Are you excited about continuing to do the math you learned in your BEAM classes? Here are a collection of problems specially selected by your instructors this summer.
Congratulations KenKen + Math students!

Together we’ve explored Kenken Puzzles and dipped our toes into several other kinds of logical puzzles. Now beam is ending, but you leave with every bit of growth you’ve done here. Every time you’ve been frustrated and kept going, every time you faced a problem that was too hard and made progress anyway, you’ve built your skills and that you take with you.

This book is a parting gift… It includes some puzzles you’ve seen before and some new ones. Each type of puzzle listed here can be found online, and often there are books of them in stores.

**Part 1- Our class together**

1.1 Strategies we’ve used

1.2 KenKen Puzzles

1.3 Other Puzzles--Alphametics and Einstein riddles

**Part 2- Nikoli Puzzles**

2.1 Nonograms

2.2 Slitherlink

2.3 Shikaku

2.4 Kakuro

**Part 3- Other similar puzzle opportunities.**

3.1 Room Puzzles

3.2 And Beyond!!!
Part 1-- Our Class Together

1.1 Our Strategies

What have we learned this summer? Much of what we’ve learned is hard to put into words, but here are some of my favorite highlights

Be Contrary, Be Skeptical

One big thing we learned is to question our own logic. If you always ask “am I sure?” “how do I know?”, “what if I missed a case?” etc., you will find flawed logic and prevent a lot of mistakes, and you’ll also develop much better arguments!

Guess carefully and rarely

Being willing to try things and play around with options when you’re not sure is a great skill! However with many logic puzzles, you want to come up with things you’re sure of as much as possible. We were careful to keep track of which things we knew for sure and which things were only guesses, since you can’t build logic on the guesses.

List all the cases...systematically!

Having a system—a way of organizing your cases (options) is very important! You don’t want to miss one. Once you know all the options, you can reason about them. Often we look for places where there are only one or two possible cases. (Or only one or two cases that don’t break something... see below.)

Process of Elimination

We only had a limited number of options, and sometimes we knew some of them didn’t work... when we were lucky, we got down to only one option left! Sometimes there was only one spot left where I could put a 7 in a particular row, sometimes there was only one number left that could go in a particular box. Either way, we eliminated options til we were let with only one.

Look for contradictions...

It’s tempting to look for options that could work, but I got way more excited when I found something that COULDN’T work. If i could make JUST ONE guess and it broke something, then I knew that that guess was wrong! Then I can eliminate that case and maybe know something for sure!
1.2 kenken

How they work: For an n by n kenken, you may use the numbers 1-n (so for a 4 by 4 kenken you can use the numbers 1, 2, 3, and 4). No number should repeat in a row, or in a column. The darker lines form “cages.” Each cage contains a small number and an operation which tells you something about the numbers in that cage. For example, a cage labeled “12 x” must contain numbers which multiply to 12 (order does not matter even for division and subtraction).

Other names: Kenken are sometimes called Inkies, KenDoku, Calcudoku, Mathdoku

Where to find them:
http://www.kenkenpuzzle.com/
http://www.nytimes.com/ref/crosswords/kenken.html?_r=0
http://www.krazydad.com/inkies/

Some examples:
1.3 Alphametics and Einstein Riddles

We also did some Alphametics (from the book “Sideways Arithmetic From Wayside School”) and Einstein Riddles. There aren’t great sources for these online, but you can find some if you search!
Part 2-- Nikoli Puzzles

Nikoli puzzles are puzzles made by a Japanese publishing company called Nikoli Co., Ltd. They have come up with many many puzzles. These puzzles often use only logic (rather than fancy math concepts from school, or outside knowledge about the world). There are WAAAAY to many of those puzzles for me to include them here, but I'll show you a few of my favorites. You can find more of these puzzles at

http://www.nikoli.co.jp/en/puzzles/

2.1 Nonograms

How they work: Nonograms start out as a blank grid. The goal is to color it in, such that each row or column has a specific sequence of dark and light squares. For example, if a given row is labeled 5,3,2 that means there should be a group of 5 dark squares in a row, then a group of 3 dark squares in a row, then a group of 2 dark squares in a row. The trick is that we don't know how many light squares go in each slot, so it could look like this:

```
5, 3, 2
```

Or like this:

```
5, 3, 2
```

Or like this:

```
5, 3, 2
```
Or a million other things! The columns also have to work this way, so a column labeled 1, 6 could look like this:

```
1 1 1
6 6 6
```

The trick is getting both the rows and the columns to work out at the same time. Like with KenKen, these can always be figured out with no guessing. And like kenken, too much guessing can make you very frustrated.

**Also known as:** Nonograms have a lot of names! According to Wikipedia, they can be called Paint by Numbers, Griddlers, Pic-a-Pix, Picross, PrismaPixels, Pixel Puzzles, Crucipixel, Edel, FigurePic, Hanjie, HeroGlyphix, Illustr-Logic, Japanese Crosswords, Kare Karala!, Logic Art, Logic Square, Logicolor, Logik-Puzzles, Logimage, Oekaki Logic, Oekaki-Mate, Paint Logic, Picture Logic, Tsunamii, Paint by Sudoku and Binary Coloring Books.

**Where you can find them:** There are lots of places to find Nonograms… books, websites etc. However a few of my favorite online spots are:

- [www.puzzle-nonograms.com/](http://www.puzzle-nonograms.com/)
- [https://www.griddlers.net/home](https://www.griddlers.net/home)
- And [https://www.griddlers.net/triddlers](https://www.griddlers.net/triddlers) (a slight variation)
Examples:
2.2 Slitherlink

How it works: A slitherlink is a grid of dots with numbers placed within them. The goal is to make 1 single continuous loop of lines (as shown below) without any crossings or branchings. Each number tells you how many lines are around the number. So for example a 2 in a box has two lines around, but you don’t know where they are.

A finished slitherlink might look like this: Or like this:

Or like this...

Also Known As: Again, I turn to wikipedia. It tells me that Slitherlink are also known as Fences, Takegaki, Loop the Loop, Loopy, Ouroboros, Suriza and Dotty Dilemma.

Where you can find them:
Again, there are many sources. One of my favorites is: www.puzzle-loop.com/
Of course, you can also find them at http://www.nikoli.co.jp/en/puzzles/slitherlink.html
Some Examples:
### 2.3 Shikaku

**How it works:** Like many Nikoli puzzles this is a grid with numbers in it. The goal here is to divide the grid into rectangles. Each rectangle should have exactly one number in it (no rectangles without numbers, no rectangles with two numbers). This number should be the number of squares in the rectangle, so a rectangle with the number 8 in it should have 8 squares in it (should have an area of 8 square units). A completed Shikaku is shown below.

![Shikaku grid](image)

**Also Known As:** Wikipedia only gives me two names for this one. It can be called Divide by Squares or Divide by Box. I've never seen it called anything except Shikaku.

**Where you can find them:**
- [www.puzzle-shikaku.com/](http://www.puzzle-shikaku.com/)

**Examples:**

![Example grids](images)
2.4 Kakuro

**How it works:** Each number written to the left of a row tells you what the numbers in that row should add up to. Each number written above a column tells you what the numbers in that column should add up to. You can use the numbers 1 through 9 (no 0), and you should not repeat any number in a given sum. Two completed Kakuro puzzles are shown below.

![Kakuro puzzles](image)

**Also Known As:** Kakuro are commonly called cross sums (because they’re like crosswords with addition). A common variation using multiplication instead of addition is often called cross products or cross multiplication.

**Where you can find them:**

Part 3- Other Puzzles

Of course there are many many other logic puzzles in the world. Some of these are brand new, and others are classics that many of your teachers may have thought about as kids. Some have been inspired by Nikoli Puzzles, some are very different. I’m putting a few of my current favorites here but you should also feel free to go find your own :).

