LAMAR UNIVERSITY
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Spring 2015

LaMP Challenge
Overview and Rules

This isn't your ordinary mathematics competition! Here's a little of what to expect...

Schedule

- 11:45am: Registration
- 12:15pm: Orientation
- 12:30pm: Opening Puzzle
- 4:30pm: Solutions Due at Game HQ
- 4:40pm: Wrap-up, Awards, and Dismissal

Opening Puzzle

Your team will explore (read: RUN!) around a nearby area to gather information which will help you solve a mathematical whodunit. *If your team turned in a correct solution to this year's teaser puzzle, then you will get a 90 second head start!*

Solve the puzzle as quickly as you can... a correct solution will earn your team 100 points, and you'll immediately gain access to your Team Headquarters to begin the next round. After 30 minutes, this challenge will end and all remaining teams will gain access to their Team HQ.

Puzzles #1-#4

Inside your Team HQ is a packet of four mathematical puzzles. Work with your teammates on each puzzle to uncover a hidden message.

Each message provides a clue to the location of an EXTRA Puzzle on campus. Report the correct decoded message to Game Headquarters, and your team will earn 100 points.

EXTRA Puzzles #1-#4

When submitting the solution to a Puzzle, teams may also give their solution to the riddle within that solution: a location on Lamar's campus. If Game HQ confirms the solution, players may run to that location to get a copy of an EXTRA Puzzle.

EXTRA Puzzles are worth 50 bonus points to the team(s) which submit the best answer to Game HQ before the end of the competition.

The Metapuzzle

For each main puzzle solution you report to Game HQ, you'll unlock a piece of today's mathematical Metapuzzle. This devious challenge will put your team to the test, and is worth anywhere from 50 to 200 points. Information about the Metapuzzle will be given once you've solved your first Puzzle (not including the Opening Puzzle).

End of the Game

All solutions to Puzzles, EXTRA Puzzles, and the Metapuzzle are due at Game HQ by 4:30pm; players not in line to submit a solution will be turned away after that time.

All players and chaperones from each team must be present in Game HQ for the wrap-up at 4:45pm. Teams not fully accounted for at that time may be penalized 10 points per minute late.

Winning the Game

The team which has earned the most points by the end of the competition is the winner. The time each team turned in its last solution will be used to break ties, so turn in your solutions as early as possible!

Rules

The main rule is to be a good sport! Players should not do anything which would interfere with other teams playing the game.

Teachers and chaperones are not allowed help players solve puzzles.

Computers and the internet are not allowed to be used during the competition. Smartphones are only allowed to be used to contact your teammates or to use a GPS app.

Be safe! Players should use the buddy system when running out to campus to search for EXTRA Puzzles, and stay within appropriate boundaries.

Contact the game organizers in case of emergencies or any issues with these rules.


LAMAR UNIVERSITY
Physical Plant
N
Lamar Institute of Technology
E. Lavaca
M.L. King Pkwy
E. Virginia
E. Virginia
Alabama
Georgia
Iowa
Jimmy Simmons Boulevard
Rolfe Christopher
Jim Gilligan Way
1. Mamie McFaddin Ward
2. Dishman Art Museum
3. Art
4. University Theatre/KVLU
5. James M. "Jimmy" Simmons Music Building and Rothwell Recital Hall
6. Health & Human Performance Complex A&B
7. Hayes Biology
8. Science Auditorium
9. Theater Arts
10. Social & Behavioral Sciences
11. Geology
12. Archer Building
13. Galloway Business
14. Montagne Center
15. Provost Umphrey Stadium, W.S. "Bud" Leonard Field and Dauphin Athletic Complex
16. Chemistry
17. Ty Terrell Track
18. Sheila Umphrey Recreational Sports Center and McDonald Gym
19. Setzer Student Center
20. Carl Parker Building Undergraduate Advising Center
21. Setzer Center Bookstore
22. Lucas Engineering
23. Wimberly (Admissions)
24. Visitors Parking
25. Plummer (Administration)
26. Communication Building
27. Post Office/Police
28. Family & Consumer Sciences
29. Mary & John Gray Library
30. Engineering Research Center
31. Cherry Engineering
32. Newman Catholic Center
33. Church of Christ Student Center
34. Honors Program
35. Latter Day Saints Student Center
36. Health Center
37. Combs Hall (Cardinal Village III)
38. Wesley Foundation Methodist Center
39. Baptist Student Center
40. Dining Hall
41. Texas Success Initiative/Developmental Studies (former ROTC Bldg.)
42. Maes
43. Gentry Hall (Cardinal Village I)
44. Morris Hall (Cardinal Village II)
45. Education
46. Hydraulics Lab
47. Speech and Hearing
48. Monroe Hall (Cardinal Village V)
49. Campbell Hall (Cardinal Village IV)
50. John Gray Center University Advancement
51. Admissions Visitors Center
52. Brooks-Shivers Hall
53. Human Resources
54. Golf Driving Range
55. Vincent-Beck Stadium
56. Soccer and Softball Complex

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Printing and Supplies

Registration/Orientation

Given out at registration:

- 10 copies of "Overview and Rules" per team
- 1 small notepad and pen/pencil per player

Given out during orientation:

- 3 copies of "Opening Puzzle (Overview)" per team

Opening Puzzle

Set up in green space:

- 1 posterboard per suspect (white for White, yellow for Mustard, etc.)
- 2 copies of "Opening Puzzle (Testimony)" per suspect per team stapled to appropriate posterboard (possibly on appropriately-colored paper)

Puzzles

Set up in Team HQs:

- 1-2 four-function calculators
- 1 packet of puzzles containing 2 copies of Puzzles #1-#4
- Supplies to write on (paper/whiteboard/markers/etc)

Set up at each puzzle solution location:

- 2 copies of the appropriate EXTRA Puzzle per team

Metapuzzle

Given out at Game HQ after solving Puzzles:

- 2 copies of "Metapuzzle" pages per team

Used during checking of Metapuzzle solution at Game HQ:

- Two chessboards

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A Mathematical Puzzlehunt Primer
2015 Teaser

Are you ready for the ultimate mathematical challenge? At the **Lamar Mathematical Puzzle (LaMP) Challenge**, your team will be challenged with riddles, codes, and (of course) puzzles which will put your math skills to the test, while sending you exploring across Lamar University's campus! If you think you have what it takes, see if you can unravel the messages below...

```
R L O K O O K E C V
A A T O E D M R U R
T S L L H R O E T E
I O R B K E P M E S
L U E V T N S E B L
N A O A N C N U F K
T I M W D B H A R E
R R E A R D C S E S
```

Message 1: `____ __ _________ __ _____`

Message 2: `________ ____ _______`

Message 3: `____ ___ ____ _________`

Solution: `________ _______ ____!`

By the way, you may remember that a **prime** number is an integer greater than 1 which only has itself and 1 as factors. Since this is puzzle prime, you may want to start by using (and then removing) the letters in prime position above... **Bring this puzzle solved to the competition, and your team will get a bonus at the start of the game!** Good luck!

