

CSU211 Exam 1 – Fall 2008

Name: _____

Student Id (last 4 digits): _____

Instructor's Name: _____

High School (State): _____

- 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 this function/program” means that you should apply the design recipe. You are *not* required to provide a template unless the problem specifically asks for one. Be prepared, however, to struggle with the development of function bodies if you choose to skip the template step.
- You may obtain a maximum of 57 points: 52 for the first six problems; and five extra-credit points for the final problem.

Problem	Points	out of
1		5
2		5
3		13
4		13
5		7
6		9
Extra		5
Total		57
Base	52	

Good luck!

Problem 1 Your new startup, WellnessTech, produces smart-phone applications that help people monitor and improve their health.¹

5 POINTS

As part of your current product offering, you are implementing code that monitors the user's heart rate during exercise. When you exercise, you should try to keep your pulse at approximately 75% of your maximum heart rate; in turn, your maximum heart rate is computed as 220 minus your age.

Design a function, `target-heart-rate` that consumes the user's age and produces his suggested target heart rate during exercise.

¹And what better tool for implementing health applications than the one named "Dr. Scheme"?

[Here is more space for you to write your answers.]

Problem 2 Evaluate the following program step by step and label each step as 5 POINTS “arith,” “plug” or “conditional”:

- **arith:** Primitive “arithmetic” (of any form)
- **plug:** Function application—“plugging in”
- **conditional:** A conditional step.

```
;;; my-max : Number Number -> Number  
;;; Return the larger of the two numbers.
```

```
(define (my-max a b)  
  (cond [(< a b) b]  
        [else  a]))
```

```
(my-max (* 3 4) 7)
```

Problem 3 The 211 professors, Van Horn and Shivers, keep track of their students using programs that operate on the following data definition:

13 POINTS

```
(define-struct student (name grade sec))

;;; A Student is (make-student String Number Section)
;;; where the grade is on a scale of 0 to 100.
;;;
;;; A Section is one of: 'morning 'afternoon
;;;
;;; A LOS (list of students) is one of:
;;; - empty
;;; - (cons Student LOS)
```

You manage to come into possession of their list, which provides the current grades of everyone in the class, and begin to wonder how the grades of the students in the two sections compare: does Shivers' morning section have more A students, or does Van Horn's afternoon section? This becomes a question of intense, if not burning, interest to your friends in the class.

As a start on your analysis of student grades, design `section-filter`, a program that consumes a list of students and a section, and returns all the students in the input list who are in this section. Thus, for example,

```
(section-filter all-students 'afternoon)
```

will produce the list containing all the students in the LOS `all-students` who are in the afternoon section of the class.

[Here is more space for you to write your answers.]

Problem 4 Your startup company, WellnessTech, keeps track of its personnel with the following data definition:

13 POINTS

```
(define-struct founder (name num-shares))
(define-struct employee (name job salary))

;;; A Person is one of:
;;; - (make-founder String Number)
;;; - (make-employee String String Number)

;;; A LOP (list of personnel) is one of:
;;; - empty
;;; - (cons Person LOP)
```

Employees are paid a monthly salary. Company founders are not paid at all; they work for shares of stock in the company.

Your investors need you to keep an eye on your “burn rate,” that is, how much money you are spending a month. Please design a function, `burn-rate`, that consumes an LOP and returns the total salary of everyone in the list.

[Here is more space for you to write your answers.]

Problem 5 You are designing a system to do automated trading on Wall Street, using the following data definition:

7 POINTS

```
(define-struct stock (company num-shares share-price))

;;; A Holding is one of:
;;; - (make-stock String Number Number)
;;; - Number
;;; where a simple number means cash, in US dollars,
;;; and a stock structure represents a block of shares
;;; in some company.
```

Write the template, `holding-template`, for a function that consumes a holding.

Problem 6 Mitochondrial DNA (or, mDNA) is unusual in that it is not produced by the standard genetic shuffle involving the genes of both parents: your mitochondrial DNA is (barring occasional random mutations) an *exact* copy of your mother's mDNA... which, in turn, is an exact copy of *her* mother's mDNA, and so forth. Thus, your mDNA provides a clear view of your matrilineal heritage, being preserved through the generations that preceded you—a sort of telescope allowing scientists to look back in time.

You have a summer job working in a biology lab that is working with an mDNA database, tracking mutations through generations of women. You work with the following data definition:

```
(define-struct mutantsamp (id mutation maternal))

;;; A SAMPLE is one of:
;;; - String
;;;   + Gives the sample's label in our freezer.
;;;
;;; - (make-mutantsamp String Number SAMPLE)
;;;   + the ID string is the sample's label in our freezer,
;;;   + the MUTATION number says which mutation occurred, and
;;;   + the MATERNAL SAMPLE is the older sample which was
;;;     mutated to make this sample.
```

Using sophisticated PCR assays, your program analyses the mDNA samples in the lab's collection, and constructs chains of these samples, related by mutations. Here is an example chain:

```
(make-mutantsamp
  "1807-mary-s"      ; Sample 1807, Mary S.
  38                ; is mutation #38
  (make-mutantsamp ; on
    "9714-anne-r"   ; sample 9714, Anne R, which is
    472             ; mutation #472 on
    "3851-janet-a")) ; sample 3851, Janet A. -- who has no
                    ; known predecessor
```

Write the template, `sample-template`, for a program that consumes a `SAMPLE`.

[Here is more space for you to write your answers.]

Problem 7 (Extra credit)

5 POINTS

You are writing a clock applet that will display the current time on your company's new Android smart phone. You use the following data definition:

```
(define-struct tm (hour min sec))

;;; A Time is (make-tm Number Number Number)
;;; where the hour field is in the range [0,23],
;;;       the min field is in the range [0,59], and
;;;       the sec field is in the range [0,59].
;;; Midnight is represented by a tm structure whose
;;; hour, min and sec fields all zero.
```

Please design a function, `tick`, that consumes a time and produces the time one second later.