3.1 Area Maze

**How it works:** You have to find the value of the question mark... here's the catch: you are NOT allowed to use fractions in the solutions. Using fractions would give you lots of awful equations and require far less problemsolving. All Area Mazes can be solved using whole numbers.

**Also Known As:** Menseki Meiro

**Where you can find them:** I got these from here: [https://www.theguardian.com/science/2015/aug/03/alex-belllos-monday-puzzle-question-area-maze-smarter-than-japanese-schoolchild](https://www.theguardian.com/science/2015/aug/03/alex-belllos-monday-puzzle-question-area-maze-smarter-than-japanese-schoolchild)

**Examples:**

![Area Maze Example 1](image1)

![Area Maze Example 2](image2)

![Area Maze Example 3](image3)
3.2 Puzzle Books… Magazines… etc. You already know about “Sideways Arithmetic from Wayside School” by Louis Sachar. I’d also love to recommend that you look in The New York Times Magazine, look around your school library (or the public library) for logic puzzle books. There’s also a radio show which a lot of people like called Wait Wait… Don’t Tell Me… Puzzles are everywhere! If you find any particular favorites please tell BEAM about them. May the puzzles be challenging and your pencils ever sharp. Good luck!
Dan’s Diabolical and Dastardly Puzzles

Dan has hidden a box of cookies! The cookies are behind a door, but he won’t tell you which door. Instead, he puts signs on the doors...

1. There are three doors. Dan says, “At most one of the signs on the doors is true.”

<table>
<thead>
<tr>
<th>Door 1</th>
<th>Door 2</th>
<th>Door 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>The cookies are behind this door</td>
<td>The cookies are not behind this door</td>
<td>The cookies are not behind door #1</td>
</tr>
</tbody>
</table>

Where are the cookies?

2. There are three doors. Dan says, “At least one of the signs is true, and at least one is false.”

<table>
<thead>
<tr>
<th>Door 1</th>
<th>Door 2</th>
<th>Door 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>The cookies are not behind door #2</td>
<td>The cookies are not behind this door</td>
<td>The cookies are behind this door</td>
</tr>
</tbody>
</table>

Where are the cookies?

3. There are three doors, and each has two signs! Dan says, “No door has more than one false statement.”

<table>
<thead>
<tr>
<th>Door 1</th>
<th>Door 2</th>
<th>Door 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>The cookies are not behind this door</td>
<td>The cookies are not behind door #1</td>
<td>The cookies are not behind this door</td>
</tr>
<tr>
<td>The cookies are all chocolate chip cookies</td>
<td>The cookies are actually all oatmeal raisin cookies</td>
<td>The cookies are really behind door #2</td>
</tr>
</tbody>
</table>
Where are the cookies?

4. There are three doors, and each has two signs! Dan says, “One door has two true statements, one has two false statements, and the last has one of each.”

<table>
<thead>
<tr>
<th>Door 1</th>
<th>Door 2</th>
<th>Door 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>The cookies are not behind this door</td>
<td>The cookies are not behind door #1</td>
<td>The cookies are not behind this door</td>
</tr>
<tr>
<td>The cookies are behind door #2</td>
<td>The cookies are actually behind door #3</td>
<td>The cookies are really behind door #1</td>
</tr>
</tbody>
</table>

Where are the cookies?

Those Dastardly TAs!

Dan’s Logic TAs, Fatima and Ariel, have taken Dan’s puzzles and made them worse! Every sign Fatima puts up is the truth, but every sign Ariel puts up is a lie.

5. There are three doors, and all the signs were written by Ariel or Fatima. This time, two of the doors have cookies behind them. Which one can you be sure has them?

<table>
<thead>
<tr>
<th>Door 1</th>
<th>Door 2</th>
<th>Door 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>There are no cookies behind this door</td>
<td>There are cookies behind this door</td>
<td>At most one of these three signs was written by Fatima</td>
</tr>
</tbody>
</table>

If you can only choose one door, which one is guaranteed to have cookies?

6. There are two doors, and all the signs were written by Ariel or Fatima. Only one door has cookies.

<table>
<thead>
<tr>
<th>Door 1</th>
<th>Door 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>The cookies are not in here</td>
<td>Exactly one of these two signs was written by Fatima</td>
</tr>
</tbody>
</table>

Where are the cookies?
7. There are three doors, and all the signs were written by Ariel or Fatima. Only one door has cookies.

<table>
<thead>
<tr>
<th>Door 1</th>
<th>Door 2</th>
<th>Door 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>The cookies are behind this door</td>
<td>The cookies are behind this door</td>
<td>At least two of these signs were written by Ariel</td>
</tr>
</tbody>
</table>

Where are the cookies? Who wrote each sign?

8. There are three doors, and all the signs were written by Ariel or Fatima. Only one door has cookies.

<table>
<thead>
<tr>
<th>Door 1</th>
<th>Door 2</th>
<th>Door 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>If the cookies are behind door #2, then the sign on door #2 was written by Fatima</td>
<td>If the cookies are behind this door, then the sign on door #1 was written by Ariel</td>
<td>The sign on the door that really has the cookies was written by Ariel</td>
</tr>
</tbody>
</table>

Where are the cookies?

**Minions!**

Marquia and Andy get jealous of Dan’s Logic TAs, and they join in. Marquia becomes a minion to Fatima: everything Marquia writes is true. Andy becomes a minion to Ariel: everything Andy writes is false.

9. Suppose you see this sign:

<table>
<thead>
<tr>
<th>Sign 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>This sign was not written by Marquia</td>
</tr>
</tbody>
</table>

Who made the sign?

10. Ariel wants to make a sign so that someone clever enough can figure out that she made it. What could she write on it?

11. Suppose you see this sign:
What can you tell about who made the sign?

12. You come across two signs; all the signs were written by Ariel, Fatima, Andy, or Marquia.

<table>
<thead>
<tr>
<th>Sign 1</th>
<th>Sign 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Both signs were written by Ariel or Andy</td>
<td>Neither of these signs were written by Andy or Marquia</td>
</tr>
</tbody>
</table>

Who wrote each sign?

13. You come across two signs; all the signs were written by Ariel, Fatima, Andy, or Marquia.

<table>
<thead>
<tr>
<th>Sign 1</th>
<th>Sign 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>If this sign was written by Fatima or Marquia, then Sign 2 was written by Ariel</td>
<td>Sign 1 was written by Marquia</td>
</tr>
</tbody>
</table>

Who wrote each sign?

14. You come across two signs; all the signs were written by Ariel, Fatima, Andy, or Marquia.

<table>
<thead>
<tr>
<th>Sign 1</th>
<th>Sign 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sign 2 was written by Marquía</td>
<td>Sign 1 was not written by Marquía</td>
</tr>
</tbody>
</table>

You can’t tell who wrote each sign, but you can tell that at least one of them was written by Fatima! Why?
15. You come across two signs; all the signs were written by Ariel, Fatima, Andy, or Marquia.

<table>
<thead>
<tr>
<th>Sign 1</th>
<th>Sign 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sign 2 was written by Ariel</td>
<td>Sign 1 was not written by Ariel</td>
</tr>
</tbody>
</table>

You can’t tell who wrote each sign, but you can tell that at least one of them was written by Andy! Why?

16. You come across two signs; all the signs were written by Ariel, Fatima, Andy, or Marquia.

<table>
<thead>
<tr>
<th>Sign 1</th>
<th>Sign 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sign 2 was written by Marquia</td>
<td>Sign 1 was written by Andy</td>
</tr>
</tbody>
</table>

You can’t tell who wrote each sign, but you can tell that at least one of them was written by Fatima or Ariel! Why?

17. You come across two signs next to each other. You read the first one, but you can’t tell anything about who made the signs. Then you read the second sign, which has the exact same text written on it, but after reading it, you can tell that both of the signs must have been written by Fatima. What could have been written on the signs?

