

NAME:

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Solutions

COS 126 Midterm 1 Written Exam, Spring 2008

This test is 8 questions, weighted as indicated. The exam is closed book, except that you are allowed to use a one page cheatsheet. No calculators or other electronic devices are permitted. Give your answers and show your work in the space provided. *Put your name, login ID, and precept number on this page (now)*, and write out and sign the Honor Code pledge before turning in the test. You have 50 minutes to complete the test.

"I pledge my honor that I have not violated the Honor Code during this examination."

1	/10
2	/5
3	/5
4	/5
5	/15
6	/5
7	/15
8	/15
TOTAL	/75

Signature

1. **Number representation** (10 points). Suppose that you have a 16-bit computer word, using two's-complement representation for integers. In the blank spaces to the right, write the **4-digit hexadecimal representation** of each entity described on the left.

A. Decimal number 256 _____ **0100** _____

B. Decimal number 100 _____ **0064** _____

C. Binary number 100 _____ **0004** _____

D. Decimal number -100 _____ **FF9C** _____

E. TOY instruction to add register A
to register B. _____ **1BAB or 1BBA** _____

2. **Toy instructions** (5 points). Which of the following TOY instructions is a no-op (never changes the contents of any register, any memory location, or the program counter)? Circle all the no-ops.

F. **2330 is a no-op**

G. **4330 is a no-op**

H. 7303

I. 8303

J. C000

3. **Array declarations** (5 points). Among the following code fragments, circle the ones that will *not* cause a compile-time error. **B and D will not cause a compile-time error.**

K. `int[] a = int[10];`

L. `int[] a = new int[10];`

M. `int[] a = {1, 2, 3}; int b = a;`

N. `int[] a;`

O. `int a = {1, 2, 3};`

4. **Scope** (5 points). Consider the following code.

```
public class Cubes {
    public static int square(int i) {
        return i * i * i;
    }
    public static void main(String[] args) {
        for (int i = 1; i <= 1000; i++) {
            StdOut.println(square(i));
        }
    }
}
```

Among the following statements, circle those that are true. **D is true.**

- P. Will not compile because `i` is not declared in `square()`.
- Q. Prints only a few lines because of scope clash with variable `i`.
- R. Prints the squares of the integers from 1 to 1000.
- S. **Prints the cubes of the integers from 1 to 1000.**
- T. Goes into an infinite loop.

5. **Recursive method** (15 points). Consider the following (recursive) static method.

```
public static int mystery(int n, int m) {  
    if (m <= 0) return 0;  
    else return n + mystery(n, m - 1);  
}
```

What value is returned for the call `mystery(6, 3)` ?

18 is returned.

What function does `mystery()` compute for positive `n` and `m`?

`mystery()` computes the product of `n` and `m`.

6. **Nested loops** (5 points). Consider the following code fragment.

```

int N = Integer.parseInt(args[0]);
char[][] pic = new char[N][N];
for (int i = 0; i < N; i++) {
    for (int j = 0; j < N; j++) {
        if ( i == j || i == 0 || i == N - 1 )
            pic[i][j] = '*';
        else
            pic[i][j] = '.';
    }
}
for (int i = 0; i < N; i++) {
    for (int j = 0; j < N; j++) {
        System.out.print(pic[i][j]);
    }
    System.out.println();
}

```

What is the output when N = 6? Circle your answer. **D is the answer.**

U.

```

*****
**....*
*.*.*
*..*.*
*...**
*****

```

B.

```

*****
.....*
...*..
..*...
.*.....
*****

```

C.

```

*.....*
*...**
*..*.*
*.*.*
**...*
*.....*

```

D.

```

*****
.*.....
..*....
...*.
....*..
.....*
*****

```

E.

```

*****
...*...
...*...
...*...
...*...
*****

```

7. **Performance** (15 points). The following table gives approximate running times for a program with N inputs, for various values of N .

N	<i>time</i>
1000	5 seconds
2000	20 seconds
5000	2 minutes
10,000	8 minutes

Which of the following best describes the likely running time of this program for $N = 100,000$? **Using the doubling hypothesis, the increase appears to be quadratic. So, when N increases by 10 (from 10,000 to 100,000) the time increases by 100 (from 8 to 800 minutes). 800 minutes is a little over 13 hours, so the best of the answers is half a day.**

V. A few minutes

W. A few hours

X. **Half a day**

Y. A few days

Z. A few weeks

Refine a power-law hypothesis to give a formula for the approximate likely running time (in **minutes**) of this program as a function of N . (You need to find the leading constant and the exponent.)

$$8 \times 10^{-8} N^2 \quad \text{or} \quad 8.3 \times 10^{-8} N^2$$

8. **Conditionals** (15 points). Consider the following program.

```
public class Conditionals {
    public static void main(String[] args) {
        int N = Integer.parseInt(args[0]);
        String s = "a";
        String t = "b";
        if (N >= 10 && N <= 20) s = s + t;
        else if (N <= 5 || N >= 25) s = t + s;
        else if (N >= 30) s = s + s;
        else s = t + t;
        if (N % 3 == 0) {
            t = s + t;
            if (N % 5 != 0) t = t + s;
        }
        System.out.println(s + t);
    }
}
```

Give the result of executing this program with

```
% java Conditionals 15
```

ababb

Which (one or more) of the following correspond to the output of Conditionals for some positive input value of N? Circle all correct answers. **Last 4 are all possible answers.**

aaaab

ababbab

abb

bbb

bbbbbbb

N=12

N=10

N=22

N=21