VEDIC MATHEMATICS NEWSLETTER

ISSUE No. 76

A warm welcome to our new subscribers.
Vedic Mathematics is becoming increasingly popular as more and more people are introduced to the beautifully unified and easy Vedic methods. The purpose of this Newsletter is to provide information about developments in education and research and books, articles, courses, talks etc., and also to bring together those working with Vedic Mathematics. If you are working with Vedic Mathematics - teaching it or doing research - please contact us and let us include you and some description of your work in the Newsletter. Perhaps you would like to submit an article for inclusion in a later issue or tell us about a course or talk you will be giving or have given. If you are learning Vedic Maths, let us know how you are getting on and what you think of this system.

This issue's article is from Steven Vogel. It is self-contained but follows on from the main article in the previous newsletter.

AN INTERESTING VEDIC MATH APPLICATION

Compound interest is a term used to describe the repeated application of an interest rate to both an investment and the interest already earned on that investment. For example, a $100 investment earning 4% interest per year would be worth $104.00 (100*1.04) at the end of the first year, and $108.16 (104*1.04) the end of the second. The general formula that deals with compound interest is:

$$FV = PV*(1+i)^n$$

FV = Future Value
PV = Present Value
i = interest rate per period
n = number of periods

This application of Vedic math shows up in chapter 40 of Bharati Krsna's Vedic Mathematics as a subject of interest, but is not explored. The type of mathematics required is found in chapter 13, titled “Elementary Squaring, Cubing, Etc.” When read carefully, it is obvious that the techniques he outlined can be extended far beyond the fourth power. To recap the basic method (anurupya, proportionality), the binomial theorem is used to expand a binomial and determine the coefficients for each term. Then the coefficients are temporarily ignored and the terms are written as a ratio of previous terms. The terms are multiplied by the coefficients and added together to arrive at the result:

$$(a+b)^4 = a^4 + 4a^3b + 6a^2b^2 + 4ab^3 + b^4$$

$$a^3b = a^4 * b/a$$

$$a^2b^2 = a^3b * b/a$$

$$ab^3 = a^2b^2 * b/a$$

$$b^4 = ab^3 * b/a$$

As a concrete example, let's evaluate $(1.04)^4$

$(1.04)^4 = (1 + .04)^4$
a = 1
b = 4
b/a = 4

terms	1	4	16	64	256	← each term = previous term * b/a
factors	1	4	6	4	1	← from the binomial theorem
product	1	16	96	256	256	