18. Do the same puzzle as before, but where this time reading the inscriptions proves that Ariel wrote them both.

19. Can you come up with a pair of identical signs where looking at just one doesn’t prove anything, but looking at both together tells you that either both were made by Fatima or both by Ariel?

20. You come across two signs labeled Sign 1, and two signs labeled Sign 2. You’re not sure which Sign 1 goes with which Sign 2:

<table>
<thead>
<tr>
<th>Sign 1-A</th>
<th>Sign 1-B</th>
<th>Sign 2-A</th>
<th>Sign 2-B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sign 2 was written by Ariel or Andy</td>
<td>Either Sign 2 was written by Ariel or Andy, or both signs were written by Fatima</td>
<td>Sign 1 was written by Fatima or Marquia</td>
<td>Sign 1 was written by either Fatima or Marquia, and at least one of these signs was written by Marquia or Andy</td>
</tr>
</tbody>
</table>

Does Sign 1-A go with Sign 2-A or Sign 2-B? Who wrote each of the four signs?
Answers

1. Door 2
2. Door 1
3. Door 2
4. Door 3
5. Door 3
6. Door 1
7. Door 3. Ariel wrote the signs on doors 1 and 2, while Fatima wrote the sign on door 3.
8. Door 1
9. Fatima

10. One possibility is, “This sign was made by Andy.”
11. It must have been made by Fatima or Ariel.
12. Ariel made Sign 1, while Fatima made Sign 2.
13. Fatima made Sign 1, while Ariel made Sign 2.
14. There are two possibilities, or “cases.”
   Case 1: If Sign 1 is true, then so is Sign 2. Since Sign 1 is true but not written by Marquia, it was written by Fatima. So in this case, Sign 1 was written by Fatima.
   Case 2: The other possibility is that Sign 1 is false. In this case, Sign 2 must be true. But since Sign 1 is false, Sign 2 cannot be written by Marquia, so it must have been written by Fatima since it is true.
15. We can tell right away that Sign 1 can’t be true, or else Sign 2 would be true and written by Ariel. So we know Sign 1 is false.

Now let’s consider two cases: either Sign 1 was written by Andy, or Sign 1 was written by Ariel. In either case, we want to prove a sign was written by Andy.
   Case 1: Sign 1 was written by Andy. All we’re trying to prove is that a sign was written by Andy, so this just works.
   Case 2: Sign 1 was written by Ariel. Then Sign 2 is false, so it must have been written by Andy or Ariel. But since Sign 1 is false, Sign 2 cannot be written by Ariel. So Sign 2 is written by Andy, and again the case works.
16. You can check that Sign 1 can’t be true, so it must be false. Then if Sign 2 is true, it was written by Fatima. If Sign 2 is false, Sign 1 must have been written by Ariel. In either case, we know that a sign was written by either Fatima or Ariel.

17. For example, “these signs were both made by Fatima, or at least one was written by Andy or Ariel.”

18. One possibility is, “At least one of these signs was written by Andy.”

19. A possibility is, “Both of these signs were written by Fatima, or at least one was written by Andy.”

20. 1-A goes with 2-B, and 1-B goes with 2-A.
   1-A was written by Fatima. 2-B was written by Ariel. 1-B and 2-A were both written by Fatima.
Numerical questions

All answers in this section are integers.

1. What is the sum of all the numerical answers (including this one)?
2. How many questions in the true/false section have an answer of True?
3. How many answers are the same as this one (including this one)?
4. What is the average of all the numerical answers (including this one)?
5. What is the answer to question 1 divided by the answer to question 5?
6. What is the answer to this question?

True/False Questions

7. Question 1 has the highest numerical answer.
8. All numerical answers are positive.
9. The answer to question 3 is greater than the answer to question 2.
10. The answer to question 4 is equal to the difference between answers 2 and 3, minus the product of answers 5 and 3.
Dan is a very proficient eater. Every day of every week he eats all three meals a day and has a single piece of chocolate for dessert. After Dan wakes up in the morning he eats cereal and a Fruit for Breakfast. A fine and nutritious start to any day. Then he spends the next several hours thinking about BEAM and how he can make it better. Around noon he takes a break and eats a delicious and hearty Sandwich for Lunch. Then he spends much of the rest of the day thinking about math, or space, or both! As you know, thinking about both math and space works up quite the appetite; so afterwards Dan is sure to eat a wholesome Dinner to sate his hunger. After Dinner Dan likes to relax by doing a number difficult logic puzzles with his twin roommates Mr. Knight and Mr. Knave. Then he goes back to sleep. Use the clues below to determine what Dan eats for Breakfast, Lunch, and Dinner on each day of the week.

1. Dan eats Kiwis for breakfast later in the week than he eats Cous Cous for dinner
2. Dan does not eat Cherries for breakfast on Sunday
3. Dan eats Durians for breakfast on either Friday or the day he has a BLT for lunch
4. Dan does not eat Kiwis on the day he eats Meatball Marinara Sub
5. Dan eats Crab cakes for dinner on the day he eats a BLT for lunch
6. Dan does not eat Grapefruit on the day he eats Pasta for dinner
7. Dan does not eat Pizza for dinner on the day he eats a Meatball Marinara Sub
8. For breakfast Dan eats Cherries earlier in the week than he eats a Banana
9. Dan eats Apples for breakfast on Wednesday
10. Of a Chicken Sandwich and breakfast Durians, Dan eats one on Monday and the other the same day he eats Crab Cakes.
11. Dan does not eat Cherries for breakfast on Tuesday
12. Dan eats a Roast Beef sandwich earlier in the week than he does Crab Cakes
13. The day Dan eats Cherries is not the day he eats Stir Fry for dinner
14. Dan also does not eat a Roast Beef sandwich when he has Stir fry for dinner
15. Dan eats a Cheese Tomato sandwich the day before he has Grapefruit for breakfast
16. On Wednesday Dan eats RoastBeef
17. Saturday, however, is Turkey Sandwich day
18. Pasta night is 3 days after the Day Dan eats a Roast Beef Sandwich for lunch
19. On Monday Dan eats either Cheese and Crackers for dinner or a Durian for breakfast
When Ruthi is not at BEAM she sometimes goes dancing, but usually she spends her time working in her secret underwater math lab in the east river. There she spends her time designing complex challenge problems to confound BEAM students. This is also where she keeps her research on all of the cool properties of all of the integers; such as 1729, the 2nd taxicab number* (The smallest number that can be expressed as the sum of two positive cubes in \( n \) distinct ways)** When she is out of her lab she leaves multiple stuffed animal guards to protect the Keys to her lair. Ruthi’s Lair has four Keys of four colors, A White Key, an Orange Key, a Purple Key and a Teal Key. They each unlock the lock that protects Ruthi’s House, her Mailbox, her Computers or her Metrocard. All of Ruthi’s Keys are guarded by stuffed animals Named Bini, Bonnie, Snoopy and Molly; and they sleep in deeper and deeper inside of her lab. The Rat sleeps deepest. Then the Dog, the Teddy, and the Doll closest to the entrance. Use the clues to figure out the name of each stuffed guard, the color of their key and what the key unlocks

1. Of the guards Snoopy, and stuffed animal who protects Ruthi’s House Key, one is a dog and the other is a Teddy Bear
2. The key to the Computers is Purple
3. The Guard of the Teal key sleeps deeper in the lab than the guard of the Orange Key
4. Bonnie does not guard the Teal Key
5. The Mailbox Key is not Teal
6. Molly Guards either the Teal Key or the Orange Key
7. The Mailbox Key is not guarded by the Guard closest to the lab entrance
8. The House Key guard sleeps deeper in the lab than Bini
9. Neither Bini nor Molly guard Ruthi’s Metrocard
10. The second guard from the entrance does not guard the White Key and does not guard the Computer Key
11. Snoopy guards the Computer Key
12. Bini does not guard the White Key
Sylvia a wonderful and smart, normal human who helps manage BEAM and certainly not an amazing super heroine who surveys Central Park every night as the Sylvan Strider. She certainly doesn’t have the power to talk to trees and have them listen and bend their limbs to her needs. Sylvia does normal things throughout the week like eating tasty food, doing fun things like Visiting her Mom or Sleeping. She also visits a different borough everyday because she loves to experience all NYC has to offer, and not because the Sylvan Strider loves and tends to the needs of the city’s parks and gardens. Use the clues to figure out where Sylvia goes each day, what she does and what she eats, and demonstrably not what she claims to be doing while she is really secretly nurturing the many groves and greenery of NY

