Code Resources Pack

Introduction:

Codes are a great way to show students some real life applications of mathematics (and possible career paths for mathematicians, as well as being a fun lesson. The following resources can be adapted for all abilities – either as stand-alone lessons or as 15 minute activities.

I’ve written a sample 2 lesson plan to give an idea of what can be done. I’ve included all hyperlinks, downloadable content and hosted the video content on <http://ibmathsresources.com/2013/05/31/cracking-codes-lesson/> - so this will be useful to look at. Cryptography Super Sleuth department is linked there for example – and is another TES resource which is well worth downloading.

**NEW: I have just created an online code challenge** [**http://ibmathsresources.com/code-challenge/**](http://ibmathsresources.com/code-challenge/) **aimed at KS3 students. There are 5 codes to crack – once the first one is broken, it gives a password which allows the students to access the next page. This would work really well as a homework activity – I also have a leaderboard which I will be updating with all those who successfully complete it!**

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**Lesson Plan Example:**

**Lesson 1:**

**Introduction: 5 minutes** – Use a Morse Code Generator (http://www.glassgiant.com/geek/morse/) to play some (very slowed down) messages for students to decode.  Discuss why this is was a good way to transmit data in the past.

**Brainstorm: 5 minutes –** Why are codes important?  Who uses them?  Why do mathematicians go into this career?  Look at all data transmission – TVs, internet, mobile phones.  Discuss the picture at the top of the page - this was transmitted from Mars – which is on average 225 million km from Earth (why on average?)  So, how can we transmit data across such a huge distance?

**Video: 10 minutes:**  Watch Marcus De Satouy video explaining codes (stop around 8.30):<http://www.youtube.com/watch?v=ecZuVBhH_iY&feature=player_embedded>

**Worksheet:  Between 30 mins and 50 minutes depending on ability and hints -** Give out code challenge worksheet – Murder in the Maths Department.  Working in groups of 2-3.  Students will probably need direction – but try to limit this to a minimum to encourage problem solving.  (First students to finish should create their own coded messages for each other).

**Lesson 2:**

**Binary Codes Introduction: 5 minutes** -  Can we see the link between binary codes and Morse codes?  Why are binary strings good for sending data?  Link back to Mars picture.  Talk about SETI – what is SETI (Search for Extra-Terrestrial Intelligence), what do they do?  (Scan sky looking for non-random data strings)

**Binary Code Worksheet: 25 minutes** - Students need to convert the binary string codes into pictures.

**Extension material: 25 minutes –** Handout Vignette Cipher, ISBN codes and Credit Card Codes for top ability students

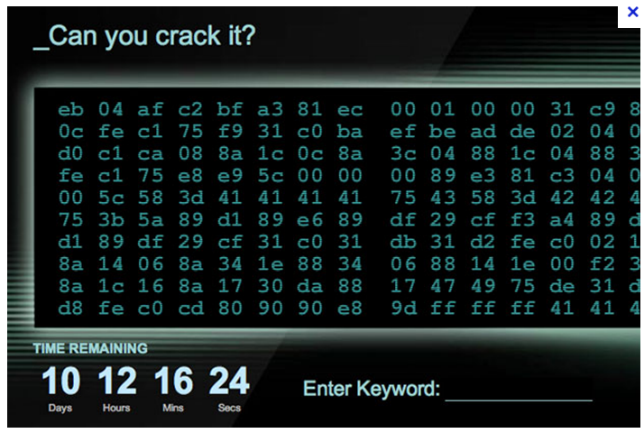
Why study codes in maths?



There is a long history of mathematicians being used in code making and code breaking - the most famous is probably the Bletchley Park code breakers, where some of the most brilliant mathematicians in the country such as Alan Turing worked in secret to crack the German WWII Enigma code.  The picture above shows an Enigma machine. The code was so complicated that the Germans were confident that it was unbreakable, however the men and women at Bletchley Park were able to crack it using incredible ingenuity. This meant that the allies were able to intercept and understand German communications – a huge breakthrough in the war.

Codes now play an integral part in all our lives - from the ISBN codes on the back of every book you buy, to the algorithm that checks if the credit card you've entered is genuine, from the encrypted data sent via the internet to the content you watch on digital TV.

Mathematicians are employed throughout a wide range of industries that send and transmit data – in particular the telecommunications industry and internet companies. Their challenge is to condense the data that needs to be sent to as small a file as possible – whilst also allowing potential errors in communication to be noticed by the receiver. As coding now goes hand in hand with computing skills, good mathematicians are highly sought after for computing courses at top universities around the world.



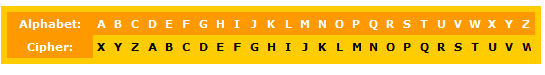
There is also still a need for the traditional code makers and code breakers. Highly sensitive data needs to be encrypted to prevent it from falling into the wrong hands – whilst our spies need to be able to crack the codes of other countries.Indeed, GCHQ (the British Intelligence Agency responsible for digital communications) last year recruited new employees by posting a code online.  Crack the code and you secured yourself an interview.

Therefore codes and coding theory represents a varied and interesting career path for good mathematicians.  Get cracking!

Caesar Shifts

The Caesar Shift is one of the simplest codes we come across in cryptography. It is a substitution code, which means that each letter is replaced with another one. The code is named after the Roman Emperor Julius Caesar who use this method to send military messages to his army.

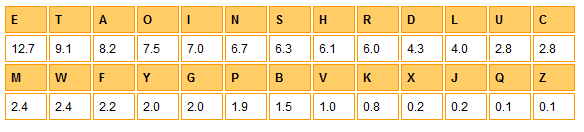
To encrypt or decrypt a Caesar shift we first list the alphabet, and then for a Caesar shift of three, we move every letter of the alphabet 3 places:



Here we would decode A as X, B as Y etc. So the message KHOOR translates to HELLO.

