The Caesar Cipher

Julius Caesar and his generals used shift codes to move the alphabet along by a certain number of places. The number of places is called the **offset**.

Example 1. All the letters have been moved up two in this code. The offset is 2. A in the message is C in code, B is D in code, C is E and all the way to Z which B in code. This is a message written in code:

VJKU KU CP GCUA QPG VQ IGV AQW UVCTVGF

To decipher the code we have to move the letters two places back in the alphabet.
So G in code is E in the message, C in code is A, U is S and A is Y so the word GCUA is EASY. Find out what the rest of the code says.

Example 2

This message has been encoded with an offset which is the solution to the equation: $13x - 7 = 4x + 83$. Work out the offset and decode the message.

IYE KXN IYEB DOKW KBO BOKNI DY WOOD DRO MYEXD YX EC MRKVVOXQO

Example 3

This coded word is made from the solutions to a set of equations. Find the solution and make the coded message using A=1, B=2, C=3 etc. The final equation tells you the offset. Now decode the word and look them up on the internet adding 'maths' to your search.

- $5x - 1 = 19$
- $2x + 1 = x + 17$
- $3x - 2 = x + 36$
- $2 - x = 3x - 46$
- $7x - 13 = 6x + 13$
- Offset: $x^2 + 49 = 14x$

When you have completed the practice examples on this page, make codes for your team and challenge them to break them.
Use: http://www.simonsingh.net/The_Black_Chamber/caesar.html to help you.

Algebra

This page is designed to show you the hardest possible things you will need to solve in the tournament! Don't worry if you cannot do them yet or even don't know what they mean. You should use this as a guide to help you practice.

You must be able to solve all equations of these types:

Linear Equations: $3x + 7 = 5x - 11$; $\frac{2}{x} + 7 = -2$

Quadratic Equations (factorisable) $x^2 - 2x - 12 = 6 + x$

Exponential Equations $3^x - 11 = 70$

You must be able to rearrange and substitute into formulae:

- Find the coefficient of x when R is the subject of: $3x + 2R = 5x - R$
- Find the value of a when $A = 24$, $b = 7$ and $h = 3$ in $A = \frac{1}{2}h(a + b)$
- The coefficient of x when we multiply out $(2x + 3)(5x - 2)$

You must be able to identify values in sequences:

- Find u_7 where $u_n = 2^n - 3$
- If $u_1 = 7$ and $u_{n+1} = 3u_n + 1$ what is u_4
- Find the 8th term in the sequence: 3, 7, 12, 19, …
- Find the fourth term in the Fibonacci sequence: 2, …, …, …, 28

You must be able to find the gradient and y –intercept of lines specified in other forms:

- Find the gradient and y –intercept of the line $2 - 3x + 7y = x - 2y + 13$

Practice your algebra:

1. Using the Algebra Practice activities on the next pages.
2. By making and solving Tarsia puzzles.
3. Using GeoGebra.
    a. Download the software at www.geogebra.org
    b. In the view options choose CAS
    c. For example, type this: solve(x^2+5x+6=0) and press return
    d. Try different equations. Experiment. Explore!

Algebra practice (easiest, but still quite tough!)

Print a copy of this page. Cut out the pieces. Match the question to the answer.

Question	Question	Answer	Answer
$5x + 3 = 43$	$\frac{1}{x} = \frac{1}{13}$	34	20
Find the sixth term in the Fibonacci sequence: 1, 1, 2, …,…,…	The coefficient of x in this expression: $5x + 2d - 2x = 1$	13	10
$\frac{x}{3} = 7$	Find the 6th term in the sequence: 2,5,8,13,…	5,1	7
Find the value of V when $I = 2$ and $R = 10$ in $V = IR$	$x^2 - 7x + 12 = 0$	8	9
If $u_n = 2n - 1$ what is u_4	$7x - 5 = 58$	11	8
The gradient and y-intercept of the line $y = 2x + 3$	The coefficient of y when simplified $3y + 2 = 1 - 7y$	21	3,4
$(x - 5)(x - 1) = 0$	$4x - 22 = 2x$	9	3
$3^x = 9$	The coefficient of x multiplied out $3x(2x + 3)$	2	2,3

Algebra practice (Middle)

Print a copy of this page. Cut out the pieces. Match the question to the answer.

Question	Question	Answer	Answer
Find u_3 where $u_n = n^2 + 8$	$x^2 - 5x + 7 = 1$	7	4,5
$\frac{x}{3} + 1 = \frac{x}{2}$	Find the fifth term in the Fibonacci sequence: 1, 3, …, …, …	4	34
The gradient and y –intercept of the line $8x + 14 = 2y$	$\frac{20 + x}{x} = 5$	8	6
Find the 7th term in the sequence: 2,3,5,8,…,…,…	$2^x - 3 = 125$	17	12
$3x + 17 = 9x - 7$	The coefficient of x when we multiply out $(3x + 2)(5x + 1)$	3	2,3
If $u_1 = 3$ and $u_{n+1} = u_n + 1$ what is u_6	Coefficient of x when simplified $7x - 2b = 3c - 5x$	5	13
$x^2 - 5x + 10 = 2x$	$3x - 17 = 7 - 5x$	12	4,7
Find the value of v when $u = 2$, $a = 10$ and $t = 1$ in $v = u + at$	The gradient and y –intercept of the line $3y - 5 = 12x$	11	2,5

Algebra practice (Hardest)

Print a copy of this page. Cut out the pieces. Match the question to the answer.

Question	Question	Answer	Answer
The gradient and y –intercept of the line $3 - 7x = 15 - x - 3y$	The coefficient of x when we multiply out $(6x + 7)(5 - 3x)$	1	25
$x^2 - 3x + 7 = 2x + 1$	Find the third term in the Fibonacci sequence: …, 3, …, …, 11 •	2,5	6
$-99 = 26 - 5^x$	$\frac{x}{3} - 2 = \frac{x}{5}$	2,4	9
Find the value of t when $v = 20$, $u = 4$ and $a = 8$ in $v = u + at$	Find u_6 where $u_n = 2n^2 - 65$	5	7,4
$8x - 4 = 5x + 11$	$x^2 - 8x + 28 = 3x$	20	2
If $u_1 = 2$ and $u_{n+1} = 4u_n - 3$ what is u_3	Coefficient of M when y is the subject $\frac{3y - 7M}{2} = 9M + y$	4	15
Find the 6th term in the sequence: -15,-12.-7,0,…	$2^x + 11 = 75$	3,2	3
$3 + \frac{4}{x} = 7$	The gradient and y –intercept of the line $-8x = 20 - 4y$	17	7