correctly when `a` and `b` have equal values.
- (D) `biggest` may not work correctly when `a` and `c` have equal values.
- (E) `biggest` may not work correctly when `b` and `c` have equal values.

15. Consider the following method.

```
public static void showMe(int arg)
{
    if (arg < 10)
    {
        showMe(arg + 1);
    }
    else
    {
        System.out.print(arg + " ");
    }
}
```

What will be printed as a result of the call `showMe(0)` ?

- (A) 10
- (B) 11
- (C) 0 1 2 3 4 5 6 7 8 9
- (D) 9 8 7 6 5 4 3 2 1 0
- (E) 0 1 2 3 4 5 6 7 8 9 10

16. Consider the following method.

```
/** Precondition: values has at least one row */
public static int calculate(int[][] values)
{
    int found = values[0][0];
    int result = 0;
    for (int[] row : values)
    {
        for (int y = 0; y < row.length; y++)
        {
            if (row[y] > found)
            {
                found = row[y];
                result = y;
            }
        }
    }
    return result;
}
```

Which of the following best describes what is returned by the `calculate` method?

- (A) The largest value in the two-dimensional array
- (B) The smallest value in the two-dimensional array
- (C) The row index of an element with the largest value in the two-dimensional array
- (D) The row index of an element with the smallest value in the two-dimensional array
- (E) The column index of an element with the largest value in the two-dimensional array

17. Consider the following method.

```
/** Precondition: num > 0 */
public static int doWhat(int num)
{
    int var = 0;

    for (int loop = 1; loop <= num; loop = loop + 2)
    {
        var += loop;
    }

    return var;
}
```

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

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

18. What is printed as a result of executing the following statement?

```
System.out.println(404 / 10 * 10 + 1);
```

- (A) 4
- (B) 5
- (C) 41
- (D) 401
- (E) 405

19. Consider the following code segment.

```
int x = 1;
while ( /* condition */ )
{
    if (x % 2 == 0)
    {
        System.out.print(x + " ");
    }
    x = x + 2;
}
```

The following conditions have been proposed to replace `/* condition */` in the code segment.

- I. $x < 0$
- II. $x \leq 1$
- III. $x < 10$

For which of the conditions will nothing be printed?

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

20. Consider the following method.

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

21. Consider the following recursive method.

```
public static void whatsItDo(String str)
{
    int len = str.length();
    if (len > 1)
    {
        String temp = str.substring(0, len - 1);
        System.out.println(temp);
        whatsItDo(temp);
    }
}
```

What is printed as a result of the call `whatsItDo("WATCH")` ?

- (A) H
- (B) WATC
- (C) ATCH
ATC
AT
A
- (D) WATC
WAT
WA
W
- (E) WATCH
WATC
WAT
WA

22. Consider the following definition.

```
int[][] numbers = {{1, 2, 3},  
                   {4, 5, 6}};
```

Which of the following code segments produces the output 123456 ?

- (A)

```
for (int[] row : numbers)
{
    for (int n : row)
    {
        System.out.print(n);
    }
}
```
- (B)

```
for (int[] row : numbers)
{
    for (int n : row)
    {
        System.out.print(row[n]);
    }
}
```
- (C)

```
for (int rc = 0; rc < numbers.length; rc++)
{
    System.out.print(numbers[rc]);
}
```
- (D)

```
for (int r = 0; r < numbers[0].length; r++)
{
    for (int c = 0; c < numbers.length; c++)
    {
        System.out.print(numbers[r][c]);
    }
}
```
- (E)

```
for (int c = 0; c < numbers[0].length; c++)
{
    for (int r = 0; r < numbers.length; r++)
    {
        System.out.print(numbers[r][c]);
    }
}
```

23. Consider the following code segment from an insertion sort program.

```
for (int j = 1; j < arr.length; j++)
{
    int insertItem = arr[j];
    int k = j - 1;

    while (k >= 0 && insertItem < arr[k])
    {
        arr[k + 1] = arr[k];
        k--;
    }

    arr[k + 1] = insertItem;

    /* end of for loop */
}
```

Assume that array `arr` has been defined and initialized with the values `{5, 4, 3, 2, 1}`. What are the values in array `arr` after two passes of the `for` loop (i.e., when `j = 2` at the point indicated by `/* end of for loop */`) ?

