Google Games

2016

Instructions:

- Your team has 60 minutes to solve as many of the 18 problems below as possible. It is NOT expected that you will solve all, or even most, of the problems in 60 minutes.
- Feel free to use any language, Google, and any web resources you might find.
- These questions are sorted alphabetically and not by difficulty.
- One point will be given for each correct answer. Solve easier questions first!
- Some problems require a dataset. References to files will be marked as `[filename]` which will refer to a file listed in the "Inputs files" section on the left sidebar at http://ggpuzzles.appspot.com/.
- Note: The goal is to find the answers to the questions. You may or may not want to write code to do so.
- Each problem specifies how to enter its answer. Some problems require a numerical answer, or a comma-delimited list of numbers. For those problems, whitespace is ignored.

Submit answers at **ggpuzzles.appspot.com** - make sure you are under the coding challenge and submitting for the correct problem!

For organizational purposes ONLY, here is a table you can use to keep track of your team's progress.

REMEMBER: You must submit answers at **ggpuzzles.appspot.com** - make sure you are under the coding challenge and submitting for the correct problem!

#	Title	Answer
1	An Urgent Message	
2	Bad Wolf	
3	Coop's Shelving	
4	Dystopian Dialing	
5	Everyone tries on their first attempt	
6	Evil Professor	
7	Gaming the stock market with time travel	
8	Golden Cactpot	
9	Hurley Numbers	
10	Island and Lakes	
11	Laundry	
12	Meeting Room	
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15	The sands of time are running out	
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17	What's the frequency, Kenneth?	
18	Winning Hearthstone	

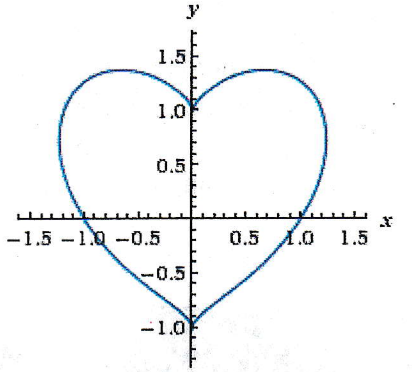
Problem 1: An Urgent Message

Working at Google Temporal has its perks, like getting to meet Julius Caesar or petting a dodo. However, it does come with difficulties. Often your text messages get scrambled. Today you have been busy trying to figure out if the chicken or the egg came first. Suddenly, you receive a message marked urgent. Not only is the message scrambled, but it is missing the sender too! However the way the text messages get scrambled is predictable: the bit order is flipped when received by your phone. Quick, you need to find out what's urgent! What could òò„¦¶öž†îN®öžvöÖ6–¶¦..¦æNöf.ävö" mean?

To ensure accuracy of transcription the message is equivalent to the following in base 64 encoded binary:

8hryGgSEprb2FgSehu4ETq72ngR29gTWNpa2BKYWLgQupuZO9mYELuR29il=

Problem 2: Bad Wolf



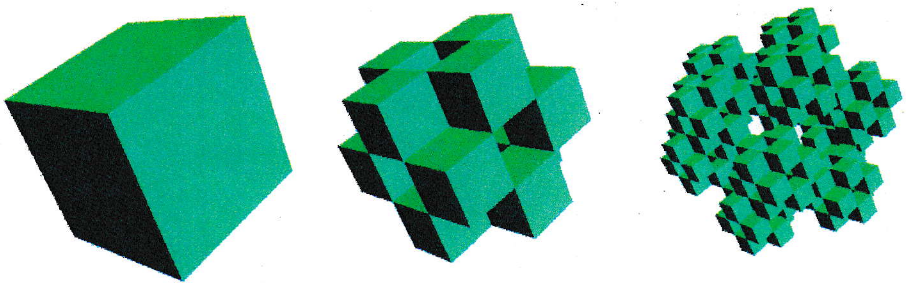
The doctor is in trouble! A shot has been fired in his general direction with a chance of hitting his two hearts. To determine the chances of it hitting his hearts, you need to determine the area of his exposed hearts. Each heart can be modeled as the following equation: $(x^2 + y^2 - 1)^3 = 2x^2y^3$

Give the total area rounded to three decimal places.

Problem 3: Coop's Shelving

Cooper has been studying the Tesseract and has made some observations. He observes that the tesseract looks like a bunch of book shelves that change once per second. The way the shelves change has a fractal-like pattern. Each passing second further divides the shelves in the same fractal pattern.

time(s): 0 1 2



The Tesseract can be modeled as as above. The center axes and corner blocks are removed from a cube diced into thirds. The same operation is then repeated on the cubes created in the next second.