Caesar shift codes can be easily broken by conducting simple frequency analysis. If you count the frequency of each of the letters in the code, you can then compare these frequencies with how often they appear in English.

Looking at the frequencies we can see that:



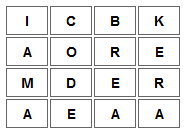
So, in a long message we would expect the most frequent code letter to correspond to E. That would be enough to crack the code. If that doesn’t work, try T or A etc. Try and decode these 2 messages:

1. ZLKDOXQRIXQFLKP VLR EXSB ZOXZHBA QEB ZXBPXO PEFCQ ZLAB
2. DOHA PZ AOL MPMAO AYPHUNBSHY UBTILY

Transposition Ciphers

Transposition Ciphers are based on a simple idea, but are more difficult to crack that codes like the Caesar shift. A transposition means that the letters of the code are simply rearranged into a different order.

For example, ICBKAOREMDERAEAA, can be rearranged into rows of length 4 to give:



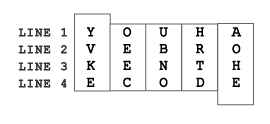
The message is then read from down the columns – I am a codebreaker.

Try and solve:

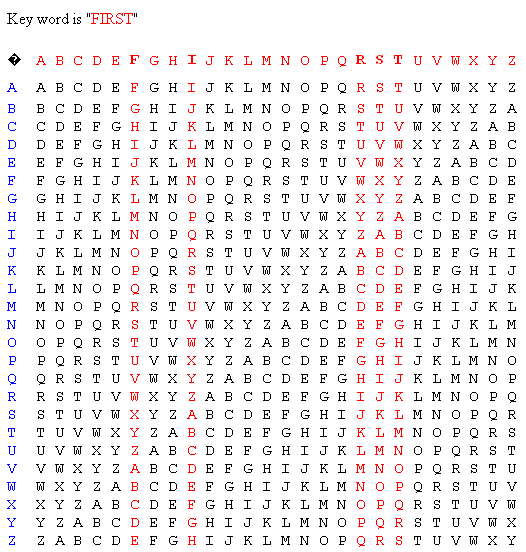
1. TIOICCBKTHSRFUORIEIAEFLDENSSMDITEAGT ( make 4 rows of length 9)
2. WTFRUELEHQRHIOSADUITUEASUQRPSGSAD (make 3 rows of length 11)

Another transposition Cipher used by the Romans was called the Scytale. This involved putting a message on a strip of paper that could only be read when wrapped around a rod of a given length. An example is given below:





Vigenere encryption

The Vigenere encryption was the creation of the French diplomat, Blaise de Vigenere in the 1500s. It combines multiple different Caesar shifts – and so is much more difficult to crack using frequency analysis. First you need to choose a keyword. The example below uses the keyword “FIRST” - so it uses five different Caesar shifts, for F, I, R, S and T.  


So for example with the codeword: BPFAG AMELX IKRDV ZTLK

With the first letter B, we look down the F column – and find B. Then look across to the far left column - this gives us W. Next we decode P by finding it in the I column, then looking across to the far left column – this will give H. Next we use the R column and look for F, and going to the far left column we get O. If we carry on with this method we get: WHO INVENTED CALCULUS?

1. **BPRLB XBYWM JVKZY NJFFT HKZFN RJVJ** (also encrypted with keyword FIRST)
2. **TOPTS ZYLLU ANWZA ZAWHQ**(encrypted with the keyword MATHS)

**ISBN CODES**



This is an ISBN code – it’s used on all books published worldwide. It’s a very powerful and clever code, because it has been designed so that if you enter the wrong ISBN code the computer will immediately know – so that you don’t end up with the wrong book. There is lots of information stored in this number. The first numbers tell you which country published it, the next the identity of the publisher, then the book reference.

**Here is how it works:**

Look at the **10 digit**ISBN number. The first digit is 1 so do 1x1. The second digit is 9 so do 2x9. The third digit is 3 so do 3x3. We do this all the way until 10x3. We then add all the totals together. If we have a proper ISBN number then we can divide this final number by 11. If we have made a mistake we can’t. This is a very important branch of coding called error detection and error correction. We can use it to still interpret codes even if there have been errors made.

If we do this for the barcode above we should get 286. 286/11 = 26 so we have a genuine barcode.

**Check whether the following are ISBNs**

1) 0-13165332-6

2) 0-1392-4191-4

3) 07-028761-4

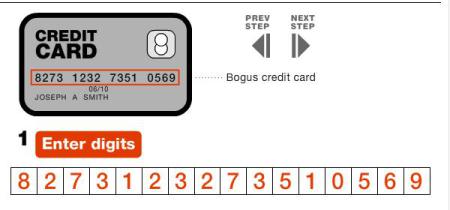
**Challenge (hard!) :**

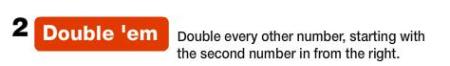
The following ISBN code has a number missing, what is it?