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Opening Puzzle
Get a Clue!
Overview

Mr. Boddy has been murdered (again?), and you may be familiar with the six Suspects who were in his mansion at the time of death: Mrs. White, Colonel Mustard, Miss Scarlet, Professor Plum, Ms. Peacock, and Mr. Green. There were six possible Weapons, and nine total Rooms.

We've interviewed all six Suspects, and their testimony has been written on posters we've displayed outdoors. By putting the facts together, you should be able to determine which **suspect** had which **weapon** in which **room**, as well as **who is guilty of murder**.

But be careful! The five innocent suspects will *always tell the truth*, but you *can't trust the guilty party*. The murderer will say anything to deflect suspicion from them.

Report the guilty Suspect, Weapon, and Room to the game organizer, and your team will receive a packet of puzzles including further instructions, and 100 points. Your team will only be allowed to guess three times, and you must finish within 30 minutes to earn any points. After 30 minutes, all teams can pick up their puzzle packets.

Once you have the puzzle packet, head to your team headquarters and start solving!

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Opening Puzzle
Get a Clue!
White's Testimony

Mrs. White: Oh dear, you think I'm a suspect?

I'm afraid you're mistaken.

- I was in the Kitchen.
- The Dining Room was empty.
- The Knife was in the Lounge.

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Opening Puzzle
Get a Clue!
Mustard's Testimony

Colonel Mustard: Me, a murderer? Nonsense!

Here's how I remember it.

- I was in the Billiard Room.
- Plum had the Wrench.
- Scarlet was in the Lounge.

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Opening Puzzle
Get a Clue!
Scarlet's Testimony

Miss Scarlet: No way I would hurt poor dear Mr. Boddy!

Let me help you find out the real culprit.

- The murder happened in the Conservatory.
- The Lead Pipe was in the Ballroom.
- White had the Candlestick.

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Opening Puzzle
Get a Clue!
Plum's Testimony

Prof. Plum: Balderdash! I couldn't have done it!

I'll be happy to educate you on why.

- I was in the Hall.
- Scarlet had the Wrench.
- Mustard was in the Conservatory.

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Opening Puzzle
Get a Clue!
Peacock's Testimony

Ms. Peacock: Why, I couldn't harm a fly!

Someone else must have done him in.

- I was in the Ballroom.
- Green had the Revolver.
- The Study was empty.

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Opening Puzzle
Get a Clue!
Green's Testimony

Mr. Green: I can't believe you suspect me.

I didn't like him, but that doesn't make me a killer!

- I was in the Library.
- Mustard had the Rope.
- The Hall was empty.

