UNIT 1 *Base Arithmetic* Teaching Notes

The representation of numbers in binary form has come into general usage only comparatively recently, due to its applications in *logic theory* in the 19th century and in *coding* in the 20th century.

Binary is, of course, the simplest way of representing numbers as it uses just 0 and 1, but it could be argued that it is not very efficient. In fact, a variety of bases and not the usual base 10 were used in early times. For example, the Babylonians essentially used base 60, and this has survived as the measurement used for both time and angles. It is not entirely clear why they used base 60, but it is conjectured that it was because 60 is easily divisible by many small integers.

The use of binary came to prominence with the advent, during the last century (1950 onwards), of electronic (rather than mechanical) number machines, where a particular device is either 'on' or 'off ' (i.e., '1' or '0'). Applications have grown with the development of both hardware and software, although other bases (particularly base 16) have also found application.

Additionally, binary is the building block of both logic theory and Boolean Algebra, and, most recently, the enormous growth in coding is in part dependent on binary type analysis, since again it involves the concept of using just '1' and '0', i.e., 'on' or 'off'. So, clearly, binary is a topic with key modern applications.

Binary has been included here both for its applicability and also for the fact that it underpins basic number theory. It provides a way of revising and reinforcing basic number work, and, above all, it should be an enjoyable and stimulating topic.

Routes		**Standard**	**Academic**	**Express**
1.1	Binary Numbers	✓	✓	✓
1.2	Adding and Subtracting Binary Numbers	✓	✓	✓
1.3	Multiplying Binary Numbers	(✓)	✓	✓
1.4	Other Bases	×	✓	✓

Language	**Standard**	**Academic**	**Express**
Base 2	✓	✓	✓
Binary numbers	✓	✓	✓

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Misconceptions

- it must be understood that in base 2, the only possible digits are 0 and 1 (0, 1, 2 in base 3, etc.), e.g. $1 + 1 = 10$, and not 2.
- the digits must be read in the correct order, e.g. 1 1 0 1 represents

  $$1 \times 8 + 1 \times 4 + 0 \times 2 + 1 \times 1 = 13$$

  and not

  $$1 \times 1 + 1 \times 2 + 0 \times 4 + 1 \times 8 \quad (= 11)$$
- pupils should know that there is no need, when adding, subtracting or multiplying numbers in binary, to first transform them to base 10 and then back to binary.

Challenging Questions

The following questions are more challenging than others in the same section:

	Section	*Question No.*	*Page*
Practice Book Y9A	1.4	8, 10	15