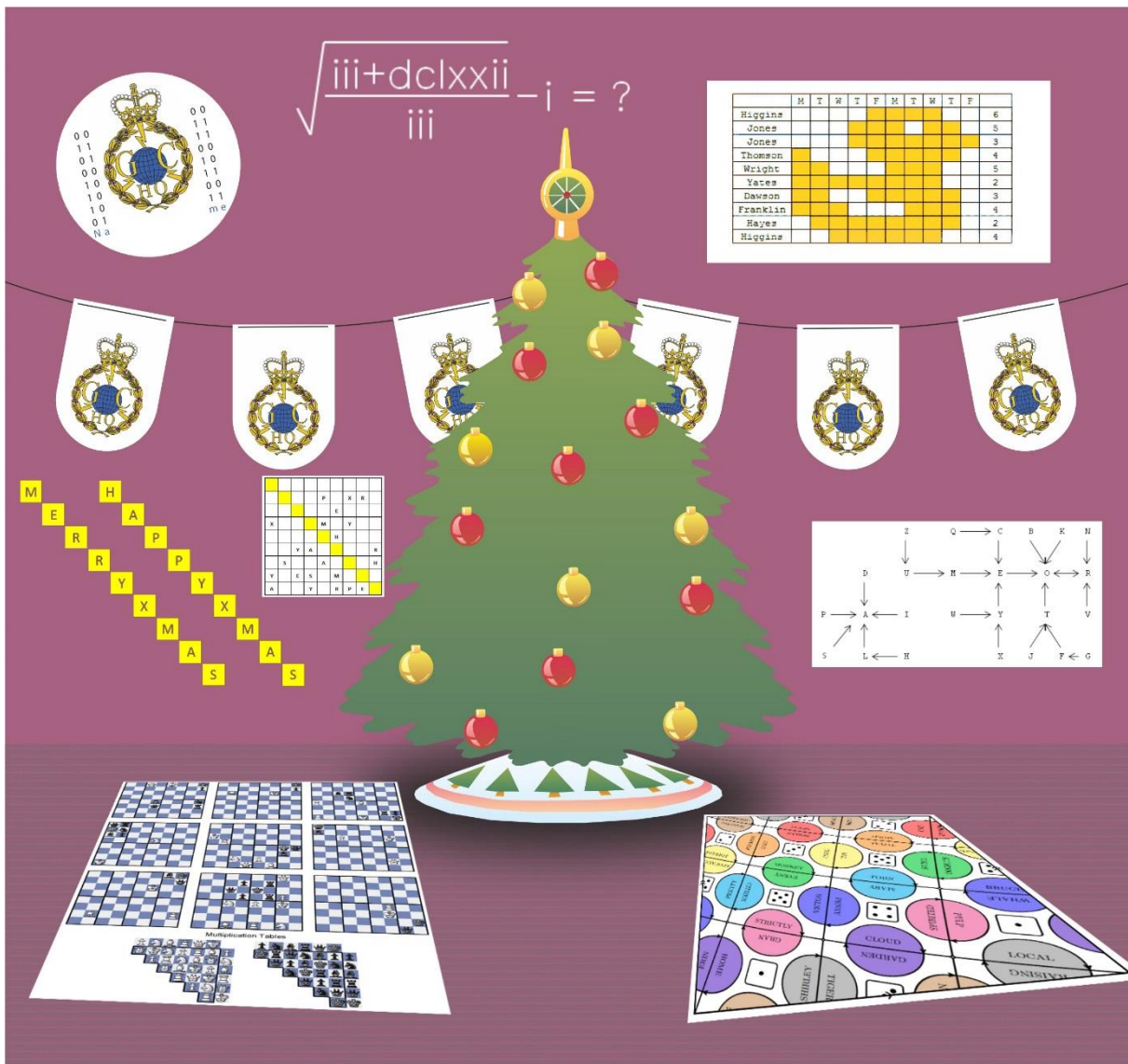




Director's Christmas Puzzle

The Answers



in aid of the

NSPCC  TM
Cruelty to children must stop. FULL STOP.

Disclaimer

Please note that:

- The judges' decision is final
- No correspondence will be entered into regarding the puzzle.

GCHQ was delighted with the interest shown in the Director's puzzle

Many people worked in virtual teams over various web forums to tackle many of the questions together, with some syndicates developing small computer programmes to test possible mathematical combinations and reach a solution more quickly.

The Sum in Part 5 caused the most confusion among players. Almost everyone got the obvious answer xiv, and quite a few got two additional answers l and xx based on interpreting the x as a multiplication sign. Based on the title, they then 'summed' the three solutions – by coincidence, the result $84 = lxxxiv$ can also be obtained by concatenating the three solutions. There were many theories about what was going on with speculation of solutions involving Leonardo da Vinci or Louis XIV!

No-one found the four additional intended answers involving further reinterpretation of x as a multiplication sign, perhaps indicating that this was not a terribly fair question.

The Manifold Agreement appears to have been solved without anyone spotting the idea of writing the tiles into the square at an angle.

Looter was many people's favourite, particularly the way the title LOOTER relates both to the answer and also to LOTR = Lord of the Rings using the theme of the rest of the puzzle.

Message was another confusingly ambiguous puzzle – there are two answers, corresponding to two different messages (HAPPYXMAS and MERRYXMAS) down the diagonal. Many solvers seemed unhappy with the idea of multiple solutions and this led them to look for other features despite none being present.

In **Registration** the answer is DUCK, and there is a clue in the text of the question – the first word of each sentence spells GET DOWN, a synonym for 'duck'. However, very few solvers noticed that this is actually a double pun – you can get 'down' from a duck.