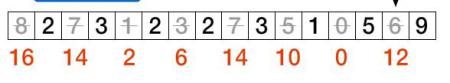
1) 0-13-1?9139-9

**CREDIT CARD CODES**

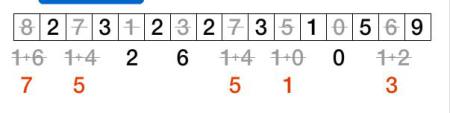
Credit cards use a different algorithm – but one based on the same principle – that if someone enters a digit incorrectly the computer can immediately know that this credit card does not exist.  This is obviously very important to prevent bank errors.  The method is a little more complicated than for the ISBN code

[](http://1millionmonkeystyping.files.wordpress.com/2013/05/creditcard2.jpg)

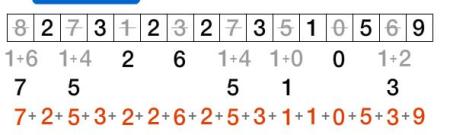
[](http://1millionmonkeystyping.files.wordpress.com/2013/05/credit-card-4.jpg)

[](http://1millionmonkeystyping.files.wordpress.com/2013/05/creditcard3.jpg)

[credit card 6](http://1millionmonkeystyping.files.wordpress.com/2013/05/credit-card-6.jpg)

[](http://1millionmonkeystyping.files.wordpress.com/2013/05/credit-card-5.jpg)

[credit card 8](http://1millionmonkeystyping.files.wordpress.com/2013/05/credit-card-8.jpg)

[](http://1millionmonkeystyping.files.wordpress.com/2013/05/credit-card-71.jpg)

[](http://1millionmonkeystyping.files.wordpress.com/2013/05/credi-card-9.jpg)

Try and use this algorithm to validate which of the following 3 numbers are genuine credit cards:

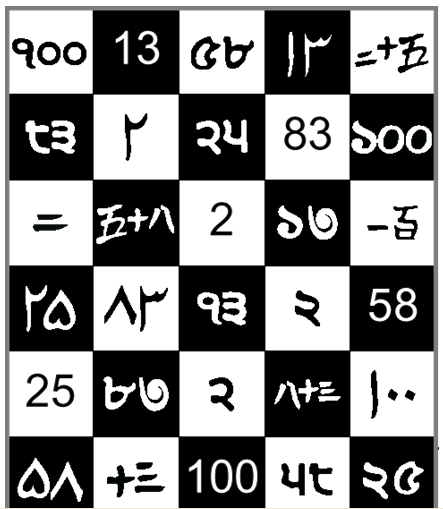
1) 5184 8204 5526 6425

2) 5184 8204 5526 6427

3) 5184 8204 5526 6424

**Enrich number puzzle**

There are 6 different numbers written in 5 different scripts. Can you find out which is which?



NASA, Aliens and Binary Codes from the Stars

SETI – the Search for Extra Terrestrial Intelligence – has spent the past 50 years scanning the stars looking for signals that could be messages from other civilisations. They look for non-random patterns in data strings that might suggest an advanced culture on another planet.

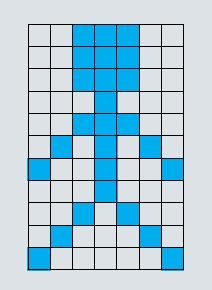
The desire to encode and decode messages is a very important branch of mathematics – with direct application to all digital communications – from mobile phones to TVs and the internet.

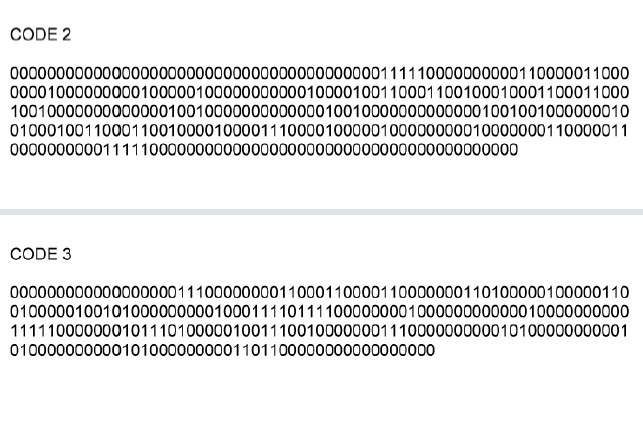
All data content can be encoded using binary strings. A very simple code could be to have 1 signify “black” and 0 to signify “white” – and then this could then be used to send a picture. Data strings can be sent which are the product of 2 primes – so that the recipient can know the dimensions of the rectangle in which to fill in the colours.

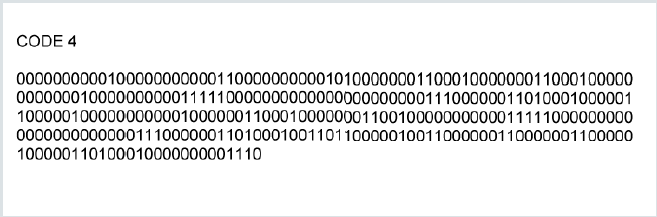
If this sounds complicated, an example:

code3

If this mystery message was received from space, how could we interpret it? Well, we would start by noticing that it is 77 digits long – which is the product of 2 prime numbers, 7 and 11. Prime numbers are universal and so we would expect any advanced civilisation to know about their properties. This gives us either a 7×11 or 11×7 rectangular grid to fill in. By trying both possibilities we see that a 7×11 grid gives the message below.

[](http://1millionmonkeystyping.files.wordpress.com/2013/03/code2.jpg)





**Can you solve the puzzle to find the hidden sentence?**

**For the puzzle use**

**X = 2**

**Y=3**

**Z= -1**

First generate some numbers by substituting the above values into the expressions below. Then convert those numbers into letters using the alphabet converter.

