NINTH QUIZ

You have 15 minutes from the start of class to complete this quiz. Read the questions with care; work with deliberate speed. Don't give us more than we ask for. The usual instructions apply. Good luck!

Problem 1 (9 points)

(a) (2 points) How many bits does it take to represent 16 different values?

(b.1) (1 point) The earliest computers used base-10 circuitry to represent data: The smallest unit of memory was a circuit that could represent a digit from 0 through 9. No modern digital computers use base-10 circuitry. What do they use instead (in one or two words)?

(b.2) (2 points) Why is the kind of memory circuitry you identified in part (b.1) better than base-10 circuitry? Give at least two reasons.

(c) (4 points) We saw (at least) three ways to represent numbers in memory: as ASCII characters (8 bits per decimal digit, just like letters and punctuation marks), in BCD (binary coded decimal, with 4 bits per decimal digit), and as binary numbers. Why is BCD almost never used today? Answer in terms of the advantages and disadvantages of each representation.

Problem 2 (5 points)

For each of the algorithms or operations described below, check the box corresponding most closely to its complexity (i.e., its O-notation) in the average case.

(a) `(cons B L)`, where B is a book structure and L is a list of book structures:

❑ Constant—O(1)   ❑ Logarithmic—O(log n)   ❑ Linear—O(n)   ❑ Quadratic—O(n^2)

(b) From a (balanced) binary search tree of n books, ordered by the book's name, producing a list of books alphabetized by name:

❑ Constant—O(1)   ❑ Logarithmic—O(log n)   ❑ Linear—O(n)   ❑ Quadratic—O(n^2)

(c) In a (balanced) binary search tree of n books, ordered by the book's title, finding a book in the tree, given the book's title:

❑ Constant—O(1)   ❑ Logarithmic—O(log n)   ❑ Linear—O(n)   ❑ Quadratic—O(n^2)

(d) Adding together the first and last elements of a vector with n elements:

❑ Constant—O(1)   ❑ Logarithmic—O(log n)   ❑ Linear—O(n)   ❑ Quadratic—O(n^2)

(e) Adding together the first and last elements of a list with n elements:

❑ Constant—O(1)   ❑ Logarithmic—O(log n)   ❑ Linear—O(n)   ❑ Quadratic—O(n^2)

Problem 3 (7 points)

Suppose we define a five-element vector as follows:

```
(define V (vector 'ham 'turkey 'cranberry 'pumpkin 'yam))
```

(a) (2 points) Draw a five-cell box showing the contents of this vector and the element number (index, subscript) of each element.

(b) (1 point) What is the value of `(vector-ref V 4)`?

(c) (2 points) Change your drawing above to show what happens when Scheme evaluates this expression:

```
(vector-set! V 4 'stuffing)
```


(d) (2 points) The function below performs on a vector the same task as a list-processing function you know well. Give this function a more appropriate name than `vector-do-something` and provide a purpose statement that describes what it does.

```
;; vector-do-something: (X -> Y) vector-of-X -> vector-of-Y
;;
;;
;;
(define vector-do-something
  (lambda (f V)
    (build-vector (vector-length V) (lambda (i) (f (vector-ref V i))))))
```