In the **Crossword** there was unfortunately a typo in the grid – 27 across was labelled 17 by mistake. Once again, this led to a lot of theorising about the significance of 17 vs 27. Apologies for the confusion.

In the **Cipher** some solvers worked out the ternary coding but couldn't solve the resulting simple substitution. Also, if you use the decryption alphabet rather than the encryption alphabet, and take an anagram of the resulting nonsense codeword, you can get PORTISHEADFC instead of the correct codeword OBFUSCATING.

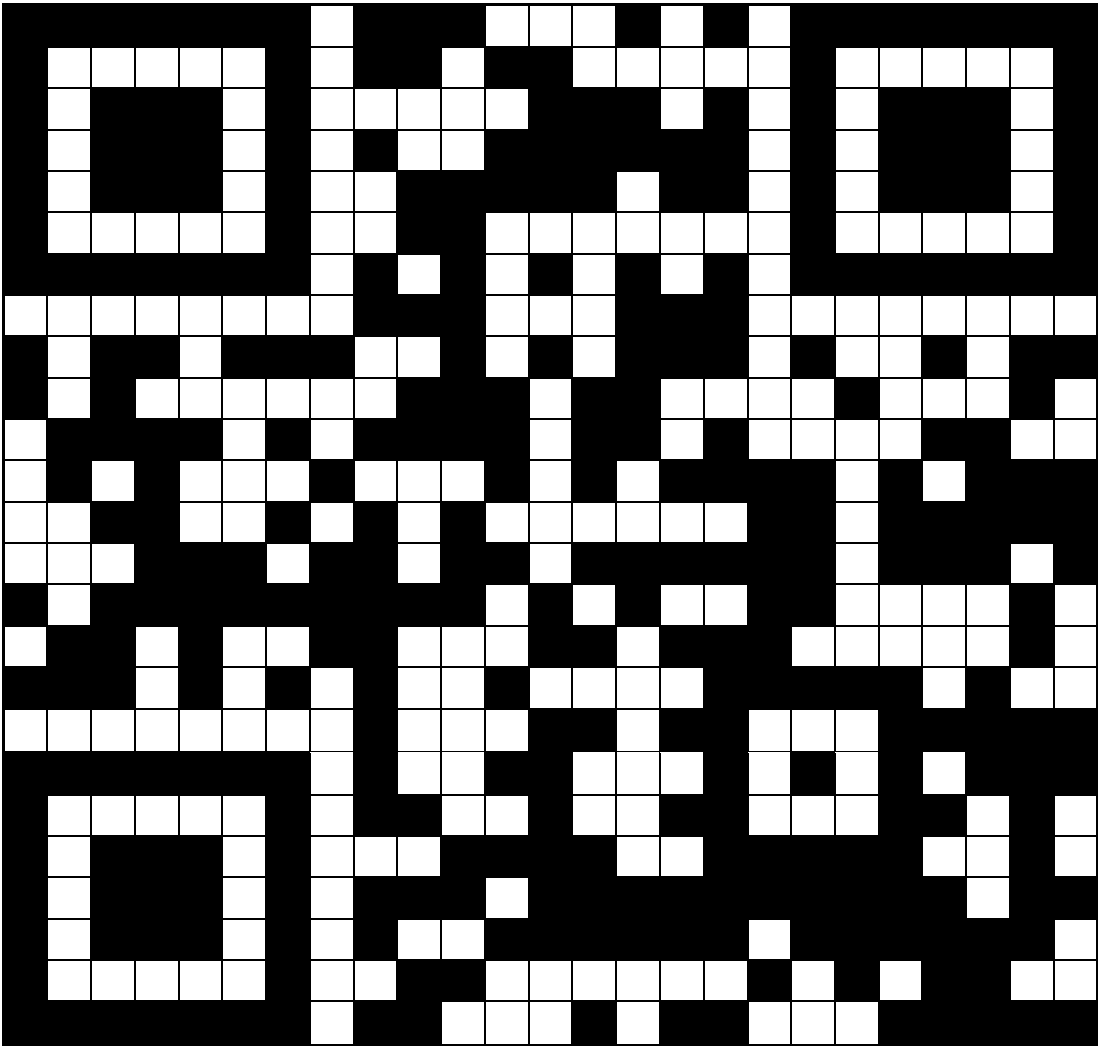
Overall There is no overall theme to the Part 5 answers. This was intentional – we wanted it to be difficult for players to tell when they had finished, and to reduce the likelihood that a full solution would be published. We also felt that the presence of answers like MXAHRYESP or MANAGERMENMERCURY would convince people that there couldn't be a strong theme, but in some cases it just made them reinterpret their answers to try and fit a theme (e.g. by extracting YES from MXAHRYESP).

Some interesting ideas were certainly put forward, including one relating to islands and another relating to gold. Perhaps this just proves that if you look at a bunch of random words hard enough, you will start to see some patterns.

Thanks to everyone who took part – we hope that above all you enjoyed getting involved. The full set of answers are as follows ...

Part 1: Grid Shading Puzzle

The solution is a QR code:



Scanning the QR code leads to the URL www.gchq.gov.uk/puzz with the Part 2 puzzles.

We pre-shaded a few cells to help people get started. Without this, the puzzle would have been slightly ambiguous, though the error correction used in QR codes means that the URL would have been recovered anyway. As a small *Easter egg*, the pre-shaded cells spell out “GCHQ” in Morse code.

Part 2: Web Link Maze

1. Which one is not the odd one out?

- A. STARLET
- B. SONNET
- C. SAFFRON
- D. SHALLOT
- E. TORRENT
- F. SUGGEST

STARLET is an odd one out because it does not contain a double letter.

