Codes and Ciphers	**UNIT 4** *ISBN Numbers* Lesson Plan 1	*Explanation and Practice*

Activity		Notes

1

Context

T: What information do you need to give when ordering a book?

(Author, title)

T: Is there a more precise way of specifying the book?

(Its ISBN number)

T: ISBN numbers uniquely define every book. An ISBN number always has 10 digits and has four parts,

> • group identifier
> • publisher's code
> • title number
> • check digit

which are separated from one another by a space or a hyphen.

T: For this publisher, how many different titles could be coded?

(1000)

T: If the publisher's code has at least three digits and at most six digits, how many different titles could be coded (using 0 as the group identifier)?

T: Who can give an answer? Please explain your method to the class.

P: We look at each combination.

No of digits in publisher's code	No. of digits in title number	No. of possible titles
6	2	$10^6 \times 10^2 = 10^8$
5	3	$10^5 \times 10^3 = 10^8$
4	4	$10^4 \times 10^4 = 10^8$
3	5	$10^3 \times 10^5 = 10^8$
	Total	4×10^8

Hence there could be 400 million titles.

T: Well done! Is this sufficient to classify all UK-published titles? *(?)*

T: In fact, the UK can use 0 or 1 for the group identifier, giving 800 million titles and there are about 1.3 million titles at the moment!

Also, the publisher's code can actually have up to seven digits and the title number up to six, so this system will last for the foreseeable future!

———— *20 mins* ————

Notes (right column):

Ps should already have knowledge of ISBN numbers but, if not, T will need to explain their purpose.

OS 4.1 is shown to illustrate these components for

ISBN 0 8 5 0 2 0 0 1 4 8

Title numbers from 000 to 999.

Ps spend about 5 minutes working in pairs on this problem. T should intervene if little progress is being made but should give Ps opportunities to show their problem-solving strategies.

T asks volunteer Ps to describe their methods and helps them if necessary. Asks other Ps if they agree/disagree, etc.

T can write headings on board and Ps complete the table.

2

Check digit

T: Like bar codes, ISBN numbers incorporate a check digit. This is how it works.

> Multiply the first nine digits by 10, 9, 8, ..., 2 respectively and find the sum of the resulting numbers.
>
> The check digit is the smallest number that needs to be added to this total so that it is exactly divisible by 11.

(continued)

T puts **OS 4.2** on OHP and/or gives out individual copies for reference.

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Activity		*Notes*
2 (continued)	So for $\boxed{0 \quad 85020 \quad 014 \quad 8}$ you take $0\times10+(8\times9+5\times8+0\times7+2\times6+0\times5)+(0\times4+1\times3+4\times2)$ $\quad = (72+40+12)+(3+8)$ $\quad =124+11$ $\quad =135$ This number is not divisible by 11 $(12\times11=132)$ but adding 8 gives $\quad 135 + 8 = 143$ and this is divisible by 11. Hence 8 is the check digit. ———— *28 mins* ————	A volunteer P completes the OS at OHP, with the class checking. Discussion, with T explaining to Ps how to calculate the check digit.
3	**Practice**: Example (from pupil material) <table><tr><td>Determine the check digit, *a*, for the following ISBN numbers: (a) 1 8699 3100 *a* (b) 0 7135 2272 *a*</td></tr></table> *(9, 1)* ———— *35 mins* ————	If the class is not too confident with this, T can go through part (a) interactively with them and let them do part (b) before reviewing the results. Praising.
4 (continued)	**Errors** T: Check digits are used to ensure that the actual number is not misread. Let's look at what happens of the ISBN number $\boxed{0 \quad 85020 \quad 0148}$ is recorded with just one error in it; for example, suppose it is transmitted (by telephone) as $\boxed{0 \quad 85030 \quad 0148}$ What is the first thing that you can deduce? *(The check digit is now incorrect)* T: Can we be sure of this? *(Not sure!)* T: Let's check it out: P (on board, explaining method while writing): $0\times10+(8\times9+5\times8+0\times7+3\times6+0\times5)+(0\times4+1\times3+4\times2)+8$ $\quad = 0+(72+40+0+18+0) + (0+3+8)+8$ $\quad = 130+11+8$ $\quad = 149 \quad \Rightarrow$ not divisible by 11, so the check digit is wrong. T: Well done. How could we have easily noted this? *(The number changes by $3\times6-2\times6=1\times6$)* T: Can it ever change by 11 with just *one* error? *(No!)* T: Why not? *(11 is prime and has no factors)*	Interactive, whole class activity to encourage Ps to think logically about the possibilities. T chooses an able P to write the calculation in the board. Other Ps help if necessary. T encourages Ps to use logical arguments to answer these questions.

Codes and Ciphers	**UNIT 3** *EAN Bar Codes* Lesson Plan 1	*Explanation and Practice*
Activity **4** *(continued)*	T: Do you understand now why 11 is used for the division? *(Yes!)* ———— *45 mins* ————	***Notes*** The discussion could be broadened by considering the strengths and weaknesses of this design; can Ps devise a design of their own?
	Homework: Activity 4.1 Suggest some reasons for the use of an ISBN check digit of the form described in this lesson.	T should introduce this before setting it for homework to make sure that Ps realise that they are not being asked to complete 100 calculations! There is a pattern.