- (A) `{2, 3, 4, 5, 1}`
- (B) `{3, 2, 1, 4, 5}`
- (C) `{3, 4, 5, 2, 1}`
- (D) `{3, 5, 2, 3, 1}`
- (E) `{5, 3, 4, 2, 1}`

24. Consider the following class.

```
public class SomeMethods
{
    public void one(int first)
    { /* implementation not shown */ }

    public void one(int first, int second)
    { /* implementation not shown */ }

    public void one(int first, String second)
    { /* implementation not shown */ }
}
```

Which of the following methods can be added to the `SomeMethods` class without causing a compile-time error?

- I.

```
public void one(int value)
{ /* implementation not shown */ }
```
- II.

```
public void one(String first, int second)
{ /* implementation not shown */ }
```
- III.

```
public void one(int first, int second, int third)
{ /* implementation not shown */ }
```

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

25. Consider the following code segment.

```
int count = 0;

for (int x = 0; x < 4; x++)
{
    for (int y = x; y < 4; y++)
    {
        count++;
    }
}
System.out.println(count);
```

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

- (A) 4
- (B) 8
- (C) 10
- (D) 16
- (E) 20

26. Consider the following two methods, which appear within a single class.

```
public static void changeIt(int[] arr, int val, String word)
{
    arr = new int[5];
    val = 0;
    word = word.substring(0, 5);

    for (int k = 0; k < arr.length; k++)
    {
        arr[k] = 0;
    }
}

public static void start()
{
    int[] nums = {1, 2, 3, 4, 5};
    int value = 6;
    String name = "blackboard";

    changeIt(nums, value, name);

    for (int k = 0; k < nums.length; k++)
    {
        System.out.print(nums[k] + " ");
    }

    System.out.print(value + " ");
    System.out.print(name);
}
```

What is printed as a result of the call `start()` ?

- (A) 0 0 0 0 0 0 black
- (B) 0 0 0 0 0 6 blackboard
- (C) 1 2 3 4 5 6 black
- (D) 1 2 3 4 5 0 black
- (E) 1 2 3 4 5 6 blackboard

Questions 27-28 refer to the following information.

Consider the following `sort` method. This method correctly sorts the elements of array `data` into increasing order.

```
public static void sort(int[] data)
{
    for (int j = 0; j < data.length - 1; j++)
    {
        int m = j;
        for (int k = j + 1; k < data.length; k++)
        {
            if (data[k] < data[m])      /* Compare values */
            {
                m = k;
            }
        }
        int temp = data[m];           /* Assign to temp */
        data[m] = data[j];
        data[j] = temp;

        /* End of outer loop */
    }
}
```

27. Assume that `sort` is called with the array `{6, 3, 2, 5, 4, 1}`. What will the value of `data` be after three passes of the outer loop (i.e., when `j = 2` at the point indicated by `/* End of outer loop */`) ?
- (A) `{1, 2, 3, 4, 5, 6}`
(B) `{1, 2, 3, 5, 4, 6}`
(C) `{1, 2, 3, 6, 5, 4}`
(D) `{1, 3, 2, 4, 5, 6}`
(E) `{1, 3, 2, 5, 4, 6}`

-
28. Assume that `sort` is called with the array `{1, 2, 3, 4, 5, 6}`. How many times will the expression indicated by `/* Compare values */` and the statement indicated by `/* Assign to temp */` execute?

	<u>Compare values</u>	<u>Assign to temp</u>
(A)	15	0
(B)	15	5
(C)	15	6
(D)	21	5
(E)	21	6

29. Consider the following recursive method.

```
/** Precondition: num ≥ 0 */  
public static int what(int num)  
{  
    if (num < 10)  
    {  
        return 1;  
    }  
    else  
    {  
        return 1 + what(num / 10);  
    }  
}
```

Assume that `int val` has been declared and initialized with a value that satisfies the precondition of the method. Which of the following best describes the value returned by the call `what(val)` ?