SONNET is an odd one out because it has 6 letters rather than 7.

SAFFRON is an odd one out because it ends in N rather than T.

TORRENT is an odd one out because it starts with T rather than S.

SUGGEST is an odd one out because it is a verb rather than a noun.

So **SHALLOT** is the only word that is not an odd one out.

2. What comes after GREEN, RED, BROWN, RED, BLUE, -, YELLOW, PINK?

- A. RED
- B. YELLOW
- C. GREEN
- D. BROWN
- E. BLUE
- F. PINK

Digits of Pi represented by the colour of the corresponding snooker ball: 3=GREEN, 1=RED, 4=BROWN, 1=RED, 5=BLUE, 9=no such ball, 2=YELLOW, 6=PINK, 5=**BLUE**.

3. Which is the odd one out?

- A. MATURE
- B. LOVE
- C. WILDE
- D. BUCKET
- E. BECKHAM
- F. SHAKA

Names containing words from the NATO phonetic alphabet: VICTOR MATURE, MIKE LOVE, OSCAR WILDE, CHARLIE BUCKET, ROMEO BECKHAM, SHAKA ZULU.

SHAKA is the odd one out because the NATO phonetic forms the second name rather than the first.

4. I was looking at a man on top of a hill using flag semaphore to send a message, but to me it looked like a very odd message. It began "ZGJJQ EZRXM" before seeming to finish with a hashtag. Which hashtag?

- A. #SGM
- B. #SEM
- C. #SEN
- D. #SGN
- E. #TEN
- F. #TGN

The man sending the semaphore message is being observed from behind, so each signal has been flipped left-to-right. The actual message begins "HAPPY CHRIS", so it ends "TMAS", which flips to produce **#SGM**.

5. What comes after 74, 105, 110, 103, 108, 101, 98, 101, 108, 108?

- A. 108
- B. 101
- C. 115
- D. 123
- E. 111
- F. 103

Decimal representations of ASCII characters spelling "Jinglebells":

74	0x4A	J
105	0x69	i
110	0x6E	n
103	0x67	g
108	0x6C	l
101	0x65	e
98	0x62	b
101	0x65	e
108	0x6c	l
108	0x6c	l
115	0x73	s

6. What comes next D, D, P, V, C, C, D, ?

- A. F
- B. E
- C. D
- D. C
- E. B
- F. A

Initials of Santa's reindeer: Dasher, Dancer, Prancer, Vixen, Comet, Cupid, Donner, and **Blitzen**.

Note that the answers to Part 2 spell out the word DEFACE.

Part 3: Word Puzzles

A. The completed sequence is a palindrome:

Buck, Cod, Dahlia, Rook, Cuckoo, Rail, Haddock, **Cub**

B. Anagrams of French numbers:

$$\begin{aligned} \text{pest} + \sqrt{(\text{unfixed} - \text{riots})} &= \text{sept} + \sqrt{(\text{dix-neuf} - \text{trois})} \\ &= 7 + \sqrt{(19 - 3)} = 11 = \text{onze} = \mathbf{zone} \end{aligned}$$

C. 'Opposite' means Morse complementation (interchanging dots and dashes):

agony	.----.-----.-.--
denial	-...-.....-.-..
witty	.---.-----.-.
tepid	-..--...-..
smart	...--.-.-.-
often	----.-.-.-.

D. The solutions to the clues are all 7-letter words:

- | | | |
|------|--|---------|
| i. | Withdraw as sailors hold festive sing-song | WASSAIL |
| ii. | It receives a worker and returns a queen | ANTENNA |
| iii. | Try and sing medley of violin parts | STRINGY |
| iv. | Fit for capture | SEIZURE |

They form the start of a 7×7 word square, making the same words down the columns and across the rows:

W	A	S	S	A	I	L
A	N	T	E	N	N	A
S	T	R	I	N	G	Y
S	E	I	Z	U	R	E
A	N	N	U	L	A	R
I	N	G	R	A	T	E
L	A	Y	E	R	E	D

The Part 4 puzzles are at: www.cub-zone-often.org.uk/layered

Part 4: Number Puzzles

Fill in the missing numbers.

A. 2, 4, 8, 1, 3, 6, 18, 26, ?, 12, 24, 49, 89, 134, 378, 656, 117, 224, 548, 1456, 2912, 4934, 8868, 1771, 3543, ...

Digits of powers of two, starting with the most significant of each power and taking alternate digits:

2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048, 4096, 8192, 16384, etc.

So the answer is **52**

B. -101250000, -1728000, -4900, 360, 675, 200, ?, ...

Numbers of the form $n^2m^310^r$, where n and r decrease by 1 each time, and m increases by 2:

$9^2(-5)^310^4$, $8^2(-3)^310^3$, $7^2(-1)^310^2$, $6^21^310^1$, $5^23^310^0$, $4^25^310^{-1}$, **$3^27^310^{-2}$** , ...

So the answer is $9 \times 343 / 100 = \mathbf{30.87}$

C. 321, 444, 675, 680, 370, 268, 949, 206, 851, ?,

Writing out the numbers in a column produces arithmetic progressions modulo 10 down the diagonals, with steps of **1**, **2** and **3** respectively:

3	2	1
4	4	4
6	7	5
6	8	0
3	7	0
2	6	8
9	4	9
2	0	6
8	5	1
2	0	8

So the answer is **208**

The Part 5 puzzles are at: <http://52.30.87.208/next>

Part 5: Miscellaneous puzzles

Where

Where does the word CYBER fit into the following list? The list reads from left to right, top to bottom.