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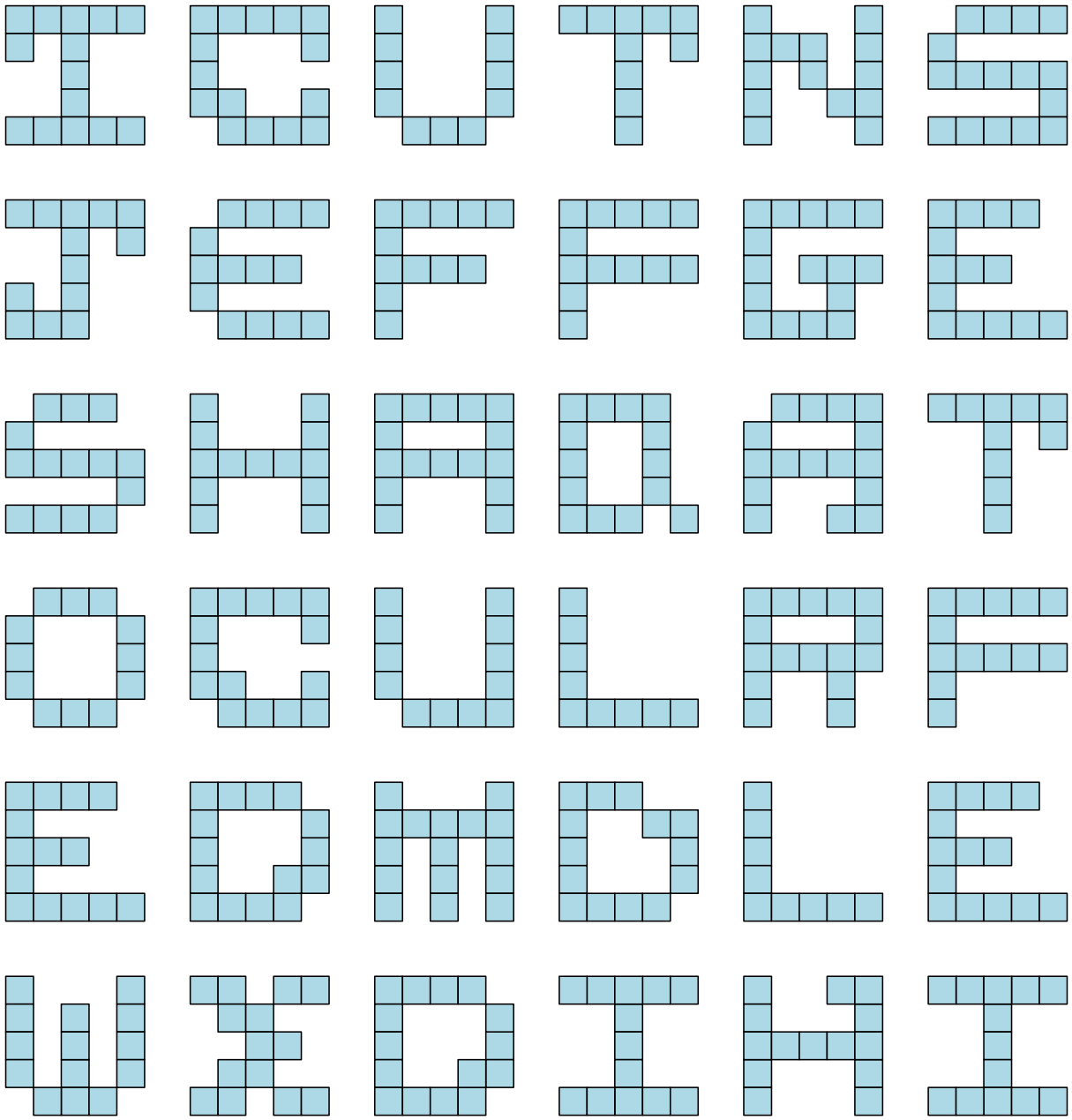
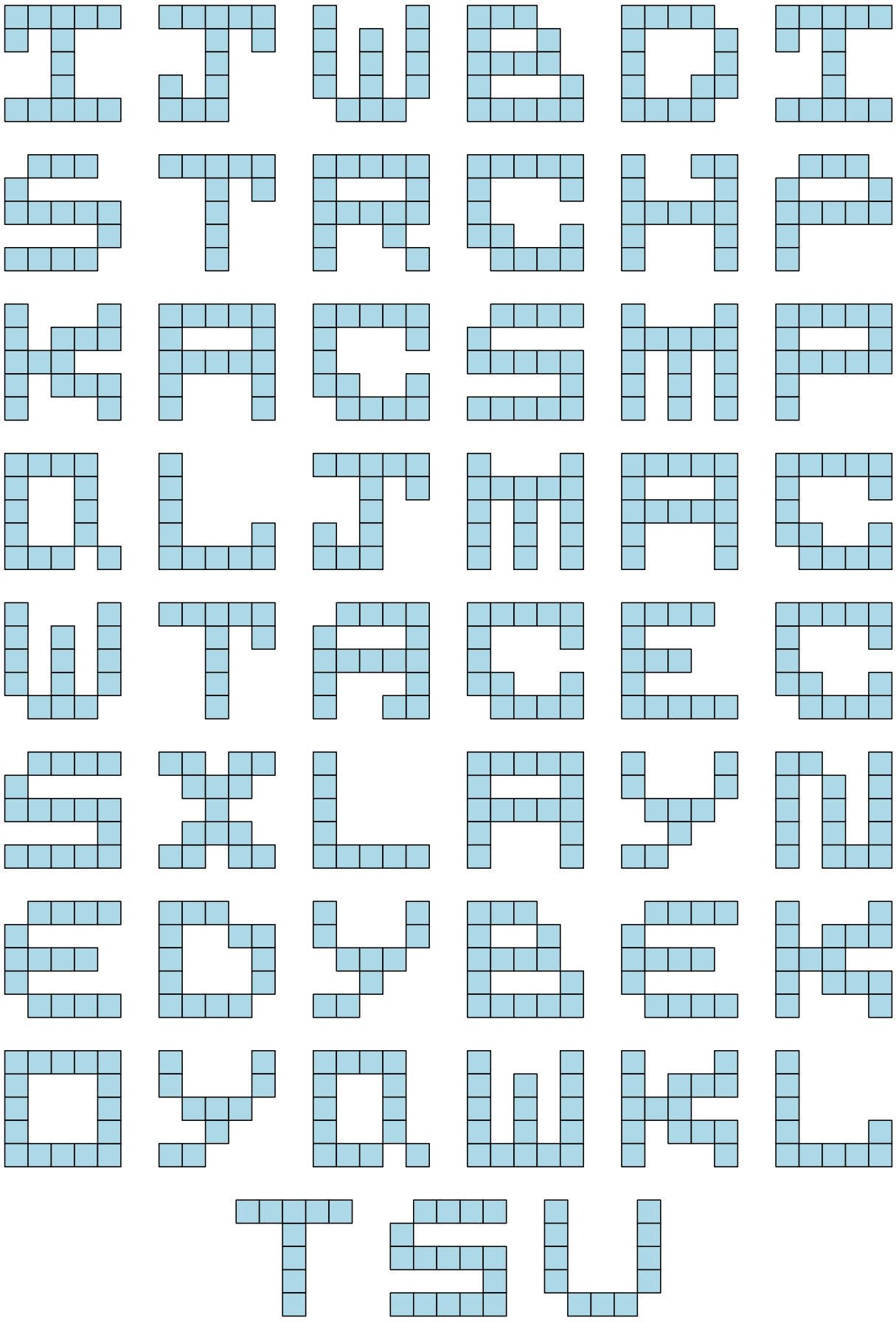
Puzzle 1
Domino Rally

We constructed letters by tiling dominoes in a 5×5 square, and we used them to write a clue to the location of an EXTRA Puzzle.

Unfortunately, a few extra letters have been snuck in, so you'll probably want to remove those first... Report your solution to Game HQ and earn 100 points!





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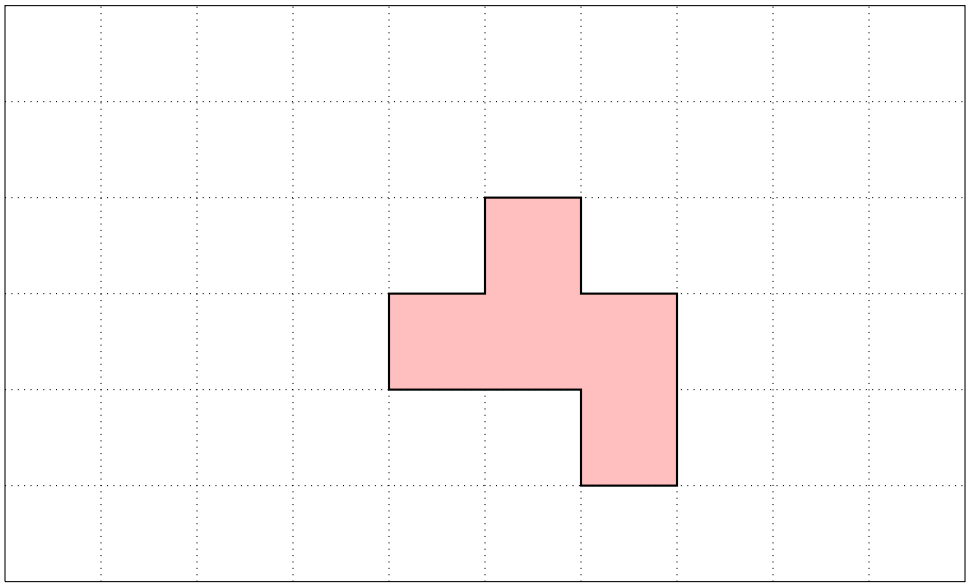
EXTRA Puzzle 1
Domino Rally

Set 'em up and knock 'em down!

In the fifties, Prof. Solomon W. Golomb defined a **pent**omino to be made up of five consecutive squares, rather than the two which make up a domino. Two pentominos are unique if one cannot be rotated or reflected to get the other.

Find a complete tiling of the below 10×6 rectangle using exactly twelve pentominos. We've filled in one pentomino below to get you started, and it is possible to find 11 other unique pentominos which complete the rectangle. The team(s) turning in a valid diagram to Game HQ with the most unique pentominos today will earn 50 points.