If the volume of the bookshelf at time t is $V(t)$, and $V(0) = 1$, find $\sum_{t=0}^{\infty} V(t)$.

Problem 4: Dystopian Dialing

You are trapped in a 2-dimensional world in the form of a giant phone keypad. You figure that the only way to get out of your predicament is to call for help, but you can't seem to remember any phone numbers. So you'd best try to dial as many different phone numbers as possible.

1	2	3
4	5	6
7	8	9
Start Dialing	0	End Call

To make a call, you step on the Start Dialing button, step on each digit in the phone number, and then step on the End Call button. You can then step back to the Start Dialing button (via the 0 button) to begin another call.

Moving from any key to any horizontally or vertically adjacent key only takes you 1 step.
But be careful! If you take more than 20,000 steps, you will collapse in exhaustion and be trapped in this strange world forever.

You quickly realize that the energy cost to dial a phone number is the Manhattan distance between all the consecutive key presses, so you can dial numbers such as 777-7777, 777-8899, and 778-8000 without taking very many steps at all. In fact, dialing all three of these numbers would take you only 16 steps in total:

S-7-8-9-E-0-S-7-8-9-E-0-S-7-8-0-E

But more importantly, **what is the maximum number of distinct phone numbers you can call before you run out of energy**?

More details:

- All phone numbers are "local" and have exactly 7 numeric digits.
- No phone number begins with a 0 or contains the sequences "5-5-5" or "9-1-1."
- You are already on the Start Dialing button when you begin the first call.
- You can move on or through any key without pressing it, if you so wish.
- You can press a key multiple times in a row without taking any additional steps.
- You cannot step diagonally or leave the keypad.
- You must end your last call.

Problem 5: Everyone tries on their first attempt

It's your first trip to the past. Just like everyone does, you have gone to Germany in the 1940s. As always, your mission failed.

Your partner and you have been separated and you need to get back to him. Fortunately your partner was able to find an enigma machine. You know that he always uses "WHO" as his key and that he uses his birthdate May 1st, 2002 in DD-MM-YY as his rotor configuration.

Each rotor on an Enigma is a combination of two substitution ciphers -- a rotation cipher and a pre-generated random mapping. The position of the wheel determines the transformation of a Letter. For instance, with WHO as a key, the third wheel's initial rotation cipher is such that A-->O, B-->P and so on. The random cipher may have O-->P. Thus, when you type A it is rotated to O, substituted to P, and then rotated back to B. This is then fed into the second rotor and then the second output into the third. A final simple substitution wheel is used, then the letter runs back through the machine in reverse.

Additionally, after each keypress, the third rotor increments to the next letter. When the rotor turns past a turnover letter (as determined by the rotor), the second rotor increments and so on. So after the first letter the key, WHO is changed to WHP. If V is the final letter on the rotor, then after a key of WHV, the key changes to WIW. The fourth rotor does not rotate.

Fortunately you know that the standard German rotors for this machine are wired as follows:

	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**	**R**	**S**	**T**	**U**	**V**	**W**	**X**	**Y**	**Z**
I	E	K	M	F	L	G	D	Q	V	Z	N	T	O	W	Y	H	X	U	S	P	A	I	B	R	C	J
II	A	J	D	K	S	I	R	U	X	B	L	H	W	T	M	C	Q	G	Z	N	P	Y	F	V	O	E
III	B	D	F	H	J	L	C	P	R	T	X	V	Z	N	Y	E	I	W	G	A	K	M	U	S	Q	O
IV	E	S	O	V	P	Z	J	A	Y	Q	U	I	R	H	X	L	N	F	T	G	K	D	C	M	W	B
V	V	Z	B	R	G	I	T	Y	U	P	S	D	N	H	L	X	A	W	M	J	Q	O	F	E	C	K
4th Rotor	Y	R	U	H	Q	S	L	D	P	X	N	G	O	K	M	I	R	B	F	Z	C	W	V	J	A	T

Turnovers for each rotor are at:

Rotor	I	II	III	IV	V
Turnover	R	F	W	K	A

For sanity checking, the process of your Enigma simulation should work as follows for the first input of key "TRY" and rotors I-II-III.

