Computer Systems

1. Suppose that we have a machine with a 16 bit word, such as:

   1010001101101101

   In displaying the contents of a word, we don't want to use binary since that takes up too much space and is hard to read. Should we use octal or hex? Why?

2. For this problem, we will define your birthday as a number computed as follows. Assume that you were born on a date described as *mmddyyyy*. Treat the string *mmyy* as an integer (you can ignore leading zeros). So, for example, if you were born on March 15, 1992, then your "birthday" is the integer 392.
   a. What is your "birthday"?
   b. Recall the following Python program that computes n!

   ```
   def factorial(n):
       result = 1
       for j in range(1,n+1):
           result *= j
       return (result)
   ```

   Type up this function in IDLE. You probably want to do this in a module so you can save it. Invoke `factorial` on your "birthday". What is the result? Notice that you probably get a very big number. But Python is willing to use multiple machine words to store a single large integer.
   c. But you can make even that system fail. Give an example of a call to `factorial` that fails to get the answer. What happens? (Hint: Try big.)

3. If computer A has a 400MB hard drive and computer B has a 20GB hard drive, how much more space does B's drive have than A's? (State this as B has x times as much space as A does. What is x?)

4. Hard drives are slow and prone to breaking (since they are mechanical). So why do computers have them?

5. Suppose that you have a monitor with resolution of 1280 x 800 pixels. It uses 24 bit color. How many bytes are required to store one screen image?

6. Consider the problem of storing a typical single-spaced page of text.
   a. Suppose that it is represented as a simple text file (as in Notepad, as opposed to a heavily formatted file, as for example a .doc file). How much space is required? (Hint: Just create one and see how big it is.)
   b. For fun, now save the same file in Word. How big is it now?

7. How many copies of War and Peace fit on a standard CD? If you have to make assumptions about how it is stored, just describe them.

8. We described clock speeds in GHz (or giga hertz).
   a. What is the origin of the unit name hertz? (Hint, use Google to find out. While you're at it, use Boolean operators to get rid of all the car rental information from the answer page that Google returns.)
   b. Give two examples of things other than computer clocks that are measured in hertz.

9. Give two examples (other than ones we discussed in class) from everyday life of:
   a. Effective use of pipelining
   b. Effective use of SIMD-style parallelism

10. Suppose that we want to compute the average of 1000 numbers.
   a. If we can only do one thing at a time, how many time steps will this take? (Assume each arithmetic operation, i.e., add, subtract, multiply, divide, takes one time step.)
   b. Suppose that we have two processors? We still have to perform the same operations. But how much elapsed time is now required? Describe how you will organize the computation to get the answer that you give.
   c. Suppose that we have ten processors? Now how much elapsed time is required?

11. For this problem, choose a computer. If you have one, use yours. If you don't, you can use a friend's. Or, if you can't find another one, use one of the ones in our lab. If you are using a Windows machine, you will be able to answer many of these questions if you start at Control Panel. Then look for something called System or something similar. On a Mac, choose About This Mac from the Apple menu in the upper-left menu bar, then click More Info.
   a. What is the clock speed of your processor(s)?
   b. How many processors (cores) do you have?
   c. How much memory (RAM) do you have?
   d. Do you have a 32 bit processor or a 64 bit processor? On a Mac, go here for how to answer this question and the next one: http://support.apple.com/kb/HT4287
   e. Are you running a 32 bit OS or a 64 bit OS?
   f. How large is your hard disk drive?
   g. Suppose that you have $1,000 to spend. Can you get something that significantly beats the system you have just described? (Your answer will take the form of a claim such as: "I'd get something with about the same clock speed (say what) but a quad core rather than a duo and I can get three times as much disk space.") You are free to answer this question with the assumption that you stay in the same family (Windows vs. Mac) or you can indicate that you'd be willing to switch. In other words, interpret this question flexibly. Then just give a precise answer that reflects your market research.