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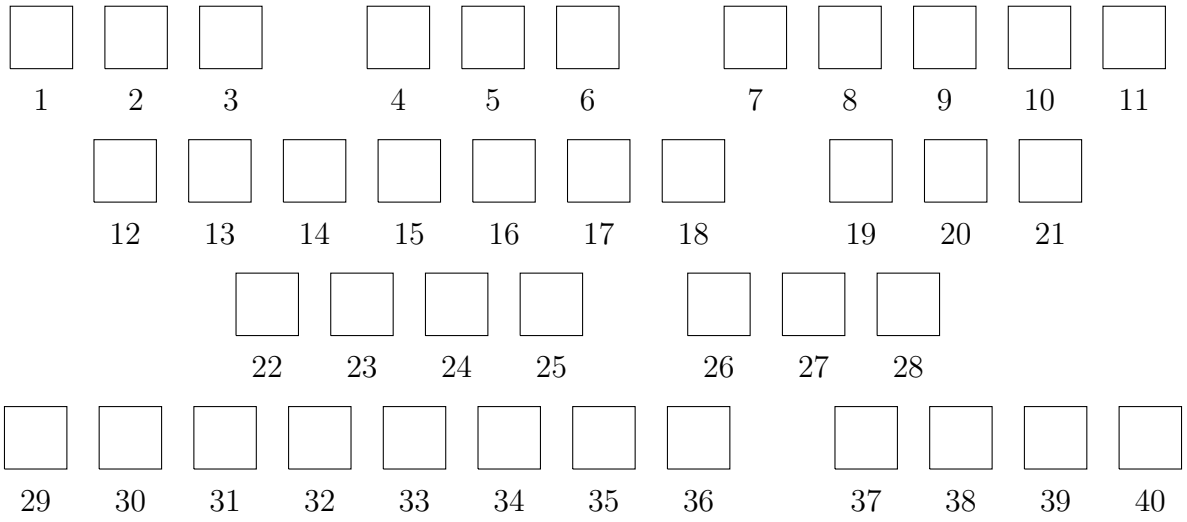
Puzzle 2
Balancing Act

The labels on the following scales can be rearranged to spell out a clue to the location of an EXTRA Puzzle. These rules will tell you how to rearrange the letters:

- These are balance scales, so the total weights on each side of a scale are exactly the same.
- The kettlebells A, B, C, D are the same for each picture, with A being the lightest to D being the heaviest.
- The ? kettlebell is always a unique weight between 1 and 40 from picture to picture.



Report the correctly decoded message above to Game HQ for 100 points!

Y

U

J

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W

C

Y

T

D

G

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D

A

I

E

H

N

H

O

Y

M

L

R

K

T

N

E

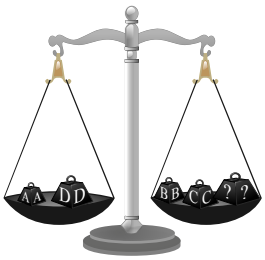
R

W

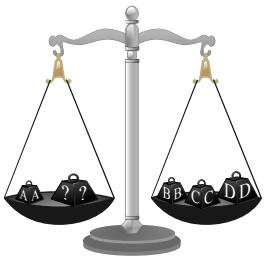
O

A

U



I



E

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EXTRA Puzzle 2
Balancing Act

We hope you didn't become unbalanced trying to puzzle that one out.

Here's another balancing challenge. This time you have twelve indistinguishable kettlebells, except that one kettlebell has a very slightly different weight than the other eleven. You don't know if it is heavier or lighter. The balance scale can support as many kettlebells on either side as you'd like.

How many times must you use the balance scale to definitively prove which kettlebell has the different weight, as well as determine if it is heavier or lighter than the other kettlebells? Report your best guess to Game HQ, and the team(s) closest to the correct answer *without going under* will receive 50 points.

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Puzzle 3
A Basic Puzzle

Our usual numbering system is called **base-10** since, for example:

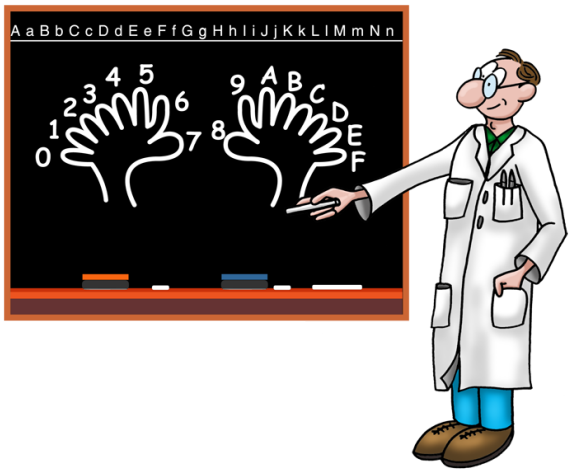
$$8324 = 8 \times 10^3 + 3 \times 10^2 + 2 \times 10 + 4$$

Computers sometimes use what's known as a **base-16** system, also known as **hexadecimal**. To get numerals bigger than 9, the letters $A = 10$, $B = 11$, etc. are used. For example:

$$8D3_{16} = 8 \times 16^2 + 13 \times 16 + 3 = 2259$$

$$FACE_{16} = 15 \times 16^3 + 10 \times 16^2 + 12 \times 16 + 14 = 64206$$

While we didn't use hexadecimal, we did use another number base to convert a clue to the location of an EXTRA Puzzle to the base-10 numbers below. Here's something to get you started: $46248 \Rightarrow ZOO$.



38210 37453776 549100 1524953 410 26353705 812282
15365 38210 72675778981241 13801 56093934413 15935

Report the decoded message above to Game HQ for 100 points!

Image courtesy http://spaceplace.nasa.gov/binary-code3/en/

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EXTRA Puzzle 3
A Basic Puzzle

Great work convering those base-10 numbers into that base-36 message!

Since hexadecimal uses the letters A through F, some hexadecmial numbers are also valid English words. Try to find a base-10 number which converts via hexadecimal to an English word which isn't a proper noun. (We will use the official 2006 Scrabble word list to decide if a word is valid.) For example:

$$64206 = 15 \times 16^3 + 10 \times 16^2 + 12 \times 16 + 14 = FACE_{16}$$

Report this base-10 number to Game HQ. The team(s) reporting the largest valid base-10 number today will earn 50 bonus points! (Sorry, 64206 will not be accepted.)

