```
 1: /* abs.asm
 2:  * Computes the absolute value of its argument:
 3:  *   R0 <- | ARG[0] |
 4:  *
 5:  * Programmer: Mayer Goldberg, 2010
 6:  */
 7:
 8:  ABS:
 9:   MOV(R0, STARG(0));
10:   CMP(R0, IMM(0));
11:   JUMP_LT(L_ABS_N);
12:   RETURN;
13:  L_ABS_N:
14:   MOV(R1, R0);
15:   MOV(R0, IMM(0));
16:   SUB(R0, R1);
17:   RETURN;
```

```
 1: /* ack.asm
 2:  * Computes Ackermann's function: R0 <- ACK(ARG[0], ARG[1])
 3:  *
 4:  * Programmer: Mayer Goldberg, 2010
 5:  */
 6:
 7:  ACK:
 8:   MOV(R1, STARG(0)); /* ARG[0] = A */
 9:   MOV(R2, STARG(1)); /* ARG[1] = B */
10:   CMP(R1, IMM(0));
11:   JUMP_EQ(L_ACK_0_B);
12:   CMP(R2, IMM(0));
13:   JUMP_EQ(L_ACK_A_0);
14:   DECR(R2);
15:   PUSH(R2);
16:   PUSH(R1);
17:   CALL(ACK);
18:   POP(R1);
19:   POP(R1);
20:   MOV(STARG(1), R0);
21:   DECR(STARG(0));
22:   JUMP(ACK); /* tail-call optimization */
23:
24:  L_ACK_A_0:
25:   MOV(STARG(1), IMM(1));
26:   DECR(STARG(0));
27:   JUMP(ACK); /* tail-call optimization */
28:
29:  L_ACK_0_B:
30:   MOV(R0, R2);
31:   INCR(R0);
32:   RETURN;
```

```
 1: /* char/char_in_range.asm
 2:  * R0 <- (ARG[1] <= ARG[0] <= ARG[2])
 3:  *
 4:  * Programmer: Mayer Goldberg, 2010
 5:  */
 6:
 7:  CHAR_IN_RANGE:
 8:   PUSH(FP);
 9:   MOV(FP, SP);
10:   PUSH(R1);
11:   MOV(R1, FPARG(0));
12:   CMP(FPARG(1), R1);
13:   JUMP_GT(L_CIR_FALSE);
14:   CMP(R1, FPARG(2));
15:   JUMP_GT(L_CIR_FALSE);
16:   MOV(R0, IMM(1));
17:   JUMP(L_CIR_EXIT);
18:  L_CIR_FALSE:
19:   MOV(R0, IMM(0));
20:  L_CIR_EXIT:
21:   POP(R1);
22:   POP(FP);
23:   RETURN;
```

```
 1: /* char/char_to_digit.asm
 2:  * '0' -> 0, ..., '9' -> 9
 3:  *
 4:  * Programmer: Mayer Goldberg, 2010
 5:  */
 6:
 7:  CHAR_TO_DIGIT:
 8:   PUSH(FP);
 9:   MOV(FP, SP);
10:   MOV(R0, FPARG(0));
11:   SUB(R0, IMM('0'));
12:   POP(FP);
13:   RETURN;
```

```
 1: /* char/char_to_lc.asm
 2:  * R0 <- to_lc(ARG[0])
 3:  *
 4:  * Programmer: Mayer Goldberg, 2010
 5:  */
 6:
 7:  CHAR_TO_LC:
 8:   PUSH(FP);
 9:   MOV(FP, SP);
10:   PUSH(R1);
11:   MOV(R1, FPARG(0));
12:   PUSH(R1);
13:   CALL(IS_CHAR_UC);
14:   POP(R1);
15:   CMP(R0, IMM(0));
16:   JUMP_EQ(L_CHAR_TO_LC);
17:   MOV(R0, FPARG(0));
18:   ADD(R0, IMM('a' - 'A'));
19:   JUMP(L_CTLC_EXIT);
20:  L_CHAR_TO_LC:
21:   MOV(R0, FPARG(0));
22:  L_CTLC_EXIT:
23:   POP(R1);
24:   POP(FP);
25:   RETURN;
```

```
 1: /* char/char_to_uc.asm
 2:  * R0 <- to_uc(ARG[0])
 3:  *
 4:  * Programmer: Mayer Goldberg, 2010
 5:  */
 6:
 7:  CHAR_TO_UC:
 8:   PUSH(FP);
 9:   MOV(FP, SP);
10:   PUSH(R1);
11:   MOV(R1, FPARG(0));
12:   PUSH(R1);
13:   CALL(IS_CHAR_LC);
14:   POP(R1);
15:   CMP(R0, IMM(0));
16:   JUMP_EQ(L_CTUC);
17:   MOV(R0, FPARG(0));
18:   SUB(R0, IMM('a' - 'A'));
19:   JUMP(L_CTUC_EXIT);
20:  L_CTUC:
21:   MOV(R0, FPARG(0));
22:  L_CTUC_EXIT:
23:   POP(R1);
24:   POP(FP);
25:   RETURN;
```

```
 1: /* char/digit_to_char.asm
 2:  * 0 -> '0', ..., 9 -> '9'
 3:  *
 4:  * Programmer: Mayer Goldberg, 2010
 5:  */
 6:
 7:  DIGIT_TO_CHAR:
 8:   MOV(R0, STARG(0));
 9:   ADD(R0, IMM('0'));
10:   RETURN;
11:
```

```
 1: /* fact.asm
 2:  * Compute the factorial function recursively: R0 <- factorial(ARG0)
 3:  *
 4:  * Programmer: Mayer Goldberg, 2010
 5:  */
 6:
 7:  FACT:
 8:   MOV(R1, STARG(0));
 9:   CMP(R1, IMM(0));
10:   JUMP_EQ(L_FACT_ZERO);
11:   DECR(R1);
12:   PUSH(R1);
13:   CALL(FACT);
14:   POP(R1); /* pop arg (N-1) to fact */
15:   MUL(R0, STARG(0));
16:   RETURN;
17:  L_FACT_ZERO:
18:   MOV(R0, IMM(1));
19:   RETURN;
```

```
 1: /* fib.asm
 2:  * Compute Fibonacci numbers recursively: R0 <- FIB(ARG[0])
 3:  *
 4:  * Programmer: Mayer Goldberg, 2010
 5:  */
 6:
 7:  FIB:
 8:   MOV(R1, STARG(0));
 9:   CMP(R1, IMM(2));
10:   JUMP_GE(L_FIB_REC);
11:   MOV(R0, R1);
12:   RETURN;
13:
14:  L_FIB_REC:
15:   DECR(R1);
16:   PUSH(R1);
17:   CALL(FIB);
18:   POP(R1);
19:   PUSH(R0);
20:   DECR(R1);
21:   PUSH(R1);
22:   CALL(FIB);
23:   POP(R1);
24:   POP(R1);
25:   ADD(R0, R1);
26:   RETURN
27:
```

```
1: /* io/getchar.asm
2:  * Read a char from stdin
3:  *
4:  * Programmer: Mayer Goldberg, 2010
5:  */
6:
7:  GETCHAR:
8:   IN(R0, IMM(1));
9:   RETURN;
```

```
 1: /* char/is_char_uc.asm
 2:  * R0 <- ('a' <= ARG[0] <= 'z') || ('A' <= ARG[0] <= 'Z')
 3:  *
 4:  * Programmer: Mayer Goldberg, 2010
 5:  */
 6:
 7:  IS_CHAR_ALPHABETIC:
 8:   PUSH(FP);
 9:   MOV(FP, SP);
10:   PUSH(R1);
11:   MOV(R1, FPARG(0));
12:   PUSH(R1);
13:   CALL(IS_CHAR_UC);
14:   POP(R1);
15:   CMP(R0, IMM(0));
16:   JUMP_NE(L_ICAT_EXIT);
17:   MOV(R1, FPARG(0));
18:   PUSH(R1);
19:   CALL(IS_CHAR_LC);
20:   POP(R1);
21:   JUMP(L_ICAT_EXIT);
22:  L_ICAT_EXIT:
23:   POP(R1);
24:   POP(FP);
25:   RETURN;
```

```
 1: /* char/is_char_lc.asm
 2:  * R0 <- (’a’ <= ARG[0] <= ’z’)
 3:  *
 4:  * Programmer: Mayer Goldberg, 2010
 5:  */
 6:
 7:  IS_CHAR_LC:
 8:   PUSH(FP);
 9:   MOV(FP, SP);
10:   PUSH(R1);
11:   MOV(R1, FPARG(0));
12:   PUSH(IMM(’z’));
13:   PUSH(IMM(’a’));
14:   PUSH(R1);
15:   CALL(CHAR_IN_RANGE);
16:   POP(R1);
17:   POP(R1);
18:   POP(R1);
19:   POP(R1);
20:   POP(FP);
21:   RETURN;
```

```
 1: /* char/is_char_uc.asm
 2:  * R0 <- ('A' <= ARG[0] <= 'Z')
 3:  *
 4:  * Programmer: Mayer Goldberg, 2010
 5:  */
 6:
 7:  IS_CHAR_UC:
 8:   PUSH(FP);
 9:   MOV(FP, SP);
10:   PUSH(R1);
11:   MOV(R1, FPARG(0));
12:   PUSH(IMM('Z'));
13:   PUSH(IMM('A'));
14:   PUSH(R1);
15:   CALL(CHAR_IN_RANGE);
16:   POP(R1);
17:   POP(R1);
18:   POP(R1);
19:   POP(R1);
20:   POP(FP);
21:   RETURN;
```

```
 1: /* char/is_char_white_space.asm
 2:  * Returns 1 if argument is a whitespace char, 0 otherwise.