Input: A
Rotor 1: A → Y→ Q →S
Rotor 2: S → J → B → K
Rotor 3: K → D → F → M
Rotor 4: M → O
Rotor 3: O → H → P → W
Rotor 2: W → N → T → C
Rotor 1: C → A → T → V
Output: V

Here is his message sent in groups of five letters:

JRGDP VNRRB ZKVFT VDDQV ORIUI MEQON KUHNO IZFOO IENEZ IFOGA EGIHH NJPFO

Problem 6: Evil Professor

You promised yourself you'll work hard to get a good grade this semester. However, on the first day of class you discover that your professor will grade your assignments based on how long you worked on them. How evil! You want to minimize the number of hours you spend on assignments, so you come up with your very own counter-evil plan.

There are 4 assignments, and each will receive an integer mark between 0 and 10, inclusive. Each assignment also has a difficulty value d, where it takes you d^m hours to achieve a mark of m.

The following table represents the professor's assignments and their difficulties in the equation d^m:

Assignment	d (Difficulty)	Hours required to achieve a mark of m
A	2	2^m
B	8	8^m
C	3	3^m
D	5	5^m

For example, it would take $2^{10} = 1024$ hours to achieve a perfect mark of 10 on Assignment A.

To pass the class, you need to satisfy the following requirements:

- Earn a minimum mark of at least 5 on every assignment.
- Earn an average mark of at least 8 across all assignments.

What is the minimum number of hours you can spend in total and still pass the class?

Problem 7: Gaming the stock market with time travel

You have invented a time machine.

You know that there was value in the thing, clearly, that you are certain of. But what is the application? In a matter of hours, you had given it into everything from mass transit to satellite launching, imagining devices the size of jumbo jets. Everything would be cheaper. It was practical, and you knew it. But above all that, beyond the positives, you knew that the easiest way to be exploited is to sell something you did not yet understand. So you kept quiet.

You currently have $10,000. You know if you go back in time a week and invest the money in GOOG at $500 a share, that you can sell it today for $700 a share.

But your purchases have an impact. Each time you go back the purchase price is increased. The new purchase price is equal to the share price from your last trip, increased by an amount equal to the fraction of the 690 million outstanding shares you bought on that trip. For example, if the price was $600 on your last trip, and you bought 69 million shares, then the price on this trip will be $660. Oddly, the sell price stays constant! This means that each trip is less profitable than the previous.

Unfortunately, thanks to the IRS's temporal division, any money left after you buy the stock disappears to a parallel dimension and is lost forever!

How many times can you repeat the process of going back in time and re-investing before you can no longer make a profit off GOOG stock this way? What is the stock price at which you bought on your final trip? How much money do you have at the end?

Output the answer as a comma separated list of "[times], [final price], [money at the end]" e.g. "1000, 532.78, 1357878.34"

Note: **At no point should you allow fractions of a share or fractions of a cent. Round down as necessary.**

Problem 8: Golden Cactpot

Given a set of payouts, and a card with 3 × 3 cells, where you can select a row, a column or a diagonal and add up all the number on that line to get a score (As you can see, there're 8 possibilities in total). Then you get corresponding payout in the chart below from Google Chrome Enterprise team as a reward. The card is filled with the digits 1 - 9 without duplication. A gang of eight gather and decide that each of them choose a unique line and share the final reward. Of course, the Enterprise team doesn't want to pay too much, so they decided to design a board that minimizes its total payment for those eight people.

Find the minimum grand total payout across all possible board layouts. Note there're definitely more than one optimal layout since you can rotate the board, but you only need to give the **minimum** payout.

Payouts by Score
Score, Payout
6 10000
7 36
8 720
9 360
10 80
11 252
12 108
13 72
14 54
15 180
16 72
17 180
18 119
19 36
20 306
21 1080
22 144
23 1800
24 3600

Examples

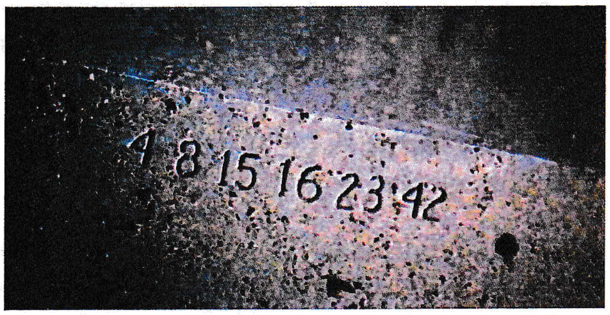
1	2	3
4	5	6
7	8	9

1	3	2
4	5	6
7	8	9

The grand total payout for the left board is 14547, but the right one gives a better answer: 14374.

