DSA

Alternate Base Systems
for Cross-Curricular Fun & Engineering Applications

OVERVIEW OF WHAT BASES ARE

INTRODUCTION
Humans use number systems as symbols for amount or quantity. There are all kinds of different ways to count. The simplest number system is a "tally-mark"one-to-one, or unary, correspondence between something like animals in herds and sticks or stones in piles; or, maybe a person's own hands (two) or fingers (five or 10) are used as symbols to represent quantity. Quantity can also be represented by written symbols.

One kind of system of counting is a *base* or radix system. A specific *base* is defined by the number of unique items which we count before we start over. For example, in a *unary-base* system of tallies, each tally represents one thing. We make a new tally, or start over, each time we count something new; 100 tallies for 100 things. In our daily lives we use multi-radix or *multiple-base* systems (ex. time: minutes, hours, days, weeks). We also use place-value counting systems, with a zero (0, 1, 2, 3, 4, . . .). The latter are the easiest and most efficient, used throughout the world today.

Place-value systems can have any *base*. Examples of Alternate Base Systems used to write numbers are: the Decimal system (10s), Binary (2s), Octal (8s), Dozenal (12s), Bill Lauritzen's Future base-12 system, Hexadecimal (16s), Vigesimal (20s, used by the ancient Mayans) and Sexagesimal (60s, used by the ancient Babylonians). Regardless of the sign, symbol, system or base used, the concept of quantity or numbering is the same.

PLACE VALUE
The value of a digit depends on its place in the overall number. Each place to the left is a successive positive power of the base; each place to the right is a successive negative power.

For example, the first place is the ones place; each digit here means only itself. To the left is the base place; this is the base to the first power, times the value of the digit. In our decimal system, this is the *tens* place. Next to the left is the base to the second power, times the value of the digit. In our decimal system, this is the *hundreds* place. And so on.

METHOD
Method for Converting Integers into any Base: Using the Dozenal Base as an example, below is a method for converting integers from the decimal base to the dozenal base:

1. Divide the number by twelve and set aside the remainder, even if it is 0;
2. Divide the quotient from step 1 by twelve, setting aside the remainder in the same way;
3. Repeat until the quotient is less than twelve; the remainders reversed form the base-twelve number.

Ex. 201 divided by 12 is 16 with a remainder of 9.   16 divided by 12 is 1 with a remainder of 4.
From this we conclude that 201 converted to dozenal base from decimal is 149.

RESOURCE
Introduction to Dozenals by Professor Gene Zirkel
http://www.dozenal.org/drupal/sites/default/files/db38206_0.pdf

EXAMPLES

Here is a number in base-10: 201.
What does it mean? It means:
two one-hundreds,
zero tens, and
one one.

What does this base-10 number, 201, equal in base-12?
It is 149. What does it mean? It means
One gross,
four dozens, and
nine ones.

(A gross is what we call twelve twelves.)

QUESTIONS

What would you do if you got a remainder of 11 in Base 12? ______________________________

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Why do we need two new symbols in order to use Base 12? ______________________________

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Can you think of a multi-radix or multiple-base system besides that which we use to measure time (seconds = base 60, minutes = base 60, hours = 12, days = base 7, weeks = base 52)?

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