 3:  *
 4:  * Programmer: Mayer Goldberg, 2010
 5:  */
 6:
 7:  IS_CHAR_WHITE_SPACE:
 8:   MOV(R0, STARG(0));
 9:   CMP(R0, IMM(' '));
10:   JUMP_LE(L_IS_CHAR_WHITE_SPACE_T);
11:   MOV(R0, IMM(0));
12:   RETURN;
13:  L_IS_CHAR_WHITE_SPACE_T:
14:   MOV(R0, IMM(1));
15:   RETURN;
```

```
 1: /* is_even.asm
 2:  * Tests whether its argument is even
 3:  *
 4:  * Programmer: Mayer Goldberg, 2010
 5:  */
 6:
 7:  IS_EVEN:
 8:   MOV(R0, STARG(0));
 9:   AND(R0, IMM(1));
10:   CMP(R0, IMM(0));
11:   JUMP_EQ(L_IS_EVEN_T);
12:   MOV(R0, IMM(0));
13:   RETURN;
14:  L_IS_EVEN_T:
15:   MOV(R0, IMM(1));
16:   RETURN;
```

```
 1: /* is_negative.asm
 2:  * Tests whether its argument is negative
 3:  *
 4:  * Programmer: Mayer Goldberg, 2010
 5:  */
 6:
 7:  IS_NEGATIVE:
 8:   CMP(STARG(0), IMM(0));
 9:   JUMP_LT(L_IS_NEGATIVE_T);
10:   MOV(R0, IMM(0));
11:   RETURN;
12:  L_IS_NEGATIVE_T:
13:   MOV(R0, IMM(1));
14:   RETURN;
```

```
 1: /* is_odd.asm
 2:  * Tests whether its argument is odd
 3:  *
 4:  * Programmer: Mayer Goldberg, 2010
 5:  */
 6:
 7:  IS_ODD:
 8:   MOV(R0, STARG(0));
 9:   AND(R0, IMM(1));
10:   CMP(R0, IMM(0));
11:   JUMP_EQ(L_IS_ODD_F);
12:   MOV(R0, IMM(1));
13:   RETURN;
14:  L_IS_ODD_F:
15:   MOV(R0, IMM(0));
16:   RETURN;
```

```
 1: /* is_positive.asm
 2:  * Tests whether its argument is positive
 3:  *
 4:  * Programmer: Mayer Goldberg, 2010
 5:  */
 6:
 7:  IS_POSITIVE:
 8:   CMP(STARG(0), IMM(0));
 9:   JUMP_GT(L_IS_POSITIVE_T);
10:   MOV(R0, IMM(0));
11:   RETURN;
12:  L_IS_POSITIVE_T:
13:   MOV(R0, IMM(1));
14:   RETURN;
```

```
 1: /* scheme/is_sob_bool.asm
 2:  * Take pointers to a Scheme object, and places in R0 either 0 or 1
 3:  * (long, not Scheme integer objects or Scheme boolean objets),
 4:  * depending on whether the argument is Boolean.
 5:  *
 6:  * Programmer: Mayer Goldberg, 2010
 7:  */
 8:
 9:  IS_SOB_BOOL:
10:   PUSH(FP);
11:   MOV(FP, SP);
12:   MOV(R0, FPARG(0));
13:   CMP(IND(R0), T_BOOL);
14:   JUMP_EQ(L_IS_SOB_BOOL_TRUE);
15:   MOV(R0, IMM(0));
16:   JUMP(L_IS_SOB_BOOL_EXIT);
17:  L_IS_SOB_BOOL_TRUE:
18:   MOV(R0, IMM(1));
19:  L_IS_SOB_BOOL_EXIT:
20:   POP(FP);
21:   RETURN;
```

```
 1: /* scheme/is_sob_char.asm
 2:  * Take pointers to a Scheme object, and places in R0 either 0 or 1
 3:  * (long, not Scheme integer objects or Scheme boolean objets),
 4:  * depending on whether the argument is char.
 5:  *
 6:  * Programmer: Mayer Goldberg, 2010
 7:  */
 8:
 9:  IS_SOB_CHAR:
10:   PUSH(FP);
11:   MOV(FP, SP);
12:   MOV(R0, FPARG(0));
13:   CMP(IND(R0), T_CHAR);
14:   JUMP_EQ(L_IS_SOB_CHAR_TRUE);
15:   MOV(R0, IMM(0));
16:   JUMP(L_IS_SOB_CHAR_EXIT);
17:  L_IS_SOB_CHAR_TRUE:
18:   MOV(R0, IMM(1));
19:  L_IS_SOB_CHAR_EXIT:
20:   POP(FP);
21:   RETURN;
22:
```

```
 1: /* scheme/is_sob_closure.asm
 2:  * Take pointers to a Scheme object, and places in R0 either 0 or 1
 3:  * (long, not Scheme integer objects or Scheme boolean objets),
 4:  * depending on whether the argument is a closure.
 5:  *
 6:  * Programmer: Mayer Goldberg, 2012
 7:  */
 8:
 9:  IS_SOB_CLOSURE:
10:   PUSH(FP);
11:   MOV(FP, SP);
12:   MOV(R0, FPARG(0));
13:   CMP(IND(R0), T_CLOSURE);
14:   JUMP_EQ(L_IS_SOB_CLOSURE_TRUE);
15:   MOV(R0, IMM(0));
16:   JUMP(L_IS_SOB_CLOSURE_EXIT);
17:  L_IS_SOB_CLOSURE_TRUE:
18:   MOV(R0, IMM(1));
19:  L_IS_SOB_CLOSURE_EXIT:
20:   POP(FP);
21:   RETURN;
22:
23:
```

```
 1: /* scheme/is_sob_integer.asm
 2:  * Take pointers to a Scheme object, and places in R0 either 0 or 1
 3:  * (long, not Scheme integer objects or Scheme boolean objets),
 4:  * depending on whether the argument is integer.
 5:  *
 6:  * Programmer: Mayer Goldberg, 2010
 7:  */
 8:
 9:  IS_SOB_INTEGER:
10:   PUSH(FP);
11:   MOV(FP, SP);
12:   MOV(R0, FPARG(0));
13:   CMP(IND(R0), T_INTEGER);
14:   JUMP_EQ(L_IS_SOB_INTEGER_TRUE);
15:   MOV(R0, IMM(0));
16:   JUMP(L_IS_SOB_INTEGER_EXIT);
17:  L_IS_SOB_INTEGER_TRUE:
18:   MOV(R0, IMM(1));
19:  L_IS_SOB_INTEGER_EXIT:
20:   POP(FP);
21:   RETURN;
22:
23:
```

```
 1: /* scheme/is_sob_nil.asm
 2:  * Take pointers to a Scheme object, and places in R0 either 0 or 1
 3:  * (long, not Scheme integer objects or Scheme boolean objets),
 4:  * depending on whether the argument is nil.
 5:  *
 6:  * Programmer: Mayer Goldberg, 2010
 7:  */
 8:
 9:  IS_SOB_NIL:
10:   PUSH(FP);
11:   MOV(FP, SP);
12:   MOV(R0, FPARG(0));
13:   CMP(IND(R0), T_NIL);
14:   JUMP_EQ(L_IS_SOB_NIL_TRUE);
15:   MOV(R0, IMM(0));
16:   JUMP(L_IS_SOB_NIL_EXIT);
17:  L_IS_SOB_NIL_TRUE:
18:   MOV(R0, IMM(1));
19:  L_IS_SOB_NIL_EXIT:
20:   POP(FP);
21:   RETURN;
22:
23:
24:
25:
```

```
 1: /* scheme/is_sob_pair.asm
 2:  * Take pointers to a Scheme object, and places in R0 either 0 or 1
 3:  * (long, not Scheme integer objects or Scheme boolean objets),
 4:  * depending on whether the argument is a pair.