First word: 7y + x, 2y + x, -z, 2(4y+2z)

Second: 5x+z, -y+11x

Third: 7y+z, 4x, 2y+z

Fourth: Y2+3z, y2, x2 +y2 + x + y, (z)2 + x4 +x, 7y + z

Fifth: 2x3+y, 2y2+z, 7y, -z, (y+x)2 + 7z, (x+y)

Sixth: (y+z)4 + 2z, 7y, -13z, -2z, x+y, 2y2

Convertyour numbers into a hidden message, using the alphabet

A=1, B=2, C=3, D=4, E=5, F=6, G=7, H=8, I=9, J=10, K=11, L=12, M=13, N=14, O=15, P=16, Q=17, R=18, S=19, T=20, U=21, V=22, W=23, X=24, Y=25, Z=26

What is the hidden message? And what is the answer?

**Code Challenge**

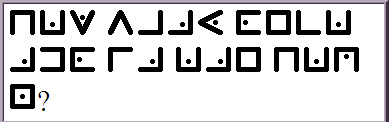
**Quick! The evil villain Dr No has stolen a nuclear bomb. The timer is ticking. The government have called on you, knowing that your maths problem solving skills will come in handy. You are humanity’s last hope – don’t let everyone down! The Bomb has an eight number display. You must enter the correct eight digits – or BOOM!**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |

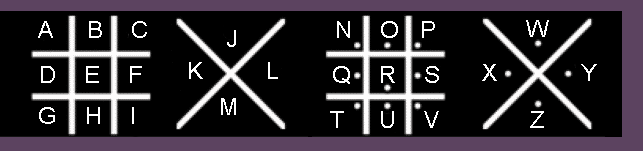
**(1)**



(2)



Clue:



(3)

**TEXQ FP PBSBK QFJBP BFDEQ**

**Clue: **

**A goes to D**

**Use Frequency Analysis to Crack the Code.**

You are a detective hunting Jack Black – an infamous jewel thief. However, his girlfriend has written a diary entry in code. You suspect that it will reveal where Jack is. If you can crack the code, you can catch him! Quick!

GITW JAJ XRH PIQW AXHR HEK RCCATK; EK YRIUJKJ HEK YBO IH HEK TRUXKU. EK PKXH HR HEK IAUZRUH. EK HROOKJ EAO YUAKC TIOK AX HEK HUIOE. EK QRRWKJ IH I FIZ RC HEK PRUQJ, YRBSEH I HATWKH HR ZIUAO, IXJ XKNKU QRRWKJ YITW.

Most frequent letters in the alphabet.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **E** | **T** | **A** | **O** | **I** | **N** | **S** | **H** | **R** | **D** | **L** | **U** | **C** |
| 12.7 | 9.1 | 8.2 | 7.5 | 7.0 | 6.7 | 6.3 | 6.1 | 6.0 | 4.3 | 4.0 | 2.8 | 2.8 |
| **M** | **W** | **F** | **Y** | **G** | **P** | **B** | **V** | **K** | **X** | **J** | **Q** | **Z** |
| 2.4 | 2.4 | 2.2 | 2.0 | 2.0 | 1.9 | 1.5 | 1.0 | 0.8 | 0.2 | 0.2 | 0.1 | 0.1 |

Most frequent letters in the decoded note.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| E | T | A | O | I | N | S | H | R | D | L | U | B | F | C | P | W | K | G | Y | M | V | Z | X | J | Q |
| 22 | 19 | 16 | 14 | 13 | 10 | 9 | 9 | 7 | 7 | 6 | 6 | 5 | 4 | 4 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |

**Code Challenge (more difficult)**

**Quick! The evil villain Dr No has stolen a nuclear bomb. The timer is ticking. The government have called on you, knowing that your maths problem solving skills will come in handy. You are humanity’s last hope – don’t let everyone down! The Bomb has a three number display. You must enter the correct eight digits – or BOOM!**

|  |  |  |
| --- | --- | --- |
|  |  |  |

**(1)**

**WIEYNMMHSOEPEBATNVRNETHLEIUR**

**Clue: This is a transposition cipher. Write the text in 4 lines of 7, one line under the other. See If you can find the hidden message!**

(2)

XIBU JT UISFF TRVBSFE

Clue: This is a Caesar cipher. You need to see how many letters the alphabet

has been shifted by. Maybe look for which letters occur most often. Maybe these could be vowels!

(3)IHTAAETALKCUTYWDOHAGRNBUW

Clue: This is a Vigenère Cipher – encoded with the key word Maths. Use the grid below to help translate. Look at the M row first. Find I in it as this is the first letter in the code. Now look at the letter above I in the top row. This is the translated letter. Now look at the A row. Find H in it as this is the second letter in the code. Look at the letter above it in the top row again. You continue to cycle through the letters of MATHS



**Cracking RSA Code – The World’s Most Important Code?**

[](http://1millionmonkeystyping.files.wordpress.com/2013/09/code2.jpg)

RSA code is the basis of all important data transfer.  Encrypted data that needs to be sent between two parties, such as banking data or secure communications relies on the techniques of RSA code.  RSA code was invented in 1978 by three mathematicians (Rivest, Shamir and Adleman).  Cryptography relies on numerous mathematical techniques from Number Theory – which until the 1950s was thought to be a largely theoretical pursuit with few practical applications.  Today RSA code is absolutely essential to keeping digital communications safe.

**To encode a message using the RSA code follow the steps below:**

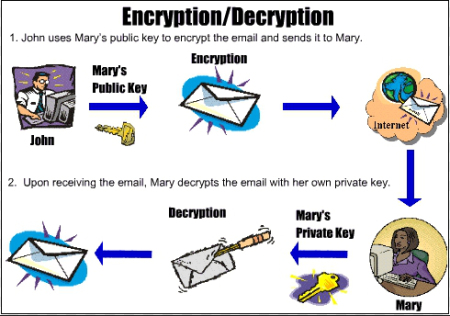
1) Choose 2 prime numbers p and q (let’s say p=7 and q=5)

2) Multiply these 2 numbers together (5×7 = 35).  This is the public key (m) – which you can let everyone know. So m = 35.

