Theory
9/24/18

1.
$LIST(SEXP_{FG}) = \{`()\} \cup \{(cons\ ATOM\ LIST(SEXP_{FG}))\} \cup \{(cons\ SEXP_{FG}\ LIST(SEXP_{FG}))\}$
$\{`()\} \in ATOM \in SEXP_{FG}$
$\{(cons\ ATOM\ LIST(SEXP_{FG}))\} \in$ with v_1= ATOM $\in SEXP_{FG}$ and v_2 = $LIST(SEXP_{FG}) \in SEXP_{FG}$
$\{(cons\ SEXP_{FG}\ LIST(SEXP_{FG}))\}$ with $v_1 = SEXP_{FG}$ and $v_2 = LIST(SEXP_{FG}) \in SEXP_{FG}$
$\therefore LIST(SEXP_{FG}) \in SEXP_{FG}$

35.
Base:

0	
= (length (reverse ‘()))	substituting
= (reverse ‘()) = ‘()	reverse null rule
= (length ‘()) = 0	

Inductive

n	
= (length (reverse (cons x xs)))	substituting
= (length (cons (reverse xs) x))	reverse cons rule
= (length reverse xs) + (length x)	length cons rule
= (n - 1) + 1	simplifying
= n	

By induction, if after one recurse of reverse both the base and inductive cases have the same length, then (length (reverse xs)) = (length xs).

A.
1.

$X \in \text{rho}$
$XS \in \text{rho}$

$<\text{CONS, rho, sigma}_1> \downarrow <\text{PRIMITIVE(CONS), sigma}_2>$
$<\text{VAR(X), rho, sigma}_2> \downarrow <\text{x, sigma}_3>$ (FORMAL)
$<\text{VAR(XS), rho, sigma}_3> \downarrow <\text{xs, sigma}_4>$ (FORMAL)
$l_1 \notin \text{sigma}_4 \quad l_2 \notin \text{sigma}_4 \quad l_1 \mathrel{!=} l_2$

$<\text{CDR, rho, sigma}_0> \downarrow <\text{PRIMITIVE(CDR), sigma}_1>$
$<\text{CONS(VAR(X) VAR(XS)), rho, sigma}_1> \downarrow <\text{(PAIR}(l_1, l_2)), \text{sigma}_4\{l_1 \rightarrow x, l_2 \rightarrow xs\}>$(CONS)

$<\text{CDR(CONS(VAR(X) VAR(XS))), rho, sigma}_0> \downarrow <\text{xs, sigma}_4>$ (CDR)

2.

Induction hypothesis:
If e_1 and e_2 are terminating expressions and cdr and cons can both terminate given terminating expressions, then (cdr (cons e_1 e_2) terminates and equals e_2

$<\text{CONS, rho, sigma}_1> \downarrow <\text{PRIMITIVE(CONS), sigma}_2>$
$<e_1, \text{rho, sigma}_2> \downarrow <e_1, \text{sigma}_3>$ (IH)
$<e_2, \text{rho, sigma}_3> \downarrow <e_2, \text{sigma}_4>$ (IH)
$l_1 \notin \text{sigma}_4 \quad l_2 \notin \text{sigma}_4 \quad l_1 \mathrel{!=} l_2$

$<\text{CDR, rho, sigma}_0> \downarrow <\text{PRIMITIVE(CDR), sigma}_1>$
$<\text{CONS}(e_1\ e_2), \text{rho, sigma}_1> \downarrow <\text{(PAIR}(l_1, l_2)), \text{sigma}_4\{l_1 \rightarrow e_1, l_2 \rightarrow e_2\}>$ (CONS)

$<\text{CDR(CONS}(e_1\ e_2)), \text{rho, sigma}_0> \downarrow <\text{sigma}_4(e_2), \text{sigma}_4>$ (CDR)

Terminates and evaluates to e_2 given terminating e_1 and e_2.