 5:  *
 6:  * Programmer: Mayer Goldberg, 2010
 7:  */
 8:
 9:  IS_SOB_PAIR:
10:   PUSH(FP);
11:   MOV(FP, SP);
12:   MOV(R0, FPARG(0));
13:   CMP(IND(R0), T_PAIR);
14:   JUMP_EQ(L_IS_SOB_PAIR_TRUE);
15:   MOV(R0, IMM(0));
16:   JUMP(L_IS_SOB_PAIR_EXIT);
17:  L_IS_SOB_PAIR_TRUE:
18:   MOV(R0, IMM(1));
19:  L_IS_SOB_PAIR_EXIT:
20:   POP(FP);
21:   RETURN;
22:
23:
24:
```

```
 1: /* scheme/is_sob_void.asm
 2:  * Take pointers to a Scheme object, and places in R0 either 0 or 1
 3:  * (long, not Scheme integer objects or Scheme boolean objets),
 4:  * depending on whether the argument is void.
 5:  *
 6:  * Programmer: Mayer Goldberg, 2010
 7:  */
 8:
 9:  IS_SOB_VOID:
10:   PUSH(FP);
11:   MOV(FP, SP);
12:   MOV(R0, FPARG(0));
13:   CMP(IND(R0), T_VOID);
14:   JUMP_EQ(L_IS_SOB_VOID_TRUE);
15:   MOV(R0, IMM(0));
16:   JUMP(L_IS_SOB_VOID_EXIT);
17:  L_IS_SOB_VOID_TRUE:
18:   MOV(R0, IMM(1));
19:  L_IS_SOB_VOID_EXIT:
20:   POP(FP);
21:   RETURN;
22:
23:
24:
```

```
 1: /* is_zero.asm
 2:  * R0 <- 1, 0 -- depending on whether ARG[0] is zero
 3:  *
 4:  * Programmer: Mayer Goldberg, 2010
 5:  */
 6:
 7:  IS_ZERO:
 8:   CMP(STARG(0), IMM(0));
 9:   JUMP_NE(L_IS_ZERO_F);
10:   MOV(R0, IMM(1));
11:   RETURN;
12:  L_IS_ZERO_F:
13:   MOV(R0, IMM(0));
14:   RETURN;
```

```
 1: /* left_string.asm
 2:  * Copy the left N chars in a string:
 3:  * R0 = dest <- left_string(dest, src, N))
 4:  *
 5:  * Programmer: Mayer Goldberg, 2010
 6:  */
 7:
 8:  LEFT_STRING:
 9:   MOV(R0, STARG(0));
10:   MOV(R1, R0);
11:   MOV(R2, STARG(1));
12:   MOV(R3, STARG(2));
13:  L_LEFT_STRING_1:
14:   CMP(R3, IMM('\0'));
15:   JUMP_EQ(L_LEFT_STRING_2);
16:   MOV(IND(R1), IND(R2));
17:   INCR(R1);
18:   INCR(R2);
19:   DECR(R3);
20:   JUMP(L_LEFT_STRING_1);
21:  L_LEFT_STRING_2:
22:   MOV(IND(R1), IMM('\0'));
23:   RETURN;
24:
```

```
 1: /* scheme/make_sob_bool.asm
 2:  * Takes 0 or 1 as an argument, and places in R0 either #f or #t
 3:  *
 4:  * Programmer: Mayer Goldberg, 2010
 5:  */
 6:
 7:  MAKE_SOB_BOOL:
 8:   PUSH(FP);
 9:   MOV(FP, SP);
10:   PUSH(IMM(2));
11:   CALL(MALLOC);
12:   DROP(1);
13:   MOV(IND(R0), T_BOOL);
14:   MOV(INDD(R0,1), FPARG(0));
15:   POP(FP);
16:   RETURN;
17:
```

```
 1: /* scheme/make_sob_char.asm
 2:  * Takes an integer 0 <= n < 256 as an argument, and places
 3:  * in R0 the corresponding character object
 4:  *
 5:  * Programmer: Mayer Goldberg, 2010
 6:  */
 7:
 8:  MAKE_SOB_CHAR:
 9:   PUSH(FP);
10:   MOV(FP, SP);
11:   PUSH(IMM(2));
12:   CALL(MALLOC);
13:   DROP(1);
14:   MOV(IND(R0), T_CHAR);
15:   MOV(INDD(R0, 1), FPARG(0));
16:   POP(FP);
17:   RETURN;
18:
```

```
 1: /* scheme/make_sob_closure.asm
 2:  * Take pointers to an environment and some code (address of a label),
 3:  * and place the corresponding Scheme closure in R0
 4:  *
 5:  * Programmer: Mayer Goldberg, 2010
 6:  */
 7:
 8:  MAKE_SOB_CLOSURE:
 9:   PUSH(FP);
10:   MOV(FP, SP);
11:   PUSH(IMM(3));
12:   CALL(MALLOC);
13:   DROP(1);
14:   MOV(IND(R0), IMM(T_CLOSURE));
15:   MOV(INDD(R0, 1), FPARG(0));
16:   MOV(INDD(R0, 2), FPARG(1));
17:   POP(FP);
18:   RETURN;
19:
```

```
 1: /* scheme/make_sob_integer.asm
 2:  * Takes an integer, and place the corresponding Scheme object in R0
 3:  *
 4:  * Programmer: Mayer Goldberg, 2010
 5:  */
 6:
 7:  MAKE_SOB_INTEGER:
 8:   PUSH(FP);
 9:   MOV(FP, SP);
10:   PUSH(IMM(2));
11:   CALL(MALLOC);
12:   DROP(1);
13:   MOV(IND(R0), T_INTEGER);
14:   MOV(INDD(R0, 1), FPARG(0));
15:   POP(FP);
16:   RETURN;
```

```
 1: /* scheme/make_sob_nil.asm
 2:  * Create a nil -- () object, and place it in R0
 3:  *
 4:  * Programmer: Mayer Goldberg, 2010
 5:  */
 6:
 7:  MAKE_SOB_NIL:
 8:   PUSH(IMM(1));
 9:   CALL(MALLOC);
10:   DROP(1);
11:   MOV(IND(R0), T_NIL);
12:   RETURN;
```

```
 1: /* scheme/make_sob_pair.asm
 2:  * Take pointers to two sexprs, and place the corresponding
 3:  * Scheme pair in R0
 4:  *
 5:  * Programmer: Mayer Goldberg, 2010
 6:  */
 7:
 8:  MAKE_SOB_PAIR:
 9:   PUSH(FP);
10:   MOV(FP, SP);
11:   PUSH(IMM(3));
12:   CALL(MALLOC);
13:   DROP(1);
14:   MOV(IND(R0), T_PAIR);
15:   MOV(INDD(R0, 1), FPARG(0));
16:   MOV(INDD(R0, 2), FPARG(1));
17:   POP(FP);
18:   RETURN;
19:
```

```
 1: /* scheme/make_sob_string.asm
 2:  * Takes CHAR1, ..., CHARn, n, on the stack. Places in R0 the address
 3:  * of a newly-allocated pointer to a Scheme string.
 4:  *
 5:  * Programmer: Mayer Goldberg, 2010
 6:  */
 7:
 8:  MAKE_SOB_STRING:
 9:   PUSH(FP);
10:   MOV(FP, SP);
11:   PUSH(R1);
12:   PUSH(R2);
13:   PUSH(R3);
14:   MOV(R0, FPARG(0));
15:   ADD(R0, IMM(2));
16:   PUSH(R0);
17:   CALL(MALLOC);
18:   DROP(1);
19:   MOV(IND(R0), IMM(T_STRING));
20:   MOV(INDD(R0, 1), FPARG(0));
21:   MOV(R1, FP);
22:   MOV(R2, FPARG(0));
23:   ADD(R2, IMM(3));
24:   SUB(R1, R2);
25:   MOV(R2, R0);
26:   ADD(R2, IMM(2));
27:   MOV(R3, FPARG(0));
28:  L_MSS_LOOP:
29:   CMP(R3, IMM(0));
30:   JUMP_EQ(L_MSS_EXIT);
31:   MOV(IND(R2), STACK(R1));
32:   INCR(R1);
33:   INCR(R2);
34:   DECR(R3);
35:   JUMP(L_MSS_LOOP);
36:  L_MSS_EXIT:
37:   POP(R3);
38:   POP(R2);
39:   POP(R1);
40:   POP(FP);
41:   RETURN;
42:
```

```
 1: /* scheme/make_sob_vector.asm
 2:  * Takes V1, ..., Vn, n, on the stack. Places in R0 the address
 3:  * of a newly-allocated pointer to a Scheme vector.