CAN	BANDIT	TRACT	HOLE	TROUT
MIDDLE	TED	CLONE	SEA	SWOOP
SALLY	CONSTANT	DESERT	ADAMS	SLIT
WONDER	TOWN	RUSSIA	LINCOLN	ARCHIPELAGO
FRONTAL	DOVE	BAND	NIGHT	LEICESTER
DADA	STAND	OIL	ZONE	BOUGHT
AUTO	PRIM	BLAISE	SECRET	ICECAP
ON	CHIC	MONTY	HONOURABLE	FI
THE	DELIGHT	TREADING	MISSION	CAIMAN
PERFECT	SON	SHERINGHAM	PONY	DELICATE
ICE	STREET	HERO	FILCH	NIP

The categories are as follows:

Words meaning 'zero' with the first letter changed:

DOVE	LOVE
DADA	NADA
OIL	NIL
ZONE	NONE
BOUGHT	NOUGHT
HERO	ZERO
FILCH	ZILCH
NIP	ZIP

Expressions beginning with 'ONE':

ARMED	BANDIT
FELL	SWOOP
HIT	WONDER
HORSE	TOWN
MAN	BAND
NIGHT	STAND
TRICK	PONY
WAY	STREET

Homophones for CY:

CI	TED
CY	CLONE
PSI	ON
PSY	CHIC
SCI	FI
SCY	THE
SI	DELIGHT
SIGH	TREADING

Bears:

BLACK	HOLE
BROWN	TROUT
GOBI	DESERT
GRIZZLY	ADAMS
KODIAK	ARCHIPELAGO
POLAR	ICECAP
SPECTACLED	CAIMAN
TEDDY	SHERINGHAM

Programming languages:

CAN	ADA
MIDDLE	C
SALLY	FORTH
LINCOLN	IMP
FRONTAL	LISP
LEICESTER	MERCURY
BLAISE	PASCAL
MONTY	PYTHON

Books by John le Carré:

CONSTANT	GARDENER
RUSSIA	HOUSE
NIGHT	MANAGER
SECRET	PILGRIM
HONOURABLE	SCHOOLBOY
MISSION	SONG
PERFECT	SPY
DELICATE	TRUTH

Doctor Who creatures:

TRACT	ATOR
SEA	DEVILS
SLIT	HEEN
AUTO	NS
PRIM	ORD
SON	TARANS
ICE	WARRIORS

The alphabetical list of associated words or strings is therefore as follows:

ADA	ARMED	ATOR	BLACK	BROWN
C	CI	CY	DEVILS	FELL
FORTH	GARDENER	GOBI	GRIZZLY	HEEN
HIT	HORSE	HOUSE	IMP	KODIAK
LISP	LOVE	MAN	MANAGER	MERCURY
NADA	NIGHT	NIL	NONE	NOUGHT
NS	ORD	PASCAL	PILGRIM	POLAR
PSI	PSY	PYTHON	SCHOOLBOY	SCI
SCY	SI	SIGH	SONG	SPECTACLED
SPY	TARANS	TEDDY	TRICK	TRUTH
WARRIORS	WAY	ZERO	ZILCH	ZIP

CYBER, with associated word MEN, completes the Doctor Who category. MEN goes between MANAGER and MERCURY, so CYBER goes between NIGHT and LEICESTER in the original list. The answer is **MANAGERMENMERCURY**.

Sum

$$\sqrt{\frac{\text{iii} + \text{dclxxii}}{\text{iii}}} - \text{i} = ?$$

The obvious answer is:

$$\sqrt{((3 + 672) / 3) - 1} = \sqrt{225 - 1} = 15 - 1 = 14 = \text{xiv}$$

However, the theme of this puzzle is ambiguity between the letter x and the multiplication operator \times . One or other (but not both) of the instances of the letter x could be interpreted as a multiplication, giving two further answers:

$$\sqrt{((3 + (660 \times 2)) / 3) - 1} = \sqrt{441 - 1} = 21 - 1 = 20 = \text{xx}$$

$$\sqrt{((3 + (650 \times 12)) / 3) - 1} = \sqrt{2601 - 1} = 51 - 1 = 50 = \text{l}$$

Yet more answers can be produced by using the ambiguity between x and \times on the right-hand side of the equation. The solutions 20 and 50 can be re-written as follows:

$$\begin{aligned}
20 &= 20 \times 1 = \text{xx} \times \text{i} = \text{xxxi} \\
20 &= 10 \times 2 = \text{x} \times \text{ii} = \text{xxii} \\
50 &= 50 \times 1 = \text{l} \times \text{i} = \text{lxi} \\
50 &= 10 \times 5 = \text{x} \times \text{v} = \text{xxv}
\end{aligned}$$

Note that subtracting 1 from the square root gives rise to these additional solutions – without this, the solutions would be 15, 21 and 51, none of which could be re-written as above. So in all there are seven valid Roman numerals that could appear on the right-hand side – **xiv**, **xx**, **l**, **xxxi**, **xxii**, **lxi** and **xxv** – corresponding to the following interpretations of the equation:

$$\sqrt{\frac{\text{iii}+\text{dclxxii}}{\text{iii}}}-\text{i} = \text{xiv}$$

$$\sqrt{\frac{\text{iii}+\text{dclx}\times\text{ii}}{\text{iii}}}-\text{i} = \text{xx}$$

$$\sqrt{\frac{\text{iii}+\text{dcl}\times\text{xii}}{\text{iii}}}-\text{i} = \text{l}$$

$$\sqrt{\frac{\text{iii}+\text{dclx}\times\text{ii}}{\text{iii}}}-\text{i} = \text{xx}\times\text{i}$$

$$\sqrt{\frac{\text{iii}+\text{dclx}\times\text{ii}}{\text{iii}}}-\text{i} = \text{x}\times\text{ii}$$