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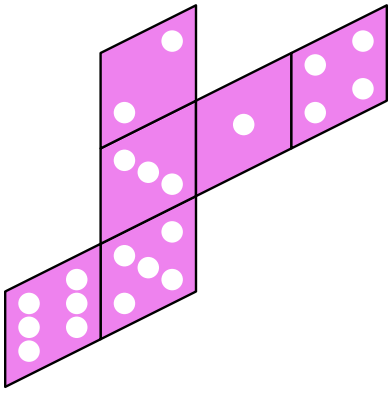
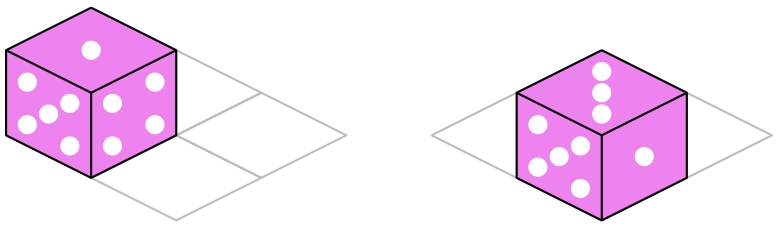
Puzzle 4
Dicey Situation

A standard six-sided die has a **planar unfolding** of this form, created by cutting along some of the edges and flattening the faces into a plane:

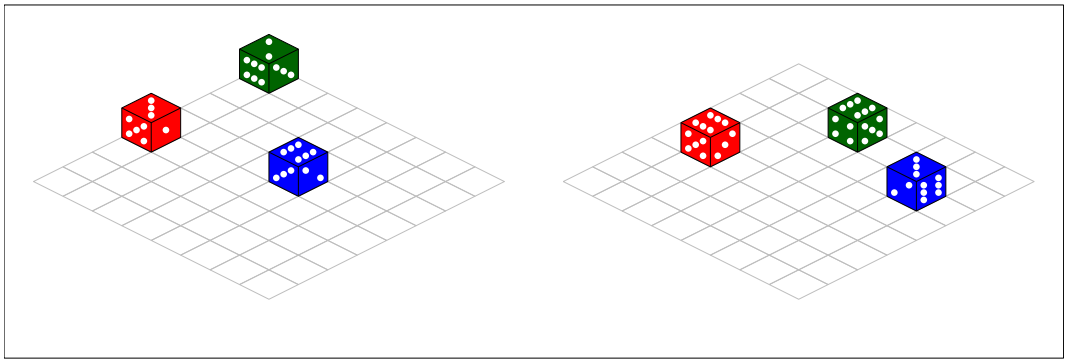


In the following images, three different-colored standard dice have been moved on an 8×8 board: red, green, and blue. Two of the dice in each figure are moved by "rolling" the dice carefully from square to square as in the following image.

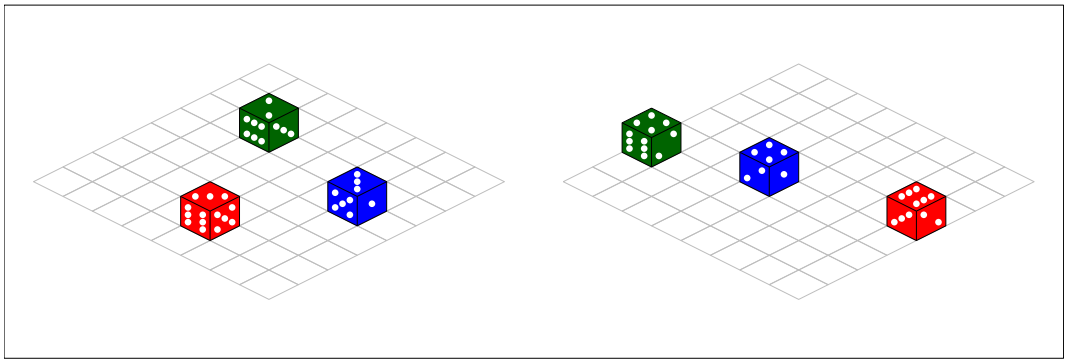


However, the third color die in each image was simply picked up and placed at its new location. A clue to the location of an EXTRA Puzzle may be obtained by concatenating the strings of letters associated with this third die from each figure. (Look out: the images don't appear in the same order as the resulting message.)

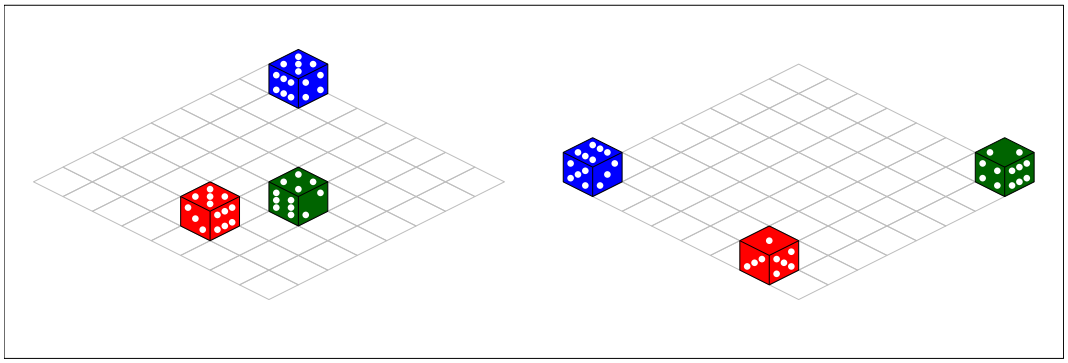
Relay the decrypted message to Game HQ for 100 points!