 4:  *
 5:  * Programmer: Mayer Goldberg, 2010
 6:  */
 7:
 8:  MAKE_SOB_VECTOR:
 9:   PUSH(FP);
10:   MOV(FP, SP);
11:   PUSH(R1);
12:   PUSH(R2);
13:   PUSH(R3);
14:   MOV(R0, FPARG(0));
15:   ADD(R0, IMM(2));
16:   PUSH(R0);
17:   CALL(MALLOC);
18:   DROP(1);
19:   MOV(IND(R0), IMM(T_VECTOR));
20:   MOV(INDD(R0, 1), FPARG(0));
21:   MOV(R1, FP);
22:   MOV(R2, FPARG(0));
23:   ADD(R2, IMM(3));
24:   SUB(R1, R2);
25:   MOV(R2, R0);
26:   ADD(R2, IMM(2));
27:   MOV(R3, FPARG(0));
28:  L_MSV_LOOP:
29:   CMP(R3, IMM(0));
30:   JUMP_EQ(L_MSV_EXIT);
31:   MOV(IND(R2), STACK(R1));
32:   INCR(R1);
33:   INCR(R2);
34:   DECR(R3);
35:   JUMP(L_MSV_LOOP);
36:  L_MSV_EXIT:
37:   POP(R3);
38:   POP(R2);
39:   POP(R1);
40:   POP(FP);
41:   RETURN;
42:
43:
```

```
 1: /* scheme/make_sob_void.asm
 2:  * Create a #<void> object, and place it in R0
 3:  *
 4:  * Programmer: Mayer Goldberg, 2010
 5:  */
 6:
 7:  MAKE_SOB_VOID:
 8:   PUSH(IMM(1));
 9:   CALL(MALLOC);
10:   DROP(1);
11:   MOV(IND(R0), T_VOID);
12:   RETURN;
```

```
 1: /* system/malloc.asm
 2:  * A stub for a more intelligent memory allocation code
 3:  * that shall be re-written later...
 4:  *
 5:  * Programmer: Mayer Goldberg, 2010
 6:  */
 7:
 8:  MALLOC:
 9:   PUSH(FP);
10:   MOV(FP, SP);
11:   PUSH(R1);
12:   MOV(R1, FPARG(0));
13:   MOV(R0, ADDR(0));
14:   ADD(ADDR(0), R1);
15:   POP(R1);
16:   POP(FP);
17:   RETURN;
18:
```

```
 1: /* mid_string.asm
 2:  * Copy the middle N chars in a string, from position Pos:
 3:  * R0 = dest <- mid_string(dest, src, Pos, N))
 4:  *
 5:  * Programmer: Mayer Goldberg, 2010
 6:  */
 7:
 8:  MID_STRING:
 9:   MOV(R3, STARG(3));
10:   MOV(R2, STARG(1));
11:   ADD(R2, STARG(2));
12:   MOV(R1, STARG(0));
13:   PUSH(R3);
14:   PUSH(R2);
15:   PUSH(R1);
16:   CALL(LEFT_STRING);
17:   POP(R1);
18:   POP(R1);
19:   POP(R1);
20:   RETURN;
```

```
 1: /* io/newline.asm
 2:  * Print a newline character to stdout
 3:  *
 4:  * Programmer: Mayer Goldberg, 2010
 5:  */
 6:
 7:  NEWLINE:
 8:   PUSH(FP);
 9:   MOV(FP, SP);
10:   PUSH(R1);
11:   PUSH(IMM('\n'));
12:   CALL(PUTCHAR);
13:   POP(R1);
14:   POP(R1);
15:   POP(FP);
16:   RETURN;
```

```
 1: /* number_to_string.asm
 2:  * Takes a pointer to a dest string and an integer, and
 3:  * writes in the destination the string representation
 4:  * of the number
 5:  *
 6:  * Programmer: Mayer Goldberg, 2010
 7:  */
 8:
 9:  NUMBER_TO_STRING:
10:   MOV(R1, STARG(0));
11:   MOV(R2, R1);
12:   MOV(R3, STARG(1));
13:   CMP(R3, IMM(0));
14:   JUMP_EQ(L_NTS_0);
15:   JUMP_LT(L_NTS_N);
16:   PUSH(R3);
17:  L_NTS_3:
18:   CALL(L_NTS_1);
19:   POP(R2);
20:   MOV(R0, R1);
21:   RETURN;
22:  L_NTS_1:
23:   PUSH(FP);
24:   MOV(FP, SP);
25:   MOV(R4, FPARG(0));
26:   CMP(R4, IMM(0));
27:   JUMP_EQ(L_NTS_2);
28:   MOV(R5, R4);
29:   DIV(R4, 10);
30:   REM(R5, 10);
31:   PUSH(R5);
32:   PUSH(R4);
33:   CALL(L_NTS_1);
34:   POP(R4);
35:   POP(R5);
36:   ADD(R5, IMM('0'));
37:   MOV(IND(R0), R5);
38:   INCR(R0);
39:   POP(FP);
40:   RETURN;
41:  L_NTS_2:
42:   MOV(R0, R2);
43:   POP(FP);
44:   RETURN;
45:  L_NTS_0:
46:   MOV(IND(R2), IMM('0'));
47:   INCR(R2);
48:   MOV(IND(R2), IMM('\0'));
49:   RETURN;
50:  L_NTS_N:
51:   MOV(IND(R2), IMM('-'));
52:   INCR(R2);
53:   MOV(R4, IMM(0));
54:   SUB(R4, R3);
55:   PUSH(R4);
56:   JUMP(L_NTS_3);
```

```
 1: /* power.asm
 2:  * Computes the integer power: R0 <- ARG[0] ^ ARG[1]
 3:  *
 4:  * Programmer: Mayer Goldberg, 2010
 5:  */
 6:
 7:  POWER:
 8:   MOV(R1, STARG(0)); /* A */
 9:   MOV(R2, STARG(1)); /* B */
10:   CMP(R2, IMM(0));
11:   JUMP_EQ(L_POWER_A_0);
12:   MOV(R3, R2);
13:   AND(R3, IMM(1));
14:   CMP(R3, IMM(0));
15:   JUMP_EQ(L_POWER_A_EVEN);
16:   SHR(R2, IMM(1));
17:   PUSH(R2);
18:   PUSH(R1);
19:   CALL(POWER);
20:   POP(R1);
21:   POP(R1);
22:   MUL(R0, R0);
23:   MUL(R0, STARG(0));
24:   RETURN;
25:
26:  L_POWER_A_0:
27:   MOV(R0, IMM(1));
28:   RETURN;
29:
30:  L_POWER_A_EVEN:
31:   SHR(R2, IMM(1));
32:   PUSH(R2);
33:   PUSH(R1);
34:   CALL(POWER);
35:   POP(R1);
36:   POP(R1);
37:   MUL(R0, R0);
38:   RETURN;
```

```
 1: /* io/putchar.asm
 2:  * Print a char to stdout
 3:  *
 4:  * Programmer: Mayer Goldberg, 2010
 5:  */
 6:
 7:  PUTCHAR:
 8:   PUSH(FP);
 9:   MOV(FP, SP);
10:   MOV(R0, FPARG(0));
11:   OUT(IMM(2), R0);
12:   POP(FP);
13:   RETURN;
```

```
 1: /* io/readline.asm
 2:  * Read chars until the end of the line or the end of the file,
 3:  * and return a pointer to a null-terminated string. This
 4:  * routine calls MALLOC to allocate its own memory for the
 5:  * string.