3) Now we need to use an encryption key (e).   Let’s say that e = 5.  e is also made public. (There are restrictions as to what values e can take – e must actually be [relatively prime](http://en.wikipedia.org/wiki/Coprime_integers) to (p-1)(q-1) )

4) Now we are ready to encode something.  First we can assign 00 = A, 01 = B, 02 = C, 03 = D, 04 = E etc. all the way to 25 = Z.  So the word CODE is converted into: 02, 14, 03, 04.

5) We now use the formula: C = ye (mod m) where y is the letter we want to encode.  So for the letters CODE we get: C = 025 = 32 (mod 35). C = 145 = 537824 which is equivalent to 14 (mod 35). C = 035 = 33 (mod 35).  C = 045 = 1024 which is equivalent to 09 (mod 35).  (Mod 35 simply mean we look at the remainder when we divide by 35).  Make use of an [online modulus calculator](http://www.miniwebtool.com/modulo-calculator/?number1=537824&number2=35)!   So our coded word becomes: 32 14 33 09.

[](http://1millionmonkeystyping.files.wordpress.com/2013/09/code3.jpg)

This form of public key encryption forms the backbone of the internet and the digital transfer of information.  It is so powerful because it is very quick and easy for computers to decode if they know the original prime numbers used, and exceptionally difficult to crack if you try and guess the prime numbers.  Because of the value of using very large primes there is a big financial reward on offer for finding them.  The [world’s current largest prime number](http://www.reuters.com/article/2013/02/08/us-usa-science-primenumber-idUSBRE9170UO20130208) is over 17 million digits long and was found in February 2013.   Anyone who can find a prime 100 million digits long will win $100,000.

**To decode the message 11 49 41 we need to do the following:**

1) In RSA encryption we are given both m and e. These are public keys.  For example we are given that m = 55 and e = 27.  We need to find the two prime numbers that multiply to give 55.  These are p = 5 and q = 11.

2) Calculate (p-1)(q-1).  In this case this is (5-1)(11-1) = 40.  Call this number theta.

3) Calculate a value d such that de = 1 (mod theta).  We already know that e is 27.  Therefore we want 27d = 1 (mod 40).  When d = 3 we have 27×3 = 81 which is 1 (mod 40).  So d = 3.

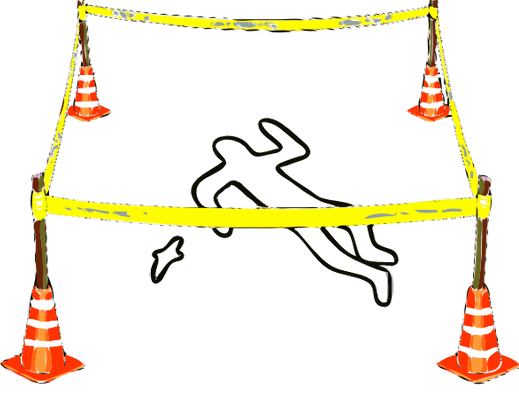
4) Now we can decipher using the formula: y = Cd (mod m), where C is the codeword.  So for the cipher text 11 49 41:  y = 113 = 08 (mod 55).  y = 493 = 04 (mod 55). y = 413 = 6 (mod 55).

5) We then convert these numbers back to letters using A = 00, B = 01 etc.  This gives the decoded word as: LEG.

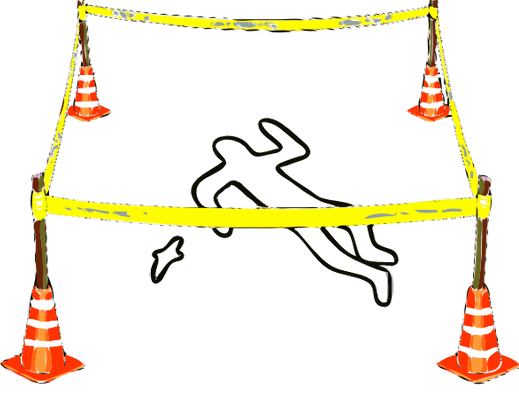
**Maths Murder Mysteries**

These 2 resources have been inspired by the excellent Cryptography Supersleuth Game also on TES here: (http://www.tes.co.uk/teaching-resource/Cryptography-Supersleuth-Game-KS3-Mystery-6022982/ ) so if you enjoy this one, please check that one out as well. I've followed a similar format - a murder in the maths department, with clues to solve to reveal the murderer. I've used different styles of codes to vary things - and I have made the clues such that you can fill in the names of teachers in your department to make it more engaging for students.

Students may need varying degrees of support on the task so make sure you know how to crack all the codes in advance! I think this is accessible for all key stages - high ability year 7s and 8s, and all of year 9s and above. A top set year 11 may be able to work through most of these with minimal guidance - a year 8 class may need plenty of prompts.... Make sure that students have to solve all the codes to win the prize – no guessing half way through!



# Maths Murder Mystery 1



A murder has been committed in the maths department! A body has been discovered surrounded by mathematical objects and only the hardworking maths teachers were in school, doing long division sums for fun at the weekend. So one of them must be the murderer!

Your task, should you choose to accept it, is to find:

1) the murderer

2) the room

3) the murder weapon

Work quickly - who knows who could be next!

**Possible murder suspects:**

1) INSERT TEACHER NAME 1 - who was wearing a white, T-shirt with 2 stripes and ripped jeans on the day of the murder.

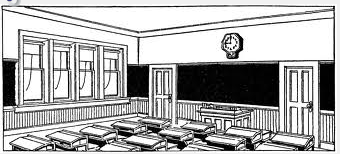
2) INSERT TEACHER NAME 2 - who was wearing a knee-length green skirt, white blouse and gold watch.

