Codes and Ciphers	**UNIT 2** *Braille* Lesson Plan 1	*Braille*

Activity		*Notes*
		T: Teacher P: Pupil Ex.B: Exercise Book
1	**Introduction**	Whole class interactive discussion.
	T: What code, designed more than 150 years ago, is still used extensively today?	Ps might also suggest Morse code or semaphore.
	T: The system of raised dots which enables blind people to read was designed in 1833 by a Frenchman, Louis Braille. Does anyone know how it works?	Ps might have some ideas but are unlikely to know that Braille uses a 3×2 configuration.
	T: Braille uses a system of dots, either raised or not, arranged in 3 rows and 2 columns.	○ ○ ○ ○ on whiteboard ○ ○ (WB).
	Here are some possible codes:	T puts these three Braille letters on WB.

T: What do you notice?   *(They use different numbers of dots)*

T: We will find out how many possible patterns there are.

———— *10 mins* ————

2	**Number of patterns**	Response will vary according to age and ability.
	T: How can we find out how many patterns there are? *(Find as many as possible)*	
	T: OK – but let us be systematic in our search. What could we first find? *(All patterns with one dot)*	
	T: Good; who would like to display these on the board?	P(s) put possible solutions on the board; T stresses the logical search for these. Agreement. Praising.

(or use **OS 2.1**)

T: Working in your exercise books (with squared paper), now find all possible patterns with just 2 dots.

T: How many have you found?

T (chooses pupil with the largest number of patterns): Draw your solutions quickly on the board and explain how you found them.

T: Well done. Now see how many you can find using 3 dots; work in pairs and work systematically.

T: Here are the possible patterns:

OS 2.1

T: Is it easy now to finish? Why?   *(Yes; symmetry)*

T: 4 dots 'on' is the same as 4 dots 'off', i.e. 2 dots 'on'.
 So how many patterns are there with 4 dots on?   *(15)*

T: 5 dots on?   *(6)*

T: 6 dots on?   *(1)*

(continued) T: We can complete the table now.

Notes column (right):

Allow about 5 minutes for this before reviewing.

It is important to stress the logical and systematic working needed.

They will need 5 minutes for this.

Discuss why there is no need for further investigation.

T asks Ps to put in values.

Codes and Ciphers	**UNIT 2** *Braille* Lesson Plan 1	*Braille*
Activity **2** *(continued)*	**OS 2.2** T: So we have a total of 64 patterns but, in practice, the zero dots pattern is not used, so there are 63. ———— *30 mins* ————	***Notes***

3	**Allocating letters and numbers**
	T: How many letters are there to code? *(26)*
	T: How many digits? *(10)*
	T: What also needs coding? *(Punctuation, capital letters, mathematical symbols, accents, etc.)*
	T: Are 63 patterns enough? *(No)*
	
	T: So how can Braille be adapted so that there are enough patterns?
	T: Braille includes a number sign, a capital letter sign, a letter sign, etc. so that one pattern, for example, ● ○
	                                                                                          ○ ○
	                                                                                          ○ ○
	can represent 1, A and a.
	OS 2.3
	T: Now you can see how it is done!
	———— *40 mins* ————
		Whole class interactive discussion.
		
		Give Ps a chance to think about possible strategies.
		
		A copy of **OS 2.3** is given to each P.

4	**Practice** T: You have just 5 minutes to decode these two messages. **OS 2.4** ———— *45 mins* ————	Copy of **OS 2.4** (Exercise 3 from Pupil Text) for each P. Individual or paired work. Interactive review and discussion.
	Homework Activity 2 Activity 1 (for high achievers)	

UNIT 2 *Braille*

Teacher Resource Material

Key Stage: *3 or 4*

Target: *High-achieving Year 7/8, mainstream Y9, coursework for GCSE*

Teaching Notes

This is a great success story of a code, developed in 1833, and still in extensive use today. The topic provides a challenge for effective design and will stimulate worthwhile and productive discussion. Many pupils will have some ideas about the topic but little knowledge of the details. Starred (*) questions are identified as the most challenging.

Solutions and Notes (*For diagrams in this unit we use black circles to represent the raised dots and white circles for the blank spaces.*)

Exercise 1 There are $2^6 = 64$ different configurations; there are two distinct approaches to deducing this result, namely

(i) *mathematical logic*: Start with just two dots, where there are clearly 4 possible configurations,

Now add a third dot, which will give 2×4 possible configurations as the third dot is either 'on' or 'off'.
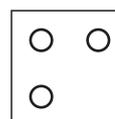
Similarly with a fourth dot, we have $2 \times 2 \times 2 \times 2 = 16$ possible configurations.
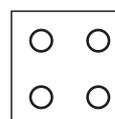

For *n* dots, there would be 2^n possible configurations.

For Braille, $n = 6$ and so there are $2^6 = 64$ possible configurations.

The advantage of this method is that we have not only solved the problems for the Braille system of dots, but for *any* system (this is helpful for Exercise 2).

