Lissajous curves are an interesting family of curves in which the x co-ordinate of each point is determined by the sine function and the y co-ordinate by the cosine:

```
TO LJ: COEFF1 :COEFF2 :STEP
   DRAW PU HT
   POS :COEFF1 :COEFF2 0 PD
   LJ1 :COEFF1 :COEFF2 0 :STEP
END

TO POS :COEFF1 :COEFF2 :ANGLE
   MAKE "X 100 * SIN ( :COEFF1 * :ANGLE )
   MAKE "Y 100 * COS ( :COEFF2 * :ANGLE )
   SETXY :X :Y
END

TO LJ1 :COEFF1 :COEFF2 :ANGLE :STEP
   POS :COEFF1 :COEFF2 :ANGLE
   LJ1 :COEFF1 :COEFF2 ( :ANGLE + :STEP ) :STEP
END
```

Logo Flavours

LCSI versions include prefix arithmetic. Atari LOGO has SUM and PRODUCT; Spectrum LOGO also has DIV and Apple LOGO has QUOTIENT, both of which correspond to MIT LOGO's QUOTIENT.
INT is used in place of INTEGER.
NUMBERP is used for NUMBER?.
The logical operators have the more usual names of AND, OR and NOT.
IF has a different syntax — IF :X = 0 PRINT "ZERO
TYPE is used in place of PRINT1.
SETPOS (followed by a list) is used for SETXY.
Use CS instead of DRAW.

Logo Exercises

1. Write a procedure to output the nth power of a number, so POWER 4 2 would output 16.
2. Write a set of procedures to convert a decimal number to hexadecimal (use a similar technique to the binary example, but this time divide by 16).
3. Write a procedure EVEN? that will output TRUE if a number is even and FALSE if it is not.
4. Use the Monte Carlo method to find the area under the curve $y=x^2$ between x=0 and x=10.

Exercise Answers

1. Convert game to using keyboard control: Change SET.DEMONS WATCH, CHECK. Delete JOYH. Add MOVE and READKEY.

```
TO SET.DEMONS
   WHEN OVER :SHEEP1 :FENCE [SETSP 0]
   WHEN OVER :SHEEP2 :FENCE [SETSP 0]
   WHEN TOUCHING :SHEEP1:SHEEP2
      [SETSP 0]
   WHEN TOUCHING :DOG :SHEEP1 [SETSP 0]
   WHEN TOUCHING :DOG :SHEEP2 [SETSP 0]
END
TO WATCH
   MOVE READKEY
   IF :SPEED = 0 [CHECK]
   WATCH
END
TO CHECK
   IF COND OVER :SHEEP1 :FENCE [ASK
      :SHEEP1 [BK 10 RT 90]]
   IF COND OVER :SHEEP2 :FENCE [ASK
      :SHEEP2 [BK 10 RT 90]]
   IF COND TOUCHING :SHEEP1 :SHEEP2 [BUMP]
   IF COND TOUCHING :DOG :SHEEP1 [ASK
      :SHEEP1 [RT 90]]
   IF COND TOUCHING :DOG :SHEEP2 [ASK
      :SHEEP 2 [RT 90]]
   SET.SPEEDS
END
TO MOVE :COM
   IF :COM = "W [ASK :DOG [SETH 0]]
   IF :COM = "S [ASK :DOG [SETH 90]]
   IF :COM = "Z [ASK :DOG [SETH 180]]
   IF :COM = "A [ASK :DOG [SETH 270]]
   IF :COM = "Q [ASK :TURTLE [DRAW.CAGE]]
END
   TO READKEY
   IF KEYP [OUTPUT RC]
   OUTPUT "
END
```

2. The meteorite game: define shape 1 as a meteorite, and shape 2 as the space ship.

```
TO PLAY
   CS FS
   SET 0 1 [—100 80] 180 199
   SET 1 1 [0 80] 180 199
   SET 2 1 [100 90] 180 199
   SET 3 2 [0 —80] 90 50
   SET.DEMONS
   RANDOM.MOVE 0
END
TO SET :NO :SHAPE :POS :HEAD :SP
   TELL :NO SETSH :SHAPE
   PU SETPOS :POS
   SETH :HEAD ST SETSP :SP
END
TO SET.DEMONS
   WHEN TOUCHING 0 3 [BANG]
   WHEN TOUCHING 1 3 [BANG]
   WHEN TOUCHING 2 3 [BANG]
   WHEN 15 [JOYH]
END
TO BANG
   TELL [0 1 2 3]
   SETSP 0 SS
   PRINT " PRINT "
   PRINT "SPLATTERED
END
TO JOYH
   IF (JOY 1) < 0 [STOP]
   ASK 3 [SETH 45 * JOY 1]
END
TO RANDOM.MOVE :NO
   IF SPEED = 0 [( PRINT "SCORE :NO ) STOP]
   ASK RANDOM 3 [SETH 145 + RANDOM 70]
   RANDOM.MOVE :NO + 1
END
```

LISSAJOUS FIGURES