- (A) The number of digits in the decimal representation of `val` is returned.
- (B) The sum of the digits in the decimal representation of `val` is returned.
- (C) Nothing is returned. A run-time error occurs because of infinite recursion.
- (D) The value 1 is returned.
- (E) The value `val/10` is returned.

30. The price per box of ink pens advertised in an office supply catalog is based on the number of boxes ordered. The following table shows the pricing.

Number of Boxes	Price per Box
1 up to but not including 5	\$5.00
5 up to but not including 10	\$3.00
10 or more	\$1.50

The following incomplete method is intended to return the total cost of an order based on the value of the parameter `numBoxes`.

```
/** Precondition: numBoxes > 0 */
public static double getCost(int numBoxes)
{
    double totalCost = 0.0;

    /* missing code */

    return totalCost;
}
```

Which of the following code segments can be used to replace `/* missing code */` so that method `getCost` will work as intended?

I.

```
if (numBoxes >= 10)
{
    totalCost = numBoxes * 1.50;
}
if (numBoxes >= 5)
{
    totalCost = numBoxes * 3.00;
}
if (numBoxes > 0)
{
    totalCost = numBoxes * 5.00;
}
```

II.

```
if (numBoxes >= 10)
{
    totalCost = numBoxes * 1.50;
}
else if (numBoxes >= 5)
{
    totalCost = numBoxes * 3.00;
}
else
{
    totalCost = numBoxes * 5.00;
}
```

III.

```
if (numBoxes > 0)
{
    totalCost = numBoxes * 5.00;
}
else if (numBoxes >= 5)
{
    totalCost = numBoxes * 3.00;
}
else if (numBoxes >= 10)
{
    totalCost = numBoxes * 1.50;
}
```

- (A) I only
- (B) II only
- (C) III only
- (D) I and II
- (E) II and III

31. Consider the following code segment.

```
String[][] board = new String[5][5];

for (int row = 0; row < 5; row++)
{
    for (int col = 0; col < 5; col++)
    {
        board[row][col] = "O";
    }
}

for (int val = 0; val < 5; val++)
{
    if (val % 2 == 1)
    {
        int row = val;
        int col = 0;
        while (col < 5 && row >= 0)
        {
            board[row][col] = "X";
            col++;
            row--;
        }
    }
}
```

Which of the following represents `board` after this code segment is executed?

(A)

	0	1	2	3	4
0	X	O	X	O	X
1	O	X	O	X	O
2	X	O	X	O	X
3	O	X	O	X	O
4	X	O	X	O	X

(B)

	0	1	2	3	4
0	O	X	O	X	O
1	X	O	X	O	X
2	O	X	O	X	O
3	X	O	X	O	X
4	O	X	O	X	O

(C)

	0	1	2	3	4
0	X	O	O	O	X
1	O	X	O	X	O
2	O	O	X	O	O
3	O	X	O	X	O
4	X	O	O	O	X

(D)

	0	1	2	3	4
0	O	X	O	O	O
1	O	O	X	O	O
2	X	O	O	X	O
3	O	X	O	O	X
4	O	O	X	O	O

(E)

	0	1	2	3	4
0	O	X	O	X	O
1	X	O	X	O	O
2	O	X	O	O	O
3	X	O	O	O	O
4	O	O	O	O	O

32. Consider the following class declaration.

```
public class StudentInfo
{
    private String major;
    private int age;

    public String getMajor()
    { return major; }

    public int getAge()
    { return age; }

    // There may be instance variables, constructors, and methods that are not shown.
}
```

The following instance variable and method appear in another class.

```
private List<StudentInfo> students;

/** @return the average age of students with the given major;
 *      -1.0 if no such students exist
 */
public double averageAgeInMajor(String theMajor)
{
    double sum = 0.0;
    int count = 0;
    for (StudentInfo k : students)
    {
        /* missing code */
    }

    if (count > 0)
    {
        return sum / count;
    }
    else
    {
        return -1.0;
    }
}
```

Which of the following could be used to replace `/* missing code */` so that `averageAgeInMajor` will compile without error?