(ii) *method of exhaustion (or systematic search)*: The best method here is to consider possible configurations with just *one* dot; with Braille there are clearly 6 of these.
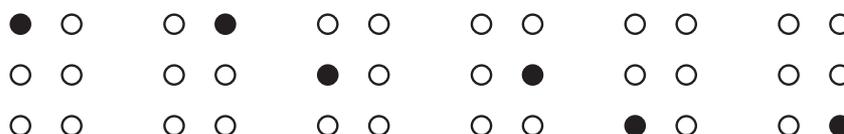
Then consider using just two dots in a systematic way.

The final table, which is symmetric, is given here.

(Note that the configuration in which no dots are 'on' is not used, which means that the answer is 63.)

No. of dots	No. of possible configurations
0	1
1	6
2	15
3	20
4	15
5	6
6	1
Total	64

UNIT 2 *Braille*   Teacher Resource Material (continued)

Exercise 2 (a)   Punctuation symbols; capital letters, mathematical symbols, common words, etc.

         (b)   If each of the letters has to have two versions, lower case and capital, and if you include digits $0 - 9$, punctuation and mathematical symbols, the total is more than 63.

         (c)   Not as it stands but you can overcome the problem by having KEY symbols for 'number', 'capital letter', etc.

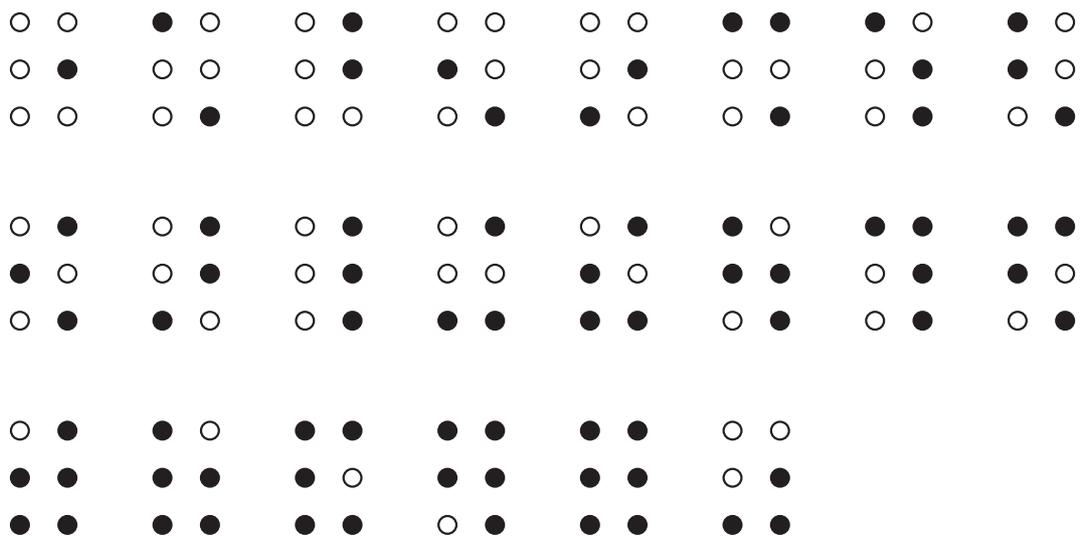*Activity 1*   Using the formula for *n* dots (whatever their display pattern),

$$\text{no. of configurations} = 2^n - 1$$

we can calculate the results, giving

    (a) $2^3 - 1 = 7$

    (b) $2^4 - 1 = 15$

    (c) $2^5 - 1 = 31$

    (d) $2^9 - 1 = 511$

    (e)* $2^{n+2} - 1$

    (f)* $2^{n+m} - 1$

Exercise 3 (a)   God save the Queen

         (b)   meet me at 1600 hours

Activity 2 (a)   There are 22 missing patterns; these are given below.

```
○ ○    ● ○    ○ ●    ○ ○    ○ ○    ● ●    ● ○    ● ○
○ ●    ○ ○    ○ ●    ● ○    ○ ●    ○ ○    ○ ●    ● ○
○ ○    ○ ●    ○ ○    ○ ●    ● ○    ○ ●    ○ ●    ○ ●


○ ●    ○ ●    ○ ●    ○ ●    ○ ●    ● ○    ● ●    ● ●
● ○    ○ ●    ○ ●    ○ ○    ● ○    ● ●    ○ ●    ● ○
○ ●    ● ○    ○ ●    ● ●    ● ●    ○ ●    ○ ●    ○ ●


○ ●    ● ○    ● ●    ● ●    ● ●    ○ ○
● ●    ● ●    ● ○    ● ●    ● ●    ○ ●
● ●    ● ●    ● ●    ○ ●    ● ●    ● ●
```

UNIT 2 *Braille*

Teacher Resource Material (continued)

Activity 2 (continued)

(b) Mathematical symbols and more punctuation; also commonly used words, for example,

and	for	of	the	with
● ●	● ●	● ○	○ ●	○ ●
● ○	● ●	● ●	● ○	● ●
● ●	● ●	● ●	● ●	● ●

Detailed Lesson Plans are provided to help teachers in their delivery of interactive whole-class teaching.