Sample Questions for Exam 1

This document contains some sample questions for the first exam, which will be given in class on Thursday 9/29. Note that the exam will have more questions than appear on this sample.

You may bring one handwritten sheet of notes to the exam with you.

Problem 1

What is the result of the evaluation of the final statement in each of the following groups of Scheme expressions? Write “error” if an error would result or “procedure” if a procedure would be returned. Assume that each group is evaluated separately.

```
(define a 1)
(define b 3)
(define c 5)

(let ((a 2)
      (b (+ a 5))
      (c b))
  (+ a b c))
```

```
(define (my-func f)
  (lambda (x y) (f (f x y) (f x y))))

((my-func *) 2 3)
```
Problem 2

a. Define applicative order evaluation

b. Define normal order evaluation

c. Given the following code,

```scheme
(define (add a b)
  (display " plus ")
  (+ a b))

(add (begin (display " one ")
            1)
     (begin (display " two ")
            2))
```

Which of the following could be printed in Scheme? In normal-order Scheme?

<table>
<thead>
<tr>
<th>Scheme</th>
<th>Normal-order Scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td>plus one two</td>
<td></td>
</tr>
<tr>
<td>plus two one</td>
<td></td>
</tr>
<tr>
<td>one plus two</td>
<td></td>
</tr>
<tr>
<td>two plus one</td>
<td></td>
</tr>
<tr>
<td>one two plus</td>
<td></td>
</tr>
<tr>
<td>two one plus</td>
<td></td>
</tr>
</tbody>
</table>
Problem 3

For the two expressions below, write the sequence of cars and cdrs needed to get the number 3 out of each list. You may find it helpful to draw the box-and-pointer diagrams, but you will not be graded on them.

(define first-list (cons 1 (cons 2 (list 3 4 5))))

(define second-list (list (cons 1 2) (cons 3 4) 5))
Problem 4

Write a function apply-twice that takes a function \( f \) as its argument and returns a function that takes one argument as input and returns the value that one would obtain if \( f \) were applied twice to that argument.

For example,

\[
((\text{apply-twice square}) \ 2)
\]

would return

\[16\]

and

\[
((\text{apply-twice (lambda (x) (+ x 2)))} \ 5)
\]

would return

\[9\]
Problem 5

Write a procedure \texttt{prod} that takes two parameters representing a range from \texttt{a} to \texttt{b}. The procedure should return the value of \(a \times (a+1) \times (a+2) \times \cdots \times b\). For example,

\[
\texttt{(prod 1 5)}
\]

will return

\[
120
\]

What is the order of growth of your \texttt{prod} procedure in terms of time and space?

Time: _________________________________

Space: _______________________________

What is \(n\) dependent upon?

Does your definition of \texttt{prod} generate a recursive or an iterative process?
Problem 6

Given the following definition of cons, write the definitions of car and cdr.

(define (cons x y)
  (lambda (m)
    (cond ((= m 0) x)
          ((= m 1) y)
          (else (error "Unknown message - CONS" m)))))