COMP 314 Homework Assignment 5

1. (14 points) For each of the problems given below, circle each complexity class the problem is known to be a member of.

Problem	**Complexity classes**
ContainsWombat	Const Lin LogLin Quad Poly Exp
StartsWithWombat	Const Lin LogLin Quad Poly Exp
ListAllTriples	Const Lin LogLin Quad Poly Exp
Factor	Const Lin LogLin Quad Poly Exp
TravelingSalesman	Const Lin LogLin Quad Poly Exp
EastwardTravelingSalesman	Const Lin LogLin Quad Poly Exp
AlwaysYes	Const Lin LogLin Quad Poly Exp
HaltsInExpTime	Const Lin LogLin Quad Poly Exp
HaltsOnEmpty	Const Lin LogLin Quad Poly Exp
Input is a Python program, output is the number of lines in the program	Const Lin LogLin Quad Poly Exp
Input is a list of numbers, output is the largest number in the list	Const Lin LogLin Quad Poly Exp
Input is a list of numbers, output is a list of all pairs of distinct numbers in the list	Const Lin LogLin Quad Poly Exp
Input is a list of numbers, output is the number of unique numbers in the list	Const Lin LogLin Quad Poly Exp
Input is single number n, output is the letter "`x`" repeated n times	Const Lin LogLin Quad Poly Exp

2. (10 points) What is "the" complexity of the following Python program? Give a reasonably detailed explanation of your answer.

```
# Python program countMultiples.py
# The input consists of two numbers: maxValue and divisor.
# The output is the number of integers between 1 and maxValue
# that are divisible by the given divisor.
numbers = map (int, input.split())
maxValue = numbers[0]
divisor = numbers[1]
count = 0
for i in range(1,maxValue+1):
    if i % divisor == 0:
        count = count + 1

print count
```

3. (a) (15 points) Write a computer program, using the programming language of your choice, that takes as input a list of words separated by space characters. (Here, a *word* is any alphanumeric string.) The output is a list of all possible permutations of the input words, with each permutation printed on a separate line. For example, if the input is "`apple banana grape32`", the output is:

```
apple banana grape32
apple grape32 banana
banana apple grape32
banana grape32 apple
grape32 apple banana
grape32 banana apple
```

(Of course, your program might print these lines in a different order.) Your program does not have to read its input from a text file. You can hardwire the input into the program, e.g. `input = "apple banana grape32"`. Hint: use recursion.

(b) (5 points) What is "the" complexity of the program you wrote for part (a)? Briefly justify your answer.

4. (a) (15 points) Write a computer program, using the programming language of your choice, that takes as input a list of words separated by space characters. (Here, a *word* is again any alphanumeric string.) The output is a list of all possible ordered pairs of the input words, with each pair printed on a separate line. For example, if the input is "`apple banana grape32`", the output is:

```
apple apple
apple banana
apple grape32
banana apple
banana banana
banana grape32
grape32 apple
grape32 banana
grape32 grape32
```

(Of course, your program might print these lines in a different order.) As in the previous question, feel free to hardwire the input into your program.

(b) (5 points) What is "the" complexity of the program you wrote for part (a)? Briefly justify your answer.

5. (5 points) Suppose the complexity of problem X is $O(n^6)$, the complexity of problem Y is $O(n^2)$. Consider a new problem W. Given an input of length n, we can

solve W by first solving n instances of X that each have length $\sqrt{n}$, then solving an instance of Y that has length n. What is "the" complexity of W? What complexity classes does W belong to? Justify your answer.

6. (5 points) Suppose the complexity of problem X is $O(n^3)$, the complexity of problem Y is $O(n \log n)$, and the complexity of problem Z is $O(3^n)$. Consider a new problem W. Given an input of length n, we can solve W by first solving an instance of X that has length $n/2$, then solving an instance of Y that has length $n/2$, then solving an instance of Z that has the fixed length 5. What is "the" complexity of W? What complexity classes does W belong to? Justify your answer.