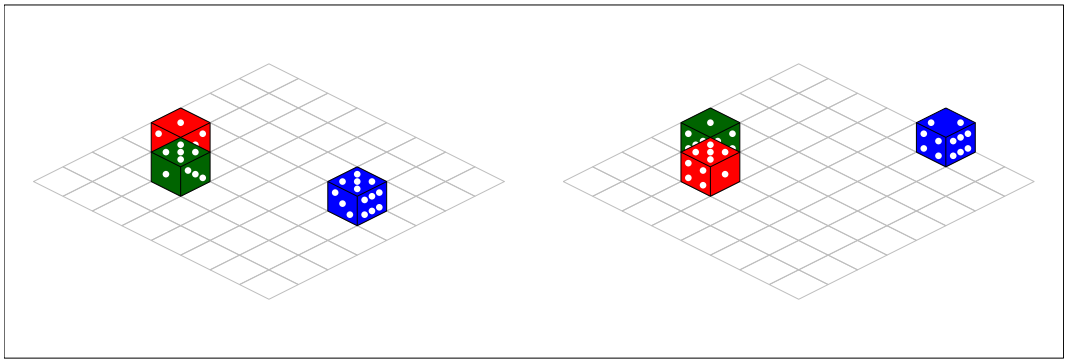
JUS — AST — GIS



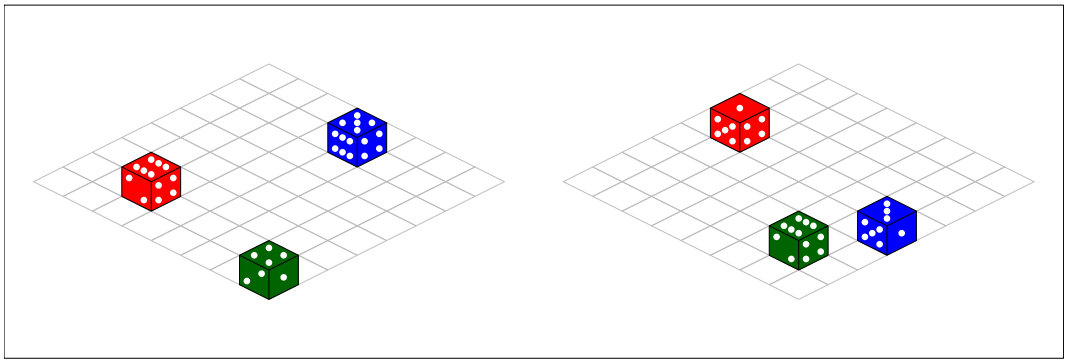
NOTJ — TARE — EDYO



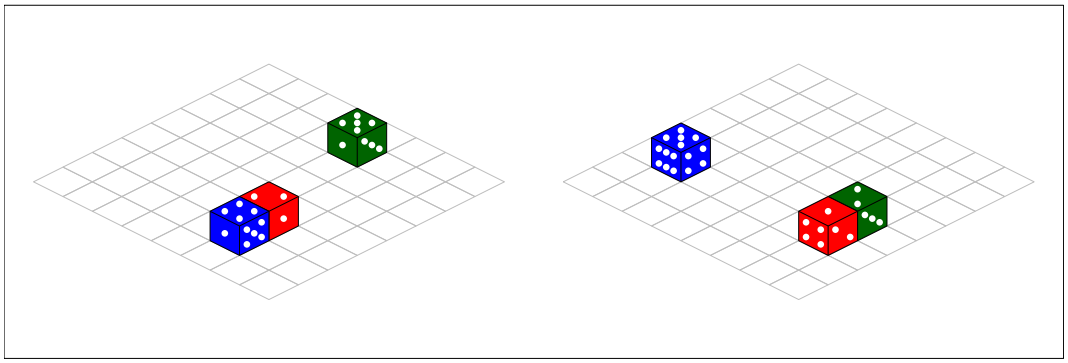
DHER — URTI — USTB



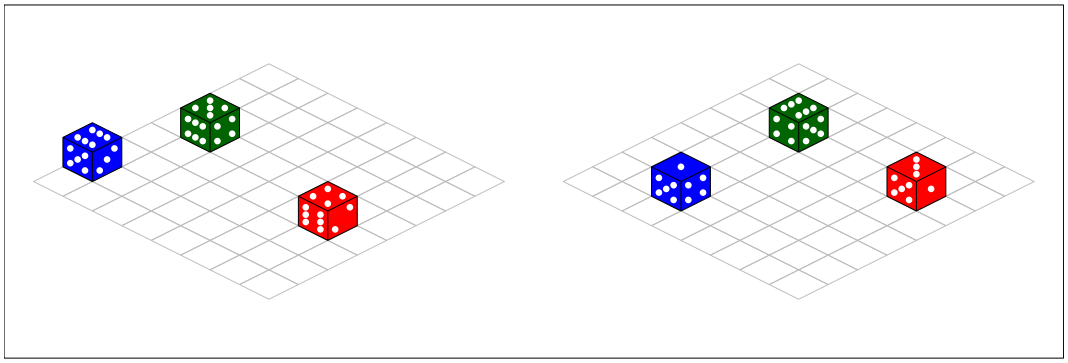
MEO — LAC — MEO



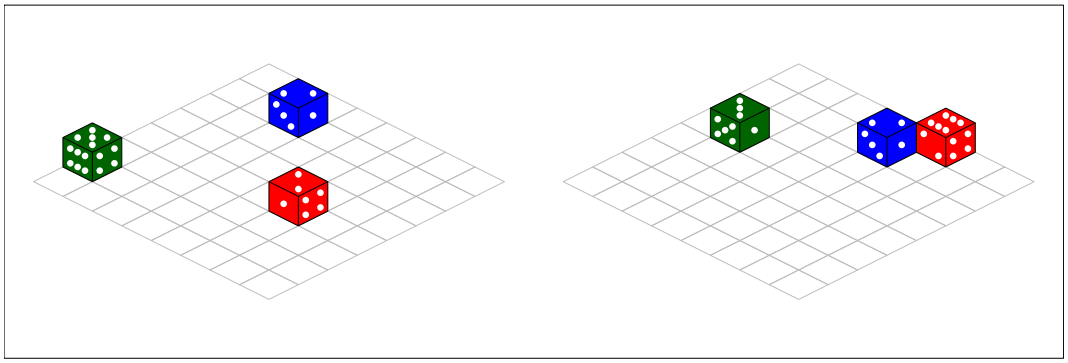
YOU — REA — YOU



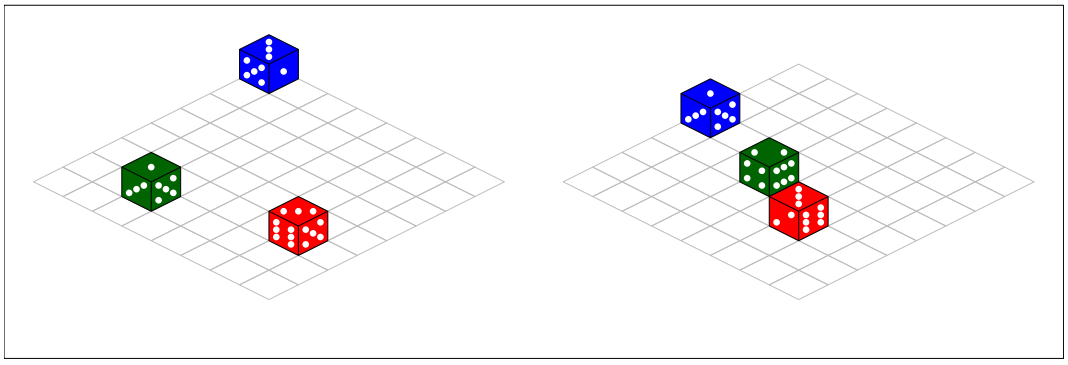
ATH — ITE — ATH



DIN — SIS — VEW



DWH — AFR — ISP



GIM — NTH — KAN

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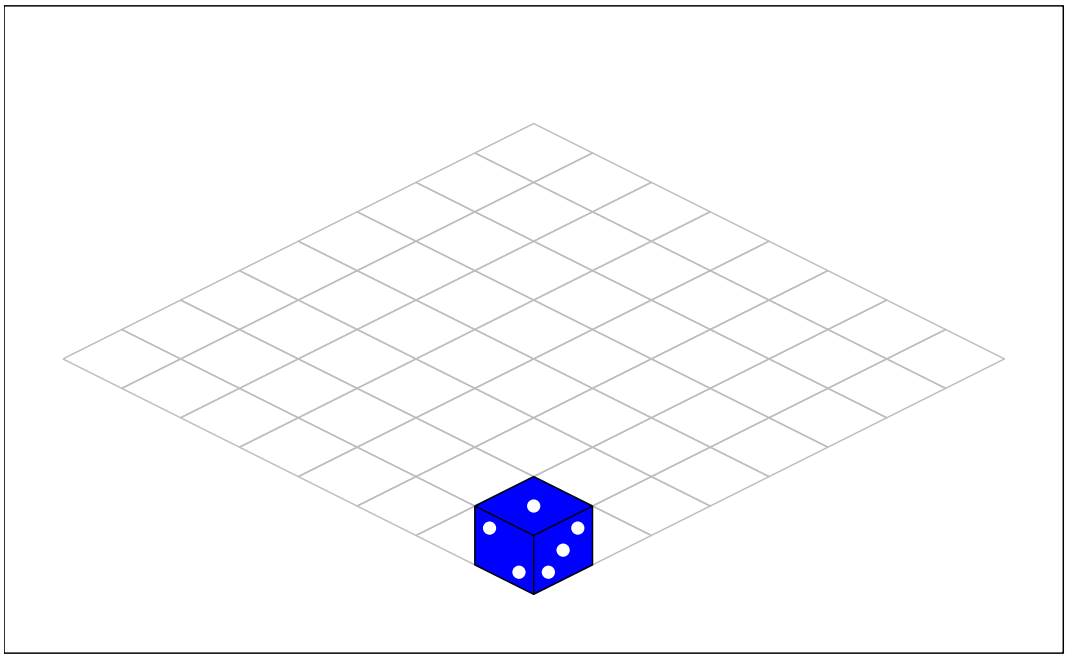
EXTRA Puzzle 4
Dicey Situation