3) INSERT TEACHER NAME 3 - who was wearing a blue Adidas T-shirt with 3 stripes on the sleeves, Bermuda shorts and a baseball cap.

4) INSERT TEACHER NAME 4 - who was wearing a black and white pin-stripe suit with shiny black shoes.

5) INSERT TEACHER NAME 5 - who was wearing a blue knitted jumper with a picture of pi on the front, and brown cords.

**Possible rooms:**



1) The Canteen

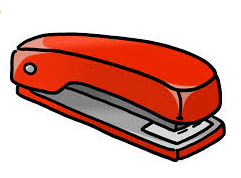
2) The Tuck-shop

3) Room 20

4) Room 18

5) Room 17

6) Room 7

**Possible murder weapons:**

1) A wooden metre ruler

2) A large metal stapler

3) A dusty trundle wheel

4) A sharp compass

5) A large maths textbook

6) An oversized calculator

**Clue number 1:**

PDA NKKI PDA IQNZAN PKKG LHWYA EJ EO W JQIXAN.

Hint: Maybe some frequency analysis would help crack this Caesar Cipher?

**Clue number 2:**

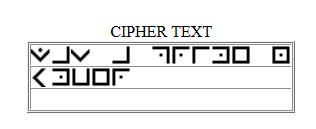
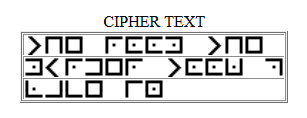
Ht me ruederhr da ta po no ht ta ah sdrt pi se

Hint: maybe letters could be swapped around somehow?

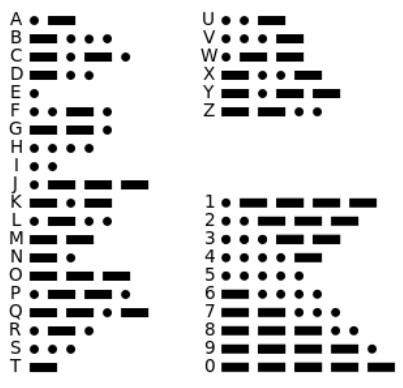
**Clue number 3:**

tcejbolatematonsawnopaewredrumeht

**Clue number 4:**



**Clue number 5:**



1 0000 0 0101 0 00 000 01 1 0 1001 1 1000 111 111 101 11 00 000 000 00 10 110

**Clue number 6:**

TRTURKCIURYPODUHOHRTPESMMPLNECIOEDOLIABAEESRKSMMEOANNENOCILY

Hint: Could splitting this into 4 lines of equal length help?

**Clue number 7:**



FHXTMDDXYWDWTZOQAKPFSTKVMEEKZ

Hint - Go along the M row and find F. What letter is above it on the top row? Now perhaps go to the second row.....

**Clue number 8:**

ʇɥǝunɯqǝɹoɟsʇɹıdǝsouʇɥǝ ʇ sɥɹʇ ıs ɐuǝʌǝudɹıɯǝunɯqǝɹ

**Maths Murder Mystery Solutions**

**Answer 1**

Caesar Shift A - E

THE ROOM THE MURDER TOOK PLACE IN IS A NUMBER

**Answer 2**

Transposition - swap every 2 grouping of letters around - so ht becomes th, me becomes em

the message then becomes:

Themur de re r h ad a t o p on th at ha d s tripes.

The murderer had a top on that had stripes

**Answer 3**

Read the message backwards:

The murder weapon was not a metal object

**Answer 4**

The room the murder was committed in was a prime number

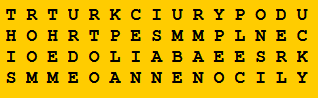
**Answer 5**

1 represents a dash, 0 represents a dot.

There is a textbook missing

Answer 6

Write in 4 lines from left to right as:



Now read down the columns to get:

THIS ROOM THE MURDER TOOK PLACE IN IS A NUMBER MANY PEOPLE CONSIDER LUCKY

**Answer 7:**

Vigenere Cipher:

FHXTMDDXYWDWTZOQAKPFSTKVMEEKZ

Look in the M row - find where F is, what letter is above it in the top row? T

Look in the A row - find where the H is, what letter is above it in the top row? Hetc.



THE MURDERER WAS WEARING TROUSERS

**Answer Number 8:**

Upside down mirror writing:

the number of stripes on the t shirt is an even prime number

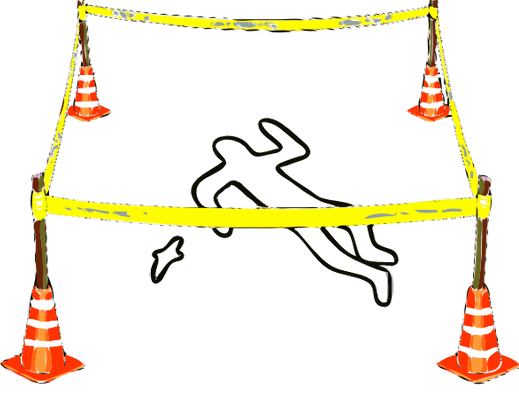
**COMPLETE ANSWER:**

**Murderer - TEACHER NUMBER 1**

**Room - 7**

**Murder Weapon - Textbook**

# Maths Murder Mystery 2



*Another* murder has been committed in the maths department! A body has been discovered surrounded by mathematical objects . Once again and only the hardworking maths teachers were in school, memorising pi to 200 digits for fun at the weekend. So one of them must be the murderer!

Your task, should you choose to accept it, is to find:

1) the murderer

2) the room

3) the murder weapon

Work quickly - who knows who could be next!

