

## 2018 AP<sup>®</sup> COMPUTER SCIENCE A FREE-RESPONSE QUESTIONS

4. This question involves reasoning about arrays of integers. You will write two static methods, both of which are in a class named `ArrayTester`.

```
public class ArrayTester
{
    /** Returns an array containing the elements of column c of arr2D in the same order as
     * they appear in arr2D.
     * Precondition: c is a valid column index in arr2D.
     * Postcondition: arr2D is unchanged.
     */
    public static int[] getColumn(int[][] arr2D, int c)
    { /* to be implemented in part (a) */ }

    /** Returns true if and only if every value in arr1 appears in arr2.
     * Precondition: arr1 and arr2 have the same length.
     * Postcondition: arr1 and arr2 are unchanged.
     */
    public static boolean hasAllValues(int[] arr1, int[] arr2)
    { /* implementation not shown */ }

    /** Returns true if arr contains any duplicate values;
     * false otherwise.
     */
    public static boolean containsDuplicates(int[] arr)
    { /* implementation not shown */ }

    /** Returns true if square is a Latin square as described in part (b);
     * false otherwise.
     * Precondition: square has an equal number of rows and columns.
     * square has at least one row.
     */
    public static boolean isLatin(int[][] square)
    { /* to be implemented in part (b) */ }
}
```

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- (a) Write a static method `getColumn`, which returns a one-dimensional array containing the elements of a single column in a two-dimensional array. The elements in the returned array should be in the same order as they appear in the given column. The notation `arr2D[r][c]` represents the array element at row `r` and column `c`.

The following code segment initializes an array and calls the `getColumn` method.

```
int[][] arr2D = { { 0, 1, 2 },
                  { 3, 4, 5 },
                  { 6, 7, 8 },
                  { 9, 5, 3 } };

int[] result = ArrayTester.getColumn(arr2D, 1);
```

When the code segment has completed execution, the variable `result` will have the following contents.

`result: {1, 4, 7, 5}`

**WRITE YOUR SOLUTION ON THE NEXT PAGE.**

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Complete method `getColumn` below.

```
/** Returns an array containing the elements of column c of arr2D in the same order as they
 * appear in arr2D.
 * Precondition: c is a valid column index in arr2D.
 * Postcondition: arr2D is unchanged.
 */
public static int[] getColumn(int[][] arr2D, int c)
```

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- (b) Write the static method `isLatin`, which returns `true` if a given two-dimensional square array is a *Latin square*, and otherwise, returns `false`.

A two-dimensional square array of integers is a Latin square if the following conditions are true.

- The first row has no duplicate values.
- All values in the first row of the square appear in each row of the square.
- All values in the first row of the square appear in each column of the square.

### Examples of Latin Squares

1	2	3
2	3	1
3	1	2

10	30	20	0
0	20	30	10
30	0	10	20
20	10	0	30

### Examples that are NOT Latin Squares

1	2	1
2	1	1
1	1	2

Not a Latin square  
because the first row  
contains duplicate  
values

1	2	3
3	1	2
7	8	9

Not a Latin square  
because the elements of  
the first row do not all  
appear in the third row

1	2
1	2

Not a Latin square  
because the elements of  
the first row do not all  
appear in either column

The `ArrayTester` class provides two helper methods: `containsDuplicates` and `hasAllValues`. The method `containsDuplicates` returns `true` if the given one-dimensional array `arr` contains any duplicate values and `false` otherwise. The method `hasAllValues` returns `true` if and only if every value in `arr1` appears in `arr2`. You do not need to write the code for these methods.

Class information for this question

```
public class ArrayTester
```

```
public static int[] getColumn(int[][] arr2D, int c)
public static boolean hasAllValues(int[] arr1, int[] arr2)
public static boolean containsDuplicates(int[] arr)
public static boolean isLatin(int[][] square)
```

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Complete method `isLatin` below. Assume that `getColumn` works as specified, regardless of what you wrote in part (a). You must use `getColumn`, `hasAllValues`, and `containsDuplicates` appropriately to receive full credit.

```
/** Returns true if square is a Latin square as described in part (b);
 *     false otherwise.
 * Precondition: square has an equal number of rows and columns.
 *                 square has at least one row.
 */
public static boolean isLatin(int[] [] square)
```

**STOP**

**END OF EXAM**