Taking two digits from each product (because 04 has two digits), and carrying over to the term before, the answer is $1.1698_{2}58_{2}56$
This method can be extended to any power, but somehow an easy method to find the coefficients must be found. Bharati Krsna tells us on page 146 about the binomial theorem's importance, and that it will be dealt with later on. On page 289 he hints that there is a comprehensive Vedic form of the binomial theorem, but again it is held off for later. One way of arriving at the binomial theorem's coefficients is by using Pascal's triangle:

```
        1
      1   1
    1   2   1
  1   3   3   1
1   4   6   4   1
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This works fine for smaller powers, but becomes unwieldy for the larger powers we encounter in compound interest calculations. It is also possible to use the equation below to develop the individual terms, but somehow it doesn't match what Bharati Krsna hinted at as a comprehensive Vedic form:

$$\binom{n}{k} = \frac{n!}{k!(n-k)!}$$

There is a method of calculating the terms of a binomial that fits more closely to the spirit of Vedic mathematics, arrived at by repeatedly applying the two sutras: “By one less that the one before” and “By one more than the one before.” We can easily arrive at the coefficients, from first to last as required, if we start with 1 and the value of the power and follow the pattern below:

for $(a+b)^4$:

start with 1
1 * 4 / 1 = 4
4 * 3 / 2 = 6
6 * 2 / 3 = 4
4 * 1 / 4 = 1

The multiplier goes down one each time from its base power, while the divisor goes up by one from 1. The result is always an integer. As you can see, it's a cleaner and easier way of arriving at the values without using factorials, and requires one multiplication and one division per step.

for $(a+b)^{10}$:

start with 1
1 * 10 / 1 = 10
10 * 9 / 2 = 45
45 * 8 / 3 = 120
120 * 7 / 4 = 210
210 * 6 / 5 = 252
252 * 5 / 6 = 210
210 * 4 / 7 = 120
120 * 3 / 8 = 45
45 * 2 / 9 = 10
10 * 1 /10 = 1

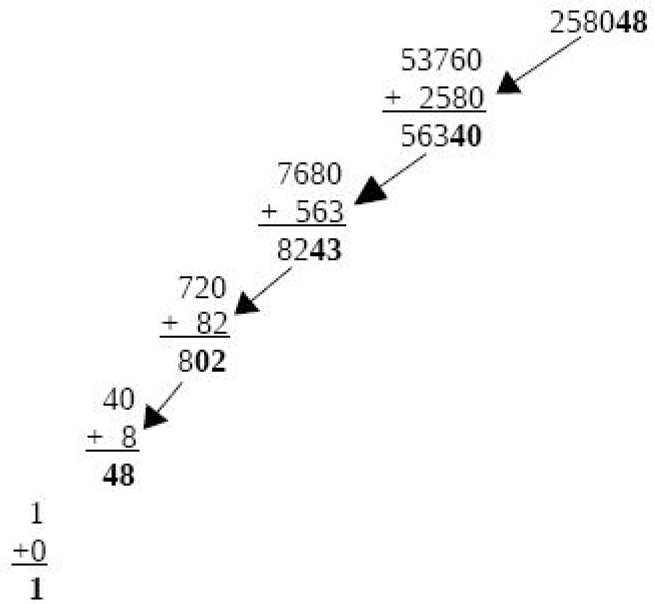
One of the nice features of Vedic mathematics is its ability to compute the most significant digits first. We can use this fact to our advantage if we consider the nature of currency. Whether it's dollars and cents or rupees and paisa, a unit of currency is only divisible so far. For number theory every digit may be important, but for practical purposes we can stop the calculation short once we reach a small enough value. If the number of periods is large enough, we can save a great deal of effort by not calculating every term, but terminating the process when we feel we have a fine enough resolution for our needs.

For example, say I wanted to know how much an investment that returned 4% per period would be worth for ten periods to 5 decimal places. I might stop the calculations at 6 terms because I only need that level of accuracy. I would first find the ratio of b to a (4/1) and use that to find my terms. Then I would find the coefficients by using the method outlined above (by one less than the one before, by one more than the one before). Then the product of the terms and the coefficients is found and those products are combined into an answer.

$(1.04)^{10} = (1 + .04)^{10}$
a = 1
b = 4
b/a = 4

terms 1 4 16 64 256 1024 ← each term = previous term * b/a
factors 1 10 45 120 210 252 ← from the binomial theorem
products 1 40 7_32_30 7_1680 5_13_1760 258_20_248 ← vertically & crosswise

answer using first 6 terms (collect two digits at a time because 04 has two digits):



So we get a value of 1.4802434048. The exact answer is 1.480244285 (rounded off), so we are off by 1 in the 6th decimal place by ending the expansion early. Not too bad considering the ease of the method. We could have multiplied 1.04 by itself ten times, but many compound interest calculations involve powers on the order of 30 to 360 so this method of approximation by dropped terms is beneficial to keep in mind. Of course 1.04^{10} can be computed with 4 multiplications and 1.04^{30} with 6, and with those smaller exponents crosswise and vertically might come in handy.

