Student Name: ____________________________________

CS 2500 Exam 2—Fall 2016

Your Beloved CS 2500 Instructors

You are attending the lecture of ____________________________________

- The exam is a **one-hour** exam. To accommodate everyone's needs for time and space, the instructors will stay for three hours.
- Write down the answers in the space provided.
- You may use the usual primitives and expression forms, including those suggested in hints; for everything else, define it.
- The phrase "design a function" means that you should apply the design recipe.

  You do not have to spell out examples as test cases (with `check-expect` and friends), but you are welcome to do so.

  When a problem asks for a complete function, you are *not* required to provide a template. But, if you exlect to skip the template step, be prepared to struggle with the development of the function.
- Some basic test taking advice: Before you start answering any problems, read *every* problem, so your brain can be thinking about the harder problems in background while you knock off the easy ones.

Problem	Max. Points
1	/ 10
2	/ 16
3	/ 6
4	/ 14
Total	/ 46

Problem 1 Design the function `remove-both`. It consumes a string `n` and a PB, the data representation of phone books designed by your current partner. The result is also a PB but with all occurrences of `n` and the following phone number removed.

Don't judge your colleague too badly. He went to a highly prestigious university that does not consider it necessary to train its CS majors as software developers.

```
; A PB is one of:
; -- '()
; -- (cons String (cons Number PB))
; interpretation A phone book such as
;     (cons "Alan" (cons 617738.1212 pb))
; means "Alan"'s phone number is 617738.1212,
; and the rest of the phone book is pb
```

Problem 2 Design the function `drop`. It consumes and produces a list of Posns. Each Posn whose y coordinate is larger than `200` is removed. All other y coordinates are increased by `3`.

(a) Develop the signature for `drop`, its purpose statement, and examples. You may assume the standard definition of *Posn*.

(b) Use the existing abstractions (2e: figures 91 and 92; 1e: figure 57, p. 313; reproduced as figures 1 and 2 at the end of the exam) to complete the design of `drop`.

(c) Complete the design of the function *without* the use of existing abstractions ("loops").

Problem 3 Design `count-wings`. The function consumes a Butterfly and counts the pairs of wings that surround its body. You may assume the standard definition of N (natural numbers).

Not every left-wing, right-wing animal is about politics.

```
(define LEFT-WING "(")
(define RIGHT-WING ")")

; A Butterfly is one of:
; -- "body"
; -- (list LEFT-WING Butterfly RIGHT-WING)
```

Problem 4 Design the function `cleanse`, which consumes an Enumeration and removes all bad strings. To simplify the problem, we assume that there is only one bad string: `"@#$%"`.

Cleansing is not censoring, though it is often performed on behalf of a censor.

```
(define-struct bullets (loi))
(define-struct points (loi))
(define-struct item (low))

; An Enumeration is one of:
; -- (make-bullets LoI)  ;; bulletized items
; -- (make-points LoI)   ;; numbered points
;
; An LoI is a [List-of Item]
;
; An Item is a structure: (make-item LoW)
;
; An LoW is a [List-of Word]
;
; A Word is one of:
; -- String
; -- Enumeration
;
; interpretation An Enumeration is a generic data
; representation of HTML, LateX, etc nested,
; itemized lists.
```

(space for problem 4)

```
; [X] N [N -> X] -> [List-of X]
; constructs a list by applying f to 0, 1, ..., (sub1 n)
; (build-list n f) == (list (f 0) ... (f (- n 1)))
(define (build-list n f) ...)

; [X] [X -> Boolean] [List-of X] -> [List-of X]
; produces a list from those items on lx for which p holds
(define (filter p lx) ...)

; [X] [List-of X] [X X -> Boolean] -> [List-of X]
; produces a version of lx that is sorted according to cmp
(define (sort lx cmp) ...)

; [X Y] [X -> Y] [List-of X] -> [List-of Y]
; constructs a list by applying f to each item on lx
; (map f (list x-1 ... x-n)) == (list (f x-1) ... (f x-n))
(define (map f lx) ...)

; [X] [X -> Boolean] [List-of X] -> Boolean
; determines whether p holds for every item on lx
; (andmap p (list x-1 ... x-n)) == (and (p x-1) ... (p x-n))
(define (andmap p lx) ...)

; [X] [X -> Boolean] [List-of X] -> Boolean
; determines whether p holds for at least one item on lx
; (ormap p (list x-1 ... x-n)) == (or (p x-1) ... (p x-n))
(define (ormap p lx) ...)
```

Figure 1: ISL's abstract functions for list-processing (1)

```
; [X Y] [X Y -> Y] Y [List-of X] -> Y
; applies f from right to left to each item in lx and b
; (foldr f b (list x-1 ... x-n)) == (f x-1 ... (f x-n b))
(define (foldr f b lx) ...)

(foldr + 0 '(1 2 3 4 5))
== (+ 1 (+ 2 (+ 3 (+ 4 (+ 5 0)))))
== (+ 1 (+ 2 (+ 3 (+ 4 5))))
== (+ 1 (+ 2 (+ 3 9)))
== (+ 1 (+ 2 12))
== (+ 1 14)

; [X Y] [X Y -> Y] Y [List-of X] -> Y
; applies f from left to right to each item in lx and b
; (foldl f b (list x-1 ... x-n)) == (f x-n ... (f x-1 b))
(define (foldl f b lx) ...)

(foldl + 0 '(1 2 3 4 5))
== (+ 5 (+ 4 (+ 3 (+ 2 (+ 1 0)))))
== (+ 5 (+ 4 (+ 3 (+ 2 1))))
== (+ 5 (+ 4 (+ 3 3)))
== (+ 5 (+ 4 6))
== (+ 5 10)
```

Figure 2: ISL's abstract functions for list-processing (2)