Awesome! Did you figure out how to roll two of the dice in every picture, or did you find a way to identify which dice movements were impossible?

Suppose one of those dice was positioned on the 8×8 grid as below. How many different positions and orientations can the die be legally moved into by rolling (as in the main puzzle)? Report your best guess to Game HQ, and the team(s) closest to the correct answer will earn 50 bonus points!



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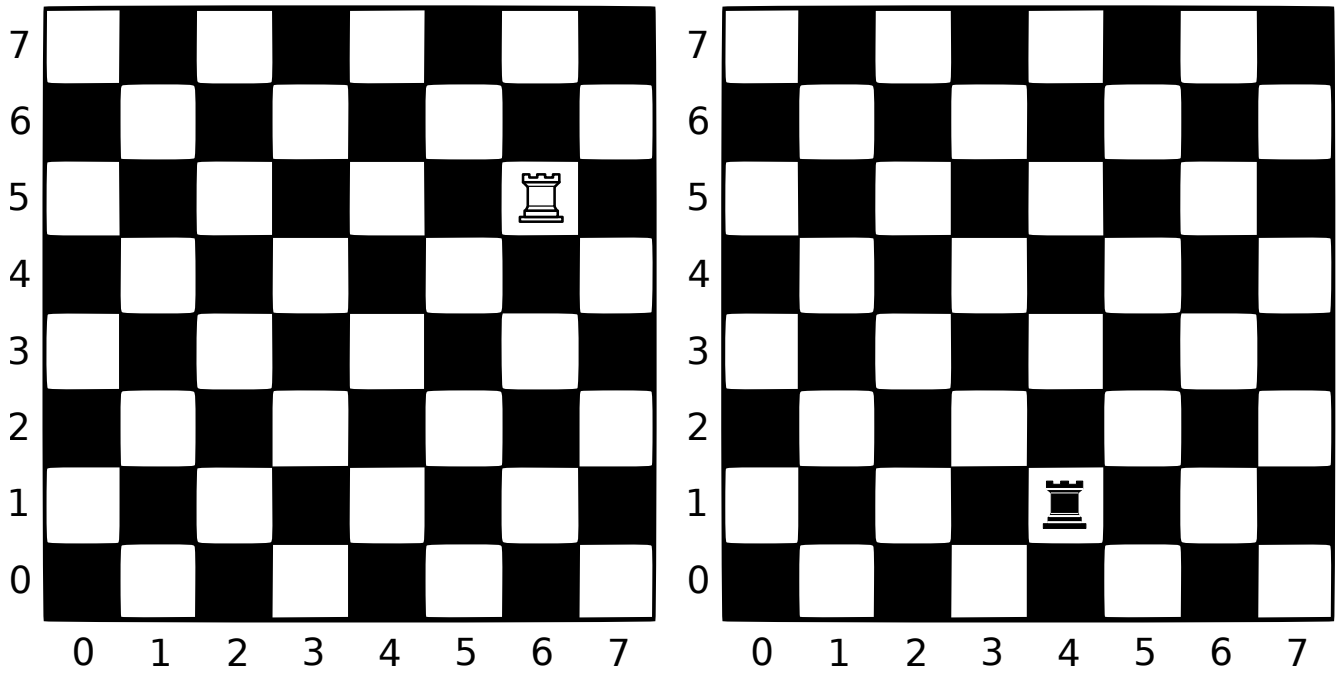
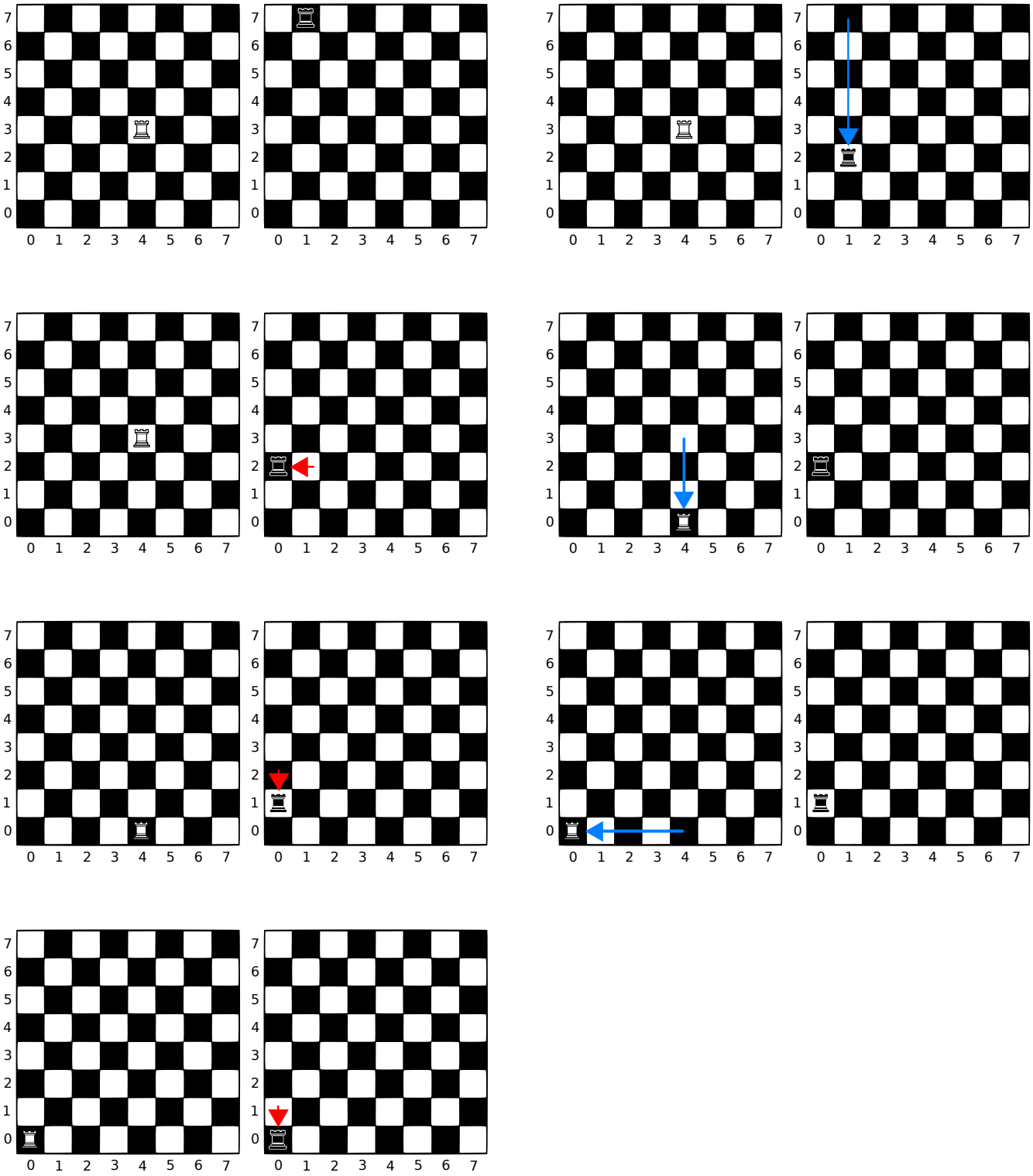
Metapuzzle
The Secret of Rook Away
Overview