 6:  *
 7:  * Programmer: Mayer Goldberg, 2010
 8:  */
 9:
10:  READLINE:
11:   PUSH(FP);
12:   MOV(FP, SP);
13:   PUSH(R1);
14:   PUSH(R2);
15:   PUSH(IMM('*'));
16:   PUSH(IMM(0));
17:   CALL(READLINE_LOOP);
18:   POP(R1);
19:   POP(R1);
20:   MOV(IND(R0), R1);
21:   POP(R2);
22:   POP(R1);
23:   POP(FP);
24:   RETURN;
25:  READLINE_LOOP:
26:   IN(R1, IMM(1)); /* read a char from stdin */
27:   CMP(R1, IMM('\n'));
28:   JUMP_EQ(READLINE_DONE);
29:   CMP(R1, IMM(-1));
30:   JUMP_EQ(READLINE_DONE);
31:   MOV(STARG(1), R1);
32:   MOV(R1, STARG(0));
33:   INCR(R1);
34:   PUSH(IMM('*'));
35:   PUSH(R1);
36:   CALL(READLINE_LOOP);
37:   POP(R1); /* INDEX */
38:   POP(R2); /* CH */
39:   ADD(R1, R0);
40:   MOV(IND(R1), R2);
41:   RETURN;
42:  READLINE_DONE:
43:   MOV(R1, STARG(0)); /* NUMBER OF CHARS */
44:   INCR(R1); /* MAKE ROOM FOR '\0' */
45:   PUSH(R1);
46:   CALL(MALLOC);
47:   POP(R1);
48:   MOV(STARG(1), IMM('\0'));
49:   RETURN;
50:
```

```
 1: /* right_string.asm
 2:  * Copy the right N chars in a string:
 3:  * R0 = dest <- right_string(dest, src, N))
 4:  *
 5:  * Programmer: Mayer Goldberg, 2010
 6:  */
 7:
 8:  RIGHT_STRING:
 9:   MOV(R1, STARG(1));
10:   PUSH(R1);
11:   CALL(STRLEN);
12:   POP(R1);
13:   MOV(R3, STARG(2));
14:   SUB(R0, R3);
15:   MOV(R2, STARG(1));
16:   MOV(R1, STARG(0));
17:   PUSH(R3);
18:   PUSH(R0);
19:   PUSH(R2);
20:   PUSH(R1);
21:   CALL(MID_STRING);
22:   POP(R1);
23:   POP(R1);
24:   POP(R1);
25:   POP(R1);
26:   RETURN;
```

```
 1: /* signum.asm
 2:  * Compute the signum function on its arg:
 3:  * R0 <- 1, 0, -1 -- depending on the sign of ARG[0]
 4:  *
 5:  * Programmer: Mayer Goldberg, 2010
 6:  */
 7:
 8:  SIGNUM:
 9:   CMP(STARG(0), IMM(0));
10:   JUMP_GT(L_SIGNUM_P);
11:   JUMP_LT(L_SIGNUM_N);
12:   MOV(R0, IMM(0));
13:   RETURN;
14:  L_SIGNUM_P:
15:   MOV(R0, IMM(1));
16:   RETURN;
17:  L_SIGNUM_N:
18:   MOV(R0, IMM(-1));
19:   RETURN;
```

```
 1: /* strcat.asm
 2:  * Equivalent to strcat in C:
 3:  * R0 = dest <- strcat(dest, src)
 4:  *
 5:  * Programmer: Mayer Goldberg, 2010
 6:  */
 7:
 8:  STRCAT:
 9:   MOV(R0, STARG(0));
10:   MOV(R1, R0);
11:   MOV(R2, STARG(1));
12:  L_STRCAT_1:
13:   CMP(IND(R1), IMM('\0'));
14:   JUMP_EQ(L_STRCAT_2);
15:   INCR(R1);
16:   JUMP(L_STRCAT_1);
17:  L_STRCAT_2:
18:   CMP(IND(R2), IMM('\0'));
19:   JUMP_EQ(L_STRCAT_3);
20:   MOV(IND(R1), IND(R2));
21:   INCR(R1);
22:   INCR(R2);
23:   JUMP(L_STRCAT_2);
24:  L_STRCAT_3:
25:   MOV(IND(R1), IMM('\0'));
26:   RETURN;
```

```
 1: /* strcpy.asm
 2:  * Equivalent to strcat in C:
 3:  * R0 = dest <- strcpy(dest, src)
 4:  *
 5:  * Programmer: Mayer Goldberg, 2010
 6:  */
 7:
 8:  STRCPY:
 9:   MOV(R0, STARG(0));
10:   MOV(R1, R0);
11:   MOV(R2, STARG(1));
12:  L_STRCPY_1:
13:   CMP(IND(R2), IMM('\0'));
14:   JUMP_EQ(L_STRCPY_2);
15:   MOV(IND(R1), IND(R2));
16:   INCR(R1);
17:   INCR(R2);
18:   JUMP(L_STRCPY_1);
19:  L_STRCPY_2:
20:   MOV(IND(R1), IMM('\0'));
21:   RETURN;
```

```
 1: /* string_reverse.asm
 2:  * Takes a pointer to a null-terminated string,
 3:  * and reverses it in place.
 4:  *
 5:  * Programmer: Mayer Goldberg, 2010
 6:  */
 7:
 8:  STRING_REVERSE:
 9:   MOV(R1, STARG(0));
10:   PUSH(R1);
11:   CALL(STRLEN);
12:   POP(R2);
13:   DECR(R0);
14:   ADD(R0, STARG(0));
15:   MOV(R1, STARG(0));
16:  L_STRING_REVERSE_0:
17:   CMP(R1, R0);
18:   JUMP_GE(L_STRING_REVERSE_1);
19:   MOV(R2, IND(R1));
20:   MOV(IND(R1), IND(R0));
21:   MOV(IND(R0), R2);
22:   DECR(R0);
23:   INCR(R1);
24:   JUMP(L_STRING_REVERSE_0);
25:  L_STRING_REVERSE_1:
26:   MOV(R0, STARG(0));
27:   RETURN;
```

```
 1: /* string_to_lc.asm
 2:  * Convert the string to lowercase
 3:  * R0 = dest <- string_to_lc(dest)
 4:  *
 5:  * Programmer: Mayer Goldberg, 2010
 6:  */
 7:
 8:  STRING_TO_LC:
 9:   MOV(R1, STARG(0));
10:  L_STR_TO_LC_1:
11:   CMP(IND(R1), IMM('\0'));
12:   JUMP_EQ(L_STR_TO_LC_2);
13:   PUSH(R1);
14:   PUSH(IND(R1));
15:   CALL(CHAR_TO_LC);
16:   POP(R1);
17:   POP(R1);
18:   MOV(IND(R1), R0);
19:   INCR(R1);
20:   JUMP(L_STR_TO_LC_1);
21:  L_STR_TO_LC_2:
22:   MOV(R0, STARG(0));
23:   RETURN;
```

```
 1: /* string_to_number.asm
 2:  * Converts a source string to a number. Similar to
 3:  * atoi in C.
 4:  *
 5:  * Programmer: Mayer Goldberg, 2010
 6:  */
 7:
 8:  STRING_TO_NUMBER:
 9:   MOV(R1, STARG(0));
10:   MOV(R0, IMM(0));
11:  L_STRING_TO_NUMBER_0:
12:   CMP(IND(R1), IMM('\0'));
13:   JUMP_EQ(L_STRING_TO_NUMBER_1);
14:   MOV(R2, IND(R1));
15:   SUB(R2, IMM('0'));
16:   MUL(R0, IMM(10));
17:   ADD(R0, R2);
18:   INCR(R1);
19:   JUMP(L_STRING_TO_NUMBER_0);
20:  L_STRING_TO_NUMBER_1:
21:   RETURN;
```

```
 1: /* string_to_uc.asm
 2:  * Convert the string to uppercase
 3:  * R0 = dest <- string_to_uc(dest)
 4:  *
 5:  * Programmer: Mayer Goldberg, 2010
 6:  */
 7:
 8:  STRING_TO_UC:
 9:   MOV(R1, STARG(0));
10:  L_STR_TO_UC_1:
11:   CMP(IND(R1), IMM('\0'));
12:   JUMP_EQ(L_STR_TO_UC_2);
13:   PUSH(R1);
14:   PUSH(IND(R1));
15:   CALL(CHAR_TO_UC);
16:   POP(R1);
17:   POP(R1);
18:   MOV(IND(R1), R0);
19:   INCR(R1);
20:   JUMP(L_STR_TO_UC_1);
21:  L_STR_TO_UC_2:
22:   MOV(R0, STARG(0));
23:   RETURN;
24:
```

```
 1: /* strlen.asm
 2:  * Takes a pointer to a null-terminated string,
 3:  * and returns its length.
 4:  *
 5:  * Programmer: Mayer Goldberg, 2010
 6:  */
 7:
 8:  STRLEN:
 9:   MOV(R1, STARG(0));
10:   MOV(R0, IMM(0));
11:  L_STRLEN_LOOP:
12:   CMP(IND(R1), IMM('\0'));
13:   JUMP_EQ(L_STRLEN_END);
14:   INCR(R1);
15:   INCR(R0);
16:   JUMP(L_STRLEN_LOOP);
17:  L_STRLEN_END:
18:   RETURN;
```

```
 1: /* io/tab.asm
 2:  * Print a tab character to stdout
 3:  *
 4:  * Programmer: Mayer Goldberg, 2010
 5:  */
 6:
 7:  TAB:
 8:   PUSH(IMM('\t'));
 9:   CALL(PUTCHAR);
10:   POP(R0);
11:   RETURN;
```

```
 1: /* io/write_integer.asm
 2:  * Print a decimal representation of an integer argument to stdout
 3:  *
 4:  * Programmer: Mayer Goldberg, 2010
 5:  */
 6:
 7:  WRITE_INTEGER:
 8:   PUSH(FP);
 9:   MOV(FP, SP);
10:   PUSH(R1);
11:   MOV(R0, FPARG(0));
12:   CMP(R0, IMM(0));
13:   JUMP_EQ(L_WI_0);
14:   JUMP_LT(L_WI_N);
15:   PUSH(R0);
16:   CALL(L_WI_LOOP);
17:   POP(R1);
18:   JUMP(L_WI_EX);
19:  L_WI_LOOP:
20:   PUSH(FP);
21:   MOV(FP, SP);
22:   MOV(R0, FPARG(0));
23:   CMP(R0, IMM(0));
24:   JUMP_EQ(L_WI_LOOP_END);
25:   REM(R0, IMM(10));
26:   PUSH(R0);
27:   MOV(R0, FPARG(0));
28:   DIV(R0, IMM(10));
29:   PUSH(R0);
30:   CALL(L_WI_LOOP);
31:   POP(R0);
32:   POP(R0);
33:   ADD(R0, IMM('0'));
34:   PUSH(R0);
35:   CALL(PUTCHAR);
36:   POP(R0);
37:  L_WI_LOOP_END:
38:   POP(FP);
39:   RETURN;
40:  L_WI_N:
41:   PUSH(IMM('-'));
42:   CALL(PUTCHAR);
43:   POP(R1);
44:   MOV(R0, FPARG(0));
45:   MOV(R1, IMM(0));
46:   SUB(R1, R0);
47:   PUSH(R1);
48:   CALL(WRITE_INTEGER);
49:   POP(R1);
50:   JUMP(L_WI_EX);
51:  L_WI_0:
52:   PUSH(IMM('0'));
53:   CALL(PUTCHAR);
54:   POP(R0);
55:   JUMP(L_WI_EX);
56:  L_WI_EX:
57:   POP(R1);
58:   POP(FP);
59:   RETURN;
```

```
 1: /* io/write.asm
 2:  * Takes a pointer to a null-terminated string,
 3:  * and prints it to STDOUT.