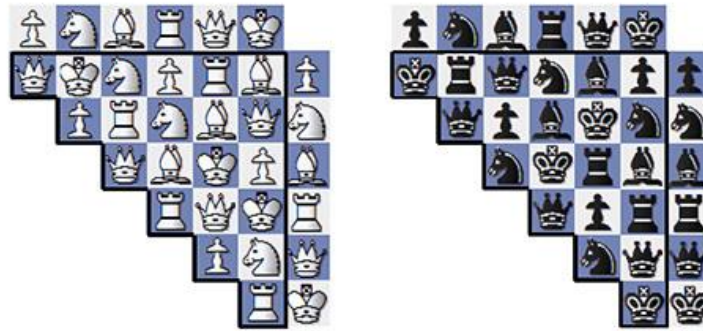
$$\sqrt{\frac{\text{iii}+\text{dcl}\times\text{xii}}{\text{iii}}}-\text{i} = \text{l}\times\text{i}$$

$$\sqrt{\frac{\text{iii}+\text{dcl}\times\text{xii}}{\text{iii}}}-\text{i} = \text{x}\times\text{v}$$

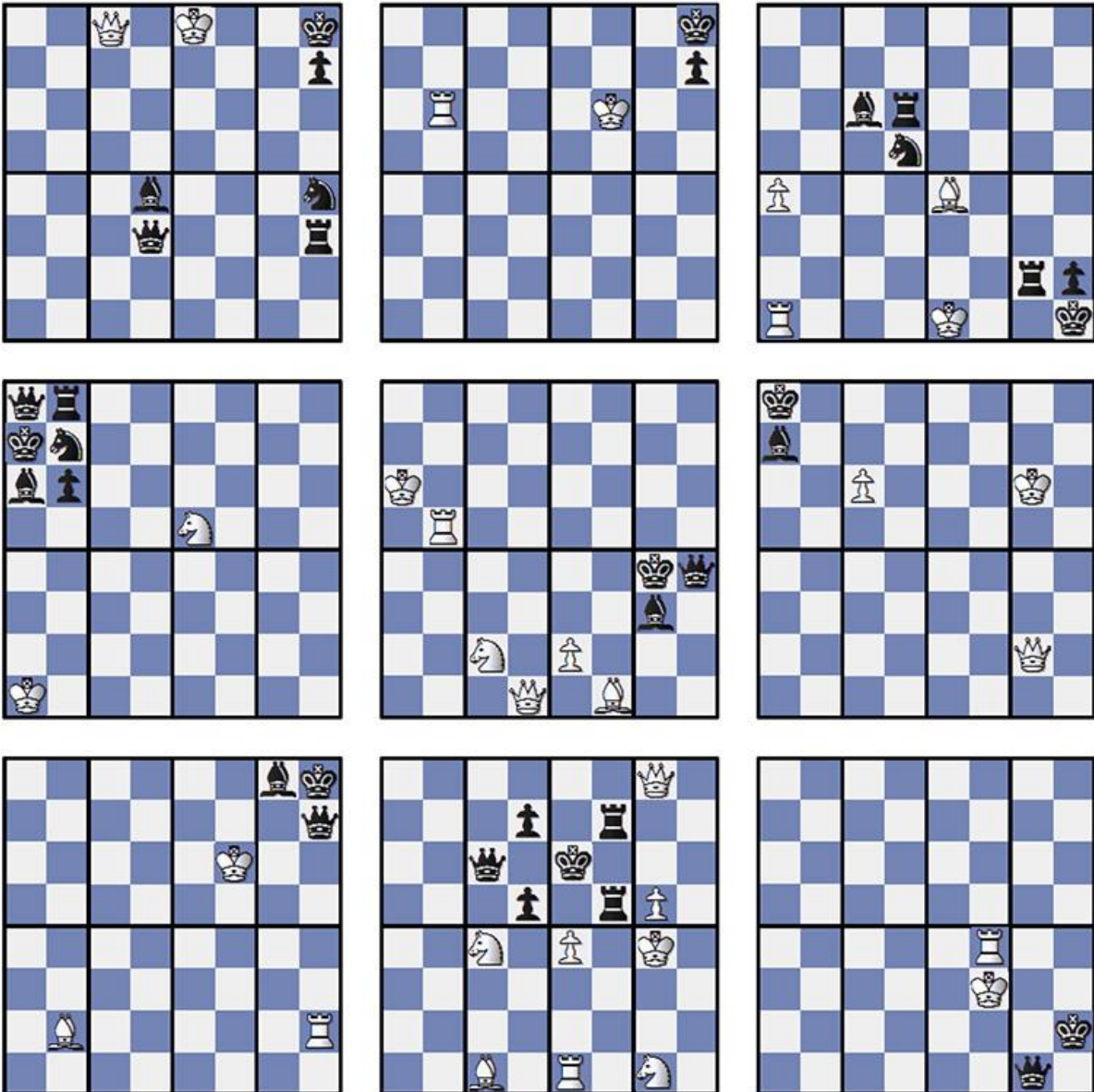
Algebraic

Obeying the six rules of chessboard multiplication we can complete the piece-wise multiplication table so that each of the nine products results in a position where white can checkmate in one move. The simplest approach is to start with the boards with the fewest pieces and work out where the black king must go for a checkmate to be possible. The multiplication tables are as follows:

Multiplication Tables



This produces the following nine chess problems:



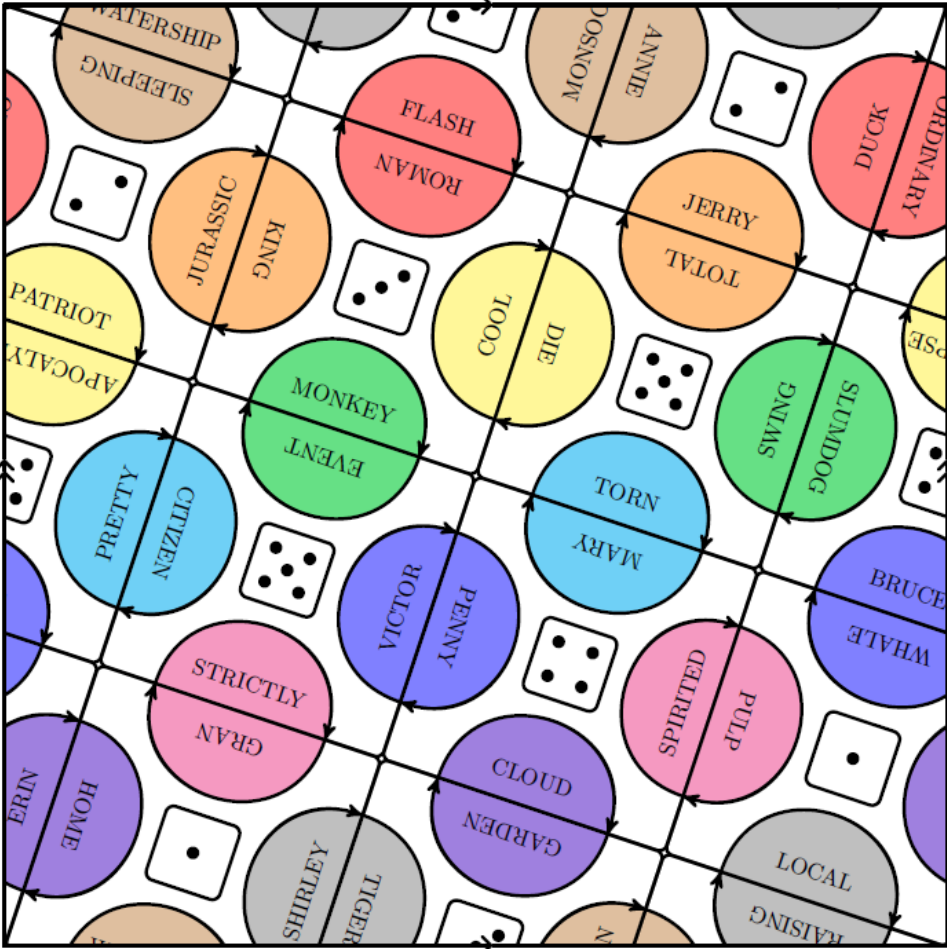
Writing out all the winning moves in algebraic notation (as the title hints at), we get:

- Kf7#
- Rb8#
- 0-0-0#
- Nc6#
- e3#
- c7#
- Kg5#
- exf5#
- Rb4#

The first letters of each move spells **KRONECKER**, the type of matrix multiplication we used to construct the boards.

Manifold Agreement

There are ten tiles, and although the square to fit them into looks like it might be 3x3 tiles in size, a careful measurement shows that it is really $\sqrt{10} \times \sqrt{10}$. This means that the tiles can be placed into the square at an angle so that the colours of the semi-circles match, as do the top and bottom and the left and right sides.



Note that you can still match the tiles without spotting this feature. The words in the tiles are the first words of two-word films.

SLEEPING BEAUTY
JURASSIC PARK
PATRIOT GAMES
ORDINARY PEOPLE

ROMAN HOLIDAY
COOL RUNNINGS
MONKEY BUSINESS
KING KONG

TOTAL RECALL
SWING TIME
TORN CURTAIN
DIE HARD

APOCALYPSE NOW
PRETTY WOMAN
BRUCE ALMIGHTY
SLUMDOG MILLIONAIRE

EVENT HORIZON
VICTOR VICTORIA
STRICKLY BALLROOM
CITIZEN KANE

MARY POPPINS
SPIRITED AWAY
CLOUD ATLAS
PENNY SERENADE

WHALE RIDER
ERIN BROCKOVICH
LOCAL HERO
PULP FICTION

GRAN TORINO
SHIRLEY VALENTINE
WATERSHIP DOWN
HOME ALONE

GARDEN STATE
MONSOON WEDDING
FLASH GORDON
TIGER BAY

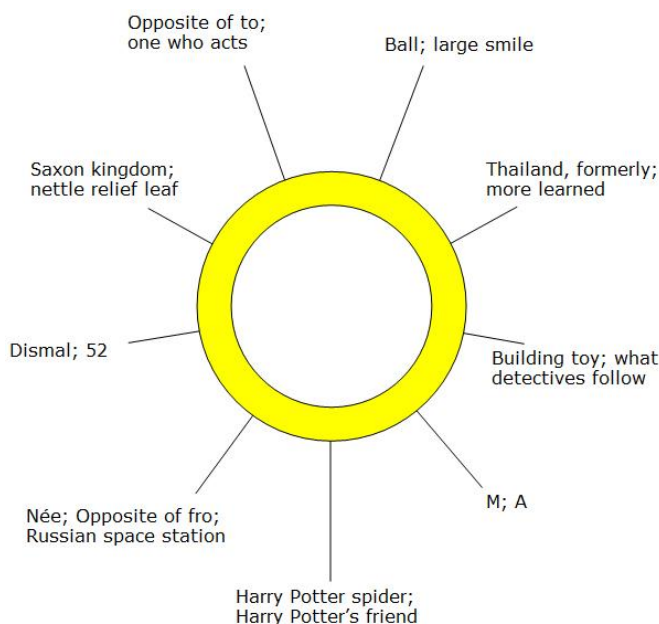
RAISING ARIZONA
DUCK SOUP
JERRY MAGUIRE
ANNIE HALL

The semi-circular arrows indicate the second words should be swapped to the adjacent tile. The four new words on a tile agree on the letter indicated by the dice pips, i.e.