- (A)

```
if (theMajor.equals(k.major))
{
    sum += k.age;
    count++;
}
```
- (B)

```
if (theMajor.equals(k.getMajor()))
{
    sum += k.getAge();
    count++;
}
```
- (C)

```
if (theMajor.equals(k.major))
{
    sum += k.getAge();
    count++;
}
```
- (D)

```
if (theMajor.equals(students[k].getMajor()))
{
    sum += students[k].getAge();
    count++;
}
```
- (E)

```
if (theMajor.equals(getMajor(k)))
{
    sum += getAge(k);
    count++;
}
```

33. Consider the problem of finding the maximum value in an array of integers. The following code segments are proposed solutions to the problem. Assume that the variable `arr` has been defined as an array of `int` values and has been initialized with one or more values.

- I.

```
int max = Integer.MIN_VALUE;
for (int value : arr)
{
    if (max < value)
    {
        max = value;
    }
}
```
- II.

```
int max = 0;
boolean first = true;
for (int value : arr)
{
    if (first)
    {
        max = value;
        first = false;
    }
    else if (max < value)
    {
        max = value;
    }
}
```
- III.

```
int max = arr[0];
for (int k = 1; k < arr.length; k++)
{
    if (max < arr[k])
    {
        max = arr[k];
    }
}
```

Which of the code segments will always correctly assign the maximum element of the array to the variable `max`?

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

34. Consider the following instance variable and method. Method `wordsWithCommas` is intended to return a string containing all the words in `listOfWords` separated by commas and enclosed in braces. For example, if `listOfWords` contains `["one", "two", "three"]`, the string returned by the call `wordsWithCommas()` should be `"{one, two, three}"`.

```
private List<String> listOfWords;

public String wordsWithCommas()
{
    String result = "{";

    int sizeOfList = /* expression */ ;

    for (int k = 0; k < sizeOfList; k++)
    {
        result = result + listOfWords.get(k);

        if ( /* condition */ )
        {
            result = result + ", ";
        }
    }

    result = result + "}";
    return result;
}
```

Which of the following can be used to replace `/* expression */` and `/* condition */` so that `wordsWithCommas` will work as intended?

- | <u><code>/* expression */</code></u> | <u><code>/* condition */</code></u> |
|---|-------------------------------------|
| (A) <code>listOfWords.size() - 1</code> | <code>k != 0</code> |
| (B) <code>listOfWords.size()</code> | <code>k != 0</code> |
| (C) <code>listOfWords.size() - 1</code> | <code>k != sizeOfList - 1</code> |
| (D) <code>listOfWords.size()</code> | <code>k != sizeOfList - 1</code> |
| (E) <code>result.length()</code> | <code>k != 0</code> |

Questions 35-36 refer to the following information.

Consider the following `binarySearch` method. The method correctly performs a binary search.

```
/** Precondition: data is sorted in increasing order. */
public static int binarySearch(int[] data, int target)
{
    int start = 0;
    int end = data.length - 1;
    while (start <= end)
    {
        int mid = (start + end) / 2;          /* Calculate midpoint */
        if (target < data[mid])
        {
            end = mid - 1;
        }
        else if (target > data[mid])
        {
            start = mid + 1;
        }
        else
        {
            return mid;
        }
    }
    return -1;
}
```

35. Consider the following code segment.

```
int[] values = {1, 2, 3, 4, 5, 8, 8, 8};  
int target = 8;
```

What value is returned by the call `binarySearch(values, target)` ?

- (A) -1
- (B) 3
- (C) 5
- (D) 6
- (E) 8

36. Suppose the `binarySearch` method is called with an array containing 2,000 elements sorted in increasing order. What is the maximum number of times that the statement indicated by `/* Calculate midpoint */` could execute?