 4:  *
 5:  * Programmer: Mayer Goldberg, 2010
 6:  */
 7:
 8:  WRITELN:
 9:   MOV(R0, STARG(0));
10:   PUSH(R0);
11:   CALL(WRITE);
12:   POP(R0);
13:   PUSH(IMM('\n'));
14:   CALL(PUTCHAR);
15:   POP(R0);
16:   RETURN;
```

```
 1: /* io/write.asm
 2:  * Takes a pointer to a null-terminated string,
 3:  * and prints it to STDOUT.
 4:  *
 5:  * Programmer: Mayer Goldberg, 2010
 6:  */
 7:
 8:  WRITE:
 9:   PUSH(FP);
10:   MOV(FP, SP);
11:   PUSH(R1);
12:   PUSH(R2);
13:   MOV(R1, FPARG(0));
14:  L_WRITE0:
15:   MOV(R2, IND(R1));
16:   CMP(R2, IMM('\0'));
17:   JUMP_EQ(L_WRITE_END);
18:   PUSH(R2);
19:   CALL(PUTCHAR);
20:   POP(R2);
21:   INCR(R1);
22:   JUMP(L_WRITE0);
23:  L_WRITE_END:
24:   POP(R2);
25:   POP(R1);
26:   POP(FP);
27:   RETURN;
28:
```

```
 1: /* scheme/write_sob_bool.asm
 2:  * Take a pointer to a Scheme Boolean object, and
 3:  * prints (to stdout) the character representation
 4:  * of that object.
 5:  *
 6:  * Programmer: Mayer Goldberg, 2010
 7:  */
 8:
 9:  WRITE_SOB_BOOL:
10:   PUSH(FP);
11:   MOV(FP, SP);
12:   MOV(R0, FPARG(0));
13:   MOV(R0, INDD(R0, 1));
14:   CMP(R0, IMM(0));
15:   JUMP_EQ(L_WRITE_SOB_BOOL_FALSE);
16:   PUSH(IMM('#'));
17:   CALL(PUTCHAR);
18:   PUSH(IMM('t'));
19:   CALL(PUTCHAR);
20:   DROP(2);
21:   JUMP(L_WRITE_SOB_BOOL_EXIT);
22:  L_WRITE_SOB_BOOL_FALSE:
23:   PUSH(IMM('#'));
24:   CALL(PUTCHAR);
25:   PUSH(IMM('f'));
26:   CALL(PUTCHAR);
27:   DROP(2);
28:  L_WRITE_SOB_BOOL_EXIT:
29:   POP(FP);
30:   RETURN;
31:
```

```
 1: /* scheme/write_sob_char.asm
 2:  * Take a pointer to a Scheme char object, and
 3:  * prints (to stdout) the character representation
 4:  * of that object.
 5:  *
 6:  * Programmer: Mayer Goldberg, 2010
 7:  */
 8:
 9:  WRITE_SOB_CHAR:
10:   PUSH(FP);
11:   MOV(FP, SP);
12:   PUSH(R1);
13:   PUSH(IMM('#'));
14:   CALL(PUTCHAR);
15:   PUSH(IMM('\\'));
16:   CALL(PUTCHAR);
17:   DROP(2);
18:   MOV(R0, FPARG(0));
19:   MOV(R0, INDD(R0, 1));
20:   CMP(R0, IMM('\n'));
21:   JUMP_EQ(L_WRITE_SOB_CHAR_NEWLINE);
22:   CMP(R0, IMM('\t'));
23:   JUMP_EQ(L_WRITE_SOB_CHAR_TAB);
24:   CMP(R0, IMM('\f'));
25:   JUMP_EQ(L_WRITE_SOB_CHAR_PAGE);
26:   CMP(R0, IMM('\r'));
27:   JUMP_EQ(L_WRITE_SOB_CHAR_RETURN);
28:   CMP(R0, IMM(' '));
29:   JUMP_EQ(L_WRITE_SOB_CHAR_SPACE);
30:   JUMP_LT(L_WRITE_SOB_CHAR_OCTAL);
31:   PUSH(R0);
32:   CALL(PUTCHAR);
33:   DROP(1);
34:   JUMP(L_WRITE_SOB_CHAR_EXIT);
35:  L_WRITE_SOB_CHAR_OCTAL:
36:   MOV(R1, R0);
37:   REM(R1, IMM(8));
38:   PUSH(R1);
39:   DIV(R0, IMM(8));
40:   MOV(R1, R0);
41:   REM(R1, IMM(8));
42:   PUSH(R1);
43:   DIV(R0, IMM(8));
44:   REM(R0, IMM(8));
45:   PUSH(R0);
46:   CALL(WRITE_INTEGER);
47:   DROP(1);
48:   CALL(WRITE_INTEGER);
49:   DROP(1);
50:   CALL(WRITE_INTEGER);
51:   DROP(1);
52:   JUMP(L_WRITE_SOB_CHAR_EXIT);
53:  L_WRITE_SOB_CHAR_RETURN:
54:   PUSH(IMM('r'));
55:   CALL(PUTCHAR);
56:   PUSH(IMM('e'));
57:   CALL(PUTCHAR);
58:   PUSH(IMM('t'));
59:   CALL(PUTCHAR);
60:   PUSH(IMM('u'));
61:   CALL(PUTCHAR);
```

```
 62:   PUSH(IMM('r'));
 63:   CALL(PUTCHAR);
 64:   PUSH(IMM('n'));
 65:   CALL(PUTCHAR);
 66:   DROP(6);
 67:   JUMP(L_WRITE_SOB_CHAR_EXIT);
 68:  L_WRITE_SOB_CHAR_PAGE:
 69:   PUSH(IMM('p'));
 70:   CALL(PUTCHAR);
 71:   PUSH(IMM('a'));
 72:   CALL(PUTCHAR);
 73:   PUSH(IMM('g'));
 74:   CALL(PUTCHAR);
 75:   PUSH(IMM('e'));
 76:   CALL(PUTCHAR);
 77:   DROP(4);
 78:   JUMP(L_WRITE_SOB_CHAR_EXIT);
 79:  L_WRITE_SOB_CHAR_TAB:
 80:   PUSH(IMM('t'));
 81:   CALL(PUTCHAR);
 82:   PUSH(IMM('a'));
 83:   CALL(PUTCHAR);
 84:   PUSH(IMM('b'));
 85:   CALL(PUTCHAR);
 86:   DROP(3);
 87:   JUMP(L_WRITE_SOB_CHAR_EXIT);
 88:  L_WRITE_SOB_CHAR_NEWLINE:
 89:   PUSH(IMM('n'));
 90:   CALL(PUTCHAR);
 91:   PUSH(IMM('e'));
 92:   CALL(PUTCHAR);
 93:   PUSH(IMM('w'));
 94:   CALL(PUTCHAR);
 95:   PUSH(IMM('l'));
 96:   CALL(PUTCHAR);
 97:   PUSH(IMM('i'));
 98:   CALL(PUTCHAR);
 99:   PUSH(IMM('n'));
100:   CALL(PUTCHAR);
101:   PUSH(IMM('e'));
102:   CALL(PUTCHAR);
103:   DROP(7);
104:   JUMP(L_WRITE_SOB_CHAR_EXIT);
105:  L_WRITE_SOB_CHAR_SPACE:
106:   PUSH(IMM('s'));
107:   CALL(PUTCHAR);
108:   PUSH(IMM('p'));
109:   CALL(PUTCHAR);
110:   PUSH(IMM('a'));
111:   CALL(PUTCHAR);
112:   PUSH(IMM('c'));
113:   CALL(PUTCHAR);
114:   PUSH(IMM('e'));
115:   CALL(PUTCHAR);
116:   DROP(5);
117:  L_WRITE_SOB_CHAR_EXIT:
118:   POP(R1);
119:   POP(FP);
120:   RETURN;
121:
```

```
 1: /* scheme/write_sob_closure.asm
 2:  * Take a pointer to a Scheme closure object, and
 3:  * prints (to stdout) the character representation
 4:  * of that object.
