Quiz 1

Problem 1. Let M be the expression

```
(if (zero? (((lambda (x)
               (define from (lambda (y) (- y (+ x 2))))
               from)
             5)
            3))
    'abort
    (lambda () 'error))
```

1(a) Circle those letters indicating Scheme rewriting rules which are appplicable to M for a first step of rewriting:

L I P C G

1(b) Show the expression or body to which M evaluates-in-*one*-step ($M \underset{\text{eval}}{\longrightarrow} ??$):

1(c) Show the body B such $M \underset{\text{rew}*}{\longrightarrow} B$ and B cannot be further rewritten, and circle those bracketed phrases which correctly describe B:

[a value] [stuck] [an immediate value] [a printable value] [an error]

Problem 2. In the body

```
(define u (lambda () (* 2 x))
(define v 4)
(define w (+ 1 (u)))
(define x (+ 1 v)
(define y (lambda () x))
(define z (lambda () y))
(cons v x)
```

circle the variable definitions which can be garbage-collected:

u v w x y z

Problem 3. Let M_1 be `(+ (x) (x))` and M_2 be `(* 2 (x))`.

3(a) There is a context of the form

```
(define (spin) (spin))
(define x (let ((state <blob1>))
            (lambda ()
               (if state
                   (begin (set! state (not state)) <blob2>)
                   (spin)))))
[ ]
```

which distinguishes M_1 and M_2. Describe expressions `<blob1>` `<blob2>` so the context makes this distinction.

3(b) Is there a functional context which distinguishes M_1 and M_2? Briefly explain.

Problem 4. Consider equations of the form `(if M 1 1)` $\underset{\text{func}}{=}$ `1`.

4(a) Show that the set of provable equations in the equational proof system for $\underset{\text{func}}{=}$ described in class is not decidable.

4(b) Show that the set of *false* $\underset{\text{func}}{=}$ equations is not half-decidable (r.e.).