

# Assignment #1

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**Due: Wednesday, October 12**

Write out answers to each of these problems. You can write them out on paper, but I encourage you to test your solutions by using the links on the class web site.

### **Problem 1—Simple exercises for the Difference Engine**

For each of the first two exercises in the puzzle box on page 57 (we did the third one in class), write out the Difference Engine program that generates the desired series.

### **Problem 2—Cannonball pyramids**

Spherical objects, such as cannonballs, can be stacked to form a pyramid. For example, a cannonball pyramid with three layers has one cannonball at the top, which sits on top of a square composed of four cannonballs, which in turn sits on top of a square of nine cannonballs. Program the Difference Engine to produce a table showing the number of cannonballs as a function of the number of layers.

### **Problem 3—Approximating trigonometric functions**

Although the method of differences works best on functions that can be expressed in polynomial form, Babbage recognized that the technique would also work for other mathematical functions over a finite range. Consider, for example, the following table, which shows the value of  $\sin(\theta)$  for values of  $\theta$  between 30.0 degrees and 32.0 degrees:

$\theta$	$\sin(\theta)$
30.0	0.500000000
30.1	0.501510737
30.2	0.503019947
30.3	0.504527624
30.4	0.506033764
30.5	0.507538363
30.6	0.509041416
30.7	0.510542918
30.8	0.512042865
30.9	0.513541252
31.0	0.515038075
31.1	0.516533329
31.2	0.518027009
31.3	0.519519112
31.4	0.521009632
31.5	0.522498565
31.6	0.523985906
31.7	0.525471651
31.8	0.526955795
31.9	0.528438335
32.0	0.529919264

Use Excel or some other spreadsheet program to create a table of the actual values of  $\sin(\theta)$ , along with first differences, second differences, and so forth. Use these differences to initialize a Difference Engine so that it delivers the values of  $\sin(\theta)$  for values of  $\theta$  ranging from 30.0 to 32.0 in increments of a tenth of a degree. How accurate is the computation by the time you reach 32.0 degrees?

**Problem 4—Programming the Analytical Engine**

Solve the three exercises in the puzzle box on page 70.