

**Computer Science 2530**  
**Spring 2020**  
**Practice Exam 3**  
**Answers**

All questions concern the C++ programming language. **Check your answers.**

**For the multiple choice questions (marked [MC]) correct answers are in bold.**

1. [MC] If variable  $p$  has type `Widget*`, then expression  $*p$  has type
  - (a) **Widget**
  - (b) `Widget*`
  - (c) `Widget**`
  - (d) `*Widget`
  - (e) `**Widget`
  
2. [MC] If variable  $x$  has type `Widget`, then expression  $\&x$  has type
  - (a) `Widget`
  - (b) **`Widget*`**
  - (c) `Widget**`
  - (d) `**Widget`
  - (e) `*Widget`
  
3. [MC] Suppose that variable  $p$  has been created, with type `int*`. Which of the following statements makes  $p$  point to newly allocated memory in the heap?
  - (a) `int* p;`
  - (b) `new int* p;`
  - (c) `p = new int*;`
  - (d) `*p = new int;`
  - (e) **`p = new int;`**

4. [MC] Suppose that variable  $p$  has been made to point to newly allocated memory as in the preceding question. Which of the following statements stores 100 into that newly allocated memory?
- (a)  $p = 100;$
  - (b)  $\text{new int}^* p = 100;$
  - (c)  $*p = 100;$
  - (d)  $p^* = 100;$
  - (e)  $p = \text{new int}^*(100);$
5. Write a definition of function  $\text{allSame}(A, n)$ , which returns true if the first  $n$  values in array  $A$  are all the same, and returns false if they are not. If  $n \leq 1$ ,  $\text{allSame}(A, n)$  must return true.

**Use recursion for this problem. Do not use any kind of loop.** A heading is given.

Work from a small example. Make sure that your code is correct for that example, but also generalize it to work for any array  $A$  and size  $n \geq 0$ .

**Example 1. ( $n = 4$ )**

n	A[n]	Same	Same
0	20		
1	20		
2	20		
3	20		

**Example 2. ( $n = 4$ )**

n	A[n]	Same	Same
0	20		
1	20		
2	20		X
3	10		X

**Example 3. ( $n = 4$ )**

n	A[n]	Same	Same
0	20	X	
1	10	X	
2	20	X	
3	20		

**Note.** If  $n > 1$ , then  $A[0], A[1], \dots, A[n-2], A[n-1]$  are all the same if the last two ( $A[n-2]$  and  $A[n-1]$ ) are equal and all of  $A[0], A[1], \dots, A[n-2]$  are the same. Notice that the two sections being checked ( $\{A[n-2], A[n-1]\}$  and  $\{A[0], \dots, A[n-1]\}$ ) must overlap.

```
bool allSame(int* A, int n)
{
    if(n <= 1)
    {
        return true;
    }
    else
    {
        return A[n-1] == A[n-2] && allSame(A, n-1);
    }
}
```

If you are uncomfortable with that, the following is also a correct answer.

```
bool allSame(int* A, int n)
{
    if(n <= 1)
    {
        return true;
    }
    else if(A[n-1] != A[n-2])
    {
        return false;
    }
    else if(allSame(A, n-1))
    {
        return true;
    }
    else
    {
        return false;
    }
}
```

6. Suppose that function `quark` is defined as follows. What is the value of `quark(8)`? (Hint: You will need to know `quark(1)`, `quark(2)`, `quark(4)` and `quark(8)`. Work those out, in that order. Show your work neatly.)

```
int quark(int n)
{
    if(n == 1)
    {
        return 2;
    }
    else
    {
        return 2*quark(n/2) + 1;
    }
}
```

$$\text{quark}(1) = 2$$

$$\text{quark}(2) = 2 * \text{quark}(1) + 1 = 2 * 2 + 1 = 5$$

$$\text{quark}(4) = 2 * \text{quark}(2) + 1 = 2 * 5 + 1 = 11$$

$$\text{quark}(8) = 2 * \text{quark}(4) + 1 = 2 * 11 + 1 = 23$$

7. What are the values of variables  $a$ ,  $b$ ,  $c$ ,  $x$  and  $y$  after performing the following sequence of statements? Work out the answer carefully, and show your work. Draw pointer diagrams.

**In order to receive any credit for this problem, you must get at least 3 of the 5 answers correct.**

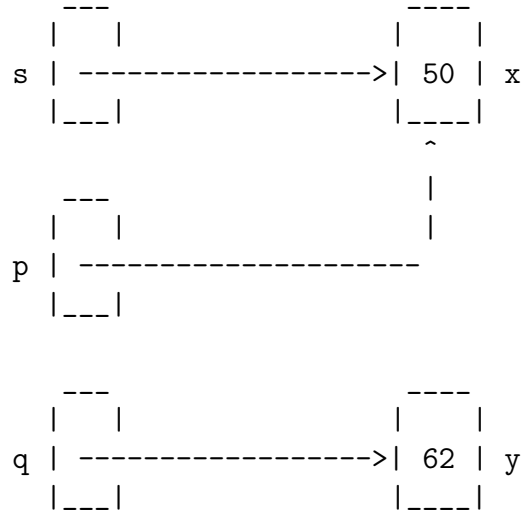
```
int a,b,c;
int x = 50;
int y = 62;
int* q = &y;
int* p = &x;
int* s = p;

*p = 14;
*q = 95;
*s = 18;
p = q;
*p = 6;
q = p;
c = *q;
b = *s;
a = *p;
```