**Possible murder suspects:**

1) INSERT TECHER NAME 1 - who was wearing a white, T-shirt with 2 stripes and ripped jeans on the day of the murder.

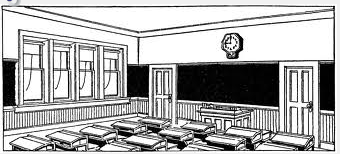
2) INSERT TEACHER NAME 2 (female) - who was wearing a knee-length green skirt, white t-shirt and gold watch.

3) INSERT TEACHER NAME 3 - who was wearing a blue vest, Bermuda shorts and a baseball cap.

4) INSERT TEACHER NAME 4 (female) - who was wearing a black and white t-shirt with anodd number on it, trousers and shiny black shoes.

5) INSERT TEACHER NAME 5 - who was wearing a blue knitted jumper with a picture of pi on the front, and brown cords.

**Possible rooms:**



1) The Canteen

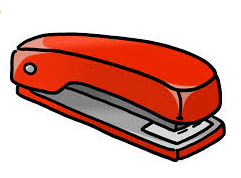
2) The Tuck-shop

3) Room 16

4) Room 25

5) Room 17

6) Room 1

**Possible murder weapons:**

1) A wooden metre ruler

2) A large wooden cube

3) A dusty trundle wheel

4) A sharp compass

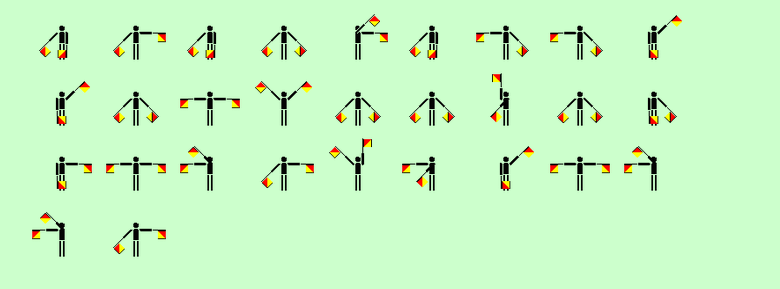
5) A large maths textbook

6) An oversized calculator



**Clue Number 1**





**Clue Number 2**

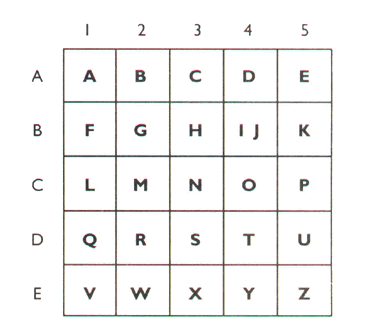


Clue number 3

PAXG RHN WXVBIAXK MABL FXLLTZX BG YNEE RHN PBEE LXX MATM MAX FNKWXKXK PTL PXTKBGZ T M LABKM



Clue number 4



D4, B3, A5, C2, A1, C3, E2,B3,C4, D2,A1,C3, B1,D2,C4,C2,D4,B3,A5, D2,C4,C4,C2, B4, D3, C3,C4, D4, B2, D5, B4, C1, D4, E4

Clue number 5



This object was found lying by the victim



Clue 6

TSRROLEAOIAVNBHMDTKAIRMTNEUEIUEOPCNOWHENMR

(Hint: Transposition Cipher)

Clue 7: What the murderer was wearing:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

0010001100101000010011111

Hint: How can you make a picture from this code and the table above?



Answers

Clue 1:

Amanwasseenrunningfromtheroom

More Semaphore codes from here (<http://geocaching.marckoppert.com/geocacheTools.php?lang=en&page=semaphoreFlags>)

Clue 2:

The room is a square number (Mirror writing)

More mirror writing codes from: <http://txtn.us/mirror-words>

Clue 3:

Use frequency analysis to see that the most common letter in the code is x. This therefore goes to e in a Caesar Shift.

WHEN YOU DECIPHER THIS MESSAGE IN FULL YOU WILL SEE THAT THE MURDERER WAS WEARING A T SHIRT

Clue 4:

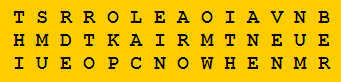
The man who ran from the room is not guilty

Clue 5:

Magic Eye – stare through the page to see a cube.

Clue 6:

Transposition Cipher in 3 lines:



THISMURDERTOOKPLACEINAROOMWITHANEVENNUMBER

Clue 7:

Work from top left across the table – colour in each square for a 1 and leave blank for 0. (so the top row is blank, blank, black, blank, blank) You should end up with a picture of the number 1.

Solution:

Teacher Number 4 is Guilty

Murder Weapon is the large wooden cube

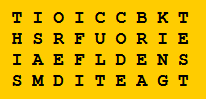
Room is 16.

**Other Solutions**

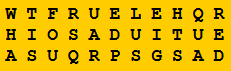
Caesar Shift

1. Caesar Shift A goes to D. CONGRATULATIONS YOU HAVE CRACKED THE CAESAR SHIFT CODE
2. A goes to T WHAT IS THE FIFTH TRIANGULAR NUMBER?

Transposition Cipher



THISISAMOREDIFFICULTCODEBREAKINGTEST



WHATISFOURSQUAREDPLUSEIGHTSQUARED?

Vignette Ciphers

1. **BPRLB XBYWM JVKZY NJFFT HKZFN RJVJ -** WHAT IS THE TENTH FIBONACCI NUMBER
2. TOPTS ZYLLU ANWZA ZAWHQ - HOW MANY SECONDS IN A DAY

See <http://www.math.tamu.edu/~dallen/hollywood/breaking/v.htm> for more Vignette Ciphers.