 5:  *
 6:  * Programmer: Mayer Goldberg, 2010
 7:  */
 8:
 9:  WRITE_SOB_CLOSURE:
10:   PUSH(FP);
11:   MOV(FP, SP);
12:   PUSH(IMM('#'));
13:   CALL(PUTCHAR);
14:   PUSH(IMM('<'));
15:   CALL(PUTCHAR);
16:   PUSH(IMM('c'));
17:   CALL(PUTCHAR);
18:   PUSH(IMM('l'));
19:   CALL(PUTCHAR);
20:   PUSH(IMM('o'));
21:   CALL(PUTCHAR);
22:   PUSH(IMM('s'));
23:   CALL(PUTCHAR);
24:   PUSH(IMM('u'));
25:   CALL(PUTCHAR);
26:   PUSH(IMM('r'));
27:   CALL(PUTCHAR);
28:   PUSH(IMM('e'));
29:   CALL(PUTCHAR);
30:   PUSH(IMM(' '));
31:   CALL(PUTCHAR);
32:   PUSH(IMM('a'));
33:   CALL(PUTCHAR);
34:   PUSH(IMM('t'));
35:   CALL(PUTCHAR);
36:   PUSH(IMM(' '));
37:   CALL(PUTCHAR);
38:   DROP(13);
39:   PUSH(FPARG(0));
40:   CALL(WRITE_INTEGER);
41:   DROP(1);
42:   PUSH(IMM(' '));
43:   CALL(PUTCHAR);
44:   PUSH(IMM('e'));
45:   CALL(PUTCHAR);
46:   PUSH(IMM('n'));
47:   CALL(PUTCHAR);
48:   PUSH(IMM('v'));
49:   CALL(PUTCHAR);
50:   PUSH(IMM(':'));
51:   CALL(PUTCHAR);
52:   PUSH(IMM(' '));
53:   CALL(PUTCHAR);
54:   DROP(6);
55:   MOV(R0, FPARG(0));
56:   PUSH(INDD(R0, 1));
57:   CALL(WRITE_INTEGER);
58:   DROP(1);
59:   PUSH(IMM(' '));
60:   CALL(PUTCHAR);
61:   PUSH(IMM('c'));
```

```
62:   CALL(PUTCHAR);
63:   PUSH(IMM('o'));
64:   CALL(PUTCHAR);
65:   PUSH(IMM('d'));
66:   CALL(PUTCHAR);
67:   PUSH(IMM('e'));
68:   CALL(PUTCHAR);
69:   PUSH(IMM(':'));
70:   CALL(PUTCHAR);
71:   PUSH(IMM(' '));
72:   CALL(PUTCHAR);
73:   DROP(7);
74:   MOV(R0, FPARG(0));
75:   PUSH(INDD(R0, 2));
76:   CALL(WRITE_INTEGER);
77:   DROP(1);
78:   PUSH(IMM('>'));
79:   CALL(PUTCHAR);
80:   DROP(1);
81:   POP(FP);
82:   RETURN;
83:
```

```
 1: /* scheme/write_sob_integer.asm
 2:  * Take a pointer to a Scheme integer object, and
 3:  * prints (to stdout) the character representation
 4:  * of that object.
 5:  *
 6:  * Programmer: Mayer Goldberg, 2010
 7:  */
 8:
 9:  WRITE_SOB_INTEGER:
10:   PUSH(FP);
11:   MOV(FP, SP);
12:   MOV(R0, FPARG(0));
13:   MOV(R0, INDD(R0, 1));
14:   PUSH(R0);
15:   CALL(WRITE_INTEGER);
16:   DROP(1);
17:   POP(FP);
18:   RETURN;
19:
```

```
 1: /* scheme/write_sob_nil.asm
 2:  * Take a pointer to a Scheme nil object, and
 3:  * prints (to stdout) the character representation
 4:  * of that object.
 5:  *
 6:  * Programmer: Mayer Goldberg, 2010
 7:  */
 8:
 9:  WRITE_SOB_NIL:
10:   PUSH(IMM('('));
11:   CALL(PUTCHAR);
12:   PUSH(IMM(')'));
13:   CALL(PUTCHAR);
14:   DROP(2);
15:   RETURN;
16:
```

```
 1: /* scheme/write_sob_pair.asm
 2:  * Take a pointer to a Scheme pair object, and
 3:  * prints (to stdout) the character representation
 4:  * of that object.
 5:  *
 6:  * Programmer: Mayer Goldberg, 2010
 7:  */
 8:
 9:  WRITE_SOB_PAIR:
10:   PUSH(FP);
11:   MOV(FP, SP);
12:   MOV(R0, FPARG(0));
13:   PUSH(INDD(R0, 2));
14:   PUSH(INDD(R0, 1));
15:   PUSH(IMM('('));
16:   CALL(PUTCHAR);
17:   DROP(1);
18:   CALL(WRITE_SOB);
19:   DROP(1);
20:   PUSH(IMM(' '));
21:   CALL(PUTCHAR);
22:   PUSH(IMM('.'));
23:   CALL(PUTCHAR);
24:   PUSH(IMM(' '));
25:   CALL(PUTCHAR);
26:   DROP(3);
27:   CALL(WRITE_SOB);
28:   DROP(1);
29:   PUSH(IMM(')'));
30:   CALL(PUTCHAR);
31:   DROP(1);
32:   POP(FP);
33:   RETURN;
34:
```

```
 1: /* scheme/write_sob.asm
 2:  * Take a pointer to a Scheme object, and
 3:  * prints (to stdout) the character representation
 4:  * of that object.
 5:  *
 6:  * Programmer: Mayer Goldberg, 2010
 7:  */
 8:
 9:  WRITE_SOB:
10:   MOV(R0, STARG(0));
11:   MOV(R0, IND(R0));
12:   CMP(R0, IMM(T_VOID));
13:   JUMP_EQ(WRITE_SOB_VOID);
14:   CMP(R0, IMM(T_NIL));
15:   JUMP_EQ(WRITE_SOB_NIL);
16:   CMP(R0, IMM(T_BOOL));
17:   JUMP_EQ(WRITE_SOB_BOOL);
18:   CMP(R0, IMM(T_CHAR));
19:   JUMP_EQ(WRITE_SOB_CHAR);
20:   CMP(R0, IMM(T_INTEGER));
21:   JUMP_EQ(WRITE_SOB_INTEGER);
22:   CMP(R0, IMM(T_STRING));
23:   JUMP_EQ(WRITE_SOB_STRING);
24:   CMP(R0, IMM(T_SYMBOL));
25:   JUMP_EQ(WRITE_SOB_SYMBOL);
26:   CMP(R0, IMM(T_PAIR));
27:   JUMP_EQ(WRITE_SOB_PAIR);
28:   CMP(R0, IMM(T_VECTOR));
29:   JUMP_EQ(WRITE_SOB_VECTOR);
30:   CMP(R0, IMM(T_CLOSURE));
31:   JUMP_EQ(WRITE_SOB_CLOSURE);
32:   PUSH(R0);
33:   PUSH(IMM('\n'));
34:   CALL(PUTCHAR);
35:   PUSH(IMM('F'));
36:   CALL(PUTCHAR);
37:   PUSH(IMM('a'));
38:   CALL(PUTCHAR);
39:   PUSH(IMM('t'));
40:   CALL(PUTCHAR);
41:   PUSH(IMM('a'));
42:   CALL(PUTCHAR);
43:   PUSH(IMM('l'));
44:   CALL(PUTCHAR);
45:   PUSH(IMM(' '));
46:   CALL(PUTCHAR);
47:   PUSH(IMM('e'));
48:   CALL(PUTCHAR);
49:   PUSH(IMM('r'));
50:   CALL(PUTCHAR);
51:   PUSH(IMM('r'));
52:   CALL(PUTCHAR);
53:   PUSH(IMM('o'));
54:   CALL(PUTCHAR);
55:   PUSH(IMM('r'));
56:   CALL(PUTCHAR);
57:   PUSH(IMM(':'));
58:   CALL(PUTCHAR);
59:   PUSH(IMM(' '));
60:   CALL(PUTCHAR);
61:   PUSH(IMM('C'));
```

```
 62:   CALL(PUTCHAR);
 63:   PUSH(IMM('o'));
 64:   CALL(PUTCHAR);
 65:   PUSH(IMM('r'));
 66:   CALL(PUTCHAR);
 67:   PUSH(IMM('r'));
 68:   CALL(PUTCHAR);
 69:   PUSH(IMM('u'));
 70:   CALL(PUTCHAR);
 71:   PUSH(IMM('p'));
 72:   CALL(PUTCHAR);
 73:   PUSH(IMM('t'));
 74:   CALL(PUTCHAR);
 75:   PUSH(IMM(' '));
 76:   CALL(PUTCHAR);
 77:   PUSH(IMM('s'));
 78:   CALL(PUTCHAR);
 79:   PUSH(IMM('e'));
 80:   CALL(PUTCHAR);
 81:   PUSH(IMM('x'));
 82:   CALL(PUTCHAR);
 83:   PUSH(IMM('p'));
 84:   CALL(PUTCHAR);
 85:   PUSH(IMM('r'));
 86:   CALL(PUTCHAR);
 87:   PUSH(IMM(' '));
 88:   CALL(PUTCHAR);
 89:   PUSH(IMM('t'));
 90:   CALL(PUTCHAR);
 91:   PUSH(IMM('y'));
 92:   CALL(PUTCHAR);
 93:   PUSH(IMM('p'));
 94:   CALL(PUTCHAR);
 95:   PUSH(IMM('e'));
 96:   CALL(PUTCHAR);
 97:   PUSH(IMM(':'));
 98:   CALL(PUTCHAR);
 99:   PUSH(IMM(' '));
100:   CALL(PUTCHAR);
101:   DROP(34);
102:   CALL(WRITE_INTEGER);
103:   DROP(1);
104:   CALL(NEWLINE);
105:   HALT;
```

```
 1: /* scheme/write_sob_string.asm
 2:  * Take a pointer to a Scheme string object, and
 3:  * prints (to stdout) the character representation
 4:  * of that object.