1. Sylvia goes to work earlier in the week than she goes dancing
2. Sylvia has Burgers in Manhattan
3. Sylvia does not eat Mexican in Queens
4. Sylvia does not eat Mexican when she goes dancing
5. Sylvia eats Chinese food on Saturday
6. Sylvia does not eat Thai food in Queens
7. Sylvia does not eat Chinese while she parties
8. Sylvia goes to Brooklyn earlier in the week than she goes partying
9. Sylvia has Pizza at work
10. Sylvia doesn’t have Burgers on Monday
11. Sylvia does not have Pizza in the Bronx
12. Sylvia eats Pizza, goes to Manhattan, Sleeps, and eats Mexican on four different days and none of those days are Friday.
13. Sylvia goes to Manhattan on Thursday
14. Sylvia Sleeps later in the week than she goes to the Bronx
PROBLEMS FROM SQUARES, PRIMES, AND THE INTEGERS IN BETWEEN

1. Find a positive whole number less than 100 that only has one odd factor. Find another one! Find all of them!

2. What is the smallest positive integer divisible by four different prime numbers?

3. A **composite** number is an integer with more than two factors. For example, 10 is composite (because it has four factors: 1, 2, 5, and 10), but 3 is not (because it only has two factors) and 1 isn’t either (because it only has one factor).
   (a) Can you find five composites in a row?
   (b) What about six or more?

4. The number 13 is prime and so is 31. How many two-digit primes are still prime when the digits are switched?

5. Dan takes a positive integer and multiplies it by 245. The product is a perfect square. What is the smallest possible number Dan could have started with?

6. Jacob’s favorite number is $2 \times 2 \times 2 \times 2 \times 3 \times 7$. What are all the odd factors of his favorite number? (HINT: try to avoid finding out his number! It’s so big!)

7. Which of these numbers are perfect squares?
   - $3^{28}$
   - $6!$
   - $121 \times 225$
   - $5^7 \times 10 \times 2^9$

8. What is the last digit of $2^{2016}$?

9. (a) What is the last digit of $3^{17}$?
   (b) What is the last digit of $2^{44} \times 5^{44}$?
   (c) What is the last digit of $17^3$?
   (d) What is the last digit of $3^{45} \times 7^{46}$?
10. Each letter in this problem represents a different digit, but one letter can’t represent two different digits.

\[
\begin{array}{c}
T R I E D \\
+ D R I V E \\
\hline
R I V E T \\
\end{array}
\]

What number is DIVERT?

11. (a) David took the four digit number 1,74□ and squared it to get 3,045,025. What missing digit does □ represent? Explain in one or two sentences how you know.

(b) Then he took the four digit number 1,74△ and squared it to get 3,059,001. What missing digit does △ represent? Explain in one or two sentences how you know.

12. Kayla thought of her favorite prime number. Then Jacob took Kayla’s prime number, added 9 to it and got another prime number. What was Kayla’s prime number?
1. A cube has six faces. Suppose you want to paint the cube. You can paint each face black or white. How many unique ways can you paint the cube? (For example, if you paint the top face black, it’s the same as painting the bottom face black, because when you roll it, it would have the same effect).

2. How many different combinations of pennies, nickels, dimes and/or quarters result in a sum of 35 cents?

3. Everyday parents drop off their children and counselors pick them up to take them to BEAM 6. Suppose the pick-up time is scheduled to be between 8 and 8:30am. Your counselor arrives at the train stop at some random time between 8 and 8:30. He or she waits 15 minutes before leaving (if the parents don’t show up). Your parents are in a rush, so when they arrive at the train station (at a random time between 8 and 8:30), they only wait 5 minutes if they don’t see a counselor. What is the probability that you actually arrive at BEAM?

4. What is the area of the shaded region?

![Diagram with dimensions 2cm x 1cm and 1cm x 2cm]
From the Japan Airlines inflight magazine, *Skyward*
1. Place letters in the empty squares to get 11 words reading across and down.

```
O A S
T I
L A D I D A
L E T
```

2. Al, Bob, Cal, Dot, and Ed all bought items from the mail-order magazine. Al & Bob paid $150, Bob & Cal paid $200, Cal & Dot paid $170, Dot & Ed paid $210, and Ed & Al paid $100. How much did each person spend?

3. Multiplying my age by 6 then subtracting 6 produces the same result as subtracting 7 from my age then multiplying by 7. How old am I?

4. In how many ways can 4 apples be distributed among 4 people - A, B, C, and D?

5. Arrange the number 1 to 9 in the boxes below so that each line of 3 boxes sums to 14, 3 numbers have already been placed.

```
<table>
<thead>
<tr>
<th>4</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
```

6. Divide the following figure in half by adding 2 toothpicks.

```
```

7. What number should replace the question mark?

```
1 2 2 1
1 9
3 7 5 7
3 4 6 9
7 7
5 9 4 7
```

---

---

1. Place numbers 1 to 15 in the white circles so that the distance from 1 to 2, 2-3, 3-4 and so on progressively increase each time.

```
A B C D E F G H I J K L M N O
```

2. A plot of land with a corner missing can be divided into 7 unequally sized pieces with 3 lines, following the gridlines as below. None line crosses itself, and each crosses the other lines just once. Following these rules, divide the land into 7 equally sized pieces with 3 cuts.

3. What do these 7 words have in common?

```
commerce, canoodle, funnel, recessive, bottom, steering, serrated
```

4. What well-known seven word phrase can be made simply using the letters that appear in MISANTHROPE?

5. Arrange the numbers 0 to 9 in the circles so that no two consecutive numbers are connected by a straight line.

```
```

6. In a game, you are forced to choose a warrior to fight against. All the warriors are waiting with their swords sheathed. One has a straight sword, another has a helical sword, a third has a semicircular sword, while the last has a wavy sword. Which one should you pick?
1. There are six different ways to put 2 dots in a 4-square L shape. Arrange the 6 pieces in a 4x6 rectangle so that the 12 dots are connected. You may flip the pieces over.

2. A superstitious pool player didn’t like 8-balls, so he had a 16-ball specially made. When he racked the balls up, he always arranged them so the each ball was the difference of the 2 balls above it. Can you find the arrangement he used?

3. Japanese yen are made of aluminum, and circuit boards contain copper. Match these elements with the product they are found in.
   - Americium (Am), Bismuth (Bi), Cerium (Ce), Magnesium (Mg), Neodymium (Nd), Polonium (Po), Rhodium (Rh), Titanium (Ti), Tungsten (W), Zirconium (Zr)
   - a. Antistatic brush
   - b. Earbud speaker magnet
   - c. Firestarter bar
   - d. Lightbulb
   - e. Flashbulbs
   - f. Optical reflector
   - g. Safe shotgun shot
   - h. Tennis racket
   - i. Smoke detector
   - j. Lighter flint

4. What is the highest number of pieces a round cake can be cut into with 5 straight vertical cuts?

5. “Reforestation” has the apt anagram “A ton o’ fir trees.” The letters of the word are used to give a clue for the word itself. Find the word clued by each of the following apt anagrams.
   - Is abc’s
   - A bar, etc.
   - i.e. Talon
   - Evade it!
   - Blah! Mess!
   - Deem as minor
   - Go in, top star
   - I call a miscount

6. A piece of land has two corners missing. Can you indicate on the gridlines how the land can be divided into 4 pieces with identical size and shape?