Great job on completing your first Puzzle! You're now able to start work on the Metapuzzle.



The game **Rook Away** is played with two players (Red and Blue), two rooks, and two chessboards. Player Red begins by placing the white rook on the left board, and the black rook on the right board. Then each player takes turns moving exactly one rook (either white or black) one or more spaces left or down (but not right, up, or diagonally), starting with Player Blue. Rooks may not be moved beyond the edge of the board, and the player who starts his or her turn without any legal moves loses the game.

We've numbered the rows and columns 0 through 7. Here's an example of a playthrough where the first player (red) positions the white rook at $(4, 3)$ and the black rook at $(1, 7)$.



Note that Player Red wins this game, since there are no more legal moves for Player Blue to make.

For the Metapuzzle, your team must figure out unbeatable strategies for the *first player* which follow different starting moves. Such strategies must guarantee he or she will win the game *no matter what the second player does*. For example, a strategy might be "after positioning both rooks on a black square, always choose to move a rook which reduces one of the largest coordinates by one".

To solve this challenge, go to Game HQ and describe your unbeatable strategies to the organizer. Depending on how clever your solution is, your team will earn points:

- **50 points** for unbeatable strategies covering 64 to 175 different starting positions.
- **100 points** for unbeatable strategies covering for 176 to 511 different starting positions.
- **200 points** for unbeatable strategies covering for 512 different starting positions (the maximum such number)

Your team will earn an extra Hint to this Metapuzzle for each additional Puzzle you solve. If you have questions about the rules of Rook Away or this Metapuzzle, feel free to ask the organizer. This one's tough, so good luck!

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Metapuzzle
The Secret of Rook Away
Hint 1 of 3

Remember that your team is allowed to submit multiple solutions, so don't worry about if your solution is "clever" enough before submitting it. You can always improve it later, and the organizer will determine how many starting positions your strategy covers.

Oh right, you wanted a hint. **The** 50 **and** 100 **point solutions we've thought of both follow what you might call a "copycat" strategy.**

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Metapuzzle
The Secret of Rook Away
Hint 2 of 3

Did you get 50 points yet at least? **There's $8^2 = 64$ ways to position both rooks on the diagonals of each chessboard, by the way.**

Hey, we know it seems off-topic, but here's a couple of definitions for you.

- "A Base-ic Puzzle" uses various number bases. A particularly useful number base is the **binary** or **base-2** system. For example, $10111_2 = 1 \times 2^4 + 0 \times 2^3 + 1 \times 2^2 + 1 \times 2 + 1 = 23$.
- A computer using binary might perform what's called the "**exclusive or**" operation $\oplus$, which swaps the 0's and 1's in the first number's binary expression whenever the corresponding digit in the second number's binary expression is a 1, and leaves it the same otherwise. For example:

$$19 \oplus 10 = 10011_2 \oplus 01010_2 = 11001_2 = 25$$

$$5 \oplus 6 = 101_2 \oplus 110_2 = 011_2 = 3$$

$$27 \oplus 35 = 011011_2 \oplus 100011_2 = 111000_2 = 56$$

$$9 \oplus 13 = 1001_2 \oplus 1101_2 = 0100_2 = 4$$

So what? Well, there's a reason we numbered the rows and columns of the chessboard 0 through 7. Or should I say 000_2 through 111_2?

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Metapuzzle
The Secret of Rook Away
Hint 3 of 3

Here's your final hint to help you wrap up this mathematical challenge. **There are** $8^3 = 512$ **ways for Player Red to position a white rook at** (A, B) **and a black rook at** (C, D) **such that** $A \oplus B \oplus C \oplus D = 0$**.**

Feel free to bounce any ideas you have off the game organizer; even if your solution isn't perfect, you might learn something to help get it there. You're almost done! We hope you've had fun playing, and good luck on this last puzzle. :-)