 5:  *
 6:  * Programmer: Mayer Goldberg, 2010
 7:  */
 8:
 9:  WRITE_SOB_STRING:
10:   PUSH(FP);
11:   MOV(FP, SP);
12:   PUSH(R1);
13:   PUSH(R2);
14:   PUSH(R3);
15:   PUSH(IMM('\"'));
16:   CALL(PUTCHAR);
17:   DROP(1);
18:   MOV(R0, FPARG(0));
19:   MOV(R1, INDD(R0, 1));
20:   MOV(R2, R0);
21:   ADD(R2, IMM(2));
22:  L_WSS_LOOP:
23:   CMP(R1, IMM(0));
24:   JUMP_EQ(L_WSS_EXIT);
25:   CMP(IND(R2), '\n');
26:   JUMP_EQ(L_WSS_NEWLINE);
27:   CMP(IND(R2), '\t');
28:   JUMP_EQ(L_WSS_TAB);
29:   CMP(IND(R2), '\f');
30:   JUMP_EQ(L_WSS_PAGE);
31:   CMP(IND(R2), '\r');
32:   JUMP_EQ(L_WSS_RETURN);
33:   CMP(IND(R2), '\\');
34:   JUMP_EQ(L_WSS_BACKSLASH);
35:   CMP(IND(R2), '\"');
36:   JUMP_EQ(L_WSS_DQUOTE);
37:   CMP(IND(R2), ' ');
38:   JUMP_LT(L_WSS_OCT_CHAR);
39:   PUSH(IND(R2));
40:   CALL(PUTCHAR);
41:   DROP(1);
42:   JUMP(L_WSS_LOOP_CONT);
43:  L_WSS_DQUOTE:
44:   PUSH(IMM('\\'));
45:   CALL(PUTCHAR);
46:   PUSH(IMM('\"'));
47:   CALL(PUTCHAR);
48:   DROP(2);
49:   JUMP(L_WSS_LOOP_CONT);
50:  L_WSS_BACKSLASH:
51:   PUSH(IMM('\\'));
52:   CALL(PUTCHAR);
53:   PUSH(IMM('\\'));
54:   CALL(PUTCHAR);
55:   DROP(2);
56:   JUMP(L_WSS_LOOP_CONT);
57:  L_WSS_RETURN:
58:   PUSH(IMM('\\'));
59:   CALL(PUTCHAR);
60:   PUSH(IMM('r'));
61:   CALL(PUTCHAR);
```

```
 62:   DROP(2);
 63:   JUMP(L_WSS_LOOP_CONT);
 64:  L_WSS_PAGE:
 65:   PUSH(IMM('\\'));
 66:   CALL(PUTCHAR);
 67:   PUSH(IMM('f'));
 68:   CALL(PUTCHAR);
 69:   DROP(2);
 70:   JUMP(L_WSS_LOOP_CONT);
 71:  L_WSS_TAB:
 72:   PUSH(IMM('\\'));
 73:   CALL(PUTCHAR);
 74:   PUSH(IMM('t'));
 75:   CALL(PUTCHAR);
 76:   DROP(2);
 77:   JUMP(L_WSS_LOOP_CONT);
 78:  L_WSS_NEWLINE:
 79:   PUSH(IMM('\\'));
 80:   CALL(PUTCHAR);
 81:   PUSH(IMM('n'));
 82:   CALL(PUTCHAR);
 83:   DROP(2);
 84:   JUMP(L_WSS_LOOP_CONT);
 85:  L_WSS_OCT_CHAR:
 86:   MOV(R0, IND(R2));
 87:   MOV(R3, R0);
 88:   REM(R3, IMM(8));
 89:   PUSH(R3);
 90:   DIV(R0, IMM(8));
 91:   MOV(R3, R0);
 92:   REM(R3, IMM(8));
 93:   PUSH(R3);
 94:   DIV(R0, IMM(8));
 95:   REM(R0, IMM(8));
 96:   PUSH(R0);
 97:   PUSH(IMM('\\'));
 98:   CALL(PUTCHAR);
 99:   DROP(1);
100:   CALL(WRITE_INTEGER);
101:   DROP(1);
102:   CALL(WRITE_INTEGER);
103:   DROP(1);
104:   CALL(WRITE_INTEGER);
105:   DROP(1);
106:  L_WSS_LOOP_CONT:
107:   INCR(R2);
108:   DECR(R1);
109:   JUMP(L_WSS_LOOP);
110:  L_WSS_EXIT:
111:   PUSH(IMM('\"'));
112:   CALL(PUTCHAR);
113:   DROP(1);
114:   POP(R3);
115:   POP(R2);
116:   POP(R1);
117:   POP(FP);
118:   RETURN;
119:
```

```
 1: /* scheme/write_sob_vector.asm
 2:  * Take a pointer to a Scheme vector object, and
 3:  * prints (to stdout) the character representation
 4:  * of that object.
 5:  *
 6:  * Programmer: Mayer Goldberg, 2010
 7:  */
 8:
 9:  WRITE_SOB_VECTOR:
10:   PUSH(FP);
11:   MOV(FP, SP);
12:   PUSH(R1);
13:   PUSH(R2);
14:   PUSH(IMM('#'));
15:   CALL(PUTCHAR);
16:   MOV(R0, FPARG(0));
17:   PUSH(INDD(R0, 1));
18:   CALL(WRITE_INTEGER);
19:   PUSH(IMM('('));
20:   CALL(PUTCHAR);
21:   DROP(3);
22:   MOV(R0, FPARG(0));
23:   MOV(R1, INDD(R0, 1));
24:   CMP(R1, IMM(0));
25:   JUMP_EQ(L_WSV_EXIT);
26:   MOV(R2, R0);
27:   ADD(R2, IMM(2));
28:   PUSH(IND(R2));
29:   CALL(WRITE_SOB);
30:   DROP(1);
31:   INCR(R2);
32:   DECR(R1);
33:  L_WSV_LOOP:
34:   CMP(R1, IMM(0));
35:   JUMP_EQ(L_WSV_EXIT);
36:   PUSH(IMM(' '));
37:   CALL(PUTCHAR);
38:   DROP(1);
39:   PUSH(IND(R2));
40:   CALL(WRITE_SOB);
41:   DROP(1);
42:   INCR(R2);
43:   DECR(R1);
44:   JUMP(L_WSV_LOOP);
45:  L_WSV_EXIT:
46:   PUSH(IMM(')'));
47:   CALL(PUTCHAR);
48:   DROP(1);
49:   POP(R2);
50:   POP(R1);
51:   POP(FP);
52:   RETURN;
53:
```

```
 1: /* scheme/write_sob_void.asm
 2:  * Take a pointer to a Scheme void object, and
 3:  * prints (to stdout) the character representation
 4:  * of that object.
 5:  *
 6:  * Programmer: Mayer Goldberg, 2010
 7:  */
 8:
 9:  WRITE_SOB_VOID:
10:   PUSH(IMM('#'));
11:   CALL(PUTCHAR);
12:   PUSH(IMM('<'));
13:   CALL(PUTCHAR);
14:   PUSH(IMM('v'));
15:   CALL(PUTCHAR);
16:   PUSH(IMM('o'));
17:   CALL(PUTCHAR);
18:   PUSH(IMM('i'));
19:   CALL(PUTCHAR);
20:   PUSH(IMM('d'));
21:   CALL(PUTCHAR);
22:   PUSH(IMM('>'));
23:   CALL(PUTCHAR);
24:   DROP(7);
25:   RETURN;
```