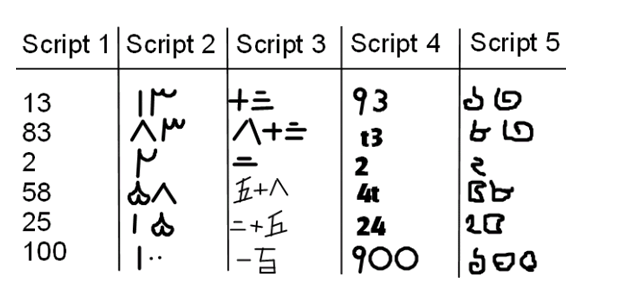
Solution ISBN

1. Yes
2. No
3. No
4. 3 – using x as the missing number we end up with 5x + 7 = 0 mod 11. So 5x = 4 mod 11. When x = 3 this is solved.

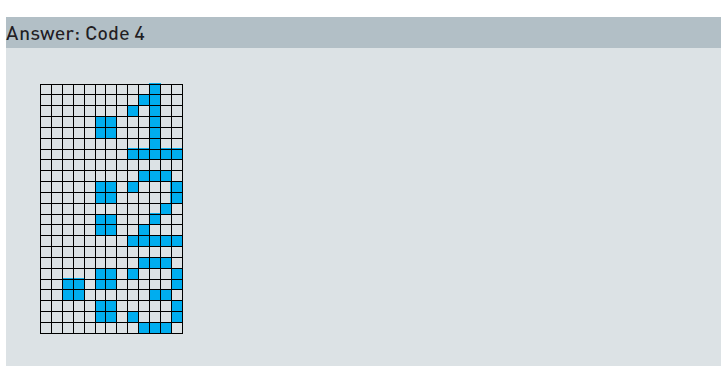
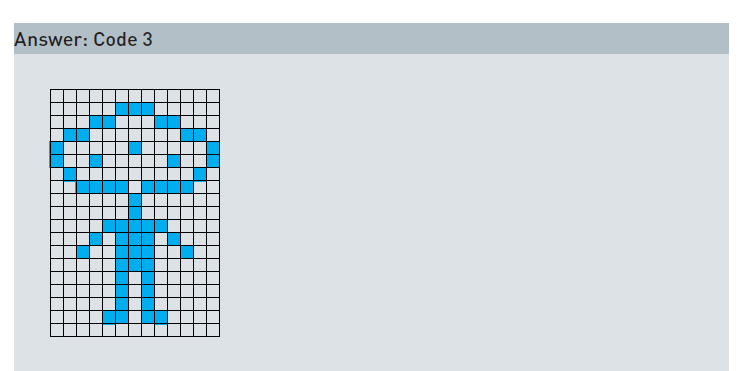
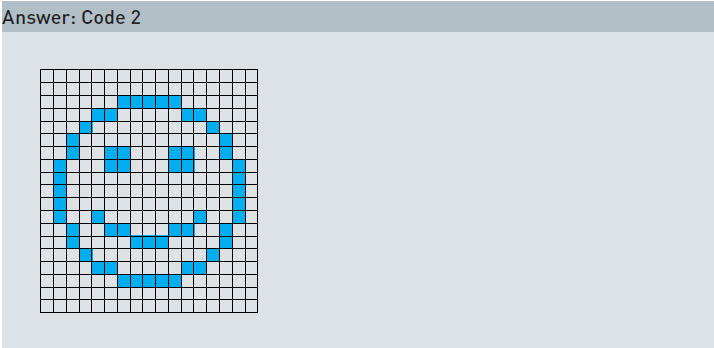
Solution to Credit card

The second one is genuine

Solution to Enrich Problem



Solution to NASA codes



More code questions in the Maths Illuminated course on primes from learner.org

Solution to hidden sentence puzzle:

What is the first square number? Answer 1

Solution to code challenge 1

**1) What is the 4th square number - 16**

2) How many seconds in one hour? - 3600

3) **WHAT IS SEVEN TIMES EIGHT - 56**

Solution to code challenge 2

Teacher note – this works best as a paired activity – otherwise it could take too long. Also you might need to give some clues (eg – the first word is jack etc)

Jack did not walk into the office; he boarded the bus at the corner. He went to the airport. He tossed his brief case in the trash. He looked at a map of the world, bought a ticket to Paris, and never looked back.

Solution to Code Challenge 3

**This is a transposition cipher so rearrange WIEYNMMHSOEPEBATNVRNETHLEIUR**

**to give:**

**WIEYNMM  
HSOEPEB  
ATNVRNE  
THLEIUR**

Then read downwards to get: WHATISTHEONLYEVENPRIMENUMBER?

Answer is 2.

2)XIBU JT UISFF TRVBSFE

Translates to:

WHAT IS THREE SQUARED = 9

Using a Caesar cipher where B goes to A etc.

3) Following the instruction we get: WHATISTHESQUAREROOTOFNINE = 3

**Final code = 293**

Resources

1. The Counton website has a large number of code generators for Caesar shifts, transposition ciphers, pigpen and Vignere codes (<http://www.counton.org/explorer/codebreaking/transposition-ciphers.php>)
2. The learner.org website has more binary string codes (<http://www.learner.org/courses/mathilluminated/pdf/MathIlluminated_01_txt.pdf>)
3. Additional resources for creating Vignere codes (<http://www.math.tamu.edu/~dallen/hollywood/breaking/v.htm>)
4. Additional resources for creating Semaphore codes

(<http://geocaching.marckoppert.com/geocacheTools.php?lang=en&page=semaphoreFlags>)

1. Additional resources for mirror writing codes (<http://txtn.us/mirror-words>)
2. Morse Code generator (<http://www.glassgiant.com/geek/morse/>)