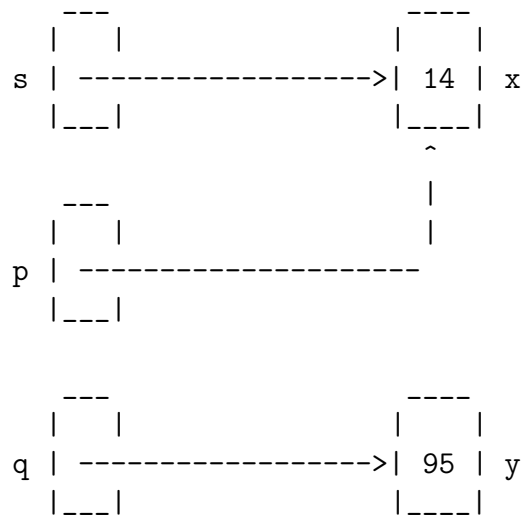
a = 6  
b = 18  
c = 6  
x = 18  
y = 6

The answer begins on the next page.

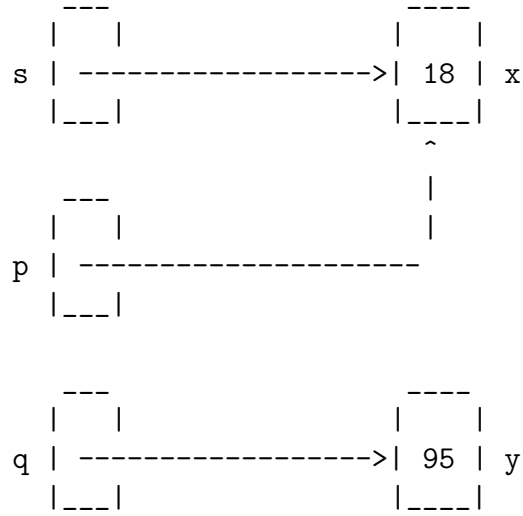
After creating  $x$ ,  $y$ ,  $q$ ,  $p$  and  $s$ , we have



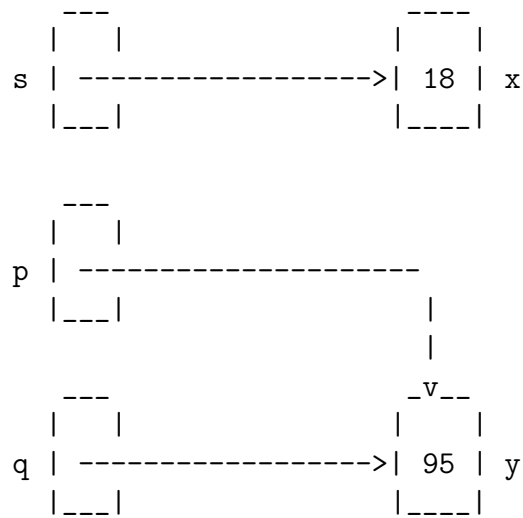
After  $*p = 14$  and  $*q = 95$ :



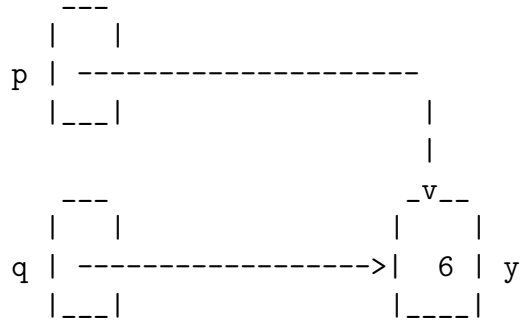
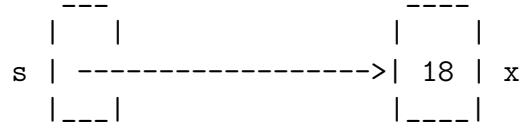
After \*s = 18:



After p = q:



After \*p = 6:



Statement `q = p` does not make any change because `p` and `q` are already the same. The last three lines make `a = 6`, `b = 18` and `c = 6`.



8. Write a C++ definition of function `twice(s)` that takes a null-terminated string `s` and yields a null-terminated string that holds string `s` twice in a row. For example, `twice("fig")` must return "figfig" and `twice("rabbit")` must return "rabbitrabbit". You may use functions from the `cstring` library. A heading is given.

```
char* twice(const char* s)
{
    int  slen  = strlen(s);
    char* result = new char[2*slen + 1];

    strcpy(result, s);
    strcat(result, s);
    return result;
}
```