7. A consonancy is a set of words with the same consonants in the same order, such as ocarina and acorn. What are consonancys for BEACH-MASTER (a male elephant seal) and COMPANY STORE?

8. By multiplying the digits of 679, it takes 5 steps to get to a single figure (679 6×7×9 = 378 3×7×8 = 168 1×6×8 = 48 4×8 = 32 3×2 = 6). What are the smallest numbers for which it takes 3 and 4 steps?


10. A metal dealer bought a golden cube, 10 cm on each side, with a mass of 19.3 kilograms. The density of gold is 19.3 grams per cubic centimeter. It turned out that the cube wasn’t gold. How was the dealer fooled?
“Here we are at a square table, facing north, south, east, and west, and having the names North, South, East, and West. But none of us has a name that matches the direction we face,” said the man facing north.

“That’s an interesting observation,” Mr. East said, turning to his right. “Don’t you agree, Mr. South?” Where is everyone sitting?

The numbers below are connected when they differ by 1 or 5. What is the fewest possible number of line crossings?

What 2-syllable words starting with L, M, N, O, and P all rhyme with one another?

Add the letters of PRIMATE to the puzzle below so that a chess king could move one square at a time to spell out the phrase “One man’s meat is another man’s poison.”

What do these words have in common?
BALL LEST MUSS POT TUN

In a 2-player game, each person may remove 1, 2, or 3 coins, but not the same number as the previous player. Whoever takes the last coin or coins wins. If the game starts with 9 coins and it is your turn first, how many should you remove to guarantee a win?

The 12 matches shown make 1 square and 4 triangles. Move the matches so that they make 3 squares and 8 triangles.

I saw these names over animal living areas 1 to 5. Curiously, none of the colors or animals matched the actual animal, or even a nearby animal. None of the names described another animal.

“My little joke,” explained the owner.

I shook my head. "I'm glad Goldfox isn't a horse." Can you determine the color and type of each animal?

On a worn, 39 cm ruler, the only marks remaining are at 0, 8, 15, 17, 20, 21, 31, and 39. What is the shortest distance that cannot be measured between 2 marks?

On a worn, 39 cm ruler, the only marks remaining are at 0, 8, 15, 17, 20, 21, 31, and 39. What is the shortest distance that cannot be measured between 2 marks?

What do these 12 words have in common:
poll, hock, dock, stifle, flank, withers, crest, cannon, muzzle, chestnut, croup, shank.

In the squares below, which is the greater angle? A+B, or C?
1. The water hyacinth is a fast-growing weed, able to double the size of its colony every 2 weeks. A square meter colony of is in a 1-square-kilometer lake. How long does it take to cover the lake?

2. On the map below, the route ABCDEFGHA is an example of a cycle, a journey that ends at the starting point, without reusing any road. ABCDA, BCFGB, CDEFC, DEHAD, EFGHE, and GHABG is a set of these cycles that uses every road exactly twice, except for road DG, a new road. Find a set of cycles that uses each road exactly twice.

3. Place words zero, one, two, three, four, five, six, seven, eight, nine, and ten into the puzzle below. The words may read horizontally, vertically, or diagonally. TWO and SEVEN have already been placed.

4. Club member numbers are on transparent badges. Two badges are overlaid, making what looks like 89. Neither badge has 8 or 9, but the sum of the badges is 89. What are the numbers?

5. The letter triple “azz” occurs twice in razzmatazz. What words contain each of the following triples twice?

```
ach  ama  ant  ard  ckt  eno  hua
igh  mat  ono  osc  own  phi  rac
tic  tor  und  utt
```

6. In the diagram below, each circle’s inflow equals its outflow. For example, with the circle at the bottom left, the inflow of 19+6 equals the outflow of 25. In addition, all of the flows are different numbers, from 1 to 30. Accordingly, enter the missing values.

7. Where are each of the following created by the body, and where are they removed? All answers are in the box below.

```
Item               Created in    Removed by
blood cells        kidneys        duodenum
gastric acid       liver          pancreas
insulin            bones          marrow
renin              stomach
urea
```

8. In a foot race, Abe was neither first nor last. Cal beat Doug, Bruce beat Abe, Abe beat Ed but was beaten by Cal, and Doug beat Bruce. Who was last?

9. Raoul asked his brother’s wife’s mother-in-law’s only husband’s only daughter to join him and his wife for lunch. What relation is she to Raoul?

Move 1 shape to obtain a symmetric figure.
1. On my puzzle shelf, Will Shortz is before Sam Loyd and after Henry Dudeney. Nob Yoshigahara is between Martin Gardner and Dudeney. Also, Gardner is directly before Shortz. What is the order of my puzzle books?

2. In a triangular garden, 4 plants are in a row. Add 6 more plants to make 5 rows of 4 plants. Each plant must be in one of the square plots.

3. One bag of potatoes weighs 30kg plus 1/4 of its weight. Another bag weighs 32kg plus 1/5 of its weight. Which bag is heavier?

4. Divide the shape into two identical pieces.

5. 16 golfers (A to P) play in foursomes over five days. After the first day, they decide on groups for the following days. Fill out the rest of the schedule below so the each golfer plays once each day, and plays just once with every other golfer. Starting hint: on day 5, golfer D cannot play with A, B, or C.

<table>
<thead>
<tr>
<th>day1</th>
<th>day2</th>
<th>day3</th>
<th>day4</th>
<th>day5</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABCD</td>
<td>GIP</td>
<td>M</td>
<td>IH</td>
<td>G</td>
</tr>
<tr>
<td>EFGR</td>
<td>N</td>
<td>FOG</td>
<td>EJ</td>
<td>JOB</td>
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<tr>
<td>IJKL</td>
<td>CEL</td>
<td>PLH</td>
<td>AK</td>
<td>AM</td>
</tr>
<tr>
<td>MNOP</td>
<td>DK</td>
<td>NK</td>
<td>B</td>
<td>CF</td>
</tr>
</tbody>
</table>

6. You have 15 true coins and 1 fake coin, which is heavier or lighter than the others. With 2 weighings on a balance scale, how do you determine whether the fake coin is heavier or lighter?

7. At a party, each guest had 1/2 a bowl of rice, 1/3 of a bowl of rice, and a 1/4 of a bowl of meat. There are 65 bowls. How many guests were there? (Sun Tsu Suan-Ching, 4th century AD)

8. Place the dominoes on the right into the blank areas in the puzzle so that every row and column contains the dots 1-8.

9. A merchant sells 2 items for 9999 yen each -- one at a 10% profit, the other at a 10% loss. Overall, did the merchant make or lose money?

10. Substitute the numbers 1-9 for the letters a-i to make this equation correct.

\[
\frac{a}{bc} + \frac{d}{ef} + \frac{g}{hi} = 1
\]

Hint: g>d>a, and ef>bc>hi.

11. The words “determinable” and “bewilderment” share most letters, a and w being the only ones unique to each. Match up the words below that differ by a single letter.

californium centenarian
groundwater guttersnipe
infomercial kitchenware
maintenance necessarily
care parentheses pretentious
screenplays spreadsheet
undergrowth windcheater

12. 3256 has the consecutive pairs 32, 24, 45, and each is the product of single digits (4×8, 5×5, and 7×8). Arrange the digits of 1-9 so that every consecutive pair is the product of single digits.

13. In the 6×6 grid, insert 12 X’s so that no 3 X’s appear in any column, row, or diagonal.

14. On 7 different business trips, 15 travellers are put into rows 5 to 9, seats A to C. But none of these 15 ever wind up sitting in the same row. How? Hint: look at problem 1.
1. Which triangle has the greater area? (1 Figure4 Triangles.svg)

2. Three colored cups in a line each have a prominent feature.
   a) blue is left of love.
   b) logo is left of blue.
   c) name is left of love.
   d) gray is left of pink.

