Last Name: _____ *(as on your ID)*

First Name: _____

ID: _____ Score: / 25

Instructions: Write your solutions to the following problems in the space provided. Read each problem carefully and recheck your work. All work must be your own and you must work independently.

Q1 — EVALUATION [5 POINTS]

(From problem 1.4 in *SICP*) Observe that our model of evaluation allows for combinations whose operators are compound expressions. Use this observation to describe the behavior of the following procedure:

```
(define (a-plus-abs-b a b)
  ((if (> b 0) + -) a b))
```

Q2 + Q3 — Parse Trees

For Q2 and Q3, use the following EBNF grammar, which defines the Scheme syntax for a <*symbol*>. A <*symbol*> defines what can be a valid identifier in Scheme. (This is a modified version of the specification in *The Scheme Programming Language, Fourth Edition,* R. Kent Dybvig, 2009.)

<*symbol*> → <*initial*> **{** <*subsequent*> **}**
<*initial*> → <*letter*> | `!` | `$` | `%` | `&` | `*` | `/` | `:` | `<` | `=` | `>` | `?` | `~` | `_` | `^`
<*subsequent*> → <*initial*> | <*digit10*> | `.` | `+` | `-` | `@`
<*letter*> → `a` | `b` | … | `z` | `A` | `B` | … | `Z`
<*digit10*> → `0` | `1` | `2` | `3` | `4` | `5` | `6` | `7` | `8` | `9`

Q2 [5 points]
Using this grammar, prove that '`a1`' (without the quotes) is a valid Scheme identifier by *drawing its parse tree.*

Q3 [5 points]
Using this grammar, prove that '`<m:`' (without the quotes) is a valid Scheme identifier by *drawing its parse tree.*

Q4 + Q5 — Iterative or Recursive

Each of the following two questions defines a procedure, `+`, for adding two positive integers in terms of the procedures `inc`, which increments its argument by `1`, and `dec`, which decrements its argument by `1`. *You must assume* `inc` *and* `dec` *are already properly defined. You may write your answer on the back of this page if you need more room. Make a clear indication of what your answer is.*

Q4 [5 points]

Using the substitution model, illustrate the process of evaluating `(+ 4 5)`. State if the process is iterative or recursive.

```
(define (+ a b)
  (if (= a 0)
      b
      (inc (+ (dec a) b))))
```

Q4 [5 points]

Using the substitution model, illustrate the process of evaluating `(+ 4 5)`. State if the process is iterative or recursive.

```
(define (+ a b)
  (if (= a 0)
      b
      (+ (dec a) (inc b))))
```