Algorithm Design

1. **(8 points). Running.** You have finished a race and would like to know what your average pace was in terms of (minutes and seconds) per mile. Describe an algorithm (i.e. an English description that illustrates step by step how to solve the problem) that takes the following as inputs:

   A variable distance that is set to the distance of the race in miles
   Three variables, hours, minutes, and seconds that are set to the finish time

Based on these four input variables your algorithm should compute the pace per mile and store them in the output variables **paceMinutes** and **paceSeconds**.

For example, given a marathon that took 3 hours, 16 minutes, and 30 seconds to finish, the input variables are:

   distance = 26.2
   hours = 3
   minutes = 16
   seconds = 30

Your algorithm should compute a 7:30 pace where the variable **paceMinutes** is set to 7 and the variable **paceSeconds** is set to 30.

For this part, give an algorithm only, do not write code. Your algorithm should be very specific – exact mathematical operators to get the desired result.

**Short Answer**

2. **(4 points)** Given the algebraic equation

   \[ y = ax^3 + 2x + 7 \]

Which of the following, if any, are correct Java statements for this equation?

   a. \( y = a \times x \times x \times x + 2 \times x + 7; \)
   b. \( y = a \times x \times x \times 2 \times (x+7); \)
   c. \( y = a \times (x \times x \times x + 2 \times x) + 7; \)
   d. \( y = (a \times x) \times x \times x + 7 + x \times 2; \)
   e. \( y = a \times (x \times x \times x) + (2 \times x) + 7; \)
3. (4 points) State the order of evaluation of the operators in each of the following Java statements, and show the value of $x$ after each statement is performed.
   a. $x=7+3*6/2-1$;
   b. $x=2 \% 2+2*2-2/2$;
   c. $x=(3*9*(3+(9*3/(3))))$;

Programming Exercises

For programming exercises, turn in a copy of your code. These are your .java files. If you like you can put everything into a zip file. Your answers for questions 1-3 can be placed in a word document or textfile.

Fill in the following comment header for all your programs. Add additional comments in your program as you deem necessary.

```
////////////////////////////////////////////////////////////////////
// CS A201
// <Your Name Here>
// <Date>
// Purpose: <Purpose>
////////////////////////////////////////////////////////////////////
```

4. (6 points) Write a program that asks the user to enter a favorite color, a favorite food, a favorite animal, and the first name of a friend or relative. The program should then print the following two lines, with the user’s input replacing the items in italics:

I had a dream that Name ate a Color Animal and said it tasted like Food!

For example, if the user entered blue for the color, hamburger for the food, dog for the animal, and Jake for the person’s name, the output would be

I had a dream that Jake ate a blue dog and said it tasted like hamburger!

Don’t forget to put the exclamation mark at the end.
5. (10 points) Race Pace Calculator

Implement the running pace calculator described in problem 1. Here are examples of the desired behavior:

Example 1 (user input in bold):
Input distance in miles: 26.2
Input hours run: 3
Input minutes run: 16
Input seconds run: 30
Your race pace is 7:30 per mile

Example 2:
Input distance in miles: 26.2
Input hours run: 3
Input minutes run: 1
Input seconds run: 2
Your race pace is 6:55 per mile

Example 3:
Input distance in miles: 26.2
Input hours run: 3
Input minutes run: 45
Input seconds run: 10
Your race pace is 8:36 per mile

Debugging

The program below will compile, but it has multiple logic errors. Find the errors and correct them.

The purpose of this program is to convert a quantity expressed as miles per hour into minutes + seconds per mile. Many treadmills output MPH on their consoles, but most runners think in terms of minutes + seconds per mile instead.

The logic the program intends to use is, starting with $X$ mph:

\[
Y \text{ (miles/min)} = \frac{1}{60} \text{ (h/min)} \times X \text{ (miles/h)}
\]
\[
M \text{ (minutes/mile)} = \left(\text{int} \left( \frac{1}{Y} \right) \right) \quad \text{// int chops off fractional part}
\]
\[
S \text{ (seconds/mile)} = \left(\frac{1}{Y} - M \right) \times 60 \text{ (sec)}
\]

Answer is then M:S
import java.util.Scanner;
class MPHConverter {
    public static void main(String[] args) {
        Scanner keyboard = new Scanner(System.in);
        double x, y;  // Original mph, miles/min
        int mins, secs;  // Converted minutes, seconds
        System.out.println("Enter pace in miles per hour:");
        x = keyboard.nextDouble();
        y = 1 / 60 * x;
        mins = (int) (1/y);
        secs = (int) (1/y - mins * 60);
        System.out.print("Your pace is ", mins + " minutes ");
        System.out.println("and ", secs + " seconds.");
    }
}

As an example, the proper answer for an input of 6.5 mph should be 9 minutes and 13 seconds.

6. (8 points) Turn in a fixed version of the conversion program. Identify what the bugs were, and how your solution fixes the problems.