Chapter 5 Exercises

1. Convert the following binary numbers to decimals:
   (a) 0.001  
   (b) 0.1101  
   (c) 0.0011  
   (d) 1011.1011

2. Convert the following decimals to binary:
   (a) 0.625  
   (b) 12.5  
   (c) –7.875  
   (d) 5.4375

3. Convert the following decimals to binary numbers with five digit accuracy by each of the techniques of pages 78-79:
   (a) 0.30000  
   (b) 0.09000  
   (c) 0.012345

   These exercises should help you to see how the programs **RATPOW1** and **RATPOW2** work.

4. Tracing programs can provide insights into how they work. There are several examples of this on page 83, but these examples are so compressed that they may not convey all that is going on. It is better to trace a program by making a table of variables, changing those variables as they are modified in the steps of the program. In the program **RPOWALL** on page 82, the variables are B, E, P, N, I, C, R, S, F and X. A table like the following will serve to keep track of these variables.

<table>
<thead>
<tr>
<th>B</th>
<th>E</th>
<th>P</th>
<th>N</th>
<th>I</th>
<th>C</th>
<th>R</th>
<th>S</th>
<th>F</th>
<th>X</th>
</tr>
</thead>
</table>

   (a) Use this kind of table to trace the program that would calculate $4^{0.75}$. Leave your values in terms of square roots until the final calculation of P.
   (b) Use another copy of this table to trace the program that would calculate $2^{6.875}$. In this exercise, do the actual calculations of the roots as you work your way through the program.
   (c) Check your answers in (a) and (b) against the answers using the program or by use of the $^2$ key.

Additional Programming Exercises

5. Fibonacci Numbers.
   Named after a pseudonym for Leonardo of Pisa who wrote about them in 1202 (although they were known at least as early as 200 BCE), Fibonacci numbers turn up in a remarkable number of places. Whole books have been written about them and journals have been devoted to study of them and their applications. (See, for example, [www.mcs.surrey.ac.uk/Personal/R.Knott/Fibonacci/fib.html](http://www.mcs.surrey.ac.uk/Personal/R.Knott/Fibonacci/fib.html) and [en.wikipedia.org/wiki/Fibonacci_number#Origins](http://en.wikipedia.org/wiki/Fibonacci_number#Origins).)

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1 One commonly cited is the growth of a population of rabbits under certain constraints. Other application areas include music, plant and animal growth, statistical analysis and mathematical research.
These numbers form a sequence beginning with 0 and 1: 0, 1, 1, 2, 3, 5, 8, 13,..., in which
each term after those first two is the sum of the two preceding it. In formal terms, we have:
F_0 = 0, F_1 = 1 and for any integer N \geq 0, F_{N+2} = F_N + F_{N+1}.
(a) Write a program that will calculate F_N for any value of N \geq 0. You may wish to follow the
definition by considering F_0 and F_1 separately from F_2, F_3, etc.
(b) Use your program to calculate the 5th and 8th Fibonacci numbers.
(c) By trial and error, determine the largest Fibonacci number for which your calculator will
report all the digits.
(d) Are there Fibonacci numbers too large for your calculator to support even with
exponential notation? If so, what is the smallest of these numbers?

6. There are three methods of depreciating the value of property.²

The simplest is straight-line depreciation. If the value today is X and you wish to depreciate
X over Y years, you simply reduce the property value by X/Y each year. Thus a car worth
$20,000 today would depreciate over 10 years at $2000 each year. Its subsequent yearly
values would then be: $18,000, $16,000, $14,000,..., $2,000, $0.

A second method is called double-declining depreciation. By this method, the depreciation
factor each year, D, is 2/Y. Thus, for our previous example, D = 2/10 = 20%. Each year the
property value would decline by 20% (or equivalently be worth 80% as much.) In this case,
for our example ($20,000 depreciated over 10 years), the successive yearly values would be:
$16,000, $12,800, $10,240,..., $2,684, $2,147. (Note that this method does not go to zero so
this last value $2,147 is usually replaced by $0.

A third method is called sum-of-the-years depreciation. By this method, the denominator of
the depreciation factor is the sum on the numbers from 1 to Y. This sum is the same as
\[
\frac{Y(Y + 1)}{2}
\]
By this method, each year the amount depreciated is the original cost, X, times the number of
years remaining divided by D. In other words the first year the amount depreciated would be:
XY/D, the second year X(Y-1)/D, the third year X(Y-2)/D, etc. In this case, again for our
example ($20,000 depreciated over 10 years), the successive yearly values would be:
$16,363.63, $13090.90, $10,181.81,..., $363.63, $0.
(a) Write a separate program (DEP1, DEP2 and DEP3) to calculate the remaining value for
successive years by each of these methods. Check your program against the values given
in the example.
(b) Combine those three programs into a single program that calculates the yearly value by
each method and reports them together.
(c) Choose an amount to be depreciated and the number of years for the depreciation to run,
then use your program developed in (b) to make a table of remaining values for
comparison. (If you have property mortgaged or if you are paying off a loan, you can use
your personal data for this problem.)

² This example is adapted from Byron S. Gottfried, Schaum's Outline of Theory and Problems of Programming with