Problem 9: Hurley Numbers

Hurley Numbers are very bad luck. They are all numbers created by concatenation of subsets of these numbers: 4 8 15 16 23 42.



For example, one Hurley number is 23158, which can be formed by concatenating "23" with "15" and "8".

Find the sum of all Hurley Numbers.

Problem 10: Island and Lakes

Given an NxM grid world where there can be land and water, count the number of islands and lakes, and the total length of all ocean shorelines, as well as the length of lake shorelines. Assume that the inputs are surrounded by ocean, specifically, that the 'outer border' of the input will all be 'water'

INPUT INSTRUCTIONS
Your input will be in the following form:

One "unit" is represented by a "1" or a "0". The number "1" represents land, and the number "0" represents water. The input file will contain on its first line dimensions of the grid world in terms of rows and columns. The 2nd line and all following lines are 0s and 1s to describe the land and water, and each line ends with a newline character, including the last line.

For example, your input might look something like this:

```
7 12
000000000000
011001111000
011000000000
000011100110
000010101110
000011100000
000000000000
```

Note that diagonals do NOT count as a connected land/water mass.

This input describes a 7 row, 12 column world.
It contains 4 islands and 1 lake.
Ocean shoreline length: 8 + 10 + 12 + 10 = 40
Lake shoreline length: 4

Your input file is `[islands.txt]`.

OUTPUT INSTRUCTIONS
Your output is to be the sum of the following 4 integers, describing the following:
Number of islands + Number of Lakes + Total Length of ocean shoreline + Total Length of lake shoreline

In the example above, your output would be 49, since that is the sum of `4 + 1 + 40 + 4`

Problem 11: Laundry

You have done something unimaginable. You broke your parents' time travel device trying to use it secretly! They are mad, and they have some equally unimaginable punishments, first of which is to do 1000 pounds of laundry. Well, you *did* break their time machine. You go to the nearest laundromat and you see that there are five laundry machines with the following maximum capacities and cost per run.

Machine	Maximum pounds of laundry per run	Dollars per run
A	1	1
B	5	4
C	7	6
D	11	9
E	19	18

Given these laundry machines, **what is the minimum amount in dollars to complete all of the laundry**?

Notes:

- You don't necessarily have to fill a machine up to its maximum capacity to run the machine. For example, although machine D can handle 11 pounds of laundry, you can use the machine with just 5 pounds of laundry.

Problem 12: Meeting Room

The Google Kirkland office only has one meeting room, but every team needs it. The meeting coordinator is not happy seeing people without a place to meet, so he decided to come up with an algorithm to book as many meetings as possible in a single day. Can you help him? Suppose you know all the meeting schedules for that day in advance. You need to find the **sequence** of meetings that can be scheduled into the room (without overlapping) and output it as a string.

Example:
You can schedule only B and A. Then your answer would be a string "BA". But this is not the best schedule.

Data

	Start	End
A	2:00pm	3:00pm
B	7:30am	8:00am
C	3:30pm	4:00pm
D	9:00am	10:00am
E	9:30am	12:00pm
F	8:20am	10:00am
G	7:00am	8:30am
H	1:10pm	3:10pm
I	1:30pm	2:50pm
J	2:20pm	4:00pm
K	2:30pm	3:45pm
L	11:00am	2:00pm

Problem 13: Primality Test

How far away is the closest prime to 600613^{128}?

Problem 14: Space Pirates

You are the organizer of an intergalactic mission to secure as much treasure as possible across the universe. You command a fleet of 5 spacecraft. Recent discoveries of wormholes connecting various galaxies have made intergalactic travel possible at low cost. Each of your ships can leave the Milky Way, travel through various wormholes to any number of connected galaxies, and then return to the Milky Way. Once a ship returns to the Milky Way, however, it has finished its expedition and cannot be redeployed.

The value of the available treasure, in millions of dollars, is provided for each galaxy. Visiting a galaxy will provide you with all the treasure from that galaxy. You can only receive the treasure available in a particular galaxy once -- visiting it with a second ship provides no additional value.

You also have a list of wormholes between galaxies, which are bidirectional. For example, a wormhole from Andromeda I to Andromeda II will also allow you to travel from Andromeda II to Andromeda I.

What is the **maximum amount of treasure** that you can secure using your five spacecraft for one expedition each?

Note: Leave your answer in millions of dollars -- submit $50,000,000 as just 50.