   Where is each cup?

3. If 75% of girls are righthanded, 75% long-haired, and 75% brown-eyed, what is the minimal percentage of right-handed, long-haired, brown-eyed girls?

4. In the fractions 19/95, deleting the 9's gives 1/5. Usually, such a deletion results in the wrong answer, but here it is correct. A longer example is 124/217 = 4/7. In the fractions below, add digits to the blanks so that deletion still gives the right answer.

   \[
   \frac{3}{8} = \frac{3}{8} \quad \frac{1}{2} = \frac{1}{2}
   \]

5. A number with 6 different digits can be input into either keypad below so that every digit horizontally, vertically, or diagonally adjacent to the previous one. If the last digit is lowest than the 1st, what is the number?

6. What do these words have in common?
   pussycat, quagmire, taxicab, bathtub

7. You have 12 kilos of nails and a large 2-pan balance. How can you measure out 9 kilos of nails?

8. Remove the letters EPIC from WIRELESS COMPUTING, and rearrange the remaining letters to form a sport.

   Add the letters to the word PERCENT and rearrange to form a new word indicated by the clue.

   HIATAL (like this)
   Answer: PARENTHEtical.

   IT catch
   RA cabinetmaker
   IE earthquake focus
   II obtains a gift
   FIO unparalleled
   PIA new to a trade
   AMID dilemma

9. How many triangles in the figure below?

10. There are 6 ways to put 2 holes in an L-tetromino. Place the 6 holey tetrominoes into the figure on the bottom.

11. In lottery A, 6 balls drawn from a bag of 14 consecutively numbered balls have to match the 6 numbers on the ticket. In lottery B, 5 balls drawn from a bag of 15 consecutively numbered balls have to match the 5 numbers on the ticket. Which lottery offers the better odds of winning?

12. A 5-digit number has digits whose sum is 35. Can it be a square?

13. You have 13 different weights labeled from 1 to 13 grams. One of them weighs slightly more or less than its label. With three weighings on a balance scale, identify the inaccurate weight, and whether it is heavier or lighter.
1. In the puzzle below, join each letter pair (AA, BB, etc.) by moving 1 square at a time, horizontally or vertically, so that each shape is 6 squares long and fits together with the rest.

```
A B C D E F G H I J K L
```

2. What movie genre has 4 consecutive letters of the alphabet in order? What theatre job has the same property?

3. Ali owes Brian a drink. Brian owes Carlo two drinks. Carlo owes Dmitri three drinks. Dmitri owes Ali four drinks. How can the drink debts be settled in the simplest fashion?

4. How many words of 4 or more letters can you make from MACHINE? Rules: each letter may be used only once per word, no hyphens, no accents, no proper names.

5. A tour joins up dots in a loop with straight lines. An example of a longest tour is shown here.

![Tour example]

For each set of 12 points, find the longest tour.

6. A three letter word related to auctions has an odd property. In CAPITAL letters, it is up/down symmetric. In lowercase letters, it is left/right symmetric. What is it?

7. 23 coins can be packed tightly into a square. How many lines go through the centers of 3 or more coins? Is it possible to pick 7 of these lines to go through the centers of all 23 coins?

8. The repeated digital sum, or digital root of 6788 is 2. (6+7+8+8=29 -> 2+9=11 -> 1+1=2). What is the digital root of the 180-digit number 10111213...96979898, made from the numbers 10 to 99?

9. Water at 50°C and 90°C is in 5 liter and 6 liter containers. A 3 liter container is available. How can some 70°C water be obtained?

10. He is noble, He is rare. He can lift you in the air. He will change your timbre, free. So I ask you, who is He?

11. Match these actors with their birth names.

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

12. The 9-digit number $2^{29}$ has 9 different digits. Which digit is missing? Hint: The repeated digit sums of 16, 32, 64, and 128, are 7, 5, 1, 2.
1. A garden path loops back to the starting square (S), and crosses itself nine times in the numbered squares. If you follow the path, and count off every other number, the sequence will be 1, 2, 3, 4, 5, 6, 7, 8, 9. All but the two black squares are visited.

2. HAVE A LITTLE FAITH IN ME -- what amazing property does this song title have?

3. With a rubber band, you can make a 5-pointed star with one hand. If the band touches 5 digits, the answer is easy. How can it be done with the band touching just 3 fingers?

4. A person claims that they can instantly count how many paperclips are in a large pile. How can the person be quickly tested?

5. What do these words have in common: buy, bring, catch, fight, seek, teach, think?


7. Fill in missing letters with a 12-letter word to get 6 words reading across.

<table>
<thead>
<tr>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>3</td>
<td>1</td>
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<td>4</td>
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<td>2</td>
<td>5</td>
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<td>6</td>
</tr>
<tr>
<td>7</td>
<td>5</td>
<td>4</td>
</tr>
</tbody>
</table>

8. Benjamin Franklin Goodrich, usually called B. F. Goodrich, was an industrialist whose company still makes tires. If the letters “aiinnnorr” are struck out from his full name, what remarkable thing remains?

9. The three 3×4 office areas need to be divided into 6 different shapes, each with area 6 and with extra cubical walls following the grid lines. How can this be done?

10. The six cubical offices above now need to be fit into the 6×6 area. How?

11. Fill in the blanks to get English words and phrases.

   domi__re_ (controlled)
   _do__ __mi_re (video editor)
   __re_do__ __mi__ (peace)
   mi__ __re__do__ (mutt)
   __re__mid o__
   (Egypt wonder)

12. What do these companies have in common: Citigroup, Ford, Kellogg, Macy’s, Qwest, Ryder, Sprint-Nextel, AT&T, Visa, and United States Steel?

13. In the game of battleships, a 1×4 battleship and other ships are placed on a 10×10 grid. The opponent calls out shots and tries to sink the ships. What is the minimum number of shots needed to guarantee a hit on the battleship?

14. Add numbers 3 to 9 to the figure below so that each line adds to 14.
1. Make a closed loop by joining the black dots with straight lines of different lengths.

2. Divide the below 11x15 rectangle into 9 squares.

3. In the below shape, how many similar copies of the same shape can be found?

4. Fill in the blanks with letters from the roman numerals MDCLXVI:
   - _____ eta__ (very colorful)
   - _nse_t___a_ (bug killing)
   - __n_a_st__ (simple)
   - ___e_n_t_a__ (For Bush, W)
   - _en________ (Caesar quote)
   - ___e_an__us__ (hot jazz)
   - _e__B_e___e (famed director)
   - a____o_v_n_st (e.g., Dear Abby)
   - we____ers_f_e_ (portfolio quality)
   - he_a_e___a (F in FACE)
   - ___e_a__e___ne (often used leeches)

5. What type of clock has the most moving parts?

6. You take a bowl of soup from a microwave, and turn right. To you, which way does the soup turn?

7. What is the resulting word if you remove the first and last sounds of the word QUARANTINE?

8. A 5x13 piece of carpet has a hole at the center. Divide it along the grid lines into 4 pieces that together can make an 8x8 square.

9. With 5 straight lines, draw through all but two points in the 4x4 grid, without lifting your pen, ending up where you started. Do not go outside the given oval.

10. The hour hand of a watch is exactly on a second mark, and is exactly 18 second marks ahead of the second hand. What time is it?

by Ed Pegg Jr
1. A chess king can move one space in any direction. Show how a king can make a tour of all 21 squares in the board below, with no direction being repeated in any row or column.

```
  |   |   |
---|---|---
  |   |   |
  |   |   |
  |   |   |
```

2. Fill in each blank with a number from 0 to 3. Numbers can be re-used.
   __ Number of blanks with a digit < 2.
   __ Number of blanks with a digit = 2.
   __ Number of blanks with a digit > 2.