A second example is to determine the value in dollars of a $1,000.00 investment made at a 3% interest rate for 30 periods. We can see we need 6 significant digits in order to have a value accurate below the penny level. First lets find the binomial coefficients:

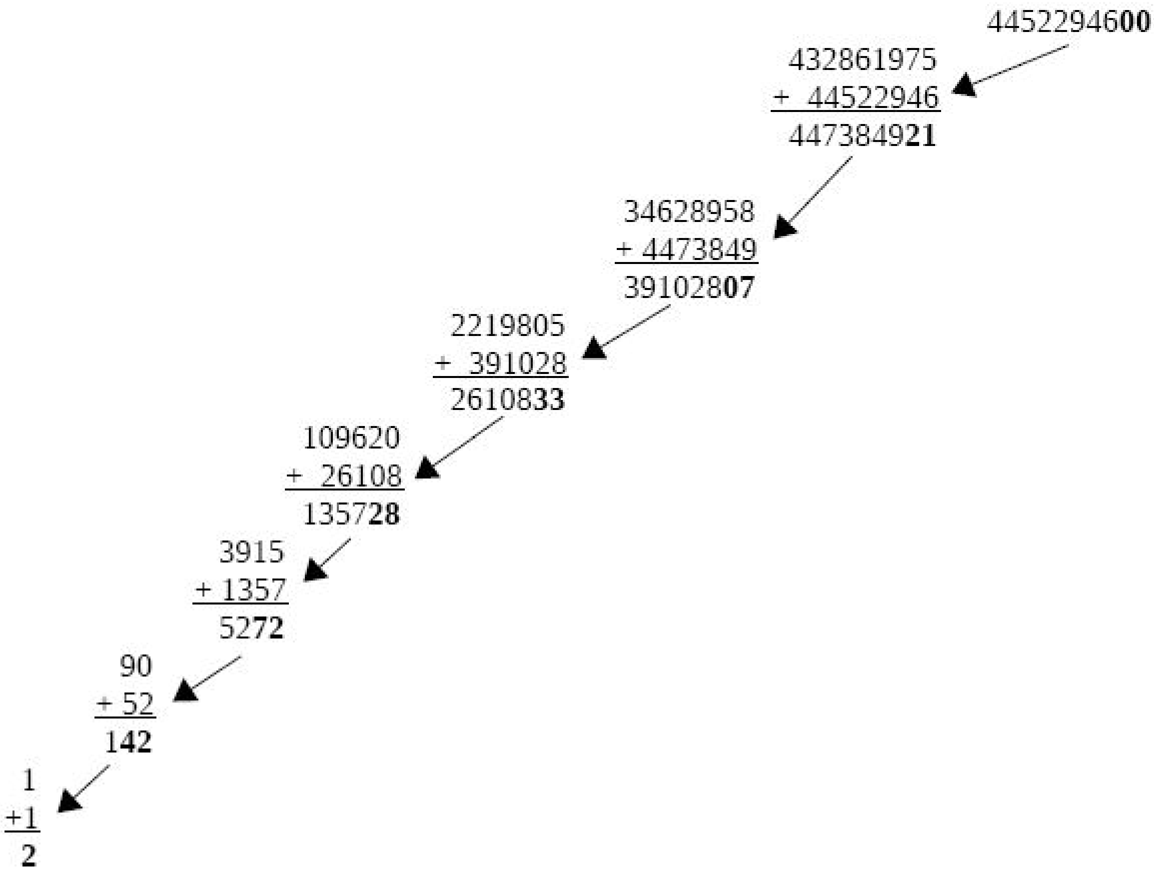
$(1.03)^{30}$
a = 1
b = 3
b/a = 3

start with					1
1	*	30	/	1	= 30
30	*	29	/	2	= 435
435	*	28	/	3	= 4060
4060	*	27	/	4	= 27405
27405	*	26	/	5	= 142506
142506	*	25	/	6	= 593775

593775 * 24 / 7 = 2035800

terms	1	3	9	27	81	243	729	2187
factors	1	30	435	4060	27405	142506	593775	2035800
products	1	90	3915	109620	2219805	34628958	432861975	4452294600

collect two digits at a time because 03 has two digits & carry over:



So our answer is 2.42725833 * 1,000 = $2,427.25833 or $2,427.26. We would be off by 2 cents, so we needed more terms to get the required resolution. The answer we got is fairly close considering we didn't require a calculator or a log table to determine a number raised to the thirtieth power. The number of terms is determined by how accurate you need the precision of the answer to be.

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NEWS

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VEDIC MATHS AT PRIMARY LEVEL

We are delighted to inform you of a new initiative for teaching maths the Vedic way for pupils in the first few years of school. Until now the Vedic system has been taught to pupils aged 7 years and older, but Vera Stevens in Australia has structured a beautiful and easy course that means Vedic Mathematics can be taught from the first year in school.

This is not the well-known Vedic methods simply taught at an earlier age, but a new holistic way of teaching numbers that fits perfectly with the Vedic ideals of simplicity and directness, and which leads naturally to the more advanced work with which you may be familiar.

Vera has been teaching her system for many years and has had extraordinary success with all abilities and ages of children, including those with special needs. We will bring you more in a future newsletter.

Vera can be contacted at: vera.stevens@bigpond.com

FREE ONLINE COURSE

A **free online certificated course** to teach the Vedic system is being offered through E-gurukul.net. You will be able to access the lessons from anywhere in the world at a time that suits you. It will start on 2nd October 2011.

The 36 audio-visual lessons are given by Kenneth Williams and the course includes various assignments. To find out more and to apply for this course please follow this link: http://e-gurukul.net/portal/?p=808

FREE BOOK

One of the most popular books on Vedic Maths is the “Vedic Mathematics Teacher’s Manual – Elementary Level”. This can now be read and downloaded on our website at http://www.vedicmaths.org. The book is for teachers or parents of children in grades 3 to 7 who wish to learn the Vedic system and teach it, but is also suitable for anyone wanting to learn Vedic Maths. Revised edition 2010.

PRACTICE SHEETS ANSWERS

The set of 14 free practice sheets at: http://www.vedicmaths.org/Practice/Practice.asp now all have answers included.

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Your comments about this Newsletter are invited.
If you would like to send us details about your work or submit an article or details about a course/talk etc. for inclusion, please let us know on news@vedicmaths.org

Previous issues of this Newsletter can be viewed and copied from the Web Site: www.vedicmaths.org
Please pass a copy of this Newsletter on to anyone you think may be interested.

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Visit the Vedic Mathematics web site at: http://www.vedicmaths.org
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