CS61A, Spring 1995
Midterm #3

Question 1 (3 points):

What will the Scheme interpreter print in response to each of the following expressions? Also, draw a ``box and pointer'' diagram for the result of each expression. Hint: It'll be a lot easier if you draw the box and pointer diagram *first*!

```
(let ((x (list 1 2 3 4)))
  (set-cdr! x (caddr x))
  x)

{\prgex%
(let ((x (list 1 2 3 4)))
  (set-car! (cdr x) (cddr x))
  x)

(let ((x (list 1 (list 2 3) 4)))
  (set-car! (cadr x) (car x))
  x)
```

Question 2 (4 points):

Define an object class called `password-protect`. The purpose of the class is to allow an object to be ``hidden'' so that a password is needed to send it messages. Here's how it works. Suppose we have this class definition:

```
(define-class (counter)
  (instance-vars (count 0))
  (method (next)
    (set! count (+ count 1))
    count))
```

In order to make a password-protected counter, we want to be able to do this:

```
> (define ppc (instantiate password-protect
                            (instantiate counter) 'exotic))
PPC
> (ask ppc 'next)
ERROR: Password incorrect
> (ask (ask ppc 'exotic) 'next)
```

```
1
> (ask (ask ppc 'exotic) 'next)
2
```

In this example, `exotic` is the password for the protected counter. When sent this password as a message, the object `ppc` returns the underlying counter object, which can then be sent its own messages.

Question 3 (4 points):

Write `deep-map!`, a procedure that takes an arbitrary list structure, applies a given function to each leaf, and *modifies the argument list* to replace each leaf with the value returned by the function. For example:

```
> (define x (list (list 3 4) 5 (list) (list (list 6))))
x
> x
((3 4) 5 () ((6)))
> (deep-map! square x)
((9 16) 25 () ((36)))
> x
((9 16) 25 () ((36)))
```

For the purposes of this problem, a ``leaf'' is anything that isn't a pair or the empty list.

Do not allocate any new pairs in your solution! Modify the existing list structure. (You are not, of course, responsible for any pairs that might be allocated by the function you are given as argument, like `square` in the example above.)

Question 4 (4 points):

Define a stream named `oz` containing all possible lists whose elements are ones and zeros, like this:

```
> (show-stream oz 40)
(() (0) (1) (0 0) (1 0) (0 1) (1 1) (0 0 0) (1 0 0) (0 1 0) (1 1 0)
 (0 0 1) (1 0 1) (0 1 1) (1 1 1) (0 0 0 0) (1 0 0 0) (0 1 0 0)
 (1 1 0 0) (0 0 1 0) (1 0 1 0) (0 1 1 0) (1 1 1 0) (0 0 0 1) (1 0 0 1)
 (0 1 0 1) (1 1 0 1) (0 0 1 1) (1 0 1 1) (0 1 1 1) (1 1 1 1) (0 0 0 0 0)
 (1 0 0 0 0) (0 1 0 0 0) (1 1 0 0 0) (0 0 1 0 0) (1 0 1 0 0) (0 1 1 0 0)
 (1 1 1 0 0) (0 0 0 1 0) ...)
```

Your solution need not have the elements in the same order as this example.

You may use any stream or procedure defined in the text.

Group question (4 points):

Draw the environment diagram for the situation after the following definition and invocation have been evaluated:

```
(define maximizer
  (let ((value 0))
    (lambda (arg)
      (if (> arg value)
          (set! value arg))
      value)))

(define foo (maximizer 6))
```

Take a peek at the solutions