3. Put numbers 0-9 in the circles so that each line adds to 13.

```
  |   |   |
---|---|---
  |   |   |
  |   |   |
```

4. Match the beverage with its notable ingredient
   1. Absinthe     a. 130 herbs
   2. Advocaat     b. agave
   3. Ale          c. almond
   4. Amaretto     d. anise
   5. Baijiu       e. apple
   6. Bourbon     f. barley
   7. Chambord     g. cherry
   8. Chartreuse   h. corn
   9. Cider        i. egg
  10. Gin         j. honey
  11. Kvass      k. juniper
  12. Limoncello   l. lemon
  13. Marsaschino   m. orange
  14. Mead        n. raspberry
  15. Nocino      o. rice
  16. Ouzo        p. rye
  17. Rum         q. sorghum
  18. Sake       r. sugarcane
  19. Tequila    s. walnut
  20. Triple sec   t. wormwood

5. F: 1, 1, 2, 3, 5, 8, 13, 21...
   L: 1, 3, 4, 7, 11, 18, 29, 47...
   F×L: 1, 3, 8, 21, 55, 144, 377, 987...
   Fibonacci (F) and Lucas (L) get a next term by adding the previous two. What is the rule for F×L?

6. Which is larger, the light area or the dark area?

7. The letters of some phrases can be arranged to make two animals, such as "summer vacation" = "marmoset + vicuna", or "bratmobile" = "mole + rabbit." Rearrange the letters of each of the below phrases to make two well known animals.
   - seesaw
   - XY plane
   - hay rake
   - pillbug
   - war chest
   - town gate
   - Lois Lane
   - hired goons
   - pack animal
   - money maker
   - parole board
   - Mornay sauce
   - morning breath

8. Roulette will double a bet made on red or black, 20/38ths of the time. If you want a 99% chance of being $1 ahead after a series of bets, how much should you be prepared to lose, 1% of the time? How should you bet?

9. In a tiled rectangle, a fault line is a straight line all the way across so that the figure could be divided into two rectangles. An old puzzle is to tile a 5×6 rectangle with 1×2 dominoes without fault lines. Tile the 9×9 square below with 1×3 trominos without any fault lines.

```
  |   |   |   |   |   |   |
---|---|---|---|---|---|---
  |   |   |   |   |   |   |
  |   |   |   |   |   |   |
  |   |   |   |   |   |   |
```

10. In 1599, Galileo called the arc formed by a point on a moving circle a cycloid, and determined that the area under this curve was equal to three circles. He hardly used any math, though. How did he do it?
1. The Plan of Heijo-Kyo (The Ancient City of Nara), is shown below, with the lines indicating streets and alleys. The Imperial Palace is one square. Divide the rest of the city into the fewest number of squares.

2. What do these words and names have in common: bar, cur, Einstein, franc, gall, German, Nobel, sod, Thor, titan, zircon?

3. Arrange seven points so that for any three chosen, two of them will 1 cm apart.

4. Match each delicious item with the primary producer. 1) Côte d'Ivoire 2) India 3) Indonesia 4) Madagascar 5) United States. a) cinnamon b) cocoa c) ginger d) strawberry e) vanilla.

5. A chess king starts at S and ends at E, eventually moving once from every square in the shaded region. The arrows indicate direction of movement. No arrow is repeated in any row or column.

6. Add math symbols to 1, 7, and 7 to make 5.

7. In which figure is the sum of circle diameters the greatest?

8. Match these symbols to their names: 1 ÷, 2 /, 3 |, 4 †, 5 \. a) pipe, b) oblique, c) obelus, d) virgule, e) solidus.

9. There are over 500 rectangles in the cornerless square below. First, determine how many rectangles there are, then remove 30 of the toothpicks so that none of the rectangles remain.

10. Who are these people, and where might they be found: George Spelvin, Alan Smithee, Tommie Atkins, and Richard Roe.

by Ed Pegg Jr
For several years, I’ve been doing the puzzle column for the Japan Airlines in-flight magazine, Skyward. I hope you’ve enjoyed seeing them.

Ed Pegg Jr

www.mathpuzzle.com
demonstrations.wolfram.com
mathworld.wolfram.com
numb3rs.wolfram.com
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For more than 30 years, it was believed that squares with sides 1-23 could not be packed in a 66×66 square. Shigeyoshi Kamakura solved it in 2004. Match his feat. Squares with side 3 and 6 have been placed for you, along with all the holes in the solution. Every fifth line from the edges is darkened as a solving aid.
It is 8:24. The hour hand can be exactly on a second mark only when the second hand is at 12.
Congratulations

Computer Programming Students!!

In the last 5 weeks, we've worked incredibly hard, and learned a lot of JavaScript! You've learned about variables, functions, conditionals and while loops. We've practiced thinking like a computer and we've solved incredibly difficult coding puzzles. Even so, we've barely begun to explore all the amazing things we can do using JavaScript, or with Computer Programming. If you want to do more, here are some possible resources. Remember, you only learn to code by coding! I hope you find these both fun and challenging.

Where Can I Use a Computer?

You will need a computer to use most of these things. If you have access to one at home, that’s great! If not, you may be able to use one at school (especially if you politely explain what you want it for). Finally, you can almost certainly use a computer at your local library branch. Library cards are free, (and awesome!). All New York Public Library branches have computers with internet access. So do all Brooklyn Public Library branches.

What’s in This Packet?

- Course Summary/Syntax Summary - Page 2
- Resources We Used in Class - Page 4
- Other Resources: JavaScript and Beyond - Page 5
BEAM 2017--JavaScript Syntax Summary

So far we know four kinds of structures!

1. Functions teach the computer how to DO something.

Syntax:
function nameOfFunction (input/placeholder){
    what the computer should do
    return
}

Example:
function greetings(name){
    return "hello"+name;
}

2. Variables teach the computer a fact.

Syntax:
let nameOfVariable = value;

Example:
Let myName="Halimeda";

We can also change the variable later.

Syntax:
nameOfVariable = newValue;

3. Conditionals tell us to only run some code SOMETIMES

Syntax:
if(condition){
    what the computer should do
}

Example:
if(name=== "Halimeda"){
    console.log("Hello, Halimeda");
}
4. While loops tell us to run some code AS LONG AS SOMETHING IS TRUE

Syntax:
```javascript
while(condition){
    what the computer should do
}
```

Example:
```javascript
let i=1
while(i<26){
    console.log(i);
}
```

We also know some other JavaScript Vocabulary (How we talk TO computers using JavaScript)

- Return NO PARENS NECESSARY--ONLY GOES IN A FUNCTION
- Console.log ()
- +, -, /, *
- %
- <,>, ===

FINALLY, we know some things to look for when debugging

Debugging First Steps: Did you?
- Run a couple tests?
- Read the error message?
- Check your spelling?
- Check the punctuation marks?
- Check that all your parentheses and brackets are matched?
- Check for capitalization?
- Remember your quotation marks?
- Remember to run your code after you made changes?
- Work through the logic yourself?
Resources We Used in Class

We used a lot of awesome programs and platforms this summer. You can keep using a lot of them!

**Code.org**

- **Course 3**—This is the course we've been working on. The whole course is really fun, and it's full of interesting, challenging puzzles. You can get to it by going to
  

- **Course 4**—Once you finish Course 3, I absolutely recommend course 4. It starts with a review of course 3, but it should get interesting and challenging pretty quickly.
  
  - click “Home” on the top right hand side of your screen
  - find “course 4” and click on it!

- Algebra Courses—There are some courses on code.org that are designed to be done by students who are learning algebra. I don’t teach with these, but I know some teachers who do, and they like them! Try them and let me know what you think.
  
  - sign into code.org and click “Home” on the top right hand side of your screen
  - go to the bottom of your screen where you see “Join a Section”
  - Type inQLXBCQ and refresh the page.
  - If you finish that course do this again with code LPTCLF
  - You can find a workbook to download at [https://code.org/curriculum/docs/algebra/student_workbook.pdf](https://code.org/curriculum/docs/algebra/student_workbook.pdf)

**Repl.it**

- You can keep working on the things we did in class. All of your repl.it assignments will stay open, and you can keep working on them!