- (A) 2,000
- (B) 1,000
- (C) 20
- (D) 11
- (E) 1

37. Consider the following incomplete method that is intended to return a string formed by concatenating elements from the parameter `words`. The elements to be concatenated start with `startIndex` and continue through the last element of `words` and should appear in reverse order in the resulting string.

```
/** Precondition: words.length > 0;
 *          startIndex >= 0
 */
public static String concatWords(String[] words, int startIndex)
{
    String result = "";

    /* missing code */

    return result;
}
```

For example, the following code segment uses a call to the `concatWords` method.

```
String[] things = {"Bear", "Apple", "Gorilla", "House", "Car"};
System.out.println(concatWords(things, 2));
```

When the code segment is executed, the string `"CarHouseGorilla"` is printed.

The following three code segments have been proposed as replacements for `/* missing code */`.

- I. for (int k = startIndex; k < words.length; k++)
 {
 result += words[k] + words[words.length - k - 1];
 }
- II. int k = words.length - 1;
 while (k >= startIndex)
 {
 result += words[k];
 k--;
 }
- III. String[] temp = new String[words.length];
 for (int k = 0; k <= words.length / 2; k++)
 {
 temp[k] = words[words.length - k - 1];
 temp[words.length - k - 1] = words[k];
 }

 for (int k = 0; k < temp.length - startIndex; k++)
 {
 result += temp[k];
 }

Which of these code segments can be used to replace `/* missing code */` so that `concatWords` will work as intended?

- (A) I only
- (B) II only
- (C) III only
- (D) I and II
- (E) II and III

38. Consider the following method.

```
/** Precondition: 0 < numVals <= nums.length */
public static int mystery(int[] nums, int v, int numVals)
{
    int k = 0;

    if (v == nums[numVals - 1])
    {
        k = 1;
    }

    if (numVals == 1)
    {
        return k;
    }
    else
    {
        return k + mystery(nums, v, numVals - 1);
    }
}
```

Which of the following best describes what the call `mystery(numbers, val, numbers.length)` does? You may assume that variables `numbers` and `val` have been declared and initialized.

- (A) Returns 1 if the last element in `numbers` is equal to `val`; otherwise, returns 0
- (B) Returns the index of the last element in `numbers` that is equal to `val`
- (C) Returns the number of elements in `numbers` that are equal to `val`
- (D) Returns the number of elements in `numbers` that are not equal to `val`
- (E) Returns the maximum number of adjacent elements that are not equal to `val`

39. Consider the following code segment.

```
List<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 str : students)
{
    System.out.print(str + "  ");
}
```

What is printed as a result of executing the 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 is printed because the first print statement will cause a runtime exception to be thrown.

Java Quick Reference

Accessible Methods from the Java Library That May Be Included on the Exam

class java.lang.Object

- boolean equals(Object other)
- String toString()

class java.lang.Integer

- Integer(int value)
- int intValue()
- Integer.MIN_VALUE // minimum value represented by an int or Integer
- Integer.MAX_VALUE // maximum value represented by an int or Integer

class java.lang.Double

- Double(double value)
- double doubleValue()

class java.lang.String

- int length()
- String substring(int from, int to) // returns the substring beginning at from
// and ending at to-1
- String substring(int from) // returns substring(from, length())
- int indexOf(String str) // returns the index of the first occurrence of str;
// returns -1 if not found
- int compareTo(String other) // returns a value < 0 if this is less than other
// returns a value = 0 if this is equal to other
// returns a value > 0 if this is greater than other

class java.lang.Math

- static int abs(int x)
- static double abs(double x)
- static double pow(double base, double exponent)
- static double sqrt(double x)
- static double random() // returns a double in the range [0.0, 1.0)

interface java.util.List<E>

- int size()
- boolean add(E obj) // appends obj to end of list; returns true
- void add(int index, E obj) // inserts obj at position index (0 ≤ index ≤ size),
// moving elements at position index and higher
// to the right (adds 1 to their indices) and adjusts size
- E get(int index)
- E set(int index, E obj) // replaces the element at position index with obj
// returns the element formerly at the specified position
- E remove(int index) // removes element from position index, moving elements
// at position index + 1 and higher to the left
// (subtracts 1 from their indices) and adjusts size
// returns the element formerly at the specified position

class java.util.ArrayList<E> implements java.util.List<E>