Input data is provided in [space_pirates_input.txt]. The format is as follows:

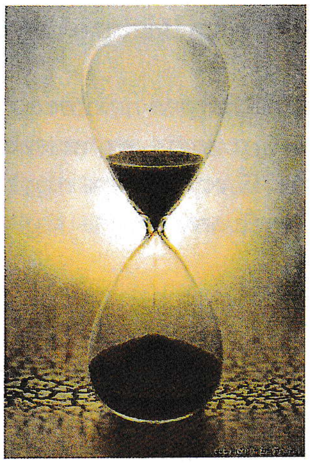
- Line 1 contains the number of galaxies (100) and number of wormholes (125) separated by a comma.
- Lines 2-101 contain the treasure values and names for each galaxy, also separated by a comma, one galaxy per line.
- Lines 102-226 contain the names of the galaxies at either end of each wormhole, also separated by a comma, one wormhole per line. The order in which the two galaxies are listed has no effect, and each wormhole only appears in the list once.

Example Input:

```
5, 3
0,Milky Way
10,Andromeda I
20,Andromeda II
50,Further Galaxy
100,Unreachable Galaxy
Milky Way,Andromeda I
Milky Way,Andromeda II
Andromeda II,Further Galaxy
```

Example Answer: 80

Problem 15: The sands of time are running out



A particular hourglass ONLY drops either 3, 5, or 8 grains of sand per second. How many different ways can the sand empty if there are exactly 1000 grains of sand? A sequence *x* is different from another sequence *y* if there exists a time *t* where the number of grains dropped in second *t* is different between the two sequences ($x[t] \neq y[t]$).

Since the answer is just under the value of a googol, express the result as the smallest congruent positive integer modulo 10^9+7 (that is, the positive remainder when the answer is divided by 10^9+7).

Problem 16: Unique Digits

You've heard there's a very special 10-digit number whose digits are unique.

Find the **largest** number c that satisfies the following conditions:

- c can be expressed as the product of two non-negative integers c = a * b.
- Every decimal digit (0-9) appears exactly once in either a or b (but not both).
- Every decimal digit (0-9) appears exactly once in c.

Problem 17: What's the frequency, Kenneth?

You are the station manager of a new FM radio station in the Atlanta, Georgia market. FM stations are specified by a frequency in megahertz (Mhz). FM stations are kept minimally 0.2 Mhz apart and only on the odd increments (99.1, 99.3, 99.5, etc.). To get the best sound you want to be as far away from an adjacent station as possible. However, in Atlanta all stations must be above 88 Mhz and below 104 MHz. Given the follow existing stations:

WABE	90.1
WCLK	91.9
WRAS	88.5
WREK	91.1
WRFG	89.3
WSB-FM	98.5
WUBL	94.9
WVEE	103.3
WWPW	96.1
WWWQ	99.7
WZGC	92.9

Determine which possible frequency is the farthest from any other adjacent station.

Problem 18: Winning Hearthstone

Hearthstone is a card game where two players battle each other with minions and spells. Each player can have up to 7 minions in play on the board, and a minion has an attack and a health attribute, notated as A/H. For example, a minion with 3 attack and 2 health can be written as 3/2.

During the player's turn, he/she can order a minion in play to attack one of the opposing minions. When it attacks, it deals damage equal to its attack to the opponent minion's health, and vice versa. After this exchange, a minion is destroyed if its health reaches zero or below. For example, if a 3/2 minion attacks a 4/6 minion, the first minion is destroyed because its health would now be 2 - 4 = -2, and the second minion would now be 4/3.

Your friend Charlie loves to play Hearthstone, but he always takes forever to figure out the optimal strategy. He gives you a game board he was particularly stuck on today, shown below:

Yours	5/6	4/6	1/4	5/2	3/3	4/4	9/12

Enemy	8/6	2/4	5/10	6/6	4/11	3/7	2/5

Charlie's optimal strategy is first to destroy as many of the enemy minions as possible. If there are multiple ways to destroy the maximum number of minions destroyed, then the combination of minion attacks that leaves his surviving minions with the most health is the best play.

Can you help Charlie find the optimal play? The solution should be in the following format:

N,H

In this format, N is the maximum number of enemy minions destroyed, and H is the sum of your surviving minions' health, assuming optimal play as described above.

Notes:

- You can choose a minion to not attack. In some cases, not attacking with a minion would produce the same number of enemy minions destroyed, with higher health values for your surviving minions.