1. True or False. [5 points each]
   (a) _______ Computers are so fast today that complexity theory is only of theoretical, but not practical, interest.
   (b) _______ If any problem can be precisely formulated in a mathematical way, there is an algorithm that solves it.
   (c) _______ Heapsort takes $\Theta(n \log n)$ time on an array of size $n$.

2. Fill in the blanks. [5 points each blank.]
   (a) In hash tables, the most popular way to solve collision is by ________.
   (b) What is the only difference between the abstract data types queue and stack?

   ________________________________

   (c) Name a divide-and-conquer searching algorithm.

   ________________________________

   (d) Name two divide-and-conquer sorting algorithms.

   ________________________________

   ________________________________

   (e) The following is pseudo-code for which sorting algorithm we’ve discussed?

   ________________________________

   int x[n];
   for(int i = n-1; i > 0; i--)
       Find the largest element of x[0], ... x[i] and swap it with x[i]
3. Write the following asymptotic complexity classes in order, using “=” to mean that two classes are exactly the same, and “⊂” to mean that one class is a proper subset of the other; log means \( \log_2 \).

\[ O(2^{\log n}), O(4n + 3), O(2^n), O(3^n), O(F_n) \text{ (the } n^{th} \text{ Fibonacci number)}, O(n \log n), O(\log^2 n), O(\log n), O(n^{i.1}), O(1.1^n), O(n^2), O(\log 2), O(\frac{1}{n}) \]

4. Solve each of the following recurrences, giving the answer in terms of \( O, \Theta, \) or \( \Omega, \) whichever is most appropriate [10 points each].

(a) \( T(n) < T(n - 2) + n^2 \)

(b) \( F(n) \geq F(\sqrt{n}) + \log n \)

(c) \( G(n) \geq G(n - 1) + n \)
(d) $F(n) = 4F(n/2) + n^2$.

(e) $H(n) \leq 2H(\sqrt{n}) + O(\log n)$.

(f) $K(n) = K(n - \sqrt{n}) + 1$.

(g) $F(n) = 4F(\frac{3n}{4}) + n^5$ (No, you don’t need a calculator.)
5. [15 points] Consider the following procedure:

```cpp
void george(int n)
{
    int m = n;
    while (m > 1)
    {
        for (int i = 1; i < m; i++)
            cout << "I cannot tell a lie. I chopped down the cherry tree." << endl;
        m = m/2;
    }
}
```

Consider the question of how many lines of output the execution of `george(n)` would produce. Write down an appropriate recurrence for this question, and give an asymptotic solution in terms of `n`, using either $O$, $\Omega$, or $\Theta$, whichever is most appropriate.

6. Write correct pseudocode (or C++ code) for ________________________________