- You can make your own projects... any challenge you can think of, go try it! To get started
  
  - click “my repls” at the top left hand side of your screen
  - click “new repl”
  - pick a language! (we worked with JavaScript)
  - If you want to, you can click “examples” to see some code you can start with.

- You can take other classes!
  
  - click “community” at the top left hand side of your screen
  - Search for a class you want and click on it
  - If you like the course, click “Take This Classroom”

**NOTE:** I don’t know who made these courses!!!

1) Be Careful! As always, DON'T give out any personal information in these classes. DON'T agree to meet in person with anyone you talk to online. Tell an adult if ANYTHING makes you feel uncomfortable online.

2) Some courses may be too easy, too hard, or badly taught. However, some might be cool. Play around until you find one that you like!
Other Resources: JavaScript and Beyond

There’s a lot more awesome JavaScript out there... it’s a really complex language! It’s hard to find good places to learn about it on the web, but here are a few ideas. There are two important types of things... Learning the structures (so you know what tools you can use) and doing puzzles (to practice USING those tools).

Resources to LEARN new tools

CodeCombat

Code Combat is a super fun set of JavaScript puzzles. It goes over some of the stuff we have worked with already and introduces a few new ones. To join this class, go to https://codecombat.com/students?cc=CrashBusHorse and follow the steps to create an account.

JavaScript For Cats

This is a summary of the kinds of stuff JavaScript can do, in super cute cat language. You can go through it at your own pace to learn about arrays and objects. Some of this will be stuff you know from this course, but a lot of it will be new, so don’t worry if it’s surprising or confusing. To see it, go to http://jsforcats.com/

Codecademy

Codecademy is a popular way to learn new coding languages! It has a JavaScript course, which you can find here: https://www.codecademy.com/learn/learn-javascript

Codecademy also has a bunch of classes in other programming languages which can be super fun.

General Assemb.ly

General Assemb.ly will teach you to create some super awesome websites using 3 languages: HTML, CSS and JavaScript. You will need to make an account to do these projects. The website is: https://dash.generalassemb.ly/projects
Resources to LEARN AND PRACTICE new tools

**Scratch**

Scratch is a block based programming language developed at MIT. You can go wild with Scratch. The general site is here: [https://scratch.mit.edu](https://scratch.mit.edu). There are also some awesome challenges, puzzles, and tutorials here: [https://scratch.mit.edu/tips](https://scratch.mit.edu/tips). You might want to start by clicking on “Try the Getting Started Tutorial”

**EdX**

EdX is a collection of online courses offered by colleges, usually for free! Things you should know about this resource:
- They can be SUPER challenging, but also super interesting.
- You can search the courses for one you want
- Some courses are always available... these are called “self paced” Other courses are only available after a certain day (though you can still go at your own pace once they start).
- You want to find courses labeled “introductory.”

Some good JavaScript courses are here: 

One possible good fit would be:
[https://www.edx.org/course/introduction-html-javascript-microsoft-dev211-1x-1](https://www.edx.org/course/introduction-html-javascript-microsoft-dev211-1x-1)

You can also look for classes on other programming languages.

**Coursera**

Coursera is similar to EdX. It has a bunch of cool programming courses. They will be SUPER challenging, but also really interesting.

You can find a few introductory JavaScript Courses here:
[https://www.coursera.org/courses?_facet_changed_=true&domains=computer-science&languages=en&query=javascript](https://www.coursera.org/courses?_facet_changed_=true&domains=computer-science&languages=en&query=javascript)

One possible good fit would be:
[https://www.coursera.org/learn/duke-programming-web](https://www.coursera.org/learn/duke-programming-web)

You can also look for classes on other programming languages. Remember, you want to find “introductory” courses.
When Ruthi is not at BEAM she sometimes goes dancing, but usually she spends her time working in her secret underwater math lab in the east river. There she spends her time designing complex challenge problems to confound BEAM students. This is also where she keeps her research on all of the cool properties of all of the integers; such as 1729, the 2nd taxicab number* (The smallest number that can be expressed as the sum of two positive cubes in $n$ distinct ways)** When she is out of her lab she leaves multiple stuffed animal guards to protect the Keys to her lair. Ruthi’s Lair has four Keys of four colors, A White Key, an Orange Key, a Purple Key and a Teal Key. They each unlock the lock that protects Ruthi’s House, her Mailbox, her Computers or her Metrocard. All of Ruthi’s Keys are guarded by stuffed animals Named Bini, Bonnie, Snoopy and Molly; and they sleep in deeper and deeper inside of her lab. The Rat sleeps deepest. Then the Dog, the Teddy, and the Doll closest to the entrance. Use the clues to figure out the name of each stuffed guard, the color of their key and what the key unlocks

1. Of the guards Snoopy, and stuffed animal who protects Ruthi’s House Key, one is a dog and the other is a Teddy Bear
2. The key to the Computers is Purple
3. The Guard of the Teal key sleeps deeper in the lab than the guard of the Orange Key
4. Bonnie does not guard the Teal Key
5. The Mailbox Key is not Teal
6. Molly Guards either the Teal Key or the Orange Key
7. The Mailbox Key is not guarded by the Guard closest to the lab entrance
8. The House Key guard sleeps deeper in the lab than Bini
9. Neither Bini nor Molly guard Ruthi’s Metrocard
10. The second guard from the entrance does not guard the White Key and does not guard the Computer Key
11. Snoopy guards the Computer Key
12. Bini does not guard the White Key
Resources to PRACTICE new tools

ioKungFoo

Sherilyn found this amazing resource! After you do Codecademy or EdX, you might want to explore ioKungFoo. You should start by going to this website:

https://iokungfoo.net/?page=open&tab=ToDo

Things you should know about this resource:

○ The directions are at the start of each exercise and they are “commented out” (like we did with //) YOU SHOULD ACTUALLY READ THEM! THEY WILL TEACH YOU STUFF!
○ ioKungFoo uses a code word called var. Var works JUST like let (for our purposes here).
  So we used let to define variables, ioKungFoo uses var. Either works.
○ You should do all 9 of the exercises on this page in order, just to get used to the site, and then go on to the 46 awesome challenges.
Sylvia a wonderful and smart, normal human who helps manage BEAM and certainly not an amazing super heroine who surveys Central Park every night as the Sylvan Strider. She certainly doesn’t have the power to talk to trees and have them listen and bend their limbs to her needs. Sylvia does normal things throughout the week like eating tasty food, doing fun things like Visiting her Mom or Sleeping. She also visits a different borough everyday because she loves to experience all NYC has to offer, and not because the Sylvan Strider loves and tends to the needs of the city’s parks and gardens. Use the clues to figure out where Sylvia goes each day, what she does and what she eats, and demonstrably not what she claims to be doing while she is really secretly nurturing the many groves and greenery of NY

1. Sylvia goes to work earlier in the week than she goes dancing
2. Sylvia has Burgers in Manhattan
3. Sylvia does not eat Mexican in Queens
4. Sylvia does not eat Mexican when she goes dancing
5. Sylvia eats Chinese food on Saturday
6. Sylvia does not eat Thai food in Queens
7. Sylvia does not eat Chinese while she parties
8. Sylvia goes to Brooklyn earlier in the week than she goes partying
9. Sylvia has Pizza at work
10. Sylvia doesn’t have Burgers on Monday
11. Sylvia does not have Pizza in the Bronx
12. Sylvia eats Pizza, goes to Manhattan, Sleeps, and eats Mexican on four different days and none of those days are Friday.
13. Sylvia goes to Manhattan on Thursday
14. Sylvia Sleeps later in the week than she goes to the Bronx