- {Watership **D**OWN, King **K**ONG, Apocalypse **N**OW, Duck **S**OUP} = O
- {Flash **G**ORDON, Die **H**ARD, Event **H**ORIZON, Jurassic **P**ARK} = R
- {Jerry **M**AGUIRE, Slumdog **M**ILLIONAIRE, Mary **P**OPPINS, Cool **R**UNNINGS} = I
- {Patriot **G**AMES, Citizen **K**ANE, Whale **R**IDER, Swing **T**IME} = E
- {Monkey **B**USINESS, Penny **S**ERENADE, Gran **T**ORINO, Pretty **W**OMAN} = N
- {Torn **C**URTAIN, Pulp **F**ICTION, Garden **S**TATE, Victor **V**ICTORIA} = T
- {Bruce **A**Lmighty, Home **A**LONE, Raising **A**RIZONA, Spirited **A**WAY} = A
- {Strictly **B**ALLROOM, Tiger **B**AY, Sleeping **B**EAUTY, Erin **B**ROCKOVICH} = B
- {Cloud **A**TLAS, Annie **H**ALL, Roman **H**OLIDAY, Shirley **V**ALENTINE} = L
- {Local **H**ERO, Ordinary **P**EOPLE, Total **R**ECALL, Monsoon **W**EDDING} = E

Reading the letters spells out **ORIENTABLE**.

Looter



As hinted at in the title, each branch of the ring has clues spelling out the nine members of the Fellowship from The Lord of the Rings, each with two extra letters:

- SPHERE GRIN**
- SIAM WISER**
- LEGO LEADS**
- GRAND ALFA**
- ARAGOG RON**
- BORN TO MIR**
- GRIM LII**
- MERCIA DOCK**
- FRO DOER**

These extra letters spell **SHIRE DRAGON TRICKER**, which is **BILBO**.

Message

This puzzle cannot be solved without using the leading diagonal feature, but there are no solutions using the traditional interpretation of all different letters down the diagonal. However, two of the possible solutions have the messages MERRYXMAS and HAPPYXMAS down the diagonal:

M	X	A	H	R	Y	E	S	P
S	E	H	M	P	A	X	R	Y
P	Y	R	X	S	E	H	M	A
X	A	P	R	M	S	Y	H	E
E	R	S	P	Y	H	A	X	M
H	M	Y	A	E	X	S	P	R
R	S	X	E	A	P	M	Y	H
Y	P	E	S	H	M	R	A	X
A	H	M	Y	X	R	P	E	S

H	X	R	M	S	A	E	P	Y
E	A	S	H	P	Y	X	R	M
M	Y	P	X	R	E	H	S	A
X	R	A	P	M	S	Y	H	E
S	E	M	R	Y	H	A	X	P
P	H	Y	A	E	X	S	M	R
R	S	X	E	A	P	M	Y	H
Y	P	E	S	H	M	R	A	X
A	M	H	Y	X	R	P	E	S

The two intended answers are therefore **MXAHRYESP** and **HXRMSAEPY**.

Graph Theory

- (a) Last letter of NATO Phonetic Alphabet → First letter: **ECHO**
- (b) Lengths in name of month → Number of month: **SEPTEMBER**
- (c) Lengths of planet names → Position in Solar System: **URANUS**
- (d) Numbers 1-10 → Scrabble score of number: **EIGHT**

Note: in part (d), we also accepted the unintended answer Ten Commandments → Verse of the Bible in which they are found (mod 10), with the answer **FOURTH**.

Wordsearch

The hidden words are all the names of countries as they are known by at least some of the locals (transliterated to the Latin alphabet where necessary):

	a	b	c	d	e	f	g	h	i	j	k
1	I	N	I	T	A	W	S	E	S	V	D
2	D	S	E	A	O	H	B	A	I	N	I
3	R	A	A	R	R	H	L	T	V	A	E
4	U	K	R	T	A	L	I	H	U	T	Z
5	K	A	I	R	E	P	I	Q	H	S	H
6	Y	R	A	E	T	M	S	N	R	A	O
7	U	T	I	R	O	A	O	B	N	Y	N
8	L	V	T	U	A	H	I	G	A	A	G
9	E	E	S	T	I	J	U	J	E	H	G
10	R	L	J	N	A	K	S	L	O	P	U
11	E	O	A	K	S	T	A	V	R	H	O

e8-e1	AOTEAROA	New Zealand (Maori)
g2-b7	BHARAT	India (Hindi (and other languages))
a2-a8	DRUKYUL	Bhutan (Dzongkha)
a9-e9	EESTI	Estonia
e5-i1	ELLAS	Greece
d6-d2	ERTRA	Eritrea (Tigrinya)
h1-a1	ESWATINI	Swaziland
j9-j2	HAYASTAN	Armenia
k5-f10	HANGUK	South Korea
j11-c11	HRVATSKA	Croatia
d10-h6	NIHON	Japan
j10-e10	POLSKA	Poland
b2-b11	SAKARTVELO	Georgia
j5-b5	SHQIPERIA	Albania
j5-e10	SRBIJA	Serbia
c9-g5	SUOMI	Finland
j1-g4	VITI	Fiji
k4-k11	ZHONGGUO	China

Once these are all removed, you are left with:

	a	b	c	d	e	f	g	h	i	j	k
1											D
2			E			H					I
3			A						V		E
4			R					H	U		
5											
6							S				
7			I	R		A					
8			T						A		
9								J	E		
10	R		J								
11	E										

This contains DHIVEHI RAAJJE (Maldives). Once this is also removed, the remaining letters can be rearranged to give the keyword: **TREASURE**.

Registration

Marking the presences in the register gives:

	M	T	W	T	F	M	T	W	T	F	
Higgins											6
Jones											5
Jones											3
Thomson											4
Wright											5
Yates											2
Dawson											3
Franklin											4
Hayes											2
Higgins											4

This is a picture of a **DUCK**. As an extra clue, the first letters of the sentences in the teacher's musings are "GET DOWN", which is synonymous with "duck", and also you can get down from a duck.

Crossword

The completed grid is as follows; when the across and down answers clash, the letter for the across clue is given first:

A	L	O/G	H	A	U	S	E	R	S
R	O	A	S	T	I	N	G	A	E
C	O	R	N	E	R/G	A	P	S	E
H	F	I	P	A	R	I	A	H	S
B	A	S	I	C	O	L	D	H	A
I	H	H	T	C	U	R	F/D	E	W
S	A	L	O/H	O	N	J	O	C	K
H	S	H	E	L	D	U	C	K	N
O	P	U	S	A	A	N	K	L	E
P	E	R	I	D	O	T	F	E	E
S	N	O	S	E	B	A	G	D	L

There are four clashes in the grid. By entering the letters P, A, L and M, all entries become words (ALPHA/PARISH, CORNEA/AROUND, CURLEW/PADLOCK and SALMON/TMESIS). So the keyword is **PALM**.

The fact that 27 across was labelled 17 was a typo – apologies for any confusion.

Cipher

When grouped into threes the numbers are generally close, and usually increasing. This suggests writing the cipher out on a width of three and taking differences mod 10 down the columns:

2	1	1
2	0	1
1	1	2
1	2	1
2	2	2
0	2	2
1	2	0
2	2	2
1	2	1
2	0	1
2	0	0
2	2	2

0	2	0
2	0	0
2	2	0
2	1	1
1	0	0
1	1	0
2	0	2
2	2	2
0	0	2
1	0	0
1	1	0
2	2	2
1	2	1
2	0	1
0	2	2
1	2	0
2	2	2
0	1	2
0	2	2
1	0	1
2	0	1
2	0	0
1	1	0

This gives us a list of trinomes using the digits 0, 1 and 2. Since there are 27 possible such trinomes, this naturally suggests that our alphabet is A-Z and space. However, decoding in the obvious way (0,0,0)->A, (0,0,1)->B, (0,0,2)->C, (0,1,0)->D leads to the following message:

WTOQ_IP_QTS_GSYWJMU_CJM_QTIP_FIKTSM

We know we are getting close, because the word lengths look plausible for English. A bit of frequency analysis and thinking about common English words allows us to find the simple substitution:

WTOQ_IP_QTS_GSYWJMU_CJM_QTIP_FIKTSM
 WHAT_IS_THE_KEYWORD_FOR_THIS_CIPHER

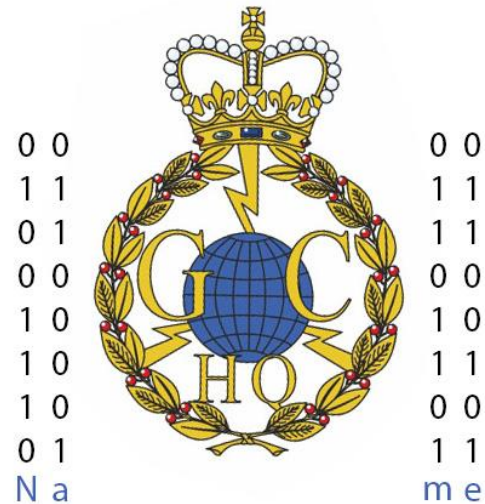
Which is obtained using the substitution table:

ABCDEFGHIJKLMNPOQRSTUVWXYZ_
 OBFUSCATINGDEHJKLMPQRVWXYZ_

Hence the keyword for this cipher is **OBFUSCATING**.

Banner (hidden)

The banners at the top and bottom of the Part 5 web page contain a hidden message in the pennants. Each GCHQ crest has a wreath comprising 32 leaves, in four arcs of eight leaves each. Some of the leaves have veins, and some have had the veins edited out:



Interpreting a leaf with veins as a one and a leaf without veins as a zero, each arc represents an 8-bit ASCII character, with the most significant bit at the top. The twelve pennants, with four characters per pennant, spell out the following:

Name the technique of hiding messages in images.

The answer is **STEGANOGRAPHY**.

Collected Part 5 Answers

The full set of intended answers to Part 5 is therefore:

MANAGERMENMERCURY
XIV
XX
L
XXXI
XXII
LXI
XXV
KRONECKER
ORIENTABLE
BILBO
MXAHRYESP
HXRMSAEPY
ECHO
SEPTEMBER
URANUS
EIGHT (or FOURTH)
TREASURE
DUCK
PALM
OBFUSCATING
STEGANOGRAPHY

There is no overall theme connecting the Part 5 answers. This was deliberately done to keep Part 5 of the quiz open-ended, by ensuring that a definitive complete solution could not be readily identified.

