

Codes and Ciphers	UNIT 1 <i>Substitution Ciphers</i> Lesson Plan 2	<i>Substitution Ciphers</i>
<p>Activity</p> <p>1A</p> <p>1B</p> <p>1C</p> <p>Extension</p>	<p>Martian alphabet</p> <p>T: The Martian alphabet has only 3 letters:</p> <p style="text-align: center;">  </p> <p>How many different substitution ciphers can you find for the Martian alphabet? I'll give you 5 minutes to work out the answer.</p> <p>T: Who thinks that they have the correct answer? (6) How did you work it out?</p> <p>T: The Venusian alphabet is similar but has one extra letter, namely  .</p> <p>How many different substitution ciphers can you find for the Venusian alphabet? Don't write them all down - use the answer for the Martian alphabet to help you.</p> <p>T: Write your answer on your slate/mini-whiteboard: show it now! (24)</p> <p>T: Why 24? (4 × 6)</p> <p>T: Now we can deduce the answer for an alphabet with 26 letters. What is it – as an expression? (26 × 25 × . . . × 2 × 1)</p> <p>T (to P): Write the expression on the board.</p> <p>T: In fact, its value is 403 291 461 126 605 635 584 000 000 which is a little over 400 million million million million.</p> <p>T: What about an alphabet with n letters - how many different substitution ciphers will there be? ($n \times (n - 1) \times \dots \times 2 \times 1$)</p> <p>T: Well done; for convenience, we write this as</p> $n! = n \cdot (n - 1) \cdot (n - 2) \dots 2 \cdot 1$ <p>$n!$ is pronounced 'n factorial'.</p> <p>T: What is the answer using the 'factorial' symbol for the Venusian alphabet? (4!) And for the English alphabet? (26!)</p> <p style="text-align: right;">20 mins</p>	<p style="text-align: center;">Notes</p> <p>Ps work in pairs: T monitors progress, intervening if necessary. Ps write in Ex.Bs.</p> <p>Ps have probably listed all possibilities. Discussion.</p> <p>T must encourage more mathematical thinking so introduces an extra letter.</p> <p>T monitors and gives just one hint.</p> <p>T checks which Ps have incorrect answers; discussion to find reasons for their mistakes.</p> <p>Agreement. Praising.</p> <p>Interactive, whole-class discussion.</p> <p>This need not be covered but it is a helpful way of writing a complex sum briefly and clearly.</p>
<p>2</p> <p>(continued)</p>	<p>Substitution ciphers</p> <p>T: What does this message say</p> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"> ZHCVHYP NYDCTG SJL GCMO </div> <p>T: Has anyone decoded it?</p> <p>T: How can we tackle this problem? (With frequency)</p> <p>T: Good idea. Before we do that, let's first review your homework.</p>	<p>Ps work individually or in pairs. T gives class 4 or 5 minutes to see if they can crack the code. Praise if anyone has succeeded, otherwise leave until later.</p>

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Activity 2 (continued)	<p>T: Who agrees with the order E T A O for the first four letters?</p> <p>T: What are the next four letters? <i>(Possibly N R I S)</i></p> <p>T: In fact, overall, in most extended passages of English text, the letter frequency is E T A O N R I S H D L F C U M G P Y W B V K X J Q Z Use this to help decode the message above.</p> <p>T: What is the message?</p> <p>T: Well done! <i>(JANUARY BRINGS THE SNOW)</i></p> <p style="text-align: right;">30 mins</p>	<p style="text-align: center;">Notes</p> <p>Interactive discussion on rank order of letter frequency; let Ps display their first 10 letters in descending order of frequency, on the board.</p> <p>OS 1.4</p> <p>T gives Ps a few more minutes; monitors work, giving helpful hints, etc.</p> <p>Agreement, self-correction. Praising.</p> <p>T encourages Ps to discuss their approach.</p>
3	<p>Challenge</p> <p>T: Working in pairs, look at the code on OS 1.5. Use all the facts you have learnt to help you to decode the message and to find the complete substitute alphabet.</p> <p>T: What progress have you made? What letters are you sure about?</p> <p>T: Your task is to decode the passage. You can though use some hints if you think that you need them. You need to complete the task for homework.</p> <p style="text-align: right;">45 mins</p>	<p>At this stage Ps are just given OS 1.5 and the letter frequency table.</p> <p>T monitors progress but does not help.</p> <p>T intervenes after 10 minutes.</p> <p>Interactive discussion, but T still does not give help.</p> <p>T can give Hints 1-3 and Hints 4-6 in separate sealed envelopes (they are listed separately on OS 1.6 and OS 1.7).</p>
	<p>Homework</p> <p>Complete the task of decoding the passage. Can you complete the substitution cipher? If not, why not?</p> <p>Extension</p> <p>Use the internet to find the letter frequencies in